Nidec

All for dreams

Advanced User Guide

Digitax ST

AC variable speed drive for servo motors

Part Number: 0475-0023-03
Issue: 3

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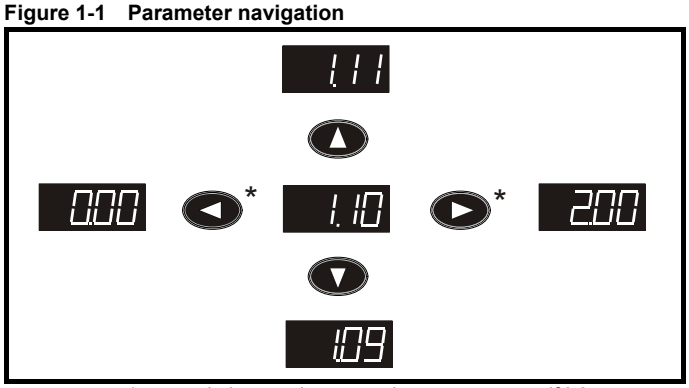
1 Parameter structure

The drive parameter structure consists of menus and parameters.

The drive initially powers up so that only menu 0 can be viewed. The up and down arrow buttons are used to navigate between parameters and once level 2 access (L2) has been enabled in Pr **0.49**, and the left and right buttons are used to navigate between menus. For further information, see section 2.7 *Parameter access level and security* on page 11.

Figure 1-1 Parameter navigation

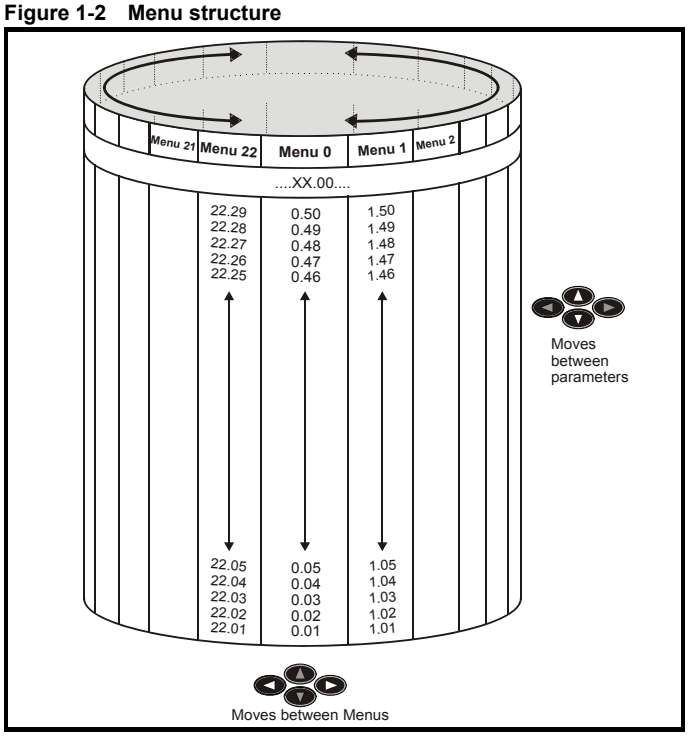


* can only be used to move between menus if L2 access has been enabled (Pr **0.49**).

The menus and parameters roll over in both directions; i.e. if the last parameter is displayed, a further press will cause the display to rollover and show the first parameter.

When changing between menus the drive remembers which parameter was last viewed in a particular menu and thus displays that parameter.

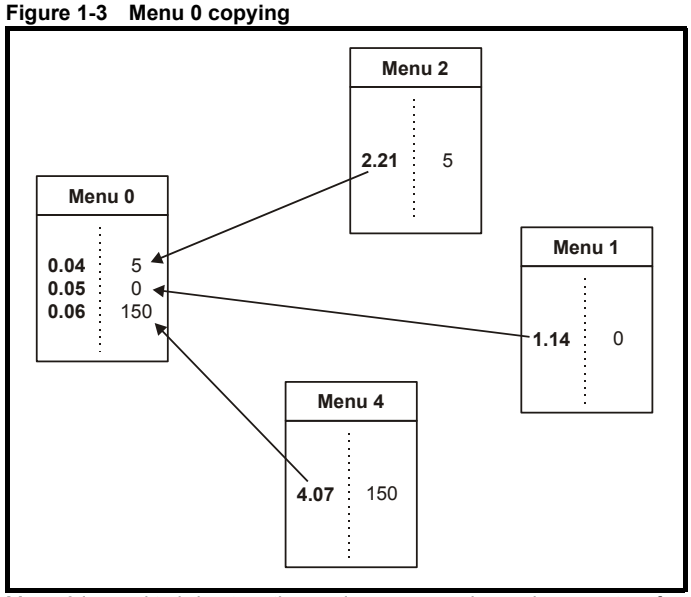
Figure 1-2 Menu structure



1.1 Menu 0

Menu 0 has up to 19 fixed parameters and 40 programmable parameters that are defined in menu 11 and menu 22. Menu 0 parameters are copies of advanced menu parameters, and although these parameters are accessible via drive serial comms, they are not accessible to any Solutions Modules. All menu 0 read/write parameters are saved on exiting the edit mode. Table 1-1 gives the default structure for menu 0. Where alternative parameters are selected with motor map 2 from menu 21 these are shown below the motor map 1 parameters.

Figure 1-3 Menu 0 copying



Menu 0 is used to bring together various commonly used parameters for basic easy set up of the drive. All the parameters in menu 0 appear in other menus in the drive (denoted by {…}).

Menus 11 and 22 can be used to change most of the parameters in menu 0. Menu 0 can also contain up to 59 parameters by setting up menu 22.

Table 1-1 Menu 0 parameters

Parameter			Range(⇳)	Default(⇨)	Type					
0.00	**xx.00**	{**x.00**}	0 to 32,767	0	RW	Uni				
0.01	Minimum reference clamp	{**1.07**}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi			PT	US
0.02	Maximum reference clamp	{**1.06**}	SPEED_LIMIT_MAX rpm	3,000.0	RW	Uni				US
0.03	Acceleration rate	{**2.11**}	0.000 to 3,200.000 s/1,000rpm	0.200	RW	Uni				US
0.04	Deceleration rate	{**2.21**}	0.000 to 3,200.000 s/1,000rpm	0.200	RW	Uni				US
0.05	Reference select	{**1.14**}	A1.A2 (0), A1.Pr (1), A2.Pr (2), Pr (3), PAd (4), Prc (5)	A1.A2 (0)	RW	Txt		NC		US
0.06	Current limit	{**4.07**}	0 to CURRENT_LIMIT_MAX %	300.0	RW	Uni		RA		US
0.07	Speed controller P gain	{**3.10**}	0.0000 to 6.5535 1/rad s^{-1}	0.0100	RW	Uni				US
0.08	Speed controller I gain	{**3.11**}	0.00 to 655.35 1/rad	1.00	RW	Uni				US
0.09	Speed controller D gain	{**3.12**}	0.00000 to 0.65535 (s)	0.00000	RW	Uni				US
0.10	Motor speed	{**3.02**}	±SPEED_MAX rpm		RO	Bi	FI	NC	PT	
0.11	Drive encoder position	{**3.29**}	0 to 65,535 1/2^{16}ths of a revolution		RO	Uni	FI	NC	PT	
0.12	Total motor current	{**4.01**}	0 to Drive_current_max A		RO	Uni	FI	NC	PT	
0.13	Analog input 1 offset trim	{**7.07**}	±10.000 %	0.000	RW	Bi				US
0.14	Torque mode selector	{**4.11**}	0 to 4	Speed control mode (0)	RW	Uni				US
0.15	Ramp mode select	{**2.04**}	FASt (0) Std (1)	Std (1)	RW	Txt				US
0.16	Ramp enable	{**2.02**}	OFF (0) or On (1)	On (1)	RW	Bit				US
0.17	Current demand filter time constant	{**4.12**}	0.0 to 25.0 ms	0.0	RW	Uni				US
0.18	Positive logic select	{**8.29**}	OFF (0) or On (1)	On (1)	RW	Bit			PT	US
0.19	Analog input 2 mode	{**7.11**}	0-20 (0), 20-0 (1), 4-20tr (2), 20-4tr (3), 4-20 (4), 20-4 (5), VOLt (6)	VOLt (6)	RW	Txt				US
0.20	Analog input 2 destination	{**7.14**}	Pr **0.00** to Pr **21.51**	Pr **1.37**	RW	Uni	DE		PT	US
0.21	Analog input 3 mode	{**7.15**}	0-20 (0), 20-0 (1), 4-20tr (2), 20-4tr (3), 4-20 (4), 20-4 (5), VOLt (6), th.SC (7), th (8), th.diSp (9)	th (8)	RW	Txt			PT	US
0.22	Bipolar reference select	{**1.10**}	OFF (0) or On (1)	OFF (0)	RW	Bit				US
0.23	Jog reference	{**1.05**}	0 to 4000.0 rpm	0.0	RW	Uni				US
0.24	Pre-set reference 1	{**1.21**}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi				US
0.25	Pre-set reference 2	{**1.22**}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi				US
0.26	Overspeed threshold	{**3.08**}	0 to 40,000 rpm	0	RW	Uni				US
0.27	Drive encoder lines per revolution	{**3.34**}	0 to 50,000	4096	RW	Uni				US
0.28	Keypad fwd/rev key enable	{**6.13**}	OFF (0) or On (1)	OFF (0)	RW	Bit				US
0.29	SMARTCARD parameter data	{**11.36**}	0 to 999	0	RO	Uni		NC	PT	US
0.30	Parameter copying	{**11.42**}	nonE (0), rEAd (1), Prog (2), AutO (3), boot (4)	nonE (0)	RW	Txt		NC		*
0.31	Drive rated voltage	{**11.33**}	200 (0), 400 (1)		RO	Txt		NC	PT	
0.32	Drive rated current	{**11.32**}	0.00 to 9999.99A		RO	Uni		NC	PT	
0.34	User security code	{**11.30**}	0 to 999	0	RW	Uni		NC	PT	PS
0.35	Serial comms mode	{**11.24**}	AnSI (0), rtu (1), Lcd (2)	rtU (1)	RW	Txt				US
0.36	Serial comms baud rate	{**11.25**}	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8) Modbus RTU only, 115200 (9) Modbus RTU only	19200 (6)	RW	Txt				US
0.37	Serial comms address	{**11.23**}	0 to 247	1	RW	Uni				US
0.38	Current loop P gain	{**4.13**}	0 to 30,000	200V drive: 75 400V drive: 150	RW	Uni				US
0.39	Current loop I gain	{**4.14**}	0 to 30,000	200V drive: 1000 400V drive: 2000	RW	Uni				US
0.40	Autotune	{**5.12**}	0 to 6	0	RW	Uni				
0.41	Maximum switching frequency	{**5.18**}	3 (0), 4 (1), 6 (2), 8 (3), 12 (4)	6 (2)	RW	Txt		RA		US
0.42	No. of motor poles	{**5.11**}	0 to 60 (Auto to 120 pole)	6 POLE (3)	RW	Txt				US
0.43	Encoder phase angle	{**3.25**}	0.0 to 359.9°	0.0	RW	Uni				US
0.44	Motor rated voltage	{**5.09**}	0 to AC_voltage_set_max V	200V drive: 230 400V drive: EUR> 400, USA> 460	RW	Uni		RA		US
0.45	Motor thermal time constant	{**4.15**}	0.0 to 3000.0	20.0	RW	Uni				US
0.46	Motor rated current	{**5.07**}	0 to Rated_current_max A	Drive rated current [**11.32**]	RW	Uni		RA		US
0.48	User drive mode	{**11.32**}	SErVO (3)	SErVO (3)	RO	Txt		NC	PT	
0.49	Security status	{**11.44**}	L1 (0), L2 (1), Loc (2)		RW	Txt			PT	US
0.50	Software version	{**11.29**}	1.00 to 99.99		RO	Uni		NC	PT	
0.51	Action on trip detection	{**10.37**}	0 to 15	0	RW					US

* Modes 1 and 2 are not user saved, modes 0, 3 and 4 are user saved

Table 1-2 Parameter type key

Coding	Attribute
{X.XX}	Copied advanced parameter
RW	Read/write: can be written by the user
RO	Read only: can only be read by the user
Bit	1 bit parameter. 'On' or 'OFF' on the display
Bi	Bipolar parameter
Uni	Unipolar parameter
Txt	Text: the parameter uses text strings instead of numbers.
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination: This parameter selects the destination of an input or logic function.
RA	Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by SMARTCARDs when the rating of the destination drive is different from the source drive and the file is a parameter file.
NC	Not copied: not transferred to or from SMARTCARDs during copying.
PT	Protected: cannot be used as a destination.
US	User save: parameter saved in drive EEPROM when the user initiates a parameter save.
PS	Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) trip occurs. With software version V01.08.00 and later, power-down save parameters are also saved in the drive when the user initiates a parameter save.

1.2 Advanced menus

The advanced menus consist of groups or parameters appropriate to a specific function or feature of the drive. These are accessible via the keypad, drive serial comms and Solutions Modules. All advanced menu parameters are only saved by setting Pr **x.00** to 1000 and applying a reset (except parameters shown as power-down saved which are saved automatically at power-down). The advanced menus are accessible when the user selects L2 in Pr **11.44** (Pr **0.49** in menu 0). This can be done even if security is programmed. Pr **11.44** can be saved in EEPROM so that either Menu 0 only, or Menu 0 and the advanced menus are accessible at power-up.

Table 1-3 Digitax ST menus

Menu	Function
1	Speed reference selection, limits and filters
2	Ramps
3	Speed feedback and control
4	Current control
5	Motor control
6	Sequencer and clock
7	Analog I/O
8	Digital I/O
9	Programmable logic and motorized pot
10	Drive status and trip information
11	Miscellaneous
12	Programmable threshold, variable selector and brake control function
13	Position control
14	User PID controller
15	Slot 1 Solutions Module menu
16	Slot 2 Solutions Module menu
17	Motion Processor
18	User application menu 1 (saved in drive EEPROM)
19	User application menu 2 (saved in drive EEPROM)
20	User application menu 3 (not saved in drive EEPROM)
21	Second motor map
22	Additional menu 0 set-up

1.3 Solutions Modules

Any Solutions Module type is recognized with all drive types in any slots. The relevant template is used to define menu 15 for the module type installed in slot 1 and menu 16 for slot 2. The slot 3 is enclosed within Digitax ST and cannot be physically accessed by the user.

1.4 Drive software version

This product is supplied with the latest software version. If this drive is to be connected to an existing system or machine, all drive software versions should be verified to confirm the same functionality as drives of the same model already present. This may also apply to drives returned from a Control Techniques Service Centre or Repair Centre. If there is any doubt please contact the supplier of the product.

The software version of the drive can be checked by looking at Pr **11.29** and Pr **11.34**. This takes the form of xx.yy.zz where Pr **11.29** displays xx.yy and Pr **11.34** displays zz. (e.g. for software version 01.01.00, Pr **11.29** = 1.01 and Pr **11.34** displays 0).

2 Keypad and display

WARNING

Beware of possible live terminals when installing the keypad.

2.1 Understanding the display

There are two keypads available for the Digitax ST. The Digitax ST Keypad has an LED display and the SM-Keypad Plus has an LCD display. The Digitax ST Keypad can be installed to the drive and the SM-Keypad Plus is remotely mounted on an enclosure door.

2.1.1 Digitax ST Keypad (LED)

The display consists of two horizontal rows of 7 segment LED displays.

The upper display shows the drive status or the current menu and parameter number being viewed.

The lower display shows the parameter value or the specific trip type.

2.1.2 SM-Keypad Plus

The display consists of three lines of text.

The top line shows the drive status or the current menu and parameter number being viewed on the left, and the parameter value or the specific trip type on the right.

The lower two lines show the parameter name or the help text.

Features :

- Parameter names displayed
- Units displayed (Hz, A, rpm, %)
- Parameter help text
- Diagnostics help text
- 5 language support: (English, French, German, Spanish and Italian)
- Displays SM-Applications virtual parameters: Menus 70 to 91
- Hardware key using the SM-Keypad Plus as a key to modify the drive set-up
- User defined parameter set
- Browsing filter
- Adjustable contrast

Figure 2-1 Digitax ST Keypad

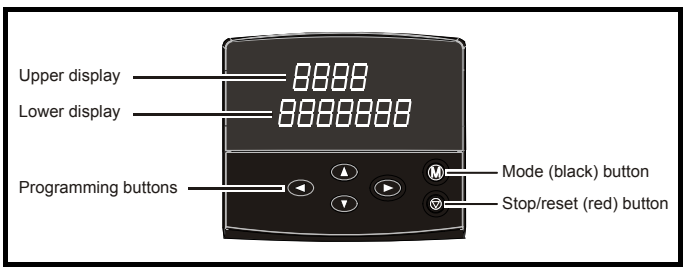
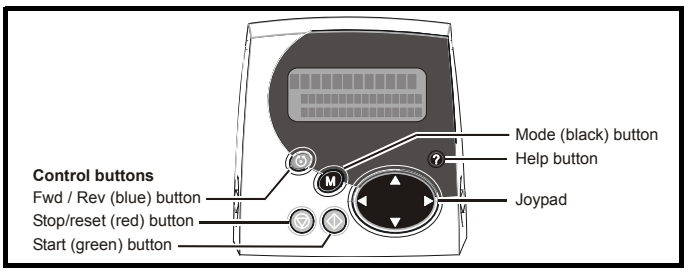


Figure 2-2 SM-Keypad Plus (remote mount only)



NOTE The red stop button is also used to reset the drive.

2.2 Keypad operation

2.2.1 Control buttons

The keypad consists of:

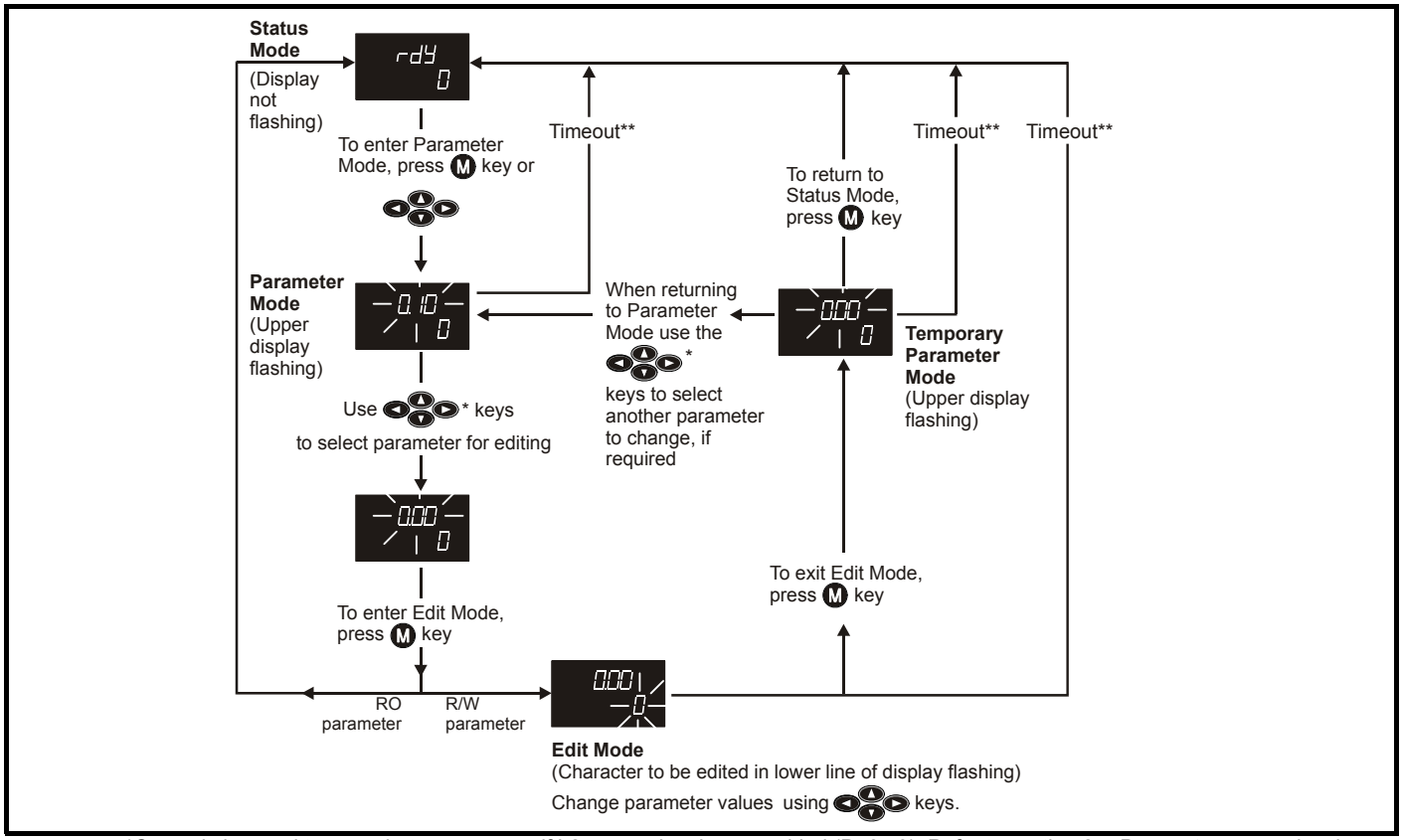
1. Programming buttons: used to navigate the parameter structure and change parameter values.
2. Mode button: used to change between the display modes – parameter view, parameter edit, status.
3. Reset button
4. Help button (Keypad Plus only) - displays text briefly describing the selected parameter.
5. Start, Fwd/Rev buttons (Keypad Plus only) - used to control the drive if Keypad mode is selected.

The Help button toggles between other display modes and parameter help mode. The up and down functions on the joypad scroll the help text to allow the whole string to be viewed. The right and left functions on the joypad have no function when help text is being viewed.

The display examples in this section show the DST-Keypad 7 segment LED display. The examples are the same for the SM-Keypad Plus except that the information displayed on the lower row on the DST-Keypad is displayed on the right hand side of the top row on the SM-Keypad Plus.

The drive parameters are accessed as shown in Figure 2-3.

Figure 2-3 Display modes



*Can only be used to move between menus if L2 access has been enabled (Pr **0.49**). Refer to section 2.7 *Parameter access level and security* on page 11.

Timeout defined by Pr **11.41 (default value = 240 s).

2.3 Status mode

In status mode the 1st row shows a four letter mnemonic indicating the status of the drive. The second row show the parameter last viewed or edited.

State	Upper row
Inhibited: enable input is inactive	inh
Ready: enable closed, but inverter not active	rdY
Stopped: inverter active, but holding zero speed	StoP
Running: inverter active and motor running	run
Mains loss: decelerating to zero in mains loss ride-through or stop modes	ACUU
Decelerating: speed is ramping to zero after a stop	dEC
Position: position control active during orientation stop	POS
Tripped: drive is tripped	triP

2.4 Parameter view mode

In this mode the 1st row shows the menu.parameter number and the 2nd row the parameter value. The 2nd row gives a parameter value range of -999,999 to 9,999,999 with or without decimal points. (32 bit parameters can have values outside this range if written by an application module. If the value is outside this range "-------" is shown and the parameter value cannot be changed from the keypad.) The Up and Down keys are used to select the parameter and the Left and Right keys are used to select the menu. 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 Pr **x.00**.

Similarly holding the Down key will cause the parameter number to decrement until Pr **x.00** 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 Pr **x.00** in the currently 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 Menu 22 is reached. A single Right key action when Menu 22 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 Menu 22. 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.

2.5 Edit mode

Up and Down keys are used to increase and decrease parameter values respectively. If the maximum value of a parameter 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. 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 other 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 exceeded 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.

Parameters can be set to 0 by pressing the Up and Down keys simultaneously.

2.6 SM-Keypad Plus

All SM-Keypad Plus displays built after data code N10 have software version 4.02.00 programmed and support 5 languages (English, French, German, Spanish and Italian) in addition to a user defined parameter set. This software also gives the user access to two menus for SM-Keypad Plus. Menu 40 is for SM-Keypad Plus set up, menu 41 selects commonly used parameters for quick browsing.

Keypads built prior to N10 only support one user defined extra parameter set only.

The SM-Keypad Plus contains two menus, menu 40 and menu 41. The parameters in these menus are listed below.

Table 2-1 Menu 40 parameter descriptions

Parameter		Range(⇳)	Default(⇨)	Type					
40.00	Parameter 0	0 to 32767	0	RW	Uni				
40.01	Language selection	English (0), Custom (1), French (2), German (3), Spanish (4), Italian (5)	English (0)	RW	Txt				US
40.02	Software version	999999		RO	Uni			PT	
40.03	Save to flash	Idle (0), Save (1), Restore (2), Default (3)	Idle (0)	RW	Txt				
40.04	LCD contrast	0 to 31	16	RW	Uni				US
40.05	Drive and attribute database upload was bypassed	Updated (0), Bypass (1)		RO	Txt			PT	
40.06	Browsing favourites control	Normal (0), Filter (1)	Normal (0)	RW	Txt				
40.07	Keypad security code	0 to 999	0	RW	Uni				US
40.08	Communication channel selection	Disable (0), Slot1 (1), Slot2 (2), Slot3 (3), Slave (4), Direct (5)	Disable (0)	RW	Txt				US
40.09	Hardware key code	0 to 999	0	RW	Uni				US
40.10	Drive node ID (Address)	0 to 255	1	RW	Uni				US
40.11	Flash ROM memory size	4Mbit (0), 8Mbit (1)		RO	Txt			PT	US
40.19	String database version number	0 to 999999		RO	Uni			PT	
40.20	Screen saver strings and enable	None (0), Default (1), User (2)	Default (1)	RW	Txt				US
40.21	Screen saver interval	0 to 600	120	RW	Uni				US
40.22	Turbo browse time interval	0 to 200ms	50ms	RW	Uni				US

Table 2-2 Menu 41 parameter descriptions

Parameter		Range(⇳)	Default(⇨)	Type					
41.00	Parameter 0	0 to 32767	0	RW	Uni				
41.01 to 41.50	Browsing filter source F01 to F50	Pr **0.00** to Pr **391.51**	0	RW	Uni				
41.51	Browsing favourites control	Normal (0), Filter (1)	Normal (0)	RW	Txt				

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

For more information about the SM-Keypad Plus, see the *SM-Keypad Plus User Guide*.

2.7 Parameter access level and security

The parameter access level determines whether the user has access to menu 0 only or to all the advanced menus (menus 1 to 22) in addition to menu 0.

The User Security determines whether the access to the user is read only or read write.

Both the User Security and Parameter Access Level can operate independently of each other as shown in the table below:

Parameter Access Level	User Security	Menu 0 status	Advanced menus status
L1	Open	RW	Not visible
L1	Closed	RO	Not visible
L2	Open	RW	RW
L2	Closed	RO	RO

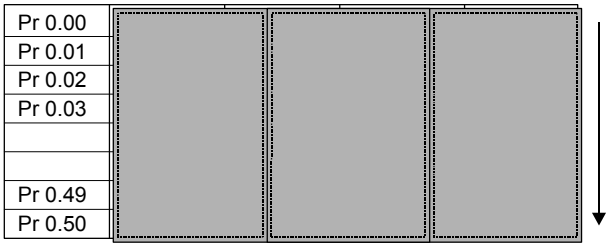
RW = Read / write access RO = Read only access

The default settings of the drive are Parameter Access Level L1 and user Security Open, i.e. read / write access to Menu 0 with the advanced menus not visible.

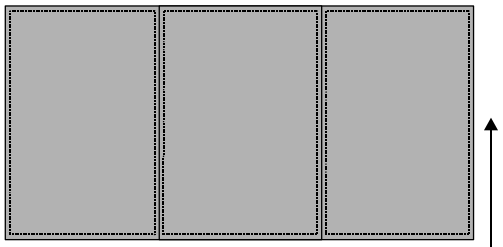
2.7.1 Access Level

The access level is set in Pr **0.49** and allows or prevents access to the advanced menu parameters.

L1 access selected - Menu 0 only visible



L2 access selected - All parameters visible



Pr 0.00	Pr 1.00	.....	Pr 21.00	Pr 22.00
Pr 0.01	Pr 1.01	.....	Pr 21.01	Pr 22.01
Pr 0.02	Pr 1.02	.....	Pr 21.02	Pr 22.02
Pr 0.03	Pr 1.03	.....	Pr 21.03	Pr 22.03
		.....		
		.....		
Pr 0.49	Pr 1.49	.....	Pr 21.30	Pr 22.28
Pr 0.50	Pr 1.50	.....	Pr 21.31	Pr 22.29

2.7.2 Changing the Access Level

The Access Level is determined by the setting of Pr **0.49** as follows:

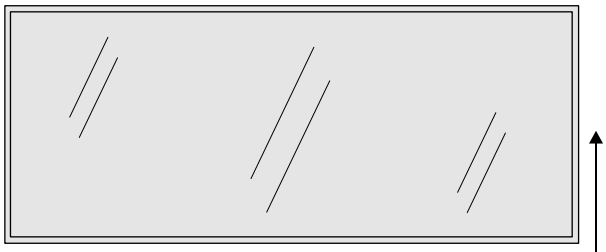
String	Value	Effect
L1	0	Access to menu 0 only
L2	1	Access to all menus (menu 0 to menu 22)

The Access Level can be changed through the keypad even if the User Security has been set.

2.7.3 User Security

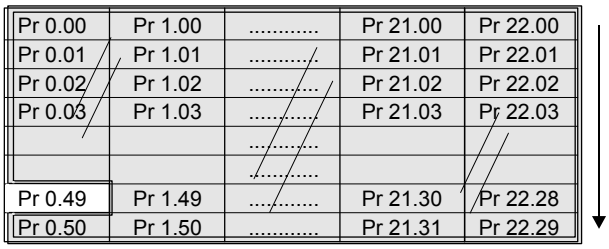
The User Security, when set, prevents write access to any of the parameters (other than Pr. **0.49** Access Level) in any menu.

User security open - All parameters: Read / Write access



Pr 0.00	Pr 1.00	.....	Pr 21.00	Pr 22.00
Pr 0.01	Pr 1.01	.....	Pr 21.01	Pr 22.01
Pr 0.02	Pr 1.02	.....	Pr 21.02	Pr 22.02
Pr 0.03	Pr 1.03	.....	Pr 21.03	Pr 22.03
		.....		
		.....		
Pr 0.49	Pr 1.49	.....	Pr 21.30	Pr 22.28
Pr 0.50	Pr 1.50	.....	Pr 21.31	Pr 22.29

User security closed - All parameters: Read Only access (except Pr **0.49** and Pr **11.44**)



Pr 0.00	Pr 1.00	.....	Pr 21.00	Pr 22.00
Pr 0.01	Pr 1.01	.....	Pr 21.01	Pr 22.01
Pr 0.02	Pr 1.02	.....	Pr 21.02	Pr 22.02
Pr 0.03	Pr 1.03	.....	Pr 21.03	Pr 22.03
		.....		
		.....		
Pr 0.49	Pr 1.49	.....	Pr 21.30	Pr 22.28
Pr 0.50	Pr 1.50	.....	Pr 21.31	Pr 22.29

Setting User Security

Enter a value between 1 and 999 in Pr **0.34** and press the M button; the security code has now been set to this value. In order to activate the security, the Access level must be set to Loc in Pr **0.49**. When the drive is reset, the security code will have been activated and the drive returns to Access Level L1. The value of Pr **0.34** will return to 0 in order to hide the security code. At this point, the only parameter that can be changed by the user is the Access Level Pr **0.49**.

Unlocking User Security

Select a read write parameter to be edited and press the M button, the upper display will now show CodE. Use the arrow buttons to set the security code and press the M button.

With the correct security code entered, the display will revert to the parameter selected in edit mode.

If an incorrect security code is entered the display will revert to parameter view mode.

To lock the User Security again, set Pr **0.49** to Loc and press the reset button.

Disabling User Security.

Unlock the previously set security code as detailed above. Set Pr **0.34** to 0 and press the M button. The User Security has now been disabled, and will not have to be unlocked each time the drive is powered up to allow read / write access to the parameters.

2.8 Alarm and trip display

An alarm can flash alternately with the data displayed on the 2nd row when one of the following conditions occur. If action is not taken to eliminate the alarm, except "Auto tunE", "Lt" and "PLC", the drive may eventually trip. Alarms flash once every 640ms except "PLC" which flashes once every 10s. Alarms are not displayed when a parameter is being edited.

Alarm string	Alarm condition
br.rS	Braking resistor (Pr **10.39** > 75.0% and the braking IGBT is active)
OVLd	Motor overload (Pr **4.20** > 75% and the drive output current > Pr **5.07**)
hot	Heatsink or control board alarms are active
Auto tunE	Auto tune in progress
Lt	Indicates that a limit switch is active and that it is causing the motor to be stopped (i.e. forward limit switch with forward reference etc.)
PLC	On-board PLC program is running

When a trip occurs the drive switches to status mode and "trip" is shown on the 1st row and the trip string flashes on the 2nd row. The read only parameters listed below are frozen with any trip except UV trip until the trip is cleared. For a list of the possible trip strings see Pr **10.20**. Pressing any of the parameter keys changes the mode to the parameter view mode. If the trip is HF01 to HF16 then no key action is recognized.

Parameter	Description
1.01	Speed reference
1.02	Speed reference
1.03	Pre-ramp reference
2.01	Post-ramp reference
3.01	Final speed reference
3.02	Speed feedback
3.03	Speed error
3.04	Speed controller output
4.01	Current magnitude
4.02	Active current
4.17	Magnetising current
5.01	Output frequency
5.02	Output voltage
5.03	Power
5.05	DC bus voltage
7.01	Analog input 1
7.02	Analog input 2
7.03	Analog input 3

2.9 Keypad control mode (SM-Keypad Plus only)

The drive can be controlled from the keypad if Pr **1.14** is set to 4. The Stop and Run keys automatically become active (the Reverse key may be optionally enabled with Pr **6.13**). The speed reference is defined by Pr **1.17**. This is a read only parameter that can only be adjusted in status mode by pressing the Up or Down keys. If keypad control mode is selected, then pressing the Up or Down keys in status mode will cause the drive to automatically display the keypad reference and adjust it in the relevant direction. This can be done whether the drive is disabled or running. If the Up or Down keys are held the rate of change of keypad reference increases with time. The units used for to display the keypad reference is rpm.

2.10 Drive reset

A drive reset is required to: reset the drive from a trip (except some “HFxx” trips which cannot be reset); and other functions as defined in section 3 *Parameter x.00* on page 13. A reset can be performed in four ways:

1. Stop 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 function of the stop key is enabled, a reset is initiated while the drive is running by holding the Run key and then pressing the Stop key. When the drive is not running the Stop key will always reset the drive.
2. The drive resets after a 0 to 1 transition of the Drive Reset parameter (Pr **10.33**). A digital input can be programmed to change this parameter.
3. Serial comms, fieldbus or applications Solutions Module: Drive reset is triggered by a value of 100 being written to the User trip parameter (Pr **10.38**).
4. Auto-reset: Pr **10.34** can be used to provide an auto-reset function.

If the drive trips EEF (internal EEPROM error) then it is not possible to reset the drive using the normal reset methods described above. 1233 or 1244 must be entered into Pr **x.00** before the drive can be reset. Default parameters are loaded after an EEF trip, and so the parameters should be reprogrammed as required and saved in EEPROM.

If the drive is reset after a trip from any source other than the Stop key, the drive restarts immediately, if:

1. A non-latching sequencer is used with the enable active and one of run forward, run reverse or run active
2. A latching sequencer is used if the enable and “not stop” are active and one of run forward, run reverse or run is active.

If the drive is reset with the Stop key the drive does not restart until a not active to active edge occurs on run forward, run reverse or run.

2.11 Second motor parameters

An alternative set of motor parameters are held in menu 21 which can be selected by Pr **11.45**. When the alternative parameter set is being used by the drive the decimal point after the right hand digit in the 1st row is on.

2.12 Special display functions

The following special display functions are used.

1. If the second motor map is being used the decimal point second from the right of the first row is on.
2. When parameters are saved to a SMARTCARD the right-most decimal point on the first row flashes for 2 seconds.

During power up one or more of the following actions may be required. Each action may take several seconds, and so special display strings are shown.

Display string	Action
boot	If a SMARTCARD is present with Pr **11.42** set to boot the parameters from the card must be transferred to the drive EEPROM.
card	If the drive is in auto or boot mode (Pr **11.42** set to 3 or 4) the drive ensures that the data on the card is consistent with the drive by writing to the card.
loading	It may be necessary for a Solutions Module to transfer parameter information from the drive. This is only carried out if the parameter information held by the Solutions Module is for a different drive software version. The drive allows up to 5 seconds for this process.

3 Parameter x.00

Parameter **x.00** is available in all menus and has the following functions.

Value	Action
1000	Save parameters when under voltage is not active (Pr **10.16** = 0) and 48V supply is not active (Pr **6.44** = 0).
1001	Save parameters under all conditions
1070	Reset all Solutions Modules
1233	Load standard defaults
1244	Load US defaults
2001	Transfer drive parameter to a card and create a bootable difference from default SMARTCARD block with data block number 1 and clear Pr **11.42**. If data block 1 exists it is over written.
3yyy	Transfer drive EEPROM data to a SMARTCARD block number yyy
4yyy	Transfer drive data as difference from defaults to SMARTCARD block number yyy
5yyy	Transfer drive ladder program to SMARTCARD block number yyy
6yyy	Transfer SMARTCARD data block yyy to the drive
7yyy	Erase SMARTCARD data block yyy
8yyy	Compare drive parameters with block yyy
9555	Clear SMARTCARD warning suppression flag
9666	Set SMARTCARD warning suppression flag
9777	Clear SMARTCARD read-only flag
9888	Set SMARTCARD read-only flag
9999	Erase SMARTCARD
110zy	Transfer electronic nameplate parameters to/from drive from/to encoder
*12000	Display non-default values only
*12001	Display destination parameters only

*These functions do not require a drive reset to become active. All other functions require a drive reset.

3.1 Parameter x.00 reset

When an action is started by setting Pr **x.00** to one of the above values and initiating a drive reset this parameter is cleared when the action is completed successfully. If the action is not started, e.g. because the drive is enabled and an attempt is made to load defaults, etc., Pr **x.00** is not cleared and no trip is produced. If the action is started and then fails for some reason a trip is always produced and Pr **x.00** is not cleared. It should be noted that parameter saves etc. can also be initiated with the copying parameter (Pr **11.42**). If actions that can be initiated by either parameter are started and then completed successfully Pr **x.00** is cleared and Pr **11.42** is cleared if it has a value of less than 3.

It should be noted that there could be some conflict between the actions of Pr **x.00** and Pr **11.42** (Parameter copying) when the drive is reset. If Pr **11.42** has a value of 1 or 2 and a valid action is required from the value of Pr **x.00** then only the action required by Pr **x.00** is performed. Pr **x.00** and Pr **11.42** are then reset to zero. If Pr **11.42** has a value of 3 or 4 it will operate correctly causing parameters to be save to a SMARTCARD each time a parameter save is performed.

3.2 Saving parameters in drive EEPROM

Drive parameters are saved to drive EEPROM by setting Pr **x.00** to 1000 or 1001 and initiating a drive reset. In addition to user save parameters, power down save parameters are also saved by these actions, but not by any other actions that result in parameters being saved to drive EEPROM (i.e. loading defaults). Power down save parameters are not saved at power down unless the drive is supplied from a normal line power supply, and so this gives the user the option of saving these parameters when required. When the parameter save is complete Pr **x.00** is reset to zero by the drive. Care should be taken when saving parameters because this action can take between 400ms and several seconds depending on how many changes are stored in the EEPROM. If the drive is powered down during a parameter save it is possible that data may be lost. When the drive is operating from a normal line power supply then it will stay active for a short time after the power is removed, however, if the drive is being powered from a 24V control supply, or it is being operated from a low voltage battery supply, the drive will power down very quickly after the supply is removed. The drive provides two features to reduce the risk of data loss when the drive is powered down.

1. If Pr **x.00** is set to 1000 a parameter save is only initiated on drive reset if the drive is supplied from a normal line power supply (Pr **10.16** = 0 and Pr **6.44** = 0). 1001 must be used to initiate a save if the drive is not supplied from a normal line power supply.
2. Two banks of arrays are provided in EEPROM to store the data. When a parameter save is initiated the data is stored in a new bank and only when the data store is complete does the new bank become active. If the power is removed before the parameter save is complete a SAVE.Er trip (user save parameter save error) or PSAVE.Er trip (power down save parameter save error) will be produced when the drive is powered up again indicating that the drive has reverted to the data that was saved prior to the last parameter save.

The second feature will significantly reduce the possibility of completely invalidating all saved data, which would result in an EEF trip on the next power-up. However the following points should be noted:

1. If the power is removed during a parameter save the current data that is being saved to the EEPROM that is different from the last data saved in the EEPROM will be lost and SAVE.Er or PSAVE.Er trip will occur on power-up.
2. This feature does not apply when user save parameters are saved automatically by adjusting the values in menu 0 with an LED keypad. However, the time taken to save parameters in this way is very short, and is unlikely to cause data loss if the power is removed after the parameter has been changed. It should be noted that any parameter changes made in this way are included in the currently active bank in the EEPROM, so that if the power is removed during a subsequent save initiated via Pr **x.00** that results in an SAVE.Er trip, the changes made via menu 0 will be retained and not lost.
3. User save parameters are saved to drive EEPROM after a transfer of data from an electronic nameplate in an encoder.
4. User save parameters are saved to drive EEPROM after a transfer of data from a SMARTCARD.
5. This feature is not provided for data saved to a SMARTCARD, and so it is possible to corrupt the data files on a SMARTCARD if the power is removed when data is being transferred to the card.
6. User save parameters are saved to drive EEPROM after defaults are loaded.
7. When a Solutions Module is changed for a different type in a slot, or a module is inserted when one was not present previously or a module is removed the EEPROM is forced to re-initialise itself on the next parameter saves. On the first parameter save one bank is cleared and then written and on the next parameter save the other bank is cleared and rewritten. Each of these parameter saves takes slightly longer than a normal parameter save.
8. When the firmware is updated from an earlier version the drive will automatically update the EEPROM correctly. If the software is

changed back to an earlier version defaults should be loaded after the change.

3.3 Loading defaults

When defaults are loaded the user save parameters are automatically saved to the drive EEPROM in all modes. Standard defaults are loaded by setting 1233 in Pr **x.00** performing a drive reset.

The following differences from standard defaults are available when different values are set in Pr **x.00**.

US Default Differences (Pr **x.00** = 1244 and perform a drive reset)

Pr	Description	Default	Voltage rating
2.08	Standard ramp volts	775V	400V
5.09	Rated voltage	460V	400V
21.09	M2 Rated voltage	460V	400V

3.4 SMARTCARD transfers

Drive parameters, set-up macros and internal ladder programs can be transferred to/from SMARTCARDs. See Pr **11.36** to Pr **11.40**.

3.5 Electronic nameplate transfers

Some encoders using Stegmann Hiperface or EnDat comms can hold motor data. The data can be transferred to/from the encoder by writing 110zy to parameter x.00 and resetting the drive where z is 0 for the drive or 1, 2 or 3 for Solutions Module slots 1, 2 or 3 respectively. See Chapter 7 *Electronic nameplate* on page 216 for details.

3.6 Display non-default values or destination parameters

If a value of 12000 is written to Pr **x.00**, then only parameters that are different from the last defaults loaded and Pr **x.00** are displayed. If a value of 12001 is written to Pr **x.00**, then only destination parameters are displayed. This function is provided to aid locating destination clashes if a dESt trip occurs.

4 Parameter description format

In the following sections descriptions are given for the advanced parameter set. With each parameter the following information block is given.

5.11	**Number of motor poles**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 60 (Auto to 120 POLE)															
Default	3 (6 POLE)															
Second motor parameter	Pr **21.11**															
Update rate	Background read															

The top row gives the menu.parameter number and the parameter name. The other rows give the following information.

Coding

NOTE

This guide will show all bit parameters (with the Bit coding), as having a parameter range of "0 to 1", and a default value of either "0" or "1". This reflects the value seen through serial communications. The bit parameters will be displayed on the DST-Keypad or SM-Keypad Plus (if used) as being "OFF" or "On" ("OFF"= 0, "On" = 1).

The coding defines the attributes of the parameter as follows:

Coding	Attribute
RW	Read/write: can be written by the user
RO	Read only: can only be read by the user
Bit	1 bit parameter. 'On' or 'OFF' on the display
Bi	Bipolar parameter
Uni	Unipolar parameter
Txt	Text: the parameter uses text strings instead of numbers.
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination: This parameter selects the destination of an input or logic function.
RA	Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by SMARTCARDs when the rating of the destination drive is different from the source drive and the file is a parameter file.
NC	Not copied: not transferred to or from SMARTCARDs during copying.
PT	Protected: cannot be used as a destination.
US	User save: parameter saved in drive EEPROM when the user initiates a parameter save.
PS	Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) trip occurs. With software version V01.08.00 and later, power-down save parameters are also saved in the drive when the user initiates a parameter save.

4.1 Parameter ranges and variable maximums:

The two values provided define the minimum and maximum values for the given parameter. In some cases the parameter range is variable and dependant on either:

- other parameters,
- the drive rating,
- or a combination of these.

The values given in Table 4-1 are the variable maximums used in the drive.

Table 4-1 Definition of parameter ranges & variable maximums

Maximum	Definition
SPEED_REF_MAX [40000.0rpm]	**Maximum speed reference** If Pr **1.08** = 0: SPEED_REF_MAX = Pr **1.06** If Pr **1.08** = 1: SPEED_REF_MAX is Pr **1.06** or – Pr **1.07** whichever is the largest (If the second motor map is selected Pr **21.01** is used instead of Pr **1.06** and Pr **21.02** instead of Pr **1.07**)
SPEED_LIMIT_MAX [40000.0rpm]	**Maximum applied to speed reference limits** A maximum limit may be applied to the speed reference to prevent the nominal encoder frequency from exceeding 500kHz. The maximum is defined by SPEED_LIMIT_MAX (in rpm) = 500kHz x 60 / ELPR = 3.0 x 10^7 / ELPR subject to an absolute maximum of 40,000 rpm. ELPR is equivalent encoder lines per revolution and is the number of lines that would be produced by a quadrature encoder. Quadrature encoder ELPR = number of lines per revolution F and D encoder ELPR = number of lines per revolution / 2 Resolver ELPR = resolution / 4 SINCOS encoder ELPR = number of sine waves per revolution Serial comms encoder ELPR = resolution / 4 This maximum is defined by the device selected with the speed feedback selector (Pr **3.26**) and the ELPR set for the position feedback device.
SPEED_MAX [40000.0rpm]	**Maximum speed** This maximum is used for some speed related parameters in menu 3. To allow headroom for overshoot etc. the maximum speed is twice the maximum speed reference. SPEED_MAX = 2 x SPEED_REF_MAX
DRIVE_CURRENT_MAX [9999.99A]	**Maximum drive current** The maximum drive current is the current at the over current trip level and is given by: DRIVE_CURRENT_MAX = K_C / 0.45
AC_VOLTAGE_SET_MAX [690V]	**Maximum output voltage set-point** Defines the maximum motor voltage that can be selected. 200V drives: 240V, 400V drives: 480V
AC_VOLTAGE_MAX [930V]	**Maximum AC output voltage** This maximum has been chosen to allow for maximum AC voltage that can be produced by the drive including quasi-square wave operation as follows: AC_VOLTAGE_MAX = 0.78 x DC_VOLTAGE_MAX 200V drives: 325V, 400V drives: 650V
DC_VOLTAGE_SET_MAX [1150V]	**Maximum DC voltage set-point** 200V rating drive: 0 to 400V, 400V rating drive: 0 to 800V
DC_VOLTAGE_MAX [1190V]	**Maximum DC bus voltage** The maximum measurable DC bus voltage. 200V drives: 415V, 400V drives: 830V
MOTOR1_CURRENT_LIMIT_MAX [1000.0%]	**Maximum current limit setting for motor map 1** The maximum current limit setting is the maximum applied to the current limit parameters in motor map 1. Where: $\text{Maximum current limit} = \left[\frac{\text{Maximum current}}{\text{Motor rated current}}\right] \times 100\%$ The Maximum current is (1.75 x K_C). Motor rated current is given by Pr **5.07**
MOTOR2_CURRENT_LIMIT_MAX [1000.0%]	**Maximum current limit settings for motor map 2** This maximum current limit setting is the maximum applied to the current limit parameters in motor map 2. The formulae for MOTOR2_CURRENT_LIMIT_MAX are the same for MOTOR1_CURRENT_LIMIT_MAX except that Pr **5.07** is replaced with Pr **21.07** and Pr **5.10** is replaced with Pr **21.10**.

Maximum	Definition
TORQUE_PROD_CURRENT_MAX [1000.0%]	**Maximum torque producing current** This is used as a maximum for torque and torque producing current parameters. It is MOTOR1_CURRENT_LIMIT_MAX or MOTOR2_CURRENT_LIMIT_MAX depending on which motor map is currently active.
USER_CURRENT_MAX [1000.0%]	**Current parameter limit selected by the user** The user can select a maximum for Pr **4.08** (torque reference) and Pr **4.20** (percentage load) to give suitable scaling for analog I/O with Pr **4.24**. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT_MAX. or MOTOR2_CURRENT_LIMIT_MAX depending on which motor map is currently active. USER_CURRENT_MAX = Pr **4.24**
POWER_MAX [9999.99kW]	**Maximum power in kW** The maximum power has been chosen to allow for the maximum power that can be output by the drive with maximum AC output voltage, maximum controlled current and unity power factor. Therefore POWER_MAX = √3 x AC_VOLTAGE_MAX x DRIVE_CURRENT_MAX

The values given in square brackets indicate the absolute maximum value allowed for the variable maximum.

Table 4-2 Maximum motor rated current

200 V			400 V		
Size	**Current scaling (Kc) A**	**Max current rating A**	**Size**	**Current scaling (Kc) A**	**Max current rating A**
DST1201x	2.92	1.70	DST1401x	2.58	1.50
DST1202x	6.52	3.80	DST1402x	4.63	2.70
DST1203x	9.26	5.40	DST1403x	6.86	4.00
DST1204x	13.03	7.60	DST1404x	10.12	5.90
			DST1405x	13.72	8.00

4.1.1 Default

The default values given are the standard drive defaults which are loaded after a drive reset with 1233 in Pr **x.00**.

4.1.2 Second motor parameter

Some parameters have an equivalent second motor value that can be used as an alternative when the second motor is selected with Pr **11.45**. Menu 21 contains all the second motor parameters. In this menu the parameter specifications include the location of the normal motor parameter which is being duplicated.

4.1.3 Update rate

Defines the rate at which the parameter data is written by the drive (write) or read and acted upon by the drive (read). Where background update rate is specified, the update time depends on the drive processor load. Generally the update time is between 2ms and 30ms, however, the update time is significantly extended when loading defaults, transferring data to/from a SMARTCARD, or transferring blocks of parameters or large communications messages to/from the drive (not a Solutions Module) via the drive serial comms port.

4.2 Sources and destinations

4.2.1 Sources

Some functions have source pointer parameters, i.e. drive outputs, PID controller etc.. The source pointer parameter range is Pr **0.00** to Pr **21.51**. The source pointer is set up to point to a parameter, which supplies the information to control the source and this is referred to as the source data parameter. For example, Pr **7.19** is the source pointer parameter for analog output 1. If Pr **7.19** is set to a value of 18.11, then Pr **18.11** is the source data parameter, and as the value of Pr **18.11** is modified the analog output level is changed.

1. If the parameter number in the source pointer parameter does not exist the input is taken as zero.
2. If the source is not a bit type source (i.e. not a digital output etc.) then the source level is defined by (source data value x 100%) / source data parameter maximum. Generally the result is rounded down to the nearest unit, but other rounding effects may occur depending on the internal scaling of the particular source function.
3. If the source is a bit, i.e. a digital output, and the source data parameter is a bit parameter then the input to the source function follows the value of the source data parameter.
4. If the source is a bit, i.e. a digital output, and the source data parameter is not a bit parameter the source input is zero if the source data value is less than source data parameter maximum / 2 rounded down to the nearest unit. The source input is one if the source data value is greater than or equal to source data parameter maximum / 2 rounded down to the nearest unit. For example if the source pointer parameter is set to Pr **18.11**, which has a maximum of 32767, the source input is zero if the source data value is less than 16383 and one if it is greater than this.

4.2.2 Destinations

Some functions have destination pointer parameters, i.e. drive inputs, etc.. The destination pointer parameter range is Pr **0.00** to Pr **21.51**. The destination pointer parameter is set up to point to a parameter, which receives information from the function referred to as the destination parameter.

1. If the parameter number in the destination pointer parameter does not exist then the output value has no effect.
2. If the destination parameter is protected then the output value has no effect.
3. If the function output is a bit value (i.e. a digital input) the destination parameter value does not operate in the same way as a source described above, but is always either 0 or 1 depending on the state of the function output whether the destination parameter is a bit parameter or not.
4. If the function output is not a bit value (i.e. analog input) and the destination parameter is not a bit parameter, the destination value is given by (function output x destination parameter maximum) / 100%. Generally the result is rounded down to the nearest unit, but other rounding effects may occur depending on the internal scaling of the particular source function (rounded down to nearest unit). Pr **1.36** and Pr **1.37** are a special case. The scaling shown in the description of parameter Pr **1.08** is used when any non-bit type quantity is routed to these parameters.
5. If the function output is not a bit value and the destination parameter is a bit value, the destination value is 0 if the function output is less than 50% of its maximum value, otherwise it is 1.
6. If more than one destination selector is routed to the same destination, the value of the destination parameter is undefined. The drive checks for this condition where the destinations are defined in any menu except menus 15 to 17. If a conflict occurs a dESt trip occurs that cannot be reset until the conflict is resolved.

4.2.3 Sources and destinations

1. Bit and non-bit parameters may be connected to each other as sources or destinations. The scaling is as described previously.
2. All new source and destination routing only changes to new set-up locations when the drive is reset.
3. When a destination pointer parameter within the drive or a dumb Solutions Module (SM-Resolver, SM-Encoder Plus, SM-Encoder Output Plus, SM-I/O plus) is changed the old destination is written to zero, unless the destination change is the result of loading defaults or transferring parameters from a SMARTCARD. When defaults are loaded the old destination is set to its default value. When parameters are loaded from a SMARTCARD the old destination retains its old value unless a SMARTCARD value is written to it.

4.3 Update rates

Update rates are given for every parameter in the header table as shown below.

3.03	**Speed error**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	1	1		1		1				
Range	±SPEED_MAX rpm															
Update rate	4ms write															

Some parameters have an increased update in special circumstances.

4.3.1 Speed reference update rate

The normal update rate for the speed references (via menu 1) is 4ms, however it is possible to reduce the sample time to 250µs by selecting the reference from particular sources. The fast update rate is only possible provided the conditions given below are met.

Analog input references (not including I/O expansion Solutions Module)

1. The reference must be derived via Pr **1.36** or Pr **1.37**
2. The analog inputs must be in voltage mode with zero offset
3. Bipolar mode must be used or unipolar mode with the minimum speed (Pr **1.07**) set to zero
4. No skip bands are enabled, i.e. Pr **1.29**, Pr **1.31** and Pr **1.33** must be zero.
5. The jog and velocity feed-forward references must not be enabled.

Applications and fieldbus Solutions Modules

Pr **91.02** must be used to define the speed reference (this parameter is only visible from the Solutions Modules). Any value written to Pr **91.02** should be automatically mapped into preset Pr **1.21** by the Solutions Module.

In fast update mode the references are sampled every 250µs. A sliding window filter may be applied to analog input 1 (see Pr **7.26**) in normal or high speed updating modes. The default value for this filter is 4ms, therefore Pr **7.26** must be set to zero to obtain the fastest possible update rate.

When fast updating is used the scaling is performed by a simple multiplication. This minimizes software execution time, but also ensures that there is no loss of resolution from the v to f converter used to implement analog input 1. Therefore the speed of the motor may be controlled with infinite resolution from analog input 1 except for deadband effects around zero reference. The scale factor used for the multiplication cannot exactly duplicate the scaling for the two stage conversion (i.e. conversion in menu 7 to a percentage of full scale, and conversion to 0.1rpm units) used when high speed updating is not in operation. Therefore the absolute scaling of the analog inputs varies slightly between normal and high speed updating. The amount of difference depends on the maximum speed, user scaling in menu 7, and the analog input 1 the filter time. The worst case difference for analog input 1 is 0.12% of full scale, and for analog inputs 2 and 3 the difference is less than 0.12% with a maximum speed of 50rpm or more. Typical differences (1500rpm maximum speed, menu 7 scaling of 1.000, analog input 1 filter of 4ms) are 0.015% for analog input 1 and 0.004% for analog inputs 2 and 3.

4.3.2 Hard speed reference update rate

The normal update rate for the hard speed reference is 4ms, however it is possible to reduce the sample time to 250µs by selecting the reference from particular sources. The fast update rate is only possible provided the conditions given below are met.

Analog inputs (not including I/O expansion Solutions Module)

The analog inputs must be in voltage mode with zero offset

Limitations are the same as for the references via menu 1 described above.

Applications and fieldbus Solutions Modules

For faster update rate Pr **91.03** must be used (this parameter is only visible from the Solutions Modules). Any value written to Pr **91.03** is automatically mapped into the hard speed reference Pr **3.22**.

Encoder reference

It is possible to use the drive encoder as the source for the hard speed reference. To do this the drive encoder reference destination (Pr **3.46**) should be routed to the hard speed reference parameter. If, and only if, the maximum drive encoder reference (Pr **3.43**) is set to the same value as the maximum reference value (SPEED_REF_MAX), and the scaling (Pr **3.44**) is 1.000, the drive takes the encoder pulses directly. This gives a form of reference slaving where the integral term in the speed controller accumulates all pulses from the reference and tries to match them to the feedback from the motor encoder. Pulses are lost if the reference reaches a minimum or maximum limit including zero speed in unipolar mode. The reference is sampled every 250µs. It is possible to apply scaling even in this high speed update mode by changing the number of encoder lines per revolution. It is also possible to use this high speed update mode with some position feedback category Solutions Modules (see description for the appropriate Solutions Module.)

4.3.3 Torque reference update rate

The normal update rate for the torque reference (Pr **4.08**) is 4ms, however it is possible to reduce the sample time to 250µs by selecting the reference from particular sources. The fast update rate is only possible provided the conditions given below are met.

Analog inputs 2 or 3 on the drive

The analog inputs must be in voltage mode with zero offset.

5 Advanced parameter descriptions

5.1 Overview

Table 5-1 Menu descriptions

Menu number	Description
0	Commonly used basic set up parameters for quick / easy programming
1	Speed reference
2	Ramps
3	Speed feedback and control
4	Torque and current control
5	Motor control
6	Sequencer and clock
7	Analog I/O
8	Digital I/O
9	Programmable logic, motorized pot and binary sum
10	Status and trips
11	General drive set-up
12	Threshold detectors and variable selectors
13	Position control
14	User PID controller
15, 16	Solutions Module slots
17	Digitax ST indexer/plus parameters
18	Application menu 1
19	Application menu 2
20	Application menu 3
21	Second motor parameters
22	Additional Menu 0 set-up

Default abbreviations:

EUR> European default value (50 Hz AC supply frequency)
USA> USA default value (60 Hz AC supply frequency)

NOTE

Parameter numbers shown in brackets {...} are the equivalent Menu 0 parameters.

In some cases, the function or range of a parameter is affected by the setting of another parameter; the information in the lists relates to the default condition of such parameters.

Table 5-2 gives a full key of the coding which appears in the following parameter tables.

Table 5-2 Key to parameter coding

Coding	Attribute
RW	Read/write: can be written by the user
RO	Read only: can only be read by the user
Bit	1 bit parameter. 'On' or 'OFF' on the display
Bi	Bipolar parameter
Uni	Unipolar parameter
Txt	Text: the parameter uses text strings instead of numbers.
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination: This parameter selects the destination of an input or logic function.
RA	Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by SMARTCARDs when the rating of the destination drive is different from the source drive and the file is a parameter file.
NC	Not copied: not transferred to or from SMARTCARDs during copying.
PT	Protected: cannot be used as a destination.
US	User save: parameter saved in drive EEPROM when the user initiates a parameter save.
PS	Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) trip occurs. With software version V01.08.00 and later, power-down save parameters are also saved in the drive when the user initiates a parameter save.

5.2 Feature look-up table

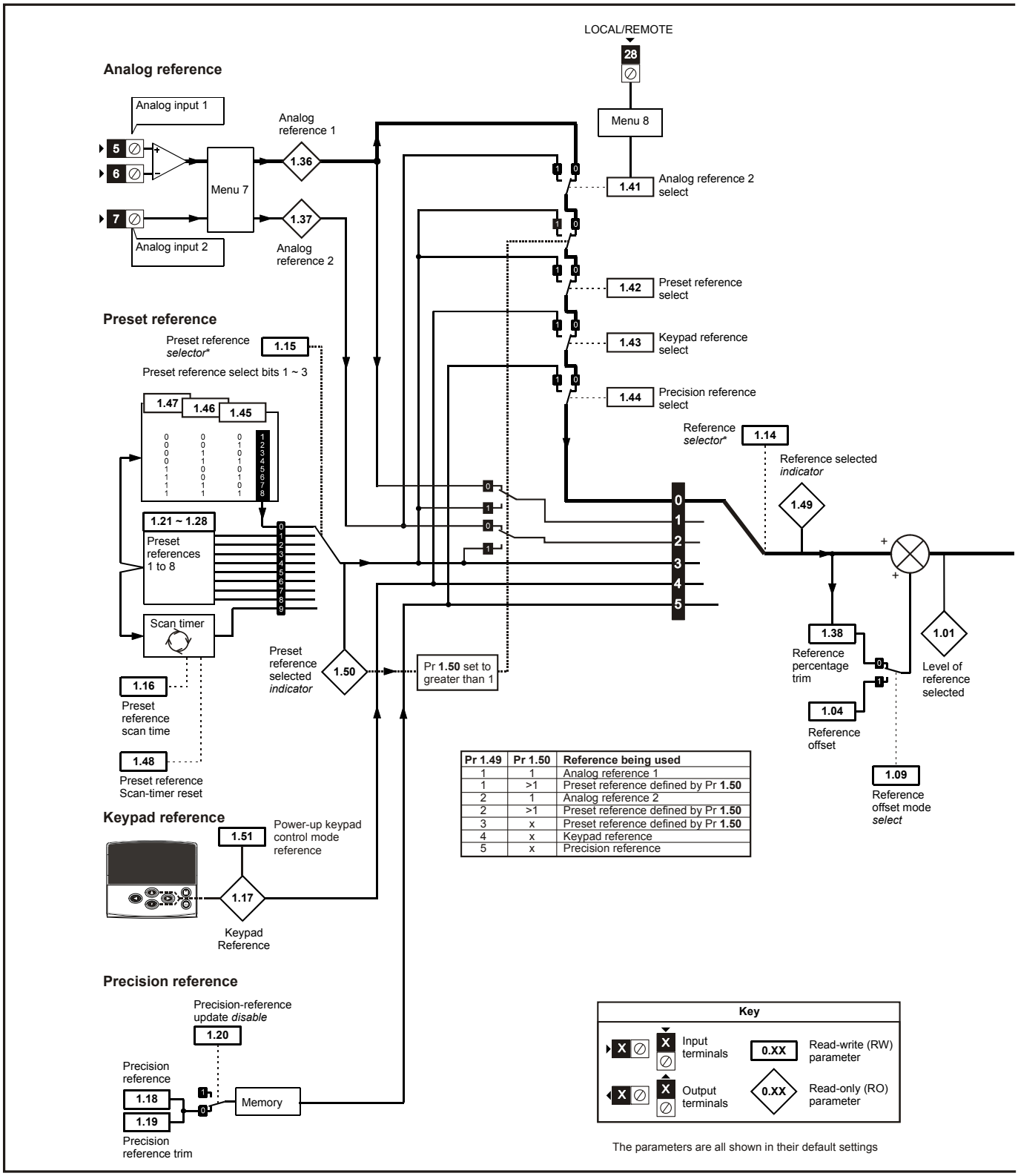
Feature	Parameter number (Pr)											
Acceleration rates	2.10	2.11 to 2.19		2.32	2.33	2.34	2.02					
Analog speed reference 1	1.36	7.10	7.01	7.07	7.08	7.09	7.25	7.26	7.30			
Analog speed reference 2	1.37	7.14	1.41	7.02	7.11	7.12	7.13	7.28	7.31			
Analog I/O	Menu 7											
Analog input 1	7.01	7.07	7.08	7.09	7.10	7.25	7.26	7.30				
Analog input 2	7.02	7.11	7.12	7.13	7.14	7.28	7.31					
Analog input 3	7.03	7.15	7.16	7.17	7.18	7.29	7.32					
Analog output 1	7.19	7.20	7.21	7.33								
Analog output 2	7.22	7.23	7.24									
Application menu	Menu 18		Menu 19		Menu 20							
At speed indicator bit	3.06	3.07	3.09	10.06	10.05	10.07						
Auto reset	10.34	10.35	10.36	10.01								
Autotune	5.12	5.17	5.24									
Binary sum	9.29	9.30	9.31	9.32	9.33	9.34						
Bipolar speed	1.10											
Brake control	12.40 to 12.49											
Braking	10.11	10.10	10.30	10.31	6.01	2.04	2.02	10.12	10.39	10.40		
Copying	11.42	11.36 to 11.40										
Stop mode	6.01											
Comms	11.23 to 11.26											
Cost - per kWh electricity	6.16	6.17	6.24	6.25	6.26	6.40						
Current controller	4.13	4.14										
Current feedback	4.01	4.02	4.17	4.04	4.12	4.20	4.23	4.24	10.08	10.09	10.17	
Current limits	4.05	4.06	4.07	4.18	4.15	4.19	4.16	5.07	10.08	10.09	10.17	
DC bus voltage	5.05	2.08										
Deceleration rates	2.20	2.21 to 2.29		2.04	2.35 to 2.37		2.02	2.08	6.01	10.30	10.31	10.39
Defaults	11.43	11.46										
Digital I/O	Menu 8											
Digital I/O read word	8.20											
Digital I/O T24	8.01	8.11	8.21	8.31								
Digital I/O T25	8.02	8.12	8.22	8.32								
Digital I/O T26	8.03	8.13	8.23	8.33								
Digital input T27	8.04	8.14	8.24									
Digital input T28	8.05	8.15	8.25	8.39								
Digital input T29	8.06	8.16	8.26	8.39								
Digital lock	13.10	13.01 to 13.09		13.11	13.12	13.16	3.22	3.23	13.19 to 13.23			
Digital output T22	8.08	8.18	8.28									
Direction	10.13	6.30	6.31	1.03	10.14	2.01	3.02	8.03	8.04	10.40		
Display timeout	11.41											
Drive active	10.02	10.40										
Drive derivative	11.28											
Drive ok	10.01	8.27	8.07	8.17	10.36	10.40						
Dynamic performance	5.26											
Electronic nameplate	3.49											
Enable	6.15	8.09	8.10	6.29								
Encoder reference	3.43	3.44	3.45	3.46								
Encoder set up	3.33	3.34 to 3.42		3.47	3.48							
External trip	10.32	8.10	8.07									
Fan speed	6.45											
Fast disable	6.29											
Field weakening	5.22	1.06										
Filter change	6.19	6.18										
Speed reference selection	1.14	1.15										
Hard speed reference	3.22	3.23										
Current rating	5.07	11.32										
I/O sequencer	6.04	6.30	6.31	6.32	6.33	6.34	6.42	6.43	6.41			
Inertia compensation	2.38	5.12	4.22	3.18								
Jog reference	1.05	2.19	2.29									
Ke	5.33											
Keypad reference	1.17	1.14	1.43	1.51	6.12	6.13						
Kt	5.32											
Limit switches	6.35	6.36										
Line power supply loss	6.03	10.15	10.16	5.05								
Local position reference	13.20 to 13.23											
Logic function 1	9.01	9.04	9.05	9.06	9.07	9.08	9.09	9.10				

Feature	Parameter number (Pr)											
Logic function 2	9.02	9.14	9.15	9.16	9.17	9.18	9.19	9.20				
Low voltage supply	6.44	6.46										
Marker pulse	3.32	3.31										
Maximum speed	1.06											
Menu 0 set up	11.01 to 11.22		Menu 22									
Minimum speed	1.07	10.04										
Motor map	5.07	5.08	5.09	5.11								
Motor map 2	Menu 21		11.45									
Motorized potentiometer	9.21	9.22	9.23	9.24	9.25	9.26	9.27	9.28				
Offset speed reference	1.04	1.38	1.09									
Onboard PLC	11.47 to 11.51											
Open collector digital outputs	8.30											
Orientation	13.10	13.13 to 13.15										
Output	5.01	5.02	5.03									
Overspeed threshold	3.08											
Phase angle	3.25	5.12										
PID controller	Menu 14											
Position feedback - drive	3.28	3.29	3.30	3.50								
Positive logic	8.29											
Power up parameter	11.22	11.21										
Precision reference	1.18	1.19	1.20	1.44								
Preset speeds	1.15	1.21 to 1.28		1.16	1.14	1.42	1.45 to 1.48		1.50			
Programmable logic	Menu 9											
Ramp (accel / decel) mode	2.04	2.08	6.01	2.02	2.03	10.30	10.31	10.39				
Rated speed autotune	5.08											
Regenerating	10.10	10.11	10.30	10.31	6.01	2.04	2.02	10.12	10.39	10.40		
Relative jog	13.17 to 13.19											
Relay output	8.07	8.17	8.27									
Reset	10.33	8.02	8.22	10.34	10.35	10.36	10.01					
S ramp	2.06	2.07										
Safe Torque Off input	8.09	8.10										
Sample rates	5.18											
Security code	11.30	11.44										
Serial comms	11.23 to 11.26											
Skip speeds	1.29	1.30	1.31	1.32	1.33	1.34	1.35					
SMARTCARD	11.36 to 11.40		11.42									
Software version	11.29	11.34										
Speed controller	3.10 to 3.17		3.19	3.20	3.21							
Speed feedback	3.02	3.03	3.04									
Speed feedback - drive	3.26	3.27	3.28	3.29	3.30	3.31	3.42					
Speed reference selection	1.14	1.15	1.49	1.50	1.01							
Status word	10.40											
Supply	6.44	5.05	6.46									
Switching frequency	5.18	5.35	7.34	7.35								
Thermal protection - drive	5.18	5.35	7.04	7.05	7.06	7.32	7.35	10.18				
Thermal protection - motor	4.15	5.07	4.19	4.16	4.25	7.15						
Thermistor input	7.15	7.03	10.37									
Threshold detector 1	12.01	12.03 to 12.07										
Threshold detector 2	12.02	12.23 to 12.27										
Time - filter change	6.19	6.18										
Time - powered up log	6.20	6.21	6.28									
Time - run log	6.22	6.23	6.28									
Torque	4.03	5.32										
Torque mode	4.08	4.11	4.09	4.10								
Trip detection	10.37	10.38	10.20 to 10.29									
Trip log	10.20 to 10.29		10.41 to 10.51		6.28							
Under voltage	5.05	10.16	10.15									
Variable selector 1	12.08 to 12.15											
Variable selector 2	12.28 to 12.35											
Velocity feed forward	1.39	1.40										
Voltage controller	5.31											
Voltage mode	5.14	5.17										
Voltage rating	11.33	5.09	5.05									
Voltage supply	6.44	6.46	5.05									
Warning	10.19	10.12	10.17	10.18	10.40							
Zero speed indicator bit	3.05	10.03										

5.3 Menu 1: Speed reference

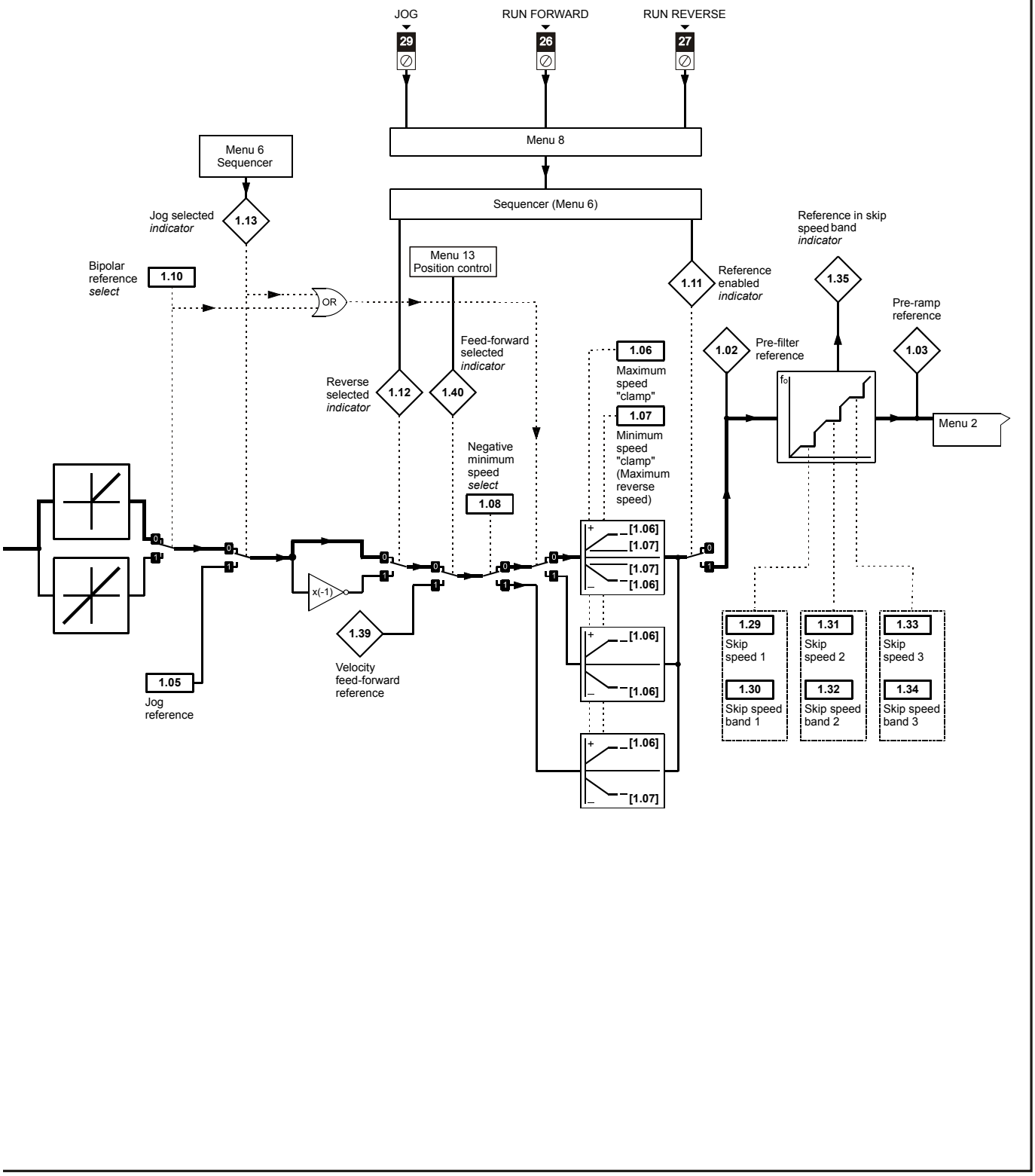
Menu 1 controls the main reference selection.

Figure 5-1 Menu 1 logic diagram



Pr 1.49	Pr 1.50	Reference being used
1	1	Analog reference 1
1	>1	Preset reference defined by Pr **1.50**
2	1	Analog reference 2
2	>1	Preset reference defined by Pr **1.50**
3	x	Preset reference defined by Pr **1.50**
4	x	Keypad reference
5	x	Precision reference

*Refer to Pr **1.14** on page 27.


JOG
RUN FORWARD
RUN REVERSE
29
26
27
Menu 8
Menu 6 Sequencer
Sequencer (Menu 6)
Jog selected indicator
1.13
Bipolar reference select
1.10
OR
Menu 13 Position control
Feed-forward selected indicator
1.40
Reverse selected indicator
1.12
1.11
Reference enabled indicator
Reference in skip speed band indicator
1.35
Pre-ramp reference
1.03
1.02
Pre-filter reference
fo
Menu 2
1.06
Maximum speed "clamp"
1.07
Minimum speed "clamp" (Maximum reverse speed)
Negative minimum speed select
1.08
x(-1)
1.39
Velocity feed-forward reference
1.05
Jog reference
[1.06]
[1.07]
[1.07]
[1.06]
[1.06]
[1.06]
[1.06]
[1.07]
1.29
Skip speed 1
1.30
Skip speed band 1
1.31
Skip speed 2
1.32
Skip speed band 2
1.33
Skip speed 3
1.34
Skip speed band 3

1.01	**Speed reference selected**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1	1		1		1				
Range	±SPEED_REF_MAX rpm															
Update rate	4ms write															

1.02	**Pre-skip filter reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1	1		1		1				
Range	±SPEED_REF_MAX rpm															
Update rate	4ms write															

1.03	**Pre-ramp reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1	1		1		1				
Range	±SPEED_REF_MAX rpm															
Update rate	4ms write															

1.04	**Reference offset**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1		
Range	±40,000.0 rpm															
Default	0															
Update rate	Background read when precision reference is active 4ms write otherwise															

See Pr **1.09** on page 26.

1.05	**Jog reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0 to 4,000.0 rpm															
Default	0.0															
Update rate	4ms read															

Reference used for jogging. See section 5.8 *Menu 6: Sequencer and clock* on page 88 for details on when the jog mode can be activated. The jog reference can be used for relative jogging in digital lock mode (see section 5.16 *Menu 13: Position control* on page 166).

1.06	**Maximum reference clamp**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1						1	1	1	
Range	±SPEED_LIMIT_MAX rpm															
Default	3,000.0															
Second motor parameter	Pr **21.01**															
Update rate	Background read															

See next page.

1.07	**Minimum reference clamp**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1					1	1	1		
Range	±SPEED_LIMIT_MAX rpm*															
Default	0.0															
Second motor parameter	Pr **21.02**															
Update rate	Background read															

*The range shown for Pr **1.07** shows the range used for scaling purposes (i.e. for routing to an analog output etc.). Further range restrictions are applied as given below.

Pr 1.08 (Neg min ref enable)	**Pr 1.10 (Bipolar mode enable)**	**Range**
0	0	0 to Pr **1.06**
0	1	0
1	0	-SPEED_LIMIT_MAX to 0 rpm
1	1	-SPEED_LIMIT_MAX to 0 rpm

The same limits are applied to Pr **21.02**, but based on the value of Pr **21.01**.

(If the second motor map is selected Pr **21.01** is used instead of Pr **1.06** and Pr **21.02** instead of Pr **1.07**)

1.08	**Negative minimum reference clamp enable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

The effects of the reference clamps (Pr **1.06** and **1.07**), the negative minimum clamp enable (Pr **1.08**) and the bipolar reference enable parameters are defined below.

The variable maximum limit for reference parameters, SPEED_REF_MAX, is defined as:

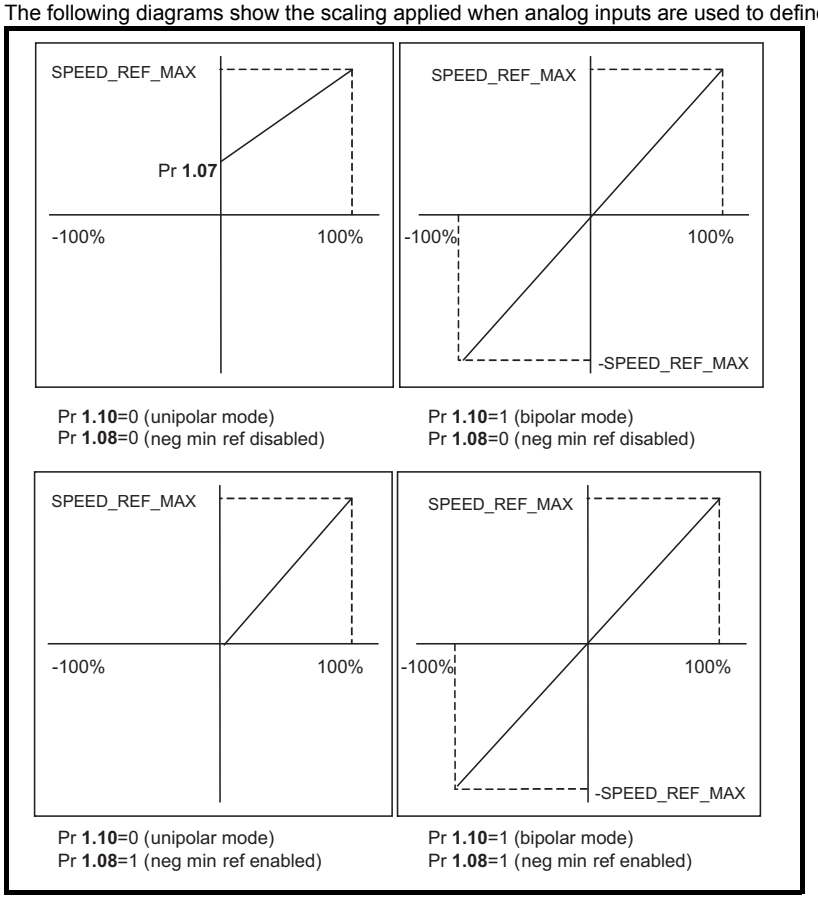
If Pr **1.08** = 0: SPEED_REF_MAX = Pr **1.06**

If Pr **1.08**=1: SPEED_REF_MAX is Pr **1.06** or -Pr **1.07** whichever is the largest

(If the second motor map is selected Pr **21.01** is used instead of Pr **1.06** and Pr **21.02** instead of Pr **1.07**)

Analog input scaling

The following diagrams show the scaling applied when analog inputs are used to define the reference and are routed via Pr **1.36** or Pr **1.37**.



Pr **1.10**=0 (unipolar mode)
Pr **1.08**=0 (neg min ref disabled)

Pr **1.10**=1 (bipolar mode)
Pr **1.08**=0 (neg min ref disabled)

Pr **1.10**=0 (unipolar mode)
Pr **1.08**=1 (neg min ref enabled)

Pr **1.10**=1 (bipolar mode)
Pr **1.08**=1 (neg min ref enabled)

Reference limits

With reference to the block diagram for Menu 1 (Figure 5-1 on page 22) the following table shows the limits applied to the reference by various blocks in the reference system. It should be noted that the minimum limit in the main reference limits block changes when either the jog reference or velocity feedforward references are active.

When one of these is active:

if Pr **1.08** = 0 the minimum = -Pr **1.06** [-Pr **21.01** for motor map 2],

if Pr **1.08** = 1 the minimum = -Pr **1.07** [-Pr **21.02** for motor map 2].

	Minimum	Maximum
Keypad control reference (Pr **1.17**)	Unipolar mode: Pr **1.07**, or 0 if Pr **1.07** < 0 Bipolar mode: -SPEED_REF_MAX	SPEED_REF_MAX
Bipolar/unipolar selector	Unipolar mode: Pr **1.07**, or 0 if Pr **1.07** < 0 Bipolar mode: no limit applied	No maximum limit applied
Main reference limits	Neg minimum ref disabled: -Pr **1.06** Neg minimum ref enabled: Pr **1.07**	Pr **1.06**

1.09	**Reference offset select**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read when precision reference is active 4ms read otherwise															

When this parameter is 0 the reference is given by

Pr **1.01** = selected reference x (100 + Pr **1.38**) / 100

and when this parameter is 1 the reference is given by

Pr **1.01** = selected reference + Pr **1.04**

1.10	**Bipolar reference enable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

See Pr **1.08** on page 25.

1.11	**Reference enabled indicator**															
1.12	**Reverse selected indicator**															
1.13	**Jog selected indicator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1		1				
Update rate	4ms read															

These parameters are controlled by the drive sequencer as defined in Menu 6. They select the appropriate reference as commanded by the drive logic. Pr **1.11** will be active if a run command is given, the drive is enabled and the drive is ok. This parameter can be used as an interlock in a Onboard PLC or SM-Applications program to show that the drive is able to respond to a speed or torque demand.

1.14	**Reference selector**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 5															
Default	0 (A1.A2)															
Second motor parameter	Pr **21.03**															
Update rate	4ms read															

Pr **1.14** defines how the value of Pr **1.49** is derived as follows:

Value of Pr 1.14	Display String	Pr 1.49
0	A1.A2 (Analog ref 1. Analog ref 2)	*Selected by terminal input
1	A1.Pr (Analog ref 1. Preset speeds)	1
2	A2.Pr (Analog ref 2. Preset speeds)	2
3	Pr (Preset speeds)	3
4	Pad (Keypad reference)	4
5	Prc (Precision reference)	5

*Pr **1.41** to Pr **1.44** can be controlled by digital inputs to force the value of Pr **1.49**:

all bits equal to zero gives 1,

Pr **1.41** = 1 then Pr **1.49** = 2
Pr **1.42** = 1 then Pr **1.49** = 3
Pr **1.43** = 1 then Pr **1.49** = 4
Pr **1.44** = 1 then Pr **1.49** = 5

The bit parameters with lower numbers have priority over those with higher numbers.

Pr **1.49** and Pr **1.50** then define the reference as follows:

Pr 1.49	Pr 1.50	Reference
1	1	Analog reference 1 (Pr **1.36**)
1	>1	Preset defined by Pr **1.50** (Pr **1.21** to Pr **1.28**)
2	1	Analog reference 2 (Pr **1.37**)
2	>1	Preset defined by Pr **1.50** (Pr **1.21** to Pr **1.28**)
3	x**	Preset defined by Pr **1.50** (Pr **1.21** to Pr **1.28**)
4	x**	Keypad reference (Pr **1.17**)
5	x**	Precision reference (Pr **1.18** and Pr **1.19**)

** x = any value

Keypad reference

If Keypad reference is selected the drive sequencer is controlled directly by the keypad keys and the keypad reference parameter (Pr **1.17**) is selected. The sequencing bits, Pr **6.30** to Pr **6.34**, have no effect and jog is disabled.

1.15	Preset selector															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 9															
Default	0															
Update rate	4ms read															

Pr **1.15** defines how the value of Pr **1.50** is derived as follows:

Value of Pr 1.15	Pr 1.50
0	Selected by terminal input*
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	Selected by timer**

*Pr **1.45** to Pr **1.47** can be controlled by digital inputs to define the value of Pr **1.50** as follows:

The presets are selected automatically in turn. Pr **1.16 defines the time between each change.

Pr 1.47	Pr 1.46	Pr 1.45	Pr 1.50
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

Pr **1.49** and Pr **1.50** then define the reference as follows:

Pr 1.49	Pr 1.50	Reference
1	1	Analog reference 1 (Pr **1.36**)
1	>1	Preset defined by Pr **1.50** (Pr **1.21** to Pr **1.28**)
2	1	Analog reference 2 (Pr **1.37**)
2	>1	Preset defined by Pr **1.50** (Pr **1.21** to Pr **1.28**)
3	x	Preset defined by Pr **1.50** (Pr **1.21** to Pr **1.28**)
4	x	Keypad reference (Pr **1.17**)
5	x	Precision reference (Pr **1.18** and Pr **1.19**)

1.16	Preset reference selector timer															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0 to 400.0 s															
Default	10.0															
Update rate	Background read															

This parameter defines the time between preset reference changes 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 control mode reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1			1		1				1
Range	±SPEED_REF_MAX rpm															
Default	0.0															
Update rate	4ms read															

The drive can be controlled from the keypad if Pr **1.14** is set to 4. The Stop and Run keys automatically become active (the Reverse key may be optionally enabled with Pr **6.13**). The speed reference is defined by Pr **1.17**. This is a read only parameter that can only be adjusted in status mode by pressing the Up or Down keys. If keypad control mode is selected, then pressing the Up or Down keys in status mode will cause the drive to automatically display the keypad reference and adjust it in the relevant direction. This can be done whether the drive is disabled or running. If the Up or Down keys are held the rate of change of keypad reference increases with time.

See also Pr **1.51** on page 33 (*Power-up keypad control mode reference*).

1.18	**Precision reference coarse**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1						1	1		
Range	±SPEED_REF_MAX rpm															
Default	0.0															
Update rate	Background read															

See below.

1.19	**Precision reference fine**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 0.099 rpm															
Default	0.000															
Update rate	Background read															

The speed reference resolution is restricted to 0.1rpm from normal parameters, but the resolution can be improved by using the precision reference. Pr **1.18** defines the coarse part of reference (either positive or negative) with a resolution of 0.1rpm and Pr **1.19** defines the fine part of the reference (always positive) with a resolution of 0.001rpm. The final reference is given by Pr **1.18** + Pr **1.19**. Therefore Pr **1.19** increases positive reference away from zero, and decreases negative references towards zero.

1.20	**Precision reference update disable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	Background read															

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 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**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1						1	1		
Range	±SPEED_REF_MAX rpm															
Default	0.0															
Update rate	4ms read															

1.29	**Skip reference 1**															
1.31	**Skip reference 2**															
1.33	**Skip reference 3**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 40,000 rpm															
Default	0															
Update rate	Background read															

See below.

1.30	**Skip reference band 1**															
1.32	**Skip reference band 2**															
1.34	**Skip reference band 3**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 250 rpm															
Default	5															
Update rate	Background read															

Three skip references are available to prevent continuous operation at a speed that would cause mechanical resonance. When a skip reference parameter is set to 0 that filter is disabled. The skip reference band parameters define the speed range either side of the programmed skip reference, over which references are rejected. The actual reject band is therefore twice that programmed in these parameters, the skip reference 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 reference is always less than demanded.

1.35	**Reference in rejection zone**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4ms write															

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

1.36	**Analog reference 1**															
1.37	**Analog reference 2**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1	1		1						
Range	±SPEED_REF_MAX rpm															
Default	0															
Update rate	4ms write															

Although most parameters can be controlled from analog inputs, these two parameters are a special case in that if an analog input is directed to one of these parameters, the scan rate of that analog input is increased to 250µs as long as:

1. The reference must be derived via Pr **1.36** or Pr **1.37**
2. The analog inputs must be in voltage mode with zero offset
3. Bipolar mode must be used or unipolar mode with the minimum speed (Pr **1.07**) set to zero
4. No skip bands are enabled, i.e. Pr **1.29**, Pr **1.31** and Pr **1.33** must be zero.
5. The jog and velocity feed-forward references must not be enabled.

These are special parameters when a non-bit type quantity uses these parameters as a destination (not just from analog inputs). The scaling and limiting applied is as described with Pr **1.08** on page 25.

1.38	**Percentage trim**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2			1				1		
Range	±100.00 %															
Default	0.00															
Update rate	4ms read															

See Pr **1.09** on page 26.

1.39	**Velocity feed forward**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1		1		1				
Range	±40,000.0 rpm															
Update rate	4ms read															

This parameter indicates the velocity feed forward reference when position control is used (see section 5.16 *Menu 13: Position control* on page 166).

1.40	**Velocity feed forward select**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4ms write															

This bit indicates that the position controller has selected the velocity feed forward as a reference for the drive.

1.41	**Analog reference 2 select**															
1.42	**Preset reference select**															
1.43	**Keypad reference select**															
1.44	**Precision reference select**															
1.45	**Preset reference 1 select**															
1.46	**Preset reference 2 select**															
1.47	**Preset reference 3 select**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

Pr **1.41** to Pr **1.44** control Pr **1.49**. The priority order is Pr **1.44** (highest), Pr **1.43**, Pr **1.42**, Pr **1.41** (lowest). If more than one parameter is active, the highest priority takes precedence.

Pr **1.41** = 1 forces Pr **1.49** = 2 (see table in Pr **1.14** on page 27 and Pr **1.15** on page 28)
Pr **1.42** = 1 forces Pr **1.49** = 3 (always selects preset references)
Pr **1.43** = 1 forces Pr **1.49** = 4 (always selects keypad control mode)
Pr **1.44** = 1 forces Pr **1.49** = 5 (always selects precision reference)

Pr **1.45** to Pr **1.47** control Pr **1.50.**

Pr **1.45** controls Pr **1.50** bit 0*
Pr **1.46** controls Pr **1.50** bit 1*
Pr **1.47** controls Pr **1.50** bit 2*

*See the description with Pr **1.14** and Pr **1.15** on page 28 for more information.

1.48	**Reference timer reset flag**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	Background read															

When this flag is set the preset timer for auto preset timer mode (Pr **01.15** = 9) is reset and preset 1 is selected. This can be used to start a new sequence of reference selection by a programmable input terminal or function. When this bit is zero the preset selection will follow the timer even when the drive is disabled.

1.49	**Reference selected indicator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	1 to 5															
Update rate	4ms write															

Indicates the reference currently selected.

1.50	**Preset reference selected indicator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	1 to 8															
Update rate	4ms write															

Indicates the preset reference currently being selected.

1.51	**Power-up keypad control mode reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 2															
Default	0															
Update rate	N/A															

Selects the value of the keypad control mode (Pr **1.17**) at power-up as follows:

0 rESEt zero

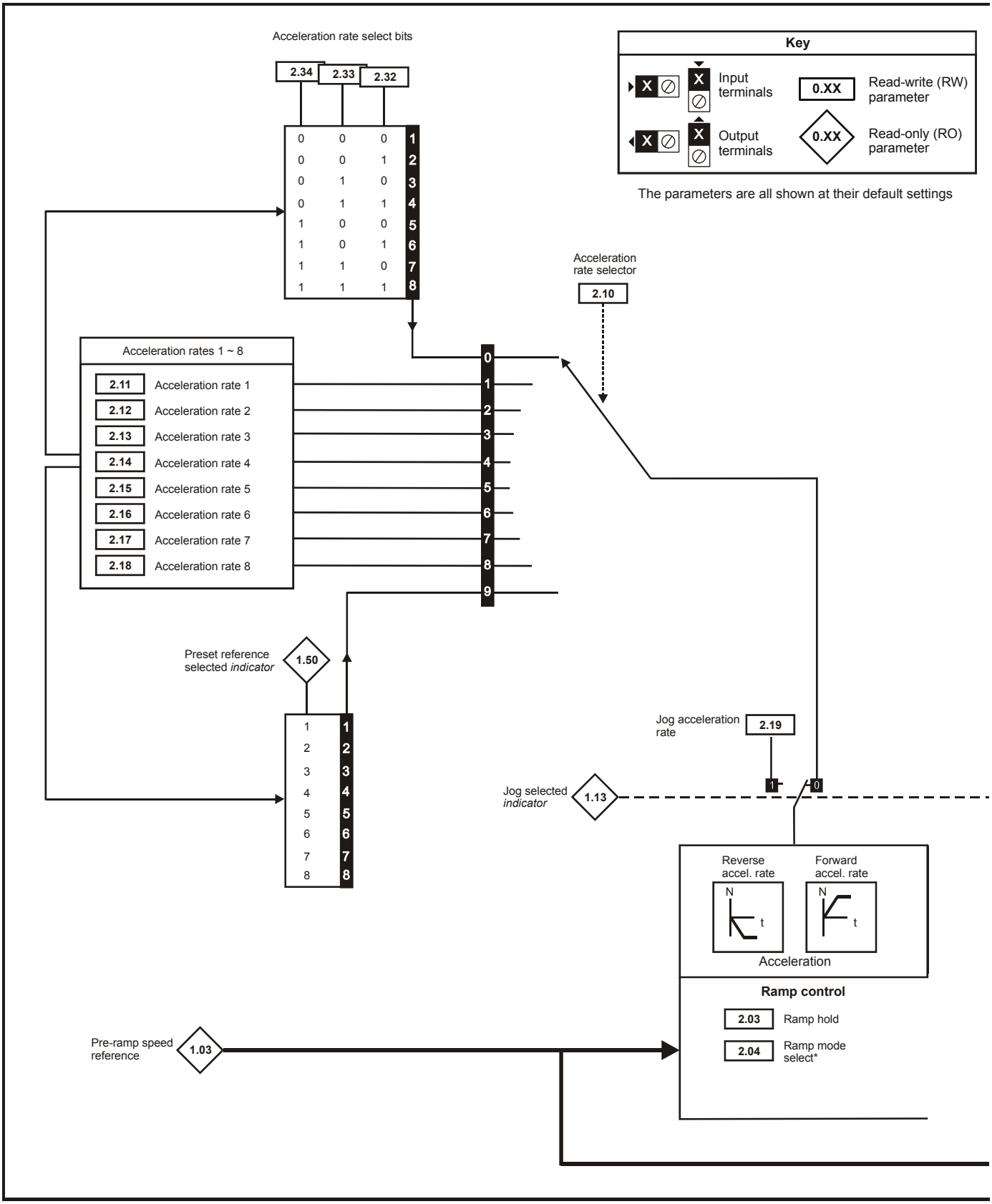
1 LASt last value used before power-down

2 PrS1 Preset 1, Pr **1.21**, before power-down

5.4 Menu 2: Ramps

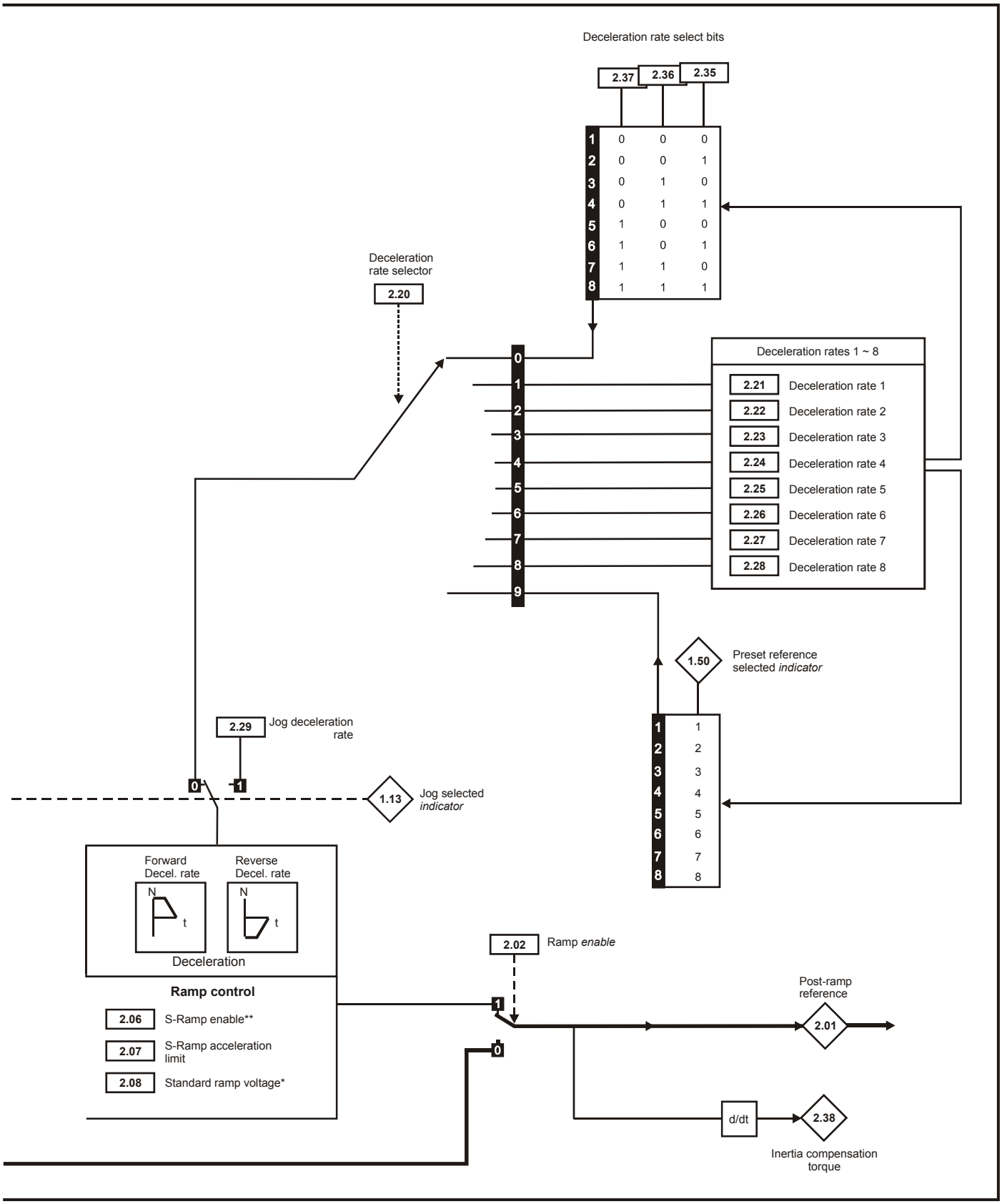
The pre-ramp speed reference passes through the ramp block controlled by menu 2 before being used by the drive as an input to the speed controller. The ramp block includes: linear ramps, an S ramp function for ramped acceleration and deceleration, deceleration ramp control to prevent rises in the DC bus voltage within the drive that would cause an over-voltage trip if no braking resistor is installed.

Figure 5-2 Menu 2 logic diagram



* For more information refer to Pr **2.04** on page 36.

** For more information refer to Pr **2.06** on page 37.



2.01	**Post ramp reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1	1		1		1				
Range	±SPEED_REF_MAX rpm															
Update rate	4ms write															

2.02	**Ramp enable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1	1	
Default	1															
Update rate	4ms read															

2.03	**Ramp hold**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

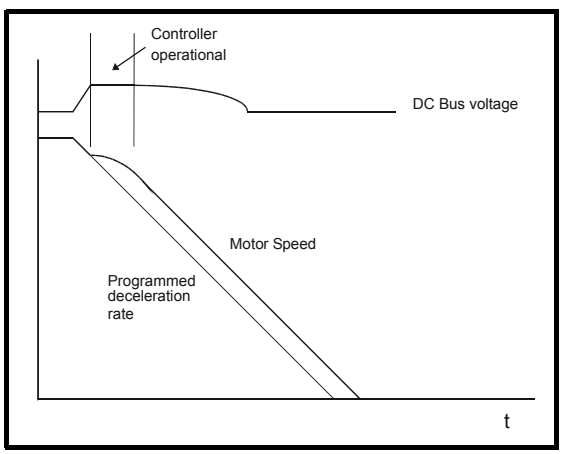
If this bit is set the ramp will be held. If S ramp is enabled the acceleration will ramp towards zero causing the ramp output to curve towards a constant speed. If a drive stop is demanded the ramp hold function is disabled.

2.04	**Ramp mode select**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 1															
Default	1															
Update rate	4ms read															

This parameter does not affect the acceleration ramp, and the ramp output always rises at the programmed acceleration rate subject to the current limits. If the drive attempts to stop the motor with an overhauling load, the motor will not stop when standard ramp mode or fast ramp mode is used. If the drive is in the deceleration state the rate of fall of the speed is monitored. If this does not fall for 10 seconds the drive forces the speed reference to zero. This only applies when the drive is in the deceleration state and not when the reference is simply set to zero. If the speed reference is just set to zero with an overhauling or very high inertia load, then the drive may not decelerate.

0: Fast ramp
Fast ramp is used where the deceleration follows the programmed deceleration rate subject to current limits.

1: Standard ramp
Standard ramp is used during deceleration if the voltage rises to the standard ramp level (Pr **2.08**). It causes a controller to operate, the output of which changes the demanded load current in the motor. As the controller regulates the DC 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. If the standard ramp voltage (Pr **2.08**) is set lower than the nominal DC bus level the drive will not decelerate the motor, but it will coast to rest. The output of the ramp controller (when active) is a current demand that is fed to the torque producing current controller. The gain of these controllers can be modified with Pr **4.13** and Pr **4.14**.



2.06	**S ramp enable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

Setting this parameter enables the S ramp function. S ramp is disabled during deceleration when the standard ramp voltage controller is active. When the motor is accelerated again after decelerating in standard ramp the acceleration ramp used by the S ramp function is reset to zero.

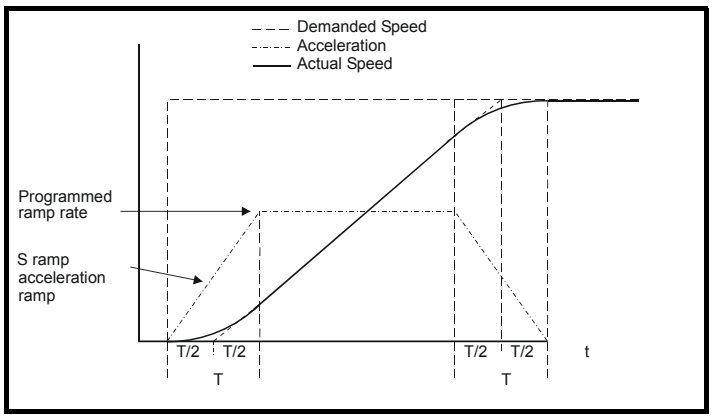
2.07	**S ramp acceleration limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 100.000 s^2/1,000rpm															
Default	0.030															
Update rate	Background read															

This parameter defines the maximum rate of change of acceleration/deceleration. If the S ramp is disabled (Pr **2.06** = 0) a linear ramp is used and the time in seconds taken for the ramp output to change by speed (Δ w*) is given by:

$T_{Ramp} = \Delta w^* \times A / 1000$

Where A is the selected ramp rate in s / 1000rpm

If the S ramp is enabled (Pr **2.06** = 1) then the ramp time is extended as shown in the diagram below.



The time taken in seconds for the ramp output to change by speed (Δw^*) is given below. Two cases are given because the total ramp time must be calculated with a different equation depending on whether the acceleration is able to reach the selected ramp rate (A) or not. If the required change is small the selected ramp rate is not reached and the ramp does not include the central linear ramp region. If the required change is larger the ramp does include the central linear region as shown in the diagram above.

$\Delta w^*_{linear} = 1000 \times J / A^2$

where:

A is the selected ramp rate in s / 1000rpm

J is Pr **2.07**, the S ramp acceleration limit in s^2 / 1000rpm

If the required change is less than Δw^*_{linear} then T_{Ramp1} should be used, but if the speed change is greater or equal to Δw^*_{linear} T_{Ramp2} should be used.

$T_{Ramp1} = 2 \sqrt{(\Delta w^* \times J / 1000)}$

$T_{Ramp2} = (\Delta w^* \times A / 1000) + (J / A)$

The default values for the ramp rate and S ramp acceleration limit have been chosen such that for the default maximum speed, the curved parts of the S ramp are 25% of the original ramp if S ramp is enabled. Therefore the ramp time is increased by a factor of 1.5.

2.08	**Standard ramp voltage**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1			1				1	1	1	
Range	0 to DC_VOLTAGE_SET_MAX V															
Default	200V rating drive: 375 400V rating drive: EUR: 750 / USA: 775															
Update rate	Background read															

This voltage is used as the control level for standard ramp mode. If 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 the drive may give an OU trip. 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 line voltage x $\sqrt{2}$.

2.10	**Acceleration rate selector**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 9															
Default	0															
Update rate	4ms read															

The acceleration rate is selected as follows.

0 Ramp rate selection by terminal input
1 - 8 Ramp rate defined by parameter number, i.e. 1 = Pr **2.11**, 2 = Pr **2.12**, etc.
9 Ramp rate selection by Pr **1.50**

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 defined by
0	0	0	Pr **2.11**
0	0	1	Pr **2.12**
0	1	0	Pr **2.13**
0	1	1	Pr **2.14**
1	0	0	Pr **2.15**
1	0	1	Pr **2.16**
1	1	0	Pr **2.17**
1	1	1	Pr **2.18**

When Pr **2.10** is set to 9 the appropriate acceleration rate is automatically selected depending on the value of Pr **1.50**, and so an acceleration rate can be programmed to operate with each reference. Since the new ramp rate is selected with the new reference, the acceleration applies towards the selected preset if the motor needs to accelerate to reach the preset.

2.11	**Acceleration rate 1**															
2.12	**Acceleration rate 2**															
2.13	**Acceleration rate 3**															
2.14	**Acceleration rate 4**															
2.15	**Acceleration rate 5**															
2.16	**Acceleration rate 6**															
2.17	**Acceleration rate 7**															
2.18	**Acceleration rate 8**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 3,200.000 s/1000rpm															
Default	0.200															
Second motor parameter	Pr **21.04** for Pr **2.11** only															
Update rate	4ms read															

If an acceleration rate is selected where the parameter is set to 0.000 the acceleration ramp is disabled and the reference changes instantly to its new value during acceleration.

2.19	**Jog acceleration rate**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.000 to 3200.000 s/1000rpm															
Default	0.000															
Update rate	Background read															

The jog acceleration rate is only used when accelerating towards the jog reference and when changing the jog reference.

2.20	**Deceleration rate selector**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 9															
Default	0															
Update rate	4ms read															

The acceleration rate is selected as follows:

0 Ramp rate selection by terminal input
1 - 8 Ramp rate defined by parameter number, i.e. 1 = Pr **2.21**, 2 = Pr **2.22**, etc.
9 Ramp rate selection by Pr **1.50**

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:

02.37	02.36	02.35	Ramp defined by
0	0	0	Pr **2.21**
0	0	1	Pr **2.22**
0	1	0	Pr **2.23**
0	1	1	Pr **2.24**
1	0	0	Pr **2.25**
1	0	1	Pr **2.26**
1	1	0	Pr **2.27**
1	1	1	Pr **2.28**

When Pr **2.20** is set to 9 the appropriate deceleration rate is automatically selected depending on the value of Pr **1.50**, and so a deceleration rate can be programmed to operate with each reference. Since the new ramp rate is selected with the new reference, the deceleration applies towards the selected preset if the motor needs to decelerate to reach the preset.

2.21	**Deceleration rate 1**															
2.22	**Deceleration rate 2**															
2.23	**Deceleration rate 3**															
2.24	**Deceleration rate 4**															
2.25	**Deceleration rate 5**															
2.26	**Deceleration rate 6**															
2.27	**Deceleration rate 7**															
2.28	**Deceleration rate 8**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 3,200.000 s/1000rpm															
Default	0.200															
Second motor parameter	Pr **21.05** for Pr **2.21** only															
Update rate	4ms read															

If an deceleration rate is selected where the parameter is set to 0.000 the deceleration ramp is disabled and the reference changes instantly to its new value during deceleration.

2.29	**Jog deceleration rate**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 3,200.000 s/1000rpm															
Default	0.000															
Update rate	Background read															

The jog deceleration rate is only used when the drive is changing speed because the jog reference has changed or to stop from the jog reference. It is not used to go from the jog to the run state. This prevents the fast ramps normally used with jog from being used when changing between running and jogging.

2.32	**Acceleration select bit 0**															
2.33	**Acceleration select bit 1**															
2.34	**Acceleration select bit 2**															
2.35	**Deceleration select bit 0**															
2.36	**Deceleration select bit 1**															
2.37	**Deceleration select bit 2**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Update rate	4ms read															

These bits are provided for control by logic input terminals for external ramp selection (see Pr **2.10** and Pr **2.20**).

2.38	**Inertia compensation torque**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1		1		1				
Range	±1,000.0 %															
Update rate	4ms write															

The motor and load inertia (Pr **3.18**), motor torque per amp (Pr **5.32**) and the rate of change of the ramp output (Pr **2.01**) are used to produce a torque feed forward value that should accelerate or decelerate the load at the required rate. This value can be used as a feed forward term that is added to the speed controller output if Pr **4.22** is set to one. Pr **2.38** shows the torque value as a percentage of rated active current.

5.5 Menu 3: Speed feedback and speed control

Menu 3 relates to different functions which are:-

- Speed feedback
- Speed controller
- “Zero speed”, “at speed” and overspeed detectors
- Drive encoder.

Speed accuracy and resolution

Digital reference resolution

When a preset speed is used the reference resolution is 0.1rpm. Improved resolution can be obtained by using the precision reference (0.001rpm).

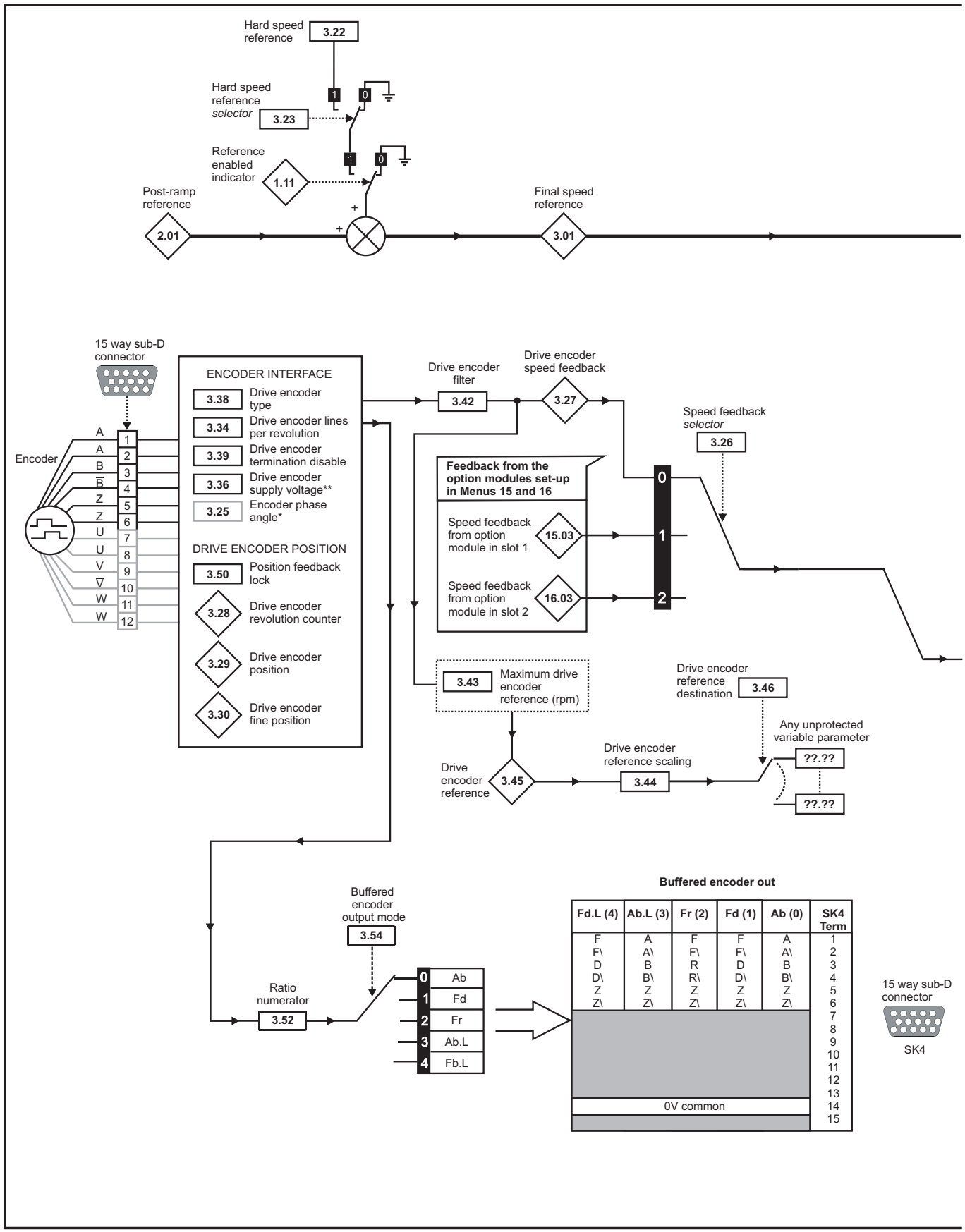
Analog reference resolution

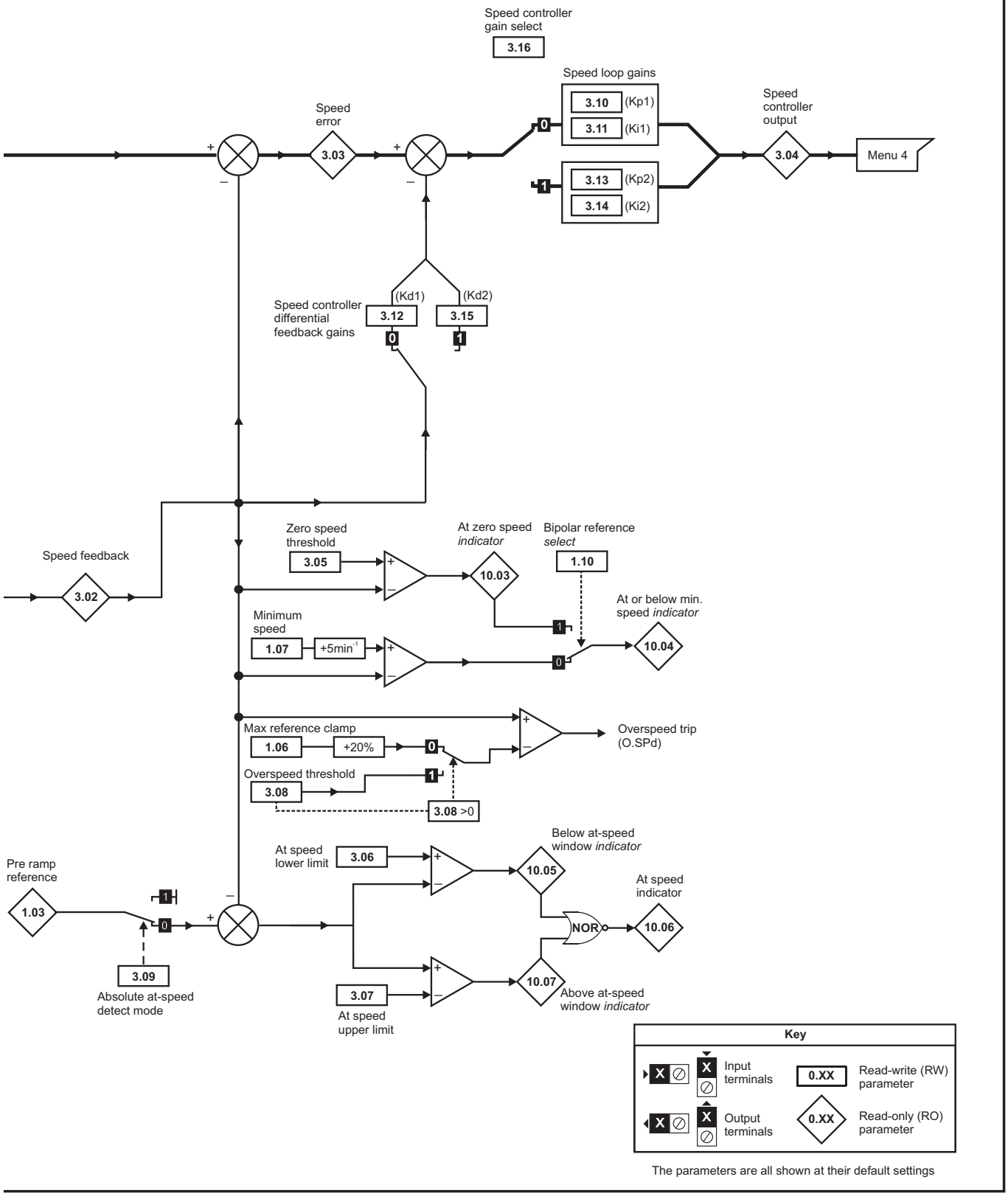
The resolution from analog input 1 is better than 16bits plus sign provided the speed reference is routed via Pr **1.36**, Pr **1.37** or Pr **3.22** in high speed update mode. The resolution from analog inputs 2 or 3 is 10bits plus sign.

Accuracy

The absolute speed accuracy depends on the accuracy of the crystal used with the drive microprocessor. The accuracy of the crystal is 100ppm, and so the absolute speed accuracy is 100ppm (0.01%) of the reference, when a preset speed is used. If an analog input is used the absolute accuracy is further limited by the absolute accuracy and non-linearity of the analog input.

Figure 5-3 Menu 3 Logic diagram





The parameters are all shown at their default settings

3.01	**Final speed reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	1	1		1		1				
Range	±SPEED_MAX rpm															
Update rate	4ms write															

This is the 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**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	1	1		1		1				
Range	±SPEED_MAX rpm															
Update rate	4ms write															

The speed feedback can be taken from the drive encoder port or a position feedback module installed in any slot as selected with Pr **3.26**. Pr **3.02** shows the level of the speed feedback selected for the speed controller. The FI attribute is set for this parameter, so display filtering is active when this parameter is viewed with one of the drive keypads. The value held in the drive parameter (accessible via comms or a Solutions Module) does not include this filter, but is a value that is obtained over a sliding 16ms period to limit the ripple seen in this parameter value. The speed feedback value includes encoder quantization ripple given by the following equation:

Ripple in Pr **3.02** = 60 / 16ms / (ELPR x 4)

where ELPR is the equivalent encoder lines per revolution as defined below.

Position feedback device	ELPR
Ab, Ab.Servo	number of lines per revolution
Fd, Fr, Fd.Servo, Fr.Servo	number of lines per revolution / 2
SC.Hiper, SC.EnDat, SC, SC.SSI	number of sine waves per revolution

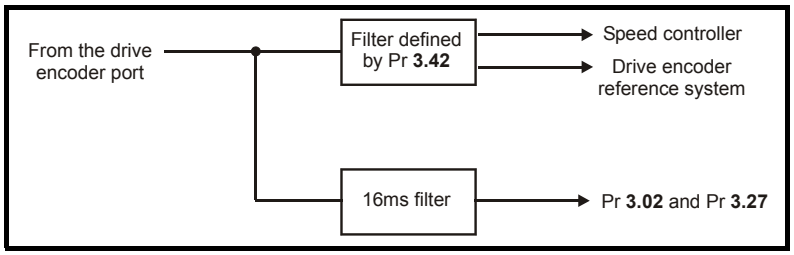
For example a 4096 line Ab type encoder gives a ripple level of 0.23rpm.

The 16ms sliding window filter is always applied to the value shown in Pr **3.02**, but this sliding window filter is not normally applied to the actual speed feedback used by the speed controller or the drive encoder reference system (Pr **3.43** to Pr **3.46**).The user may apply a filter to the speed controller input and the drive encoder reference system input if required by setting Pr **3.42** to the required filter time. The encoder ripple seen by the speed controller is given by:

Encoder speed ripple = 60 / Filter time / (ELPR x 4)

If Pr **3.42** is set to zero (no filter) the ripple seen by the speed controller and drive encoder reference system is given by:

Encoder speed ripple = 60 / 250µs / (ELPR x 4)



The diagram above shows the filter arrangement. It should be noted that the same filtering is provided at the speed controller input and for Pr **3.02** when the feedback is obtained from a Solutions Module, but the variable length window filter is controlled by Pr **x.19**.

It is not advisable to use the speed feedback filter unless it is specifically required for high inertia applications with high controller gains, or if a commutation signal only encoder is used, because the filter has a non-linear transfer function. It is preferable to use the current demand filters (see Pr **4.12** or **4.23**) as these are linear first order filters that provide filtering on noise generated from both the speed reference and the speed feedback. It should be noted that any filtering included within the speed controller feedback loop, either on the speed feedback or the current demand, introduces a delay and limits the maximum bandwidth of the controller for stable operation.

The speed ripple can be quite high, for example with a 4096 line encoder the speed ripple is 14.6rpm, but this does not define the resolution of the speed feedback which is normally much better and depends on the length of the measuring period used to obtain the feedback. This is shown in the improved resolution of the value accessible in Pr **3.02** which is measured over 16ms, i.e. a resolution of 0.23rpm with a 4096 line encoder. The speed controller itself accumulates all pulses from the encoder, and so the speed controller resolution is not limited by the feedback, but by the resolution of the speed reference. If a SINCOS encoder is used the encoder speed ripple is reduced by a factor of $2^{(2 - \text{INTERPOLATION BITS})}$ For example with the nominal 10 bits of interpolation information, the speed ripple is reduced by a factor of 256. This shows how a SINCOS encoder can reduce noise caused by encoder quantization without any filtering in the speed feedback or the current demand, so that high gains may be used to give high dynamic performance and a very stiff system.

3.03	**Speed error**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	1	1		1		1				
Range	±SPEED_MAX rpm															
Update rate	4ms write															

The speed error is the difference between the final speed demand and the speed feedback in rpm. This does not include the effect of the D term in the speed controller feedback branch.

3.04	**Speed controller output**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	1	1		1		1				
Range	±TORQUE_PROD_CURRENT_MAX %															
Update rate	4ms write															

The output of the speed regulator is a torque demand given as a percentage of rated motor torque. This is then modified to account for changes in motor flux if field weakening is active, and then used as the torque producing current reference.

3.05	**Zero speed threshold**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 200 rpm															
Default	5															
Update rate	Background read															

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**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 40,000 rpm															
Default	5															
Update rate	Background read															

3.07	**At speed upper limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 40,000 rpm															
Default	5															
Update rate	Background read															

"At speed" flag (Pr **10.06**) is set if the speed feedback (Pr **3.02**) is on the boundaries or within the at speed window. Flags Pr **10.07** and Pr **10.05** are set if the reference is above or below the window respectively.

If Pr **3.09 =** 0 reference window mode is used and the "at speed" condition is true if

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

(If the lower limit is less than zero then zero is used as the lower limit.)

If Pr **3.09 =** 1 absolute window mode is used and the "at speed" condition is true if

Pr **3.06** ≤ |Pr **3.02**| ≤ Pr **3.07**

3.08	**Overspeed threshold**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 40,0000 rpm															
Default	0															
Update rate	Background read															

If the speed feedback (Pr **3.02**) exceeds this level in either direction an overspeed trip is produced. If this parameter is set to zero the overspeed threshold is automatically set to 1.2 x SPEED_REF_MAX.

The motor speed and the motor voltage can be monitored to detect that the motor is accelerating in an uncontrolled way because the motor phasing angle has not been set up correctly in Pr **3.25** (Pr **21.20** if motor map 2 is selected). If the overspeed threshold is set to zero phasing angle error monitoring is enabled. If the overspeed threshold is set to any other value this feature is disabled.

3.09	**Absolute “at speed” detect**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

See Pr **3.06** and Pr **3.07** on page 45.

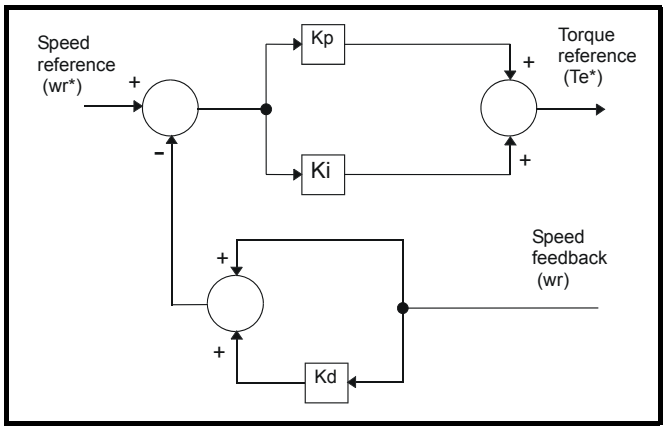
3.10	**Speed controller proportional gain (Kp1)**															
3.13	**Speed controller proportional gain (Kp2)**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							4						1	1	1	
Range	0.0000 to 6.5535 (1/ rad s^{-1})															
Default	0.0100															
Second motor parameter	Pr **21.17**															
Update rate	Background read															

3.11	**Speed controller integral gain (Ki1)**															
3.14	**Speed controller integral gain (Ki2)**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 655.35 s/rad s^{-1}															
Default	1.00															
Second motor parameter	Pr **21.18**															
Update rate	Background read															

3.12	**Speed controller differential feedback gain (Kd1)**															
3.15	**Speed controller differential feedback gain (Kd2)**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							5						1	1	1	
Range	0.00000 to 0.65535 s^{-1}/rad s^{-1}															
Default	0.00000															
Second motor parameter	Pr **21.19**															
Update rate	Background read															

3.16	**Speed controller gain select**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

The following diagram shows a generalised representation of the speed controller. The controller includes proportional (Kp) and integral (Ki) feed-forward terms, and a differential (Kd) feedback term. The drive holds two sets of these gains and either set may be selected for use by the speed controller with Pr **3.16**. If Pr **3.16** = 0, gains Kp1, Ki1 and Kd1 are used, if Pr **3.16** = 1, gains Kp2, Ki2 and Kd2 are used. Pr **3.16** may be changed when the drive is enabled or disabled.



Proportional gain (Kp)

If Kp has a value and Ki is set to zero the controller will only have a proportional term, and there must be a speed error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual speeds. This effect, called regulation, depends on the level of the proportional gain, the higher the gain the smaller the speed error for a given load. If the proportional gain is too high either the acoustic noise produced by speed feedback quantisation (using digital encoders, resolvers, etc.) becomes unacceptable, or the closed-loop stability limit is reached (using SINCOS encoders).

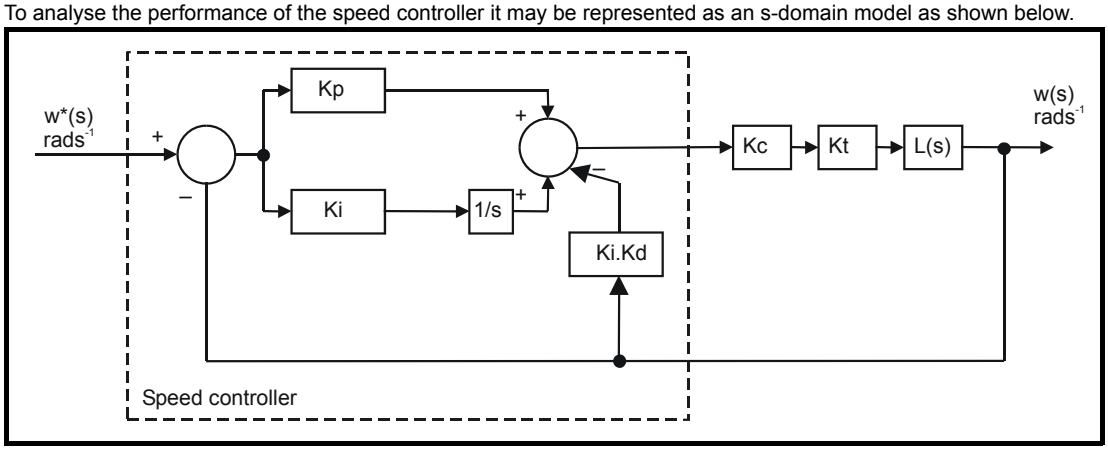
Integral gain (Ki)

The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of the system, i.e. it reduces the positional displacement produced by applying a load torque to the motor. Unfortunately increasing the integral gain also reduces the system damping giving overshoot after a transient. For a given integral gain the damping can be improved by increasing the proportional gain. A compromise must be reached where the system response, stiffness and damping are all adequate for the application. The integral term is implemented in the form of $\sum$(Ki x error), and so the integral gain can be changed when the controller is active without causing large torque demand transients.

Differential gain (Kd)

The differential gain is provided in the feedback of the speed controller to give additional damping. The differential term is implemented in a way that does not introduce excessive noise normally associated with this type of function. Increasing the differential term reduces the overshoot produced by under-damping, however, for most applications the proportional and integral gains alone are sufficient. It should be noted that the differential term is limited internally so that it is ineffective if speed in rpm x Kd x Ki is greater than 170.

To analyse the performance of the speed controller it may be represented as an s-domain model as shown below.



Where:

Kc is the conversion between the speed controller output and the torque producing current. A value of unity at the output of the speed controller gives a torque producing current equal to Kc. The drive automatically compensates the torque producing current for flux variations in field weakening, and so Kc can be assumed to have a constant value even in field weakening. See menu 4 for the value of Kc each drive size).

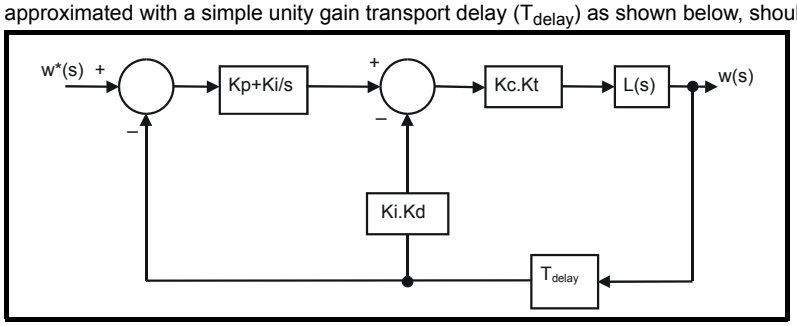
Kt is the torque constant of the motor (i.e. torque in Nm per amp of torque producing current). This value is normally available for a servo motor from the manufacturer, however for induction motors the value must be calculated from

Kt = Motor rated torque / Motor rated torque producing current

= Motor rated torque / $\sqrt{(\text{Motor rated current}^2 - \text{No load current}^2)}$

L(s) is the transfer function of the load.

The s-domain system above may be used to determine the performance of systems with a relatively low bandwidth. However, the real drive system also includes non-ideal delays due to the torque controller response, and speed measurement and control delays. These delays, which can be approximated with a simple unity gain transport delay (T_{delay}) as shown below, should be taken into account for more accurate results.



3.17	Speed controller set-up method															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 3															
Default	0															
Update rate	Background (1s) read															

The user may enter the required speed controller gains into Pr **3.10** to Pr **3.15.** However, if the load is predominantly a constant inertia and constant torque, the drive can calculate the required Kp and Ki gains, provided a value of motor plus load inertia (Pr **3.18**) and the motor torque per amp (Pr **5.32**) are set-up correctly. The gain values are calculated to give a required compliance angle or bandwidth. The calculated values for Kp and Ki are written to Pr **3.10** and Pr **3.11** once per second when one of these set-up methods is selected (i.e. Pr **3.17** = 1 or 2). The values are calculated from a linear model assuming a pure inertia load, not including unwanted delays in the speed and current controllers. The Kd gain is not affected. If Pr **3.17** is set to 3 automatic gain set up is not active, but Kp is boosted by a factor of 16.

0: user set-up

With the default value the user should enter the required speed controller gains.

1: Bandwidth set-up

If bandwidth based set-up is required the following parameters must be set correctly: Pr **3.20** = required bandwidth, Pr **3.21** = required damping factor, Pr **3.18** = motor + load inertia (it is possible to measure the load inertia as part of the auto-tuning process, see Pr **5.12** on page 81), Pr **5.32** = motor torque per amp.

$Ki = J / (Kc \times Kt) \times (2\pi \times \text{Bandwidth} / Kbw)^2 = \text{Pr } \mathbf{3.18} / (Kc \times \text{Pr } \mathbf{5.32}) \times (2\pi \times \text{Pr } \mathbf{3.20} / Kbw)^2$

Where: $Kbw = \sqrt{[(2\xi^2 + 1) + \sqrt{((2\xi^2 + 1)^2 + 1)}]}$

$Kp = 2 \xi \sqrt{[(Ki \times J) / (Kc \times Kt)]} = 2 \xi \sqrt{[(\text{Pr } \mathbf{3.11} \times \text{Pr } \mathbf{3.18}) / (Kc \times \text{Pr } \mathbf{5.32})]}$

2: Compliance angle set-up

If compliance angle based set-up is required the following parameters must be set correctly: Pr **3.19** = required compliance angle, Pr **3.21** = required damping factor, Pr **3.18** = motor + load inertia (it is possible to measure the load inertia as part of the auto-tuning process, see Pr **5.12** on page 81), Pr **5.32** = motor torque per amp.

$Ki = 1 / \text{Compliance angle (rad s}^{-1})$

$Kp = 2 \xi \sqrt{[(Ki \times J) / (Kc \times Kt)]} = 2 \xi \sqrt{[(\text{Pr } \mathbf{3.11} \times \text{Pr } \mathbf{3.18}) / (Kc \times \text{Pr } \mathbf{5.32})]}$

3: Kp gain times 16

If this parameter is set to 3 the Kp gain (from whichever source) is multiplied by 16. This is intended to boost the range of Kp for applications with very high inertia. It should be noted that if high values of Kp are used it is likely that the speed controller output will need to be filtered (see Pr **4.12**) or the speed feedback will need to be filtered (see Pr **3.42**). If the feedback is not filtered it is possible the output of the speed controller will be a square wave that changes between the current limits causing the integral term saturation system to malfunction.

3.18	**Motor and load inertia**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							5						1	1	1	
Range	0.00000 to 90.00000 kg m^2															
Default	0.00000															
Update rate	Background (1s) read															

The motor and load inertia represents the total inertia driven by the motor. This is used to set the speed controller gains (see Pr **3.13** on page 46) and to provide torque feed-forwards during acceleration when required. (see Pr **4.11** on page 72) (It is possible to measure the inertia as part of the auto-tune process, see Pr **5.12** on page 81.

3.19	**Compliance angle**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 359.9 °mechanical															
Default	4.0															
Update rate	Background (1s) read															

The compliance angle is the required angular displacement when the drive delivers a torque producing current equivalent to the current scaling (Kc) with no field weakening.

3.20	**Bandwidth**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255 Hz															
Default	10 Hz															
Update rate	Background (1s) read															

The bandwidth is defined as the theoretical 3dB point on the closed-loop gain characteristic of the speed controller as a second order system. At this point the phase shift is approximately 60°. This parameter is used to define the bandwidth used for setting up the speed loop gain parameters automatically when Pr **3.17** = 1.

3.21	**Damping factor**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 10.0															
Default	1.0															
Update rate	Background (1s) read															

This is the damping factor related to the response of the system to a torque transient, and so if the damping factor is unity the response to a load torque transient is critically damped. The step response of the speed controller gives approximately 10% overshoot with unity damping factor. This parameter is used to define the damping factor used for setting up the speed loop gain parameters automatically when Pr **3.17** = 1 or 2.

.

3.22	**Hard speed reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1						1	1	1	
Range	±SPEED_REF_MAX rpm															
Default	0.0															
Update rate	4ms read															

3.23	Hard speed reference selector															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

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 reference input. The hard speed reference is selected when Pr **3.23** = 1.

3.25	Encoder phase angle															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1					1	1	1	
Range	0.0 to 359.9 ° electrical															
Second motor parameter	Pr **21.20**															
Update rate	Background read															

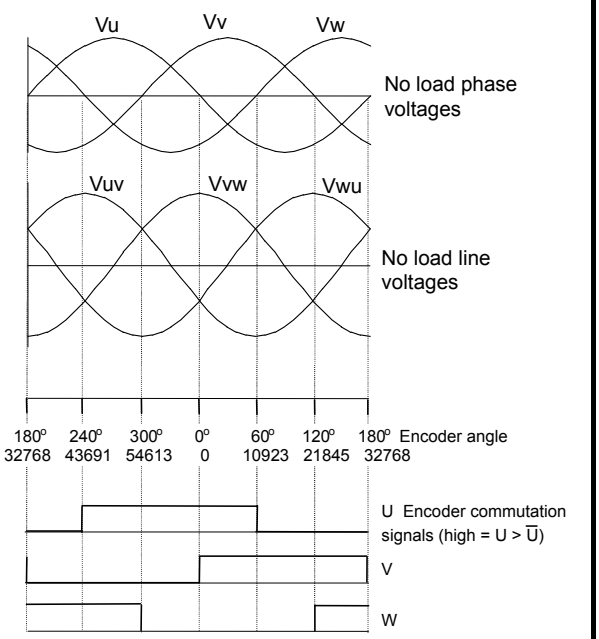
The phase angle between the rotor flux in a servo motor and the encoder position is required for the motor to operated correctly. If the phase angle is known it can be set in this parameter by the user. Alternatively the drive can automatically measure the phase angle by performing a phasing test (see Pr **5.12** on page 81). When the test is complete the new value is written to this parameter. The encoder phase angle can be modified at any time and becomes effective immediately. This parameter has a factory default value of 0.0, but is not affected when defaults are loaded by the user.

The alignment required for zero encoder phase angle (i.e. Pr **3.25** = 0.0) is given below for different feedback devices. Forward rotation of the motor is produced when Vu leads Vv leads Vw. Although it is not essential, forward rotation of a motor is normally defined as clockwise when looking at the motor shaft end. When the motor is rotating forwards the motor speed is shown as positive and the position increases.

Encoder with commutation signals (Ab.Servo, Fd.Servo, Fr.Servo)

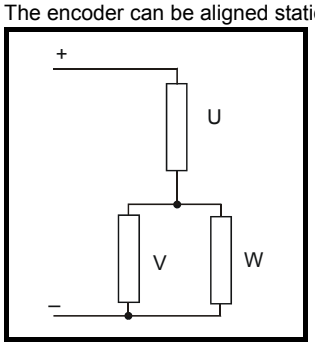
The alignment required between the no-load motor voltages and the commutation signals for Pr **3.25** = 0 is shown in the following diagram below:

It should be noted that if the encoder is advanced (i.e. the UVW signals are moved to the right with respect to the voltages) the phasing angle in Pr **3.25** is increased from zero. If the encoder is retarded the phasing angle changes to 359.9° and then reduces towards zero.



Encoder alignment for zero encoder phase angle

The encoder can be aligned statically by connecting the motor to a DC power supply as shown:



The motor will move to one of a number of positions defined by the number of motor pole pairs (i.e. 3 positions for a six pole motor, etc.). The encoder should be adjusted so that the U commutation signal is high, W is low and V is toggling in one of these positions.

Any other feedback device

The alignment required between the no-load motor voltages and the commutation signals for Pr **3.25** = 0 is shown in the diagram below for a 2 or 4 pole motor. For higher numbers of poles 0° should still be aligned as shown, but one electrical cycle shown corresponds to 360°/ (Number of poles / 2). The encoder can be aligned statically by connecting the motor to a DC power supply as already shown. The motor will move to one of a number of positions defined by the number of motor pole pairs (i.e. 3 positions for a six pole motor, etc.). The encoder should be adjusted so that the position displayed by the drive is n x 65536 / (Number of poles / 2), where n = 0, 1, ... (Number of poles / 2)

It should be noted that if the encoder is advanced (i.e. the encoder is moved so that the angle moves to the right with respect to the voltages) the phasing angle in Pr **3.25** is increased from zero. If the encoder is retarded the phasing angle changes to 359.9° and then reduces towards zero.

3.26	**Speed feedback selector**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 2															
Default	0															
Second motor parameter	Pr **21.21**															
Update rate	Background read (Only has any effect when the drive is disabled)															

0, drv: Drive encoder

The position feedback from the encoder connected to the drive itself is used to derive the speed feedback for the speed controller and to calculate the motor rotor flux position.

1, Slot1: Solutions Module in slot 1

The position feedback from the Solutions Module in Solutions Module slot 1 is used to derive the speed feedback for the speed controller and to calculate the motor rotor flux position. If a position feedback category Solutions Module is not installed in slot 1 the drive produces an EnC9 trip.

2, Slot2: Solutions Module in slot 2

3.27	Drive encoder speed feedback															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1				1	1		1		1				
Range	±40,000.0 rpm															
Update rate	4ms write															

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

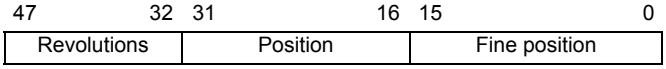
It should be noted that the value shown by this parameter is measured over a 16 ms sliding window period (in the same way as Pr **3.02**), and so the ripple in this parameter accessible via comms or by a Solutions Module is as defined for Pr **3.02**. The FI attribute for this parameter is set, and so further filtering is applied when this parameter is viewed with one of the drive keypads.

3.28	Drive encoder revolution counter															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1					1		1		1			1	
Range	0 to 65,535 revolutions															
Update rate	4ms write															

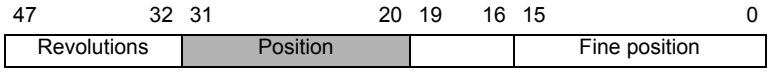
3.29	Drive encoder position															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1					1		1		1			1	
Range	0 to 65,535 ($1/2^{16}$ths of a revolution)															
Update rate	4ms write															

3.30	Drive encoder fine position															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1					1		1		1			1	
Range	0 to 65,535 ($1/2^{32}$ths of a revolution)															
Update rate	4ms write															

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



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



When the encoder rotates by more than one revolution, the revolutions in Pr **3.28** increment or decrement in the form of a sixteen bit roll-over counter. If an absolute position feedback device (except an encoder with commutation signals) is used the position is initialized at power-up with the absolute position. If a multi-turn absolute encoder is used the revolution counter is also initialized with the absolute revolutions at power-up.

If a linear encoder is used the turns information is used to represent movement by the number of poles defined by Pr **5.11** (or **21.11** for motor map 2). Therefore if the number of poles is set to two, one revolution is the movement by one pole pitch.

3.31	Drive encoder marker position reset disable															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

3.32	Drive encoder marker flag															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	250 µs write															

An incremental digital encoder or a SINCOS encoder without communications may have a marker channel. When this channel becomes active it may be used to reset the encoder position and set the marker flag (Pr **3.31** = 0), or just to set the marker flag (Pr **3.31** = 1). The marker flag is set each time the marker input becomes active, but it is not reset by the drive, and so it must be cleared by the user.

If Pr **3.35** is set to zero the marker system operates in a conventional manner and only resets the position (Pr **3.29** and Pr **3.30**) and not the turns (Pr **3.28**) on a marker event. If Pr **3.35** is set to one the whole position (Pr **3.28** to Pr **3.30**) are reset on a marker event. The full reset mode allows the marker to give a form of registration where the marker event defines zero position.
The marker function only operates when Ab, Fd, Fr, Ab.Servo, Fd.Servo, Fr.Servo type encoders are selected with Pr **3.38**.

3.33	**Drive encoder turns bits / Linear encoder comms to sine wave ratio**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255															
Default	16															
Update rate	Background read (Only has any effect when the drive is disabled)															

This parameter has a different function depending on the type of encoder selected with Pr **3.38** and Pr **3.39.**

Ab, Fd, Fr, Ab.Servo, Fd.Servo, Fr.Servo, SC
It is sometimes desirable to mask off the most significant bits of the revolution counter with these types of encoders. This does not have to be done for the drive to function correctly. If Pr **3.33** is zero the revolution counter (Pr **3.28**) is held at zero. If Pr **3.33** has any other value it defines the maximum number of the revolution counter before it is reset to zero. For example, if Pr **3.33** = 5, then Pr **3.28** counts up to 31 before being reset. If Pr **3.33** is greater than 16, the number of turns bits is 16 and the Pr **3.28** counts up to 65535 before being reset.

SC.Hiper, SC.EnDat, SC.SSI and 03.39 = 1 or 2 (Rotary encoder)
Pr **3.33** must contain the number of bits in the comms message used to give the multi-turn information. For a single turn comms encoder, Pr **3.33** must be set to zero. As well as setting the number of comms turns bits this parameter also sets up a mask on the turns displayed in Pr **3.28** as described above. With SC.Hiper or SC.EnDat encoders it is possible for this parameter to be obtained automatically from the encoder (see Pr **3.41**). If Pr **3.33** is greater than 16 the number of turns bits is 16.

SC.Hiper, SC.EnDat, SC.SSI and 03.39 = 0 (Linear encoder)
When a linear encoder is selected no mask is placed on the turns information displayed in Pr **3.28**, and so this parameter always displays the turns information as a full 16 bit value with a maximum of 65535. Linear SINCOS encoders with comms are normally specified with a length for each sine wave period and the length for the least significant bit of the position in the comms message. Pr **3.33** should be set up with the ratio between these two lengths so that the drive can determine the drive encoder position during initialization. The Linear encoder comms to sine wave ratio is defined as follows:

$$\text{Linear encoder comms to sine wave ratio} = \frac{\text{Length for a sine wave period}}{\text{Length representing the LS bit of the position in the comms message}}$$

With SC.Hiper or SC.EnDat encoders it is possible for this parameter to be obtained automatically from the encoder (see Pr **3.41**). This ratio can be greater than 255 for some EnDat encoders. If this is the case it is possible to use auto-configuration to set up the correct value provided the ratio is less than or equal to 65535. The value cannot be stored in Pr **3.33** because it will be too large, and so Pr **3.33** is set to 255. Auto-configuration must be enabled (Pr **3.41**=1) and this setting must be saved, so that auto-configuration is carried out at power-up and each time the drive encoder is initialized. Once auto-configuration has been carried out so that the internally stored value (not visible to the user) is larger than 255, this value cannot be changed via Pr **3.33**. The internal value can be reset to re-enable the function of Pr **3.33** by powering down and then powering up again, or by auto-configuration with an alternative encoder where the corresponding value for Pr **3.33** is less than or equal to 255.

EnDat, SSI
Pr **3.33** must contain the number of bits in the comms message used to give the multi-turn information. If the encoder gives no turns information, for example a single turn comms encoder, Pr **3.33** must be set to zero. As well as setting the number of comms turns bits that the drive will attempt to obtain from the encoder, this parameter also sets up a mask on the turns displayed in Pr **3.28** as described above. With an EnDat encoder it is possible for this parameter to be obtained automatically from the encoder (see Pr **3.41**). If Pr **3.33** is greater than 16 the number of turns bit is 16.
It should be noted that some SSI encoders include leading zeros before the turns information. In this case the number of turns bits should include the leading zeros.

3.34	**Drive encoder lines per revolution**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0* to 50,000															
Default	4,096															
Update rate	Background read (Only has any effect when the drive is disabled)															

*Limited to a minimum of 1 except for Ab.Servo, Fd.Servo and Fr.Servo encoders.

When Ab, Fd, Fr, AbServo, Fd.Servo, Fr.Servo, SC, SC.Hiper, SC.EnDat or SC.SSI encoder are used the equivalent number of encoder lines per revolution must be set-up correctly in Pr **3.34** to give the correct speed and position feedback. This is particularly important if the encoder is selected for speed feedback with Pr **3.26**.

The equivalent number of encoder lines per revolution (ELPR) is defined as follows.

Position feedback device	ELPR
Ab, Ab.Servo	number of lines per revolution
Fd, Fr, Fd.Servo, Fr.Servo	number of lines per revolution / 2
SC.Hiper, SC.EnDat, SC, SC.SSI	number of sine wave periods per revolution

For any type of linear encoder one revolution is the motor pole pitch multiplied by the number of poles set up in Pr **5.11** or Pr **21.11**.

Ab.Servo, Fd.Servo, Fr.Servo
The incremental (A/B) signal frequency should not exceed 500kHz.

It should be noted that if this parameter is set to zero the incremental signals are ignored and only the UVW commutation signals are used to define the motor position. See Pr **3.38.** If Pr **3.34** or the motor pole pairs defined by either Pr **5.11** or Pr **21.11** (depending on the motor map selected) are modified and the encoder type is Ab.Servo, Fd.Servo or Fr.Servo then encoder is re-initialized. This ensures that the control position used by the drive to determine the flux axis of the motor is re-aligned with the commutation signals when the encoder moves again and prevents possible errors.

SC.Hiper, SC.EnDat, SC, SC.SSI
The sine wave signal frequency can be up to 500kHz, but the resolution is reduced at higher frequencies. The table below shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port. The total resolution in bits per revolution is the ELPR plus the number of bits of interpolated information. Although it is possible to obtain 11 bits of interpolation information, the nominal design value is 10 bits.

Volt/Freq	1 kHz	5 kHz	50 kHz	100 kHz	200 kHz	500 kHz
1.2	11	11	10	10	9	8
1.0	11	11	10	9	9	7
0.8	10	10	10	9	8	7
0.6	10	10	9	9	8	7
0.4	9	9	9	8	7	6

If the position feedback device is a rotary SINCOS encoder with comms the position supplied via comms gives a number of counts per revolution that is a power of two and the resolution is defined by the single turns comms bit (Pr **3.35**). It is assumed therefore that the number of periods per revolution is also a power of two, and so if a SC.Hiper, SC.EnDat or SC.SSI type devices is selected and Pr **3.39** is 1 or 2 to select a rotary encoder = 1 or 2, Pr **3.34** is forced to be a power of two between 2 and 32768.

When Pr **3.34** is adjusted an EnC7 trip is produced, because the encoder requires re-initialization. If this parameter is set to a value that is not a power of two and the encoder is set up as a linear encoder (Pr **3.39** = 0) the sample rate for the current controllers is reduced to 6 kHz for 6 or 12 kHz switching frequency. All other switching frequencies are unaffected. See Pr **5.37** on page 87.

If the position feedback device is SC.Hiper or SC.EnDat it is possible for the drive to set up this parameter automatically from information obtained from the encoder (see Pr **3.41** on page 60).

EnDat, SSI
Where encoder comms alone is used as position feedback, the equivalent lines per revolution (Pr **3.34**) is not used in setting up the encoder interface. If auto-configuration is used (see Pr **3.41** on page 60), then Pr **3.41** is set to zero if this is successful.

Linear motors
The value entered in this parameter for a linear motor should be calculated as follows:

$$\textbf{Pr 3.34 PPR setting} = \frac{\textbf{Motor pole pitch}}{(\textbf{Encoder pitch} \times \textbf{4})}$$

If this value is not an integer then an SM-Universal Encoder Plus is required.

3.35	Drive encoder single turn comms bits / Linear encoder comms bits/Marker mode															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 32 bits															
Default	0															
Update rate	Background read (Only has any effect when the drive is disabled)															

Ab, Fd, Fr, Ab.Servo, Fd.Servo, Fr.Servo, SC
Pr **3.35** defines the marker mode. If this parameter is zero the marker system operates in a conventional manner, but if this parameter is non-zero the marker causes a full position reset.

SC.Hiper, SC.EnDat, SC.SSI and 03.39 = 1 or 2 (Rotary encoder)
Pr **3.35** must be set to the number of comms bits used to represent one revolution of the encoder. The single turn comms resolution may be higher than the resolution of the sine waves per revolution.

SC.Hiper, SC.EnDat, SC.SSI and 03.39 = 0 (Linear encoder)
Pr **3.35** must be set up to the total number of bits representing the whole encoder position in the comms message. This parameter is not used with linear SC.Hiper encoders as the number of bits used to represent the whole position is always 32.

EnDat, SSI
Pr **3.35** must be set to the number of bits used to represent one revolution of the encoder.

Although Pr **3.35** can be set to any value from 0 to 32, if the value is less than 1, the resolution is 1 bit. Some SSI encoders (SC.SSI or SSI) include a power supply monitor alarm using the least significant bit of the position. It is possible for the drive to monitor this bit and produce an EnC6 trip if the power supply is too low (see Pr **3.40**). If the encoder gives this information the comms resolution should be set up to include this bit whether it is being monitored by the drive or not. It should be noted that some SSI encoders include trailing zeros after the position. This parameter should be set up to include the trailing zero bits.

It is possible for the drive to set up this parameter automatically from information obtained from the encoder via Hiperface or EnDat interfaces (see Pr **3.41**).

3.36	**Drive encoder supply voltage**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 2															
Default	0															
Update rate	Background read															

The encoder supply voltage present on the drive encoder connector is defined by this parameter as 0 (5 V), 1 (8 V), or 2 (15 V).

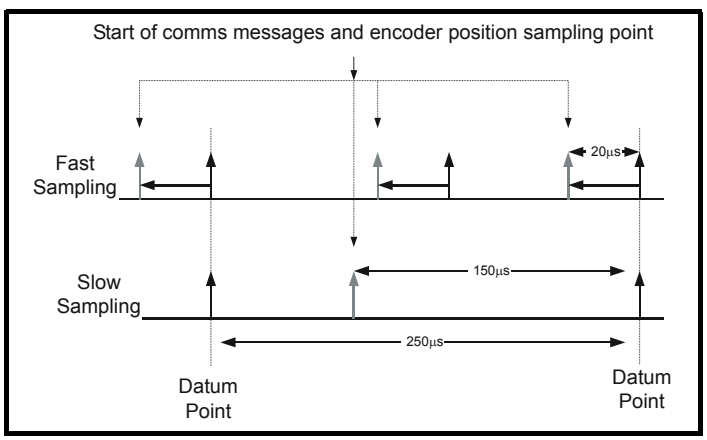
3.37	**Drive encoder comms baud rate**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 7															
Default	2															
Update rate	Background read (Only has any effect when the drive is disabled)															

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

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

Any baud rate can be used when encoder comms is used with a SINCOS encoder to obtain the absolute position during initialization. When encoder comms is used alone (EnDat or SSI selected with Pr **3.38**) the time taken to obtain the comms position must be 160µs or less, otherwise the drive initiates an EnC4 trip.

There is a delay obtaining the position from an encoder using comms alone. The length of this delay affects the sample rate and timing of the position used by the drive for control and the position passed to Solutions Modules. If for an EnDat encoder the position within one turn can be obtained in 30 µs and the whole comms message including CRC can be obtained in 60 µs then fast sampling is used, otherwise slow sampling is used as shown below. If for an SSI encoder the whole position can be obtained in 30 µs fast sampling is used. In each case the position is sampled within the encoder at the start of the comms message from the drive.



In the example the current/torque sampling rate is 4 kHz, but this will change if a different switching frequency is selected. If fast sampling is used the control position used to define the drive reference frame is obtained every current/torque control sample and the position passed to Solutions Modules is obtained 20 µs before the datum point where other types of encoders are sampled. If slow sampling is used both the control position and the position passed to Solutions Modules is obtained 150 µs before the datum. When fast sampling is used the delay introduced into the control system by the encoder is less, and so a higher control system bandwidth will be possible. So that the position values from the encoder can be used in a position control system compensation is provided for the delay in obtaining the position before it is made available to Solutions Modules or in the drive position parameters so that it appears to have been sampled at the datum. This compensation is based on the delay (i.e. 20 µs or 150 µs) and the change of position over the previous sample.

EnDat comms

The following equations are used by the drive to determine the time taken to obtain the position information from an EnDat encoder. These are based on $t_{cal} \leq 5$ µs, where t_{cal} is the time from the first clock edge of the position command message from the drive to the first clock edge when the encoder responds as defined in the EnDat specification. This limit of 5 µs may exclude a small number of EnDat encoders from being used by the drive as a comms only feedback device. It is also assumed that $t_D \leq 1.25$ µs where t_D is the data delay from the encoder as defined by the EnDat specification for 105 m of cable. Although with higher clock rates shorter cables must be used, and t_D will be less than 1.25 µs, the calculation performed by the drive always assumes t_D=1.25 µs. It should be noted that all values are rounded up to the nearest microsecond.

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

Where: T = 1/Baud Rate, t_{cal} = 5 µs

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

= $t_{command} + t_D$ + (2 + Pr **3.35**) x T

Where: t_D = 1.25 µs

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

= Time for single turn position + (Pr **3.33** + 5) x T

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

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

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

A recovery time (tm) is specified for EnDat encoders, that is the time required between the end of one data transfer and the beginning of the next one. If this time is not allowed between messages that transfer the position from the encoder, the encoder operates in continuous mode and the data from the encoder will be incorrect and cause CRC errors. tm is nominally 20 µs, but may vary from 10 µs to 30 µs (EnDat 2.1 specification). If tm is greater than 23 µs and 6 or 12 kHz switching is used, which have a fast sample rate of 83 µs, it is possible for the time allowed for tm to be too short. Therefore if 6 or 12 kHz switching are used the total message transfer time should not exceed 53 µs unless tm can be guaranteed to be less than 30 µs by a suitable margin.

SSI comms

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

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

= t_D + (Pr **3.33** + Pr **3.35** + 1) x T

For example an encoder with 12 turns bits, 13 bit single turn resolution and a baud rate of 1 M would give the following time:

Time to obtain the position data = 28 µs (27.25 µs rounded up)

The drive does not include the recovery time of the encoder in these calculations, therefore the user must ensure that there is sufficient time after the data transfer before the next transfer begins. If the encoder does not recover in time its output will be low just before the new transfer beings and will cause an EnC5 trip.

3.38	**Drive encoder type**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 11															
Default	3															
Update rate	Background read (Only has any effect when the drive is disabled)															

The following encoders can be connected to the drive encoder port.

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

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

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

A phasing test must be performed after every drive power-up or encoder trip.

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

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

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

The UVW commutation signals are used to define the motor position during the first 120° electrical rotation after the drive is powered-up or the encoder is initialised. If the Drive encoder lines per rev (Pr **3.34**) is set to zero the incremental signals are ignored and the drive can run with commutation signals alone. A phase locked loop is used to smooth the feedback, but particularly at low speeds the motor movement includes a significant ripple. Low speed loop gains should be used and the drive encoder filter (Pr **3.42**) should be set to 16 ms.

6, SC: SinCos: Encoder with no serial communications

A phasing test must be performed after every drive power-up or encoder trip.

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

This type of encoder gives absolute position and can be used for motor control. The drive can check the position from the sine and cosine waveforms against the internal encoder position using serial communications and if an error occurs the drive initiates a trip. An applications or fieldbus Solutions Module can communicate with the encoder via parameters that are not visible from the keypad or drive 485 comms.

8, EnDAt: Absolute EnDat only encoder

This type of encoder gives absolute position and can be used for motor control. Additional communications with the encoder from an applications or fieldbus module is not possible

9, SC.Endat: Absolute SinCos encoder using EnDat comms protocol

This type of encoder gives absolute position and can be used for motor control. The drive can check the position from the sine and cosine waveforms against the internal encoder position using serial communications and if an error occurs the drive initiates a trip. An applications or fieldbus Solutions Module can communicate with the encoder via parameters that are not visible from the keypad or drive 485 comms

10, SSI: Absolute SSI only encoder

This type of encoder gives absolute position and can be used for motor control. Additional communications with the encoder from an applications or fieldbus module is not possible. SSI encoders use either gray code or binary format which can be selected with Pr **3.41**.

11, SC.SSI: SinCos encoder using SSI comms protocol

This type of encoder gives absolute position and can be used for motor control. The drive can check the position from the sine and cosine waveforms against the internal encoder position using serial communications and if an error occurs the drive initiates a trip.

All SINCOS encoders and encoders using communications must be initialized before their position data can be used. The encoder is automatically initialized at power-up, after trips EnC1 to EnC8 or Enc11 to Enc17 are reset, and when the initialization (Pr **3.47**) is set to 1. If the encoder is not initialized or the initialization is invalid the drive initiates trip EnC7.

3.39	**Drive encoder termination select / Rotary encoder select / Comms only encoder mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1		
Range	0 to 2															
Default	1															
Update rate	Background read															

Ab, Fd, Fr, Ab Servo, Fd Servo, Fr Servo - Drive encoder termination select

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

Encoder input	Pr 3.39=0	Pr 3.39=1	Pr 3.39=2
A-A\	Disabled	Enabled	Enabled
B-B\	Disabled	Enabled	Enabled
Z-Z\	Disabled	Disabled	Enabled
U-U\, V-V\, W-W\	Enabled	Enabled	Enabled

SC - Drive encoder termination select

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

Encoder input	Pr 3.39=0	Pr 3.39=1	Pr 3.39=2
A-A\	Disabled	Enabled	Enabled
B-B\	Disabled	Enabled	Enabled
Z-Z\	Disabled	Disabled	Enabled

SC.Hiper, SC.EnDat, SC.SSI - Rotary encoder select

If Pr **3.39** is set to 1 or 2 the encoder is a rotary encoder and the following apply:

1. Pr **3.33** defines the number of turns bits in the comms message from the encoder and a mask is applied to Pr **3.28** to remove turns bits in excess of those provided in the encoder comms position.
2. The number of encoder lines per revolution defined by Pr **3.34** is forced to a power of two between 2 and 32768.
3. Pr **3.35** defines the number of comms bits used to define a single turn.

If Pr **3.39** is set to 0 the encoder is a linear encoder and the following apply:

1. Pr **3.33** defines the ratio between the length of a sine wave period and the length of the least significant comms bit.
2. No mask is applied to the turns displayed in Pr **3.28.**
3. Pr **3.35** defines the number of comms bits used to give the whole position value.

If the position feedback device is SC.Hiper or SC.EnDat it is possible for the drive to set up this parameter automatically from information obtained from the encoder (see Pr **3.41**).

EnDat, SSI - Comms only encoder mode

If this parameter is set to 1 or 2 the drive always takes the complete absolute position for these comms only type encoders. The turns (Pr **3.28**), position (Pr **3.29**) and fine position (Pr **3.30**) will be an exact representation of the position from the encoder. If the encoder does not provide 16bits of turns information, the internal representation of the turns used by the position controller in Menu 13 and functions within the SM-Applications Module such as the Advanced Position Controller, rolls over at the maximum position value from the encoder. This jump in position is likely to cause unwanted effects. As the SSI format does not include any error checking it is not possible for the drive to detect if the position data has been corrupted by noise on the encoder signals. The benefit of using the absolute position directly from an SSI encoder is that even if the encoder communications are disturbed by noise and position errors occur, the position will always recover the correct position after the disturbance has ceased. The EnDat format includes a CRC that is used by the drive to detect corrupted data, and so if the position data has been corrupted the drive uses the previous correct data until new uncorrupted data is received.

It should be noted that if the encoder does not provide at least 6 bits of turns information the speed feedback used to generate the drive over speed trip is incorrect when the position rolls over or under the maximum value. Therefore this mode should not be used with encoders that do not provide this turns information unless the encoder is not going to pass through the maximum position.

If this parameter is set to 0 the drive only takes the absolute position directly from the encoder during initialization. The change of position over each sample is then used to determine the current position. This method always gives 16 bits of turns information that can be used without jumps in position by the position controller in Menu13 and SM-Applications modules etc. This method will only operate correctly if the change of position over any 250 μs period is less than 0.5 of a turn, or else the turns information will be incorrect. The turns can then only be corrected by re-initializing the encoder. Under normal operating conditions and at a maximum speed of 40,000 rpm the maximum change of position is less than 0.5 turns, however, if noise corrupts the data from an SSI encoder it is possible to have apparent large change of position, and this can result in the turns information becoming and remaining corrupted until the encoder is re-initialized. This problem should not occur with EnDat encoders because three consecutive corrupted messages at the slowest sample rate (i.e. 25 μs) would be required even at the maximum speed of 40,000 rpm before the change of position would be the required 0.5 turns to give possible corruption of the turns information. If three consecutive messages with CRC errors occur this will cause the drive to produce an EnC5 trip. The drive can only be re-enabled after the trip is reset which will re-initialize the encoder and correct the absolute turns.

If an SSI encoder is used, but is not powered from the drive, and the encoder is powered up after the drive, it is possible that the first change of position detected could be large enough to cause the problem described above. This can be avoided if the encoder interface is initialized via Pr **3.47** after the encoder has powered up. If the encoder includes a bit that indicates the status of the power supply the power supply monitor should be enabled (see Pr **3.40**). This will ensure that the drive remains tripped until the encoder is powered up and the action of resetting the trip will re-initialize the encoder interface.

If the position feedback device is EnDat it is possible for the drive to set up this parameter automatically from information obtained from the encoder (see Pr **3.41**).

3.40	**Drive encoder error detection level**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 7															
Default	1															
Update rate	Background read															

Trips can be enabled/disabled using Pr **3.40** as follows.

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

Encoder trips

The following table shows trips that can be initiated that are related to the drive encoder feedback and whether they can be enabled and disabled by Pr **3.40**.

Encoders	Reason for error	Drive trip
All	Power supply short circuit	EnC1
Ab, Fd, Fr, Ab.Servo, Fd.Servo, Fr.Servo, SC, SC.Hiper, SC.EnDat, SC.SSI	+Hardware wire-break detect on A, B and Z inputs(1) Software wire break detection on sine wave signals There is no wire break detection on the U, V and W commutation inputs	EnC2
Ab.Servo, Fd.Servo, Fr.Servo SC.Hiper, SC.EnDat, SC.SSI	+Phase error(2) +Sine/cosine phase error(3)	EnC3
SC.Hiper, SC.EnDat, SC.SSI EnDat SSI	Comms failure (timeout)(5) Comms transfer time is too long	EnC4
SC.Hiper, SC.EnDat, EnDat	Checksum/CRC error or SSI not ready at start of position transfer (i.e. data input not one)	EnC5
SC.Hiper, SC.EnDat, EnDat SSI, SC.SSI	The encoder has indicated an error +Power supply failure	EnC6
SC, SC.Hiper, SC.EnDat, SC.SSI, EnDat, SSI	initialization has failed due to a comms error.	EnC7
SC.Hiper, SC.EnDat, EnDat	Auto-configuration has been requested by changing Pr **3.41**, but an initialization has not occurred to perform auto-configuration.	EnC8
All	Speed feedback selected from an option slot that does not have a position feedback category Solutions Module installed	EnC9
All	Incorrect encoder phasing(4)	EnC10
SC, SC.Hiper, SC.EnDat, SC.SSI	Failure of analog position alignment during encoder initialization	Enc11
SC.Hiper	The encoder type could not be identified during auto-configuration	Enc12
SC.EnDat, EnDat	The number of encoder turns read from the encoder during auto-configuration is not a power of 2	Enc13
SC.EnDat, EnDat	The number of bits defining the encoder position within a turn read from the encoder during auto-configuration is too large.	Enc14
SC.Hiper, SC.EnDat, EnDat	The number of periods per revolution is either less than 1 or greater than 50000 when read or calculated from the encoder data during auto-configuration.	Enc15
SC.EnDat, EnDat	The number of comms bits per period are larger than 255.	Enc 16
SC.Hiper, SC.EnDat, EnDat	This is a rotary encoder (Pr **3.39**=1 or 2) and the lines per revolution read from this encoder are not a power of two.	Enc 17

+These trips can be enabled/disabled by Pr **3.40**

1. If the terminations are not enabled on the A, B or Z inputs the wire break system will not operate. (Note that as default the Z input terminations are disabled to disable wire break detection on this input). No wire break detection is provided on the U, V or W commutation signals.
2. Phase error for a servo type encoder is to detect that the incremental pulses have been counted incorrectly. The error is detected if the incremental position moves by 10° with respect to the position defined by the UVW commutation signals. The trip is initiated if the error is detected for 10 consecutive samples.
3. Phase error for SinCos encoders with comms is detected by interrogating the encoder every second via comms to compare the incremental position determined from the sine waves with the incremental position via comms. If the error is greater than 10° for 10 consecutive samples the trip is initiated. It should be noted that this system should not be used where 180 x Pr **5.11** (or Pr **21.11** for motor map 2) / Pr **3.34** is greater than 10° or else incorrect EnC3 trips will occur.
4. Incorrect encoder phasing is detected if the motor reaches half of the speed defined by SPEED_REF_MAX and the phasing error is larger enough for the motor to accelerate uncontrollably. It can be disabled by setting Pr **3.08** to any value greater than zero.
5. This trip can also be caused when data is transferred between the encoder and a Solutions Module, such as an SM-Applications module, and an error other than those covered by EnC5 or EnC6 occurs.

Wire-break detection

It may be important to detect a break in the connections between the drive and the position feedback device. This feature is provided for most encoder types either directly or indirectly as listed below.

Device	Detection method	Drive Trip
Ab, Fd, Fr, Ab.Servo, Fd.Servo, Fr.Servo	Hardware detectors on the A(F), B(D,R) and Z signal detect a wire break.	EnC2
SC, SC.Hiper, SC.EnData, SC.SSI	The differential levels of the sine and cosine waveforms are available to the drive. The drive detects wire break if $Sine^2+Cosine^2$ is less than the value produced by two valid waveforms with a differential peak to peak magnitude of 0.25 V (1/4 of the nominal level). This detects wire break in the sine and cosine connections.	EnC2
SC.Hiper, SC.EnDat, EnDat	Wire break in the comms jumper (link) is detected by a CRC or timeout error.	EnC4, EnC5
SSI	Wire break detection is difficult with these devices. However, if power supply monitoring is enabled the drive will be looking for a one at the start of the message and a zero to indicate that the power supply is okay. If the clock stops or the data line is disconnected the data input to the drive may stay in one state or the other and cause a trip.	EnC5, EnC6

Encoder initialization

Encoder initialization will occur as follows: at drive power-up, when requested by the user via Pr **3.47**, when trips PS.24V or EnC1 to EnC8 or Enc11 to Enc17 are reset. initialization causes an encoder with comms to be re-initialized and auto-configuration to be performed if selected. After initialization Ab.Servo, Fd.Servo and Fr.Servo encoders will use the UVW commutations signals to give position feedback for the first 120° (electrical) of rotation when the motor is restarted.

A delay is provided during initialization for some encoders to allow the encoder to be ready to provide position information after it has powered up. The delay is provided during initialization because this occurs during drive power-up and after encoder power supply trips are reset. The delays are as follows:

Encoder type	Initialization delay
Ab, Fd, Fr, Ab.Servo, Fd.Servo, Fr.Servo	None
SC.Hiper	150 ms, then encoder reset, then 150 ms
SC.EnDat, EnDat	1.0 s
All other types	1.2 s

Encoder power supply trips

The encoder power supply from the drive can be switched off by the drive either because the encoder power supply is overloaded (EnC1 trip) or because the internal 24 V supply within the drive is overloaded (PS.24V trip). The internal 24 V supply provides power for the encoder power supply, user 24 V output, digital I/O, Solutions Modules etc. To ensure that an EnC1 trip is not initiated when the internal 24 V is overloaded, and subsequently switched off by the drive, there is a delay of 40 ms in the detection of EnC1 trip. It is possible for other encoder trips such as wire break detection (EnC2) to occur when the power supply is removed from the encoder. Therefore overloading the internal 24 V supply or the encoder supply could result in an immediate EnC2 trip. To ensure that the correct reason for the trip is given PS.24V and EnC1 trips override an existing EnC2 to EnC8 or Enc11 trip. This means that both the original trip (EnC2 to EnC8 or Enc11) and then the new trip (PS.24V or EnC1) are stored in the trip log.

3.41	Drive encoder auto configuration enable / SSI binary format select															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1	1	
Default	0															
Update rate	Background read															

SC.Hiper, SC.EnDat, EnDat

When a SC.Hiper, SC.EnDat or EnDat encoder is being used, the drive will interrogate the encoder on power-up. If Pr **3.41** is set to one and the encoder type is recognized based on the information provided by the encoder, the drive will set the encoder turns / linear encoder comms to sine wave ratio (Pr **3.33**), the equivalent lines per revolution (Pr **3.34**) and the encoder comms resolution / linear encoder comms bits (Pr **3.35**). For SC.Hiper or SC.EnDat encoders the rotary encoder select (Pr **3.39**) is also set up. If the encoder is not recognized, there is a comms error or the resulting parameter values are out of range the drive initiates an EnC7 or Enc12 to Enc17 trip to prompt the user to enter the information. The drive can auto-configure with any of the following devices.

Rotary EnDat encoders

The encoder turns, comms resolution and equivalent lines per rev are set up directly using the data read from the encoder.

Linear EnDat encoders

The comms resolution is set to the number of bits required for the whole position within the position data messages from the encoder. The linear encoder comms to sine wave ratio is calculated from the sine wave period and LS comms bit length. The encoder does not give the equivalent lines per rev directly, but gives the length of a sinewave period in nm. Therefore the drive uses the pole pitch (Pr **5.36** or **21.31**) and the number of motor poles (Pr **5.11** or **21.11**) for the current active motor (defined by Pr **11.45**) to calculate the equivalent lines per revolution.

ELPR = Pole pitch x Number of motor pole pairs / Length of a sinewave

Normally the Number of motor poles will be set to 2, and so

ELPR = Pole pitch / Length of a sinewave

It should be noted that the equivalent lines per rev parameter is only updated when auto-configuration occurs, i.e. when the encoder is initialized, and that it uses the pole pitch for the currently active motor. The value for Pole pitch x Number of motor pole pairs is limited to 655.35mm by the drive. If the pole pitch is left at its default value of zero which would give ELPR = 0, or the result of the calculation is over 50000, the drive will initiate an Enc15 trip.

Rotary hiperface encoders

The drive can recognize any of the following devices: SCS 60/70, SCM 60/70, SRS 50/60, SRM 50/60, SHS 170, SCS-KIT 101, SKS36, SKM36. If the drive cannot recognize the encoder type it will initiate Enc12 trip.

Linear Hiperface encoders

The drive can recognize the LINCODER. The calculations used for linear EnDat encoders are also used to determine the equivalent lines per revolution. However, the length of a sine wave is fixed at 5mm.

EnDat encoders

If the encoder type is EnDat comms only then after auto-configuration Pr **3.39** is set to zero if the number of turns bits is less than 6. This automatically selects absolute mode and prevents over speed trips at the encoder roll-over points which would otherwise occur.

SSI, SC.SSI

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

3.42	Drive encoder filter															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 5 (0 to16 ms)															
Default	0															
Update rate	Background read															

0 = 0 ms, 1 = 1 ms, 2 = 2 ms, 3 = 4 ms, 4 = 8 ms, 5 = 16 ms

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

3.43	Maximum drive encoder reference															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 40,000 rpm															
Default	3,000															
Update rate	Background read															

3.44	Drive encoder reference scaling															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	Background read															

3.45	Drive encoder reference															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1				1			1		1				
Range	±100.0 %															
Update rate	4ms write															

3.46	Drive encoder reference destination															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.50**															
Default	Pr **0.00**															
Update rate	Read on reset															

The drive encoder input can be used as a reference to control a drive parameter. The drive encoder reference parameter (Pr **3.45**) gives the speed of the encoder input as a percentage of the maximum drive encoder reference provided that the number of encoder lines per revolution (Pr **3.34**) has been set up correctly. This may then be scaled and routed to any non-protected drive parameter.

3.47	Re-initialize position feedback															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Update rate	Background read															

3.48	Position feedback initialized															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

At power-up Pr **3.48** is initially zero, but is set to one when the drive encoder and any encoders connected to position category modules have been initialized. The drive cannot be enabled until this parameter is one.

If any trips occur that could indicate that the encoder system is no longer initialized correctly (i.e. EnC2-EnC8 and Enc11-Enc17), or the internal 24 V or encoder power supplies are overloaded (i.e. EnC1 or PS.24V), Pr **3.48** is set to zero and the drive cannot be enabled until the encoder is re-initialized. It is likely that the failure of either of these supplies will cause one of the other encoder trips and it should be noted that EnC1 or PS.24V trips can override EnC2-EnC8 and Enc11-Enc17 trips so that the power supply overload is not mistaken for an encoder error.

3.49	Full motor object electronic nameplate transfer															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Read on reset															

When this parameter is set to one, additional information for the motor object can be transferred from Pr **18.11** to Pr **18.17** as shown below.

User parameter	Motor object parameter
Pr **18.11**	Motor object version number
Pr **18.12**	Motor type (MSW)
Pr **18.13**	Motor type (LSW)
Pr **18.14**	Motor manufacturer
Pr **18.15**	Motor serial number (MSW)
Pr **18.16**	Motor serial number
Pr **18.17**	Motor serial number (LSW)

3.50	Position feedback lock															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4 ms read															

If Pr **3.50** is set to one Pr **3.28**, Pr **3.29** and Pr **3.30** are not updated. If this parameter is set to zero these parameters are updated normally.

3.52	**Encoder simulation ratio numerator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							4						1	1	1	
Range	0.0000 to 1.0000															
Default	1.0000															
Update rate	Background read															

The encoder simulation source is the drive encoder input and can be any incremental type or any SINCOS type. If a SINCOS is used as the source the simulation output is derived from the zero crossings of the sine waves and does not include interpolated information. The encoder simulation provides an output with minimal delay from the drive encoder input. The ratio between the change of drive encoder position and the change of encoder simulation output position is defined by Pr **3.52**. The table below shows the possible ratios.

Pr 3.52	Ratio
0.0000 to 0.0312	1/32
0.0313 to 0.0625	1/16
0.0626 to 0.1250	1/8
0.1251 to 0.2500	1/4
0.2501 to 0.5000	1/2
0.5001 to 1.0000	1

3.54	**Encoder simulation mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 4															
Default	0															
Update rate	Background read															

Pr **3.54** selects the format of the encoder simulation output as shown in the table below.

03.54	String	Mode
0	Ab	Quadrature outputs
1	Fd	Frequency and direction outputs
2	Fr	Forward and reverse outputs
3	Ab.L	Quadrature outputs with marker lock
4	Fd.L	Frequency and direction outputs with marker lock

The marker output is derived directly from the encoder simulation input source marker. The width of the marker pulse is not adjusted with the encoder simulation ratio, but remains the same width as the input marker. If a mode without marker lock is selected then the relationship between the marker position and the incremental signals is undefined. If a mode with marker lock is selected the incremental position is shifted when the first input marker occurs so that with Ab mode the marker is aligned with A high and B high, and with Fd mode the marker is aligned with F high. Marker lock is required when the system that is receiving the encoder simulation signals requires a defined relationship between the marker and the incremental signals. Marker lock should not be used if the drive encoder equivalent lines per revolution (ELPR) is not a power of 2 or the ELPR of the encoder simulation output is less than 1 after the divide ratio has been applied.

5.5.1 Communication with Hiperface and EnDat encoders

It is possible to use the communications channel between the drive and a Hiperface or EnDat encoder. This allows access to the encoder functions including reading the encoder position and, reading and writing to encoder memory. The system can be used to communicate with SC.Hiper and SC.EnDat type encoders provided that the position checking system has been disabled, by setting Pr **90.21** to one.

To send a message to the encoder the required message must be written to the transmit register (Pr **90.22**). To read the response from the encoder the data is read from the receive register (Pr **90.23**).

Bits 13-15 of the registers are used to indicate the following:

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

Data should be written to the transmit register (Pr **90.22**) when the register has been reset to zero by the drive. The data will be transferred to the comms buffer and the transmit register will be cleared.

Data can be read from the receive register (Pr **90.23**) at any time. If there is receive data in the buffer bit 15 will be set. Once the data has been read the register should be cleared and the drive will then transfer more data.

The actual encoder comms buffer is 16 bytes long and any messages that exceed this length (including the checksum added for Hiperface) will cause an error. The status flags are defined as follows:

Bit	Meaning
0	The number of bytes put into the transmit buffer is not consistent with the expected message length. (Hiperface only)
1	The number of bytes written to the transmit buffer, or the expected length of the store data transmit message, or the expected length of a read data message have exceed the length of the buffer. (Hiperface only)
2	The command code is not supported.
3	The encoder has signalled an error.
4	There was an error in the checksum/CRC of the received message.
5	A timeout occurred.

SC.Hiper type encoders

The Stegmann Hiperface comms protocol is an asynchronous byte based system. Up to 15 bytes of data can be written to the buffer. The first byte should be the encoder address. The checksum will be calculated by the drive and added to the end of the message before the message is transmitted to the encoder. The drive checks the checksum of the received message. If successfully received, the receive message can be read via the receive register (Pr **90.23**) including the address and the checksum received from the encoder. It should be noted that the encoder must be set up for 9600 baud, 1 start bit, 1 stop bit and even parity (default set-up) for the encoder comms to operate with the drive. Also the data block security should not be enabled in the encoder if the drive encoder nameplate system is to operate correctly.

The following commands are supported:

Code	Command
0x42	Read position
0x43	Set position
0x44	Read analog value
0x46	Read counter
0x47	Increment counter
0x49	Clear counter
0x4a	Read data (maximum of 10 bytes)
0x4b	Store data (maximum of 9 bytes)
0x4c	Data field status
0x4d	Create a data field
0x4e	Available memory
0x50	Read encoder status
0x52	Read type
0x53	Reset encoder

Example of a Hiperface transfer: read position

Disable drive encoder position check by setting Pr **90.21** to one. This should be set back to zero at the end of the transfer if encoder position checking is required.

Transfer the "read position" message to the encoder comms buffer by writing the sequence of words shown in the table below to Pr **90.22**. A check should be carried out before each word is written to ensure that the parameter is zero (i.e. the drive has taken any previous data).

	Bit 15	Bit 14	Bit 13	Data	
0xa0ff	1	0	1	0xff	Broadcast message so address = 0xff
0xc042	1	1	0	0x42	Read position command

As bit 14 of the second word is set to one the drive will add the checksum and transfer this message to the encoder. When the encoder response has been received by the drive the first byte of the message will be placed in the least significant byte of Pr **90.23** and bit 15 will be set to one. This data should be read and the parameter cleared so that the drive will put the next byte into this parameter. The sequence of data that should appear in Pr **90.23** for an encoder with an address of 0x40 and a position of 0x03, 0x59, 0x63, 0x97 is shown in the table below.

	Bit 15	Bit 14	Bit 13	Data	
0x8040	1	0	0	0x40	Encoder address
0x8042	1	0	0	0x42	Read position command
0x8003	1	0	0	0x03	Position byte 0 (MS byte)
0x8059	1	0	0	0x59	Position byte 1
0x8063	1	0	0	0x63	Position byte 2
0x8097	1	0	0	0x97	Position byte 3 (LS byte)
0xc0ac	1	1	0	0xac	Checksum

Example of Hiperface transfer: Delete data field

Transfer the "delete data field" message to the encoder comms buffer by writing the sequence of words shown in the table below to Pr **90.22.** A check should be carried out before each word is written to ensure that the parameter is zero (i.e. the drive has taken any previous data).

	Bit 15	Bit 14	Bit 13	Data	
0xa0ff	1	0	1	0xff	Broadcast message so address = 0xff
0x804d	1	0	0	0x4d	Create data field command
0x8002	1	0	0	0x02	Data field 2
0x8065	1	0	0	0x65	Status of data existing data field 2 with bit 7 set to zero
0x8055	1	1	0	0x55	Code for data field at default of 0x55

The response from the encoder is a follows.

	Bit 15	Bit 14	Bit 13	Data	
0x8040	1	0	0	0x40	Encoder address
0x8042	1	0	0	0x4d	Create data field command
0x8003	1	0	0	0x02	Data field 2
0x8059	1	0	0	0x65	Status of the data field before delete
0x8063	1	1	0	0x78	Checksum

SC.EnDat

The Heidenhain EnDat protocol is a synchronous protocol using the following command message format (drive to encoder).

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

The following commands are supported:

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

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

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

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

If any other command is used then the response is as follows (encoder to drive).

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

Example of EnDat transfer: Read position

Disable drive encoder position check by setting Pr **90.21** to one. This should be set back to zero at the end of the transfer if encoder position checking is required.

Transfer the "read position" message to the encoder comms buffer by writing the sequence of words shown in the table below to Pr **90.22**. A check should be carried out before each word is written to ensure that the parameter is zero (i.e. the drive has taken any previous data).

	Bit 15	**Bit 14**	**Bit 13**	**Data**	
0xa000	1	0	1	0x00	Read position command
0xc000	1	1	0	0x00	Address

The second word contains the address which is not required for the command, but has been passed to the drive so that a word with bit 14 set to one is received by the drive to initiate the data transfer to the encoder. When the encoder response has been received by the drive the first byte of the message will be placed in the least significant byte of Pr **90.23** and bit 15 will be set to one. This data should be read and the parameter cleared so that the drive will put the next byte into this parameter. The sequence of data that could appear in Pr **90.23** for an encoder with 12 turns bits and 13 position bits is shown in the table below.

	Bit 15	**Bit 14**	**Bit 13**	**Data**	
0x8000	1	0	0	0x00	
0x8000	1	0	0	0x00	
0x8000	1	0	0	0x00	
0x8000	1	0	0	0x00	
0x8000	1	0	0	0x00	Bit7 = bit 0 of position, Bit6 = alarm bit
0x809f	1	0	0	0x9f	Bits 8-1 of position
0x804e	1	0	0	0x4e	Bits 3-0 of turns and 12-9 of position
0xc074	1	1	0	0x74	Bits 11-4 of turns

Turns = 0111 0100 0100 = 0x744

Position = 1 1101 0011 1110 = 0x1d3e

Alarm bit = 0

Example of EnDat transfer: Encoder send parameter

Data written to Pr **90.22**

	Bit 15	**Bit 14**	**Bit 13**	**Data**	
0xa004	1	0	1	0x04	Encoder to send parameter command
0x8000	1	0	0	0x00	Address zero
0x8000	1	0	0	0x00	Data (not required)
0xc000	1	1	0	0x00	Data (not required)

Data read from Pr **90.23**

	Bit 15	**Bit 14**	**Bit 13**	**Data**	
0x8000	1	0	0	0x00	Address
0x8012	1	0	0	0x12	Data
0x8034	1	1	0	0x34	Data

The data in the parameter at address zero is 0x1234.

5.6 Menu 4: Torque and current control

The scaling of the current feedback is based on the rating of the drive as follows:

Level	x Current scaling (Kc)	x Maximum current rating
Over-current trip	1/0.45 = 2.22	3.81
Maximum standard operating current	1.75	3.00
Current scaling (Kc)	1.0	1.72
Maximum current rating	0.581	1.0

Current scaling (Kc) is 1 per unit current and is related to the scaling of the drive current feedback. Kc is greater than the Maximum current rating defined by Pr **11.32**. The Maximum current rating is the maximum value of rated motor current (defined by Pr **5.07** or Pr **21.07**) that can be set. The limit up to which the drive can control current normally is the Maximum standard operating current or 1.75 x Kc. The current range above this is allowed for current controller overshoot and for additional current feedback pulses associated with long cable operation.

The Maximum standard operating current is 1.75 x Kc which allows for an overload based on the Maximum current rating of 300 %.

The table below gives the current scaling (Kc) and Maximum current rating for all drive sizes and voltage ratings.

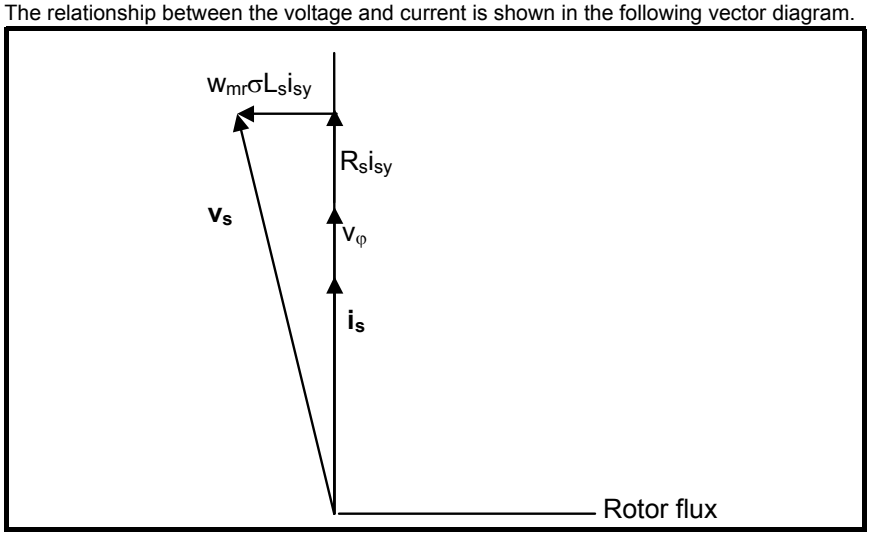
Table 5-3 Current ratings

200V			400V		
Model	**Current scaling (Kc)**	**Max current rating**	**Model**	**Current scaling (Kc)**	**Max current rating**
DST1201	2.92	1.70	DST1401	2.58	1.50
DST1202	6.52	3.80	DST1402	4.63	2.70
DST1203	9.26	5.40	DST1403	6.86	4.00
DST1204	13.03	7.60	DST1404	10.12	5.90
			DST1405	13.72	8.00

The drive operates in the rotor flux reference frame. The maximum normal operating current is controlled by the current limits.

DRIVE_CURRENT_MAX is full scale current feedback, i.e. Kc / 0.45.

The relationship between the voltage and current is shown in the following vector diagram.



Definitions:

$\mathbf{v_s}$ = motor terminal voltage vector

$\mathbf{i_s}$ = motor current vector

Vφ = voltage produced by the rotor magnets

MOTOR1_CURRENT_LIMIT_MAX is used as the maximum for some parameters such as the user current limits. The current maximum current limit is defined as follows (with a maximum of 1000%):

$$\textbf{CURRENT_LIMIT_MAX} = \left[\frac{\textbf{Maximum current}}{\textbf{Motor rated current}}\right] \times \textbf{100\%}$$

Where:

Motor rated current is given by Pr **5.07**

(MOTOR2_CURRENT_LIMIT_MAX is calculated from the motor map 2 parameters)

The Maximum current is (1.75 x Kc)

The rated active and rated magnetising currents are calculated from motor rated current (Pr **5.07**) as:
rated active current = motor rated current
rated magnetising current = 0

Example:

Work out the available current limit for a DST1405 with a motor rated current of 8 A set in Pr **5.07** (i.e. equal to the Maximum current rating of the drive).

From Table 5-3 above the Current scaling (Kc) value for a DST1405 is 13.72 A.

$$\text{CURRENT_LIMIT_MAX} = \left[\frac{\text{Maximum current}}{\text{Motor rated current}}\right] \times 100\ \%$$

$$= \left[\frac{1.75 \times Kc}{8A}\right] \times 100\ \%$$

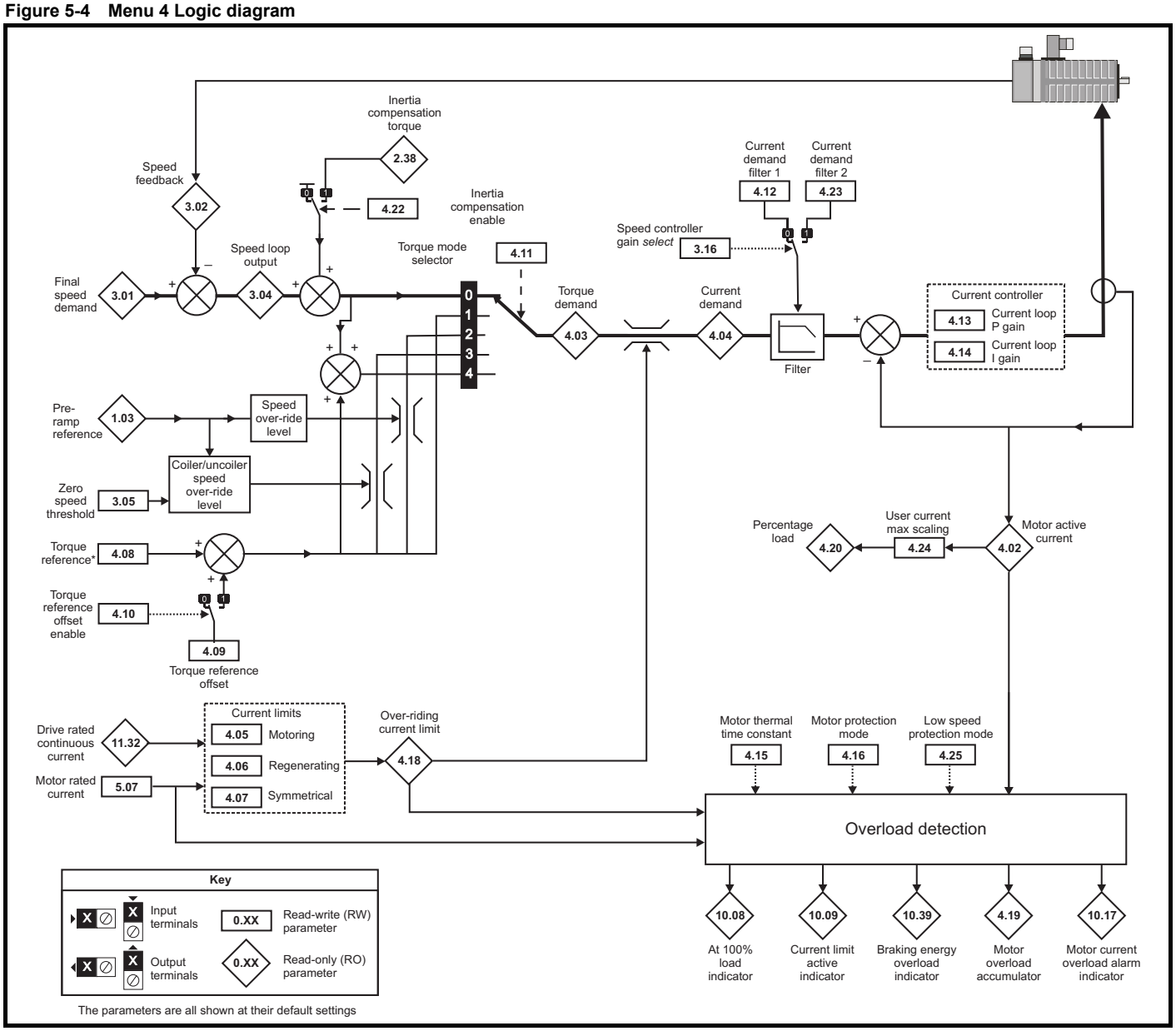
$$= \left[\frac{1.75 \times 17.32\ A}{8A}\right] \times 100\ \%$$

$$= 300\ \%$$

If the motor rated current is reduced then the maximum available current limit increases up to a maximum of 1000 %.

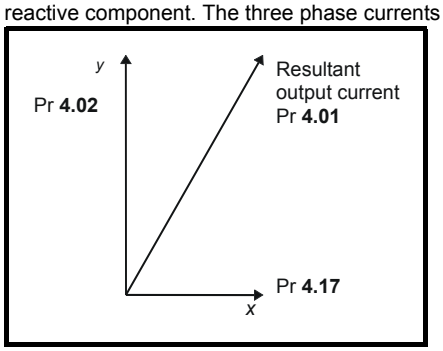
The drive only requires the motor rated current to set the maximum current limit correctly and scale the current limits, and so no auto-tuning is required to set these accurately.

Figure 5-4 Menu 4 Logic diagram



4.01	**Current magnitude**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	2	1		1		1			1	
Range	0 to DRIVE_CURRENT_MAX A															
Update rate	4ms write															

This parameter is the r.m.s. current from each output phase of the drive. In normal operation with a permanent magnet servo motor, this parameter shows the magnitude of the active current in Pr **4.02**. When in the field weakening range, the phase currents consist of an active component and a reactive component. The three phase currents can be combined to form a resultant current vector as shown below:



The resultant current magnitude is displayed by this parameter. The active current is the torque producing current for a motor drive. The reactive current is the magnetizing or flux producing current.

4.02	**Active current**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	2	1		1		1				
Range	±DRIVE_CURRENT_MAX A															
Update rate	4ms write															

The active current is the torque producing current.

Direction of active current	Direction of rotation	Torque direction
+	+	Forward (accelerating)
-	+	Reverse (decelerating)
+	-	Forward (decelerating)
-	-	Reverse (accelerating)

The active current is aligned with the y axis of the reference frame. The x axis of the reference frame is aligned with the rotor flux vector. The motor torque is proportional to the torque producing current when field weakening is not active. Once field weakening is active the torque producing current is boosted to compensate for the reduction in motor flux.

4.03	**Torque demand**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	1	1		1		1				
Range	±TORQUE_PROD_CURRENT_MAX %															
Update rate	4ms write															

The torque demand can be derived from the speed controller and/or the torque reference and offset. The units of the torque demand are % of rated torque. 100% rated torque is defined as the torque produced by 100% rated active current.

4.04	**Current demand**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	1	1		1		1				
Range	±TORQUE_PROD_CURRENT_MAX %															
Update rate	4ms write															

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. The level of flux is derived from the motor model within the drive controllers.

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

4.05	**Motoring current limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1		1				1	1	1	
Range	0 to MOTOR1_CURRENT_LIMIT_MAX %															
Default	300.0															
Second motor parameter	Pr **21.27**															
Update rate	Background read															

4.06	**Regen current limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1		1				1	1	1	
Range	0 to MOTOR1_CURRENT_LIMIT_MAX %															
Default	300.0															
Second motor parameter	Pr **21.28**															
Update rate	Background read															

4.07	**Symmetrical current limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1		1				1	1	1	
Range	0 to MOTOR1_CURRENT_LIMIT_MAX %															
Default	300.0															
Second motor parameter	Pr **21.29**															
Update rate	Background read															

The motoring current limit applies in either direction of rotation when the machine is producing motoring torque. Similarly the regen 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.

4.08	**Torque reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	2						1	1		
Range	±USER_CURRENT_MAX %															
Default	0.00															
Update rate	4ms read															

4.09	**Torque offset**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1						1	1		
Range	±USER_CURRENT_MAX %															
Default	0.0															
Update rate	4ms read															

4.10	Torque offset select															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

The torque offset is added to the torque reference when Pr **4.10** is one. The torque offset is updated every 4ms when connected to an analog input, and so Pr **4.08** should be used for fast updating if required.

4.11	Torque mode selector															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 4															
Default	0															
Update rate	4ms read															

When this parameter is set to 1, 2 or 3 the ramps are not active while 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 coast stopping or stopping without ramps are used. However, if ramp stop mode is used the ramp output is pre-loaded with the actual speed at the changeover point to avoid unwanted jumps in the speed reference.

0: Speed control mode

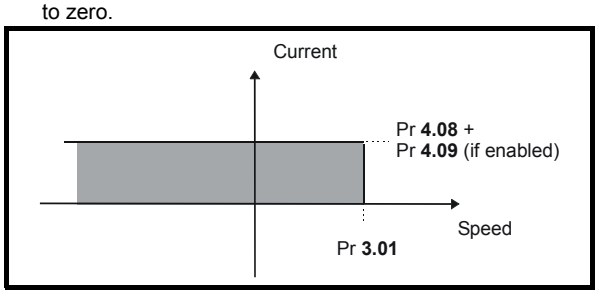
The torque demand is equal to the speed loop output.

1: Torque control

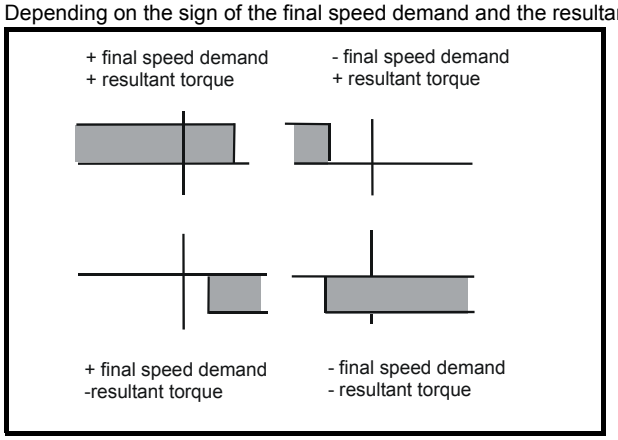
The torque demand is given by the sum of the torque reference and the torque offset, if enabled. The speed is not limited in any way, however, the drive will trip at the overspeed threshold if runaway occurs.

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 below 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 below are possible.



This mode of operation can be used where torque control is required, but the maximum speed must be limited by the drive.

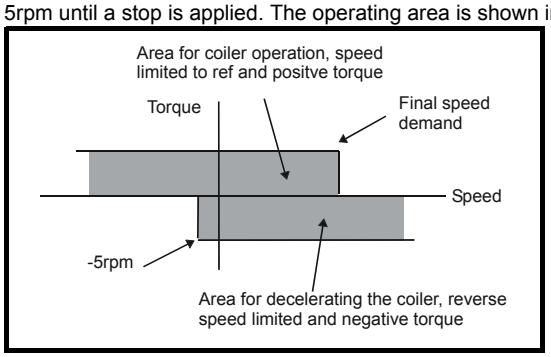
3: Coiler/uncoiler mode

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 -5 rpm.

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 +5 rpm.

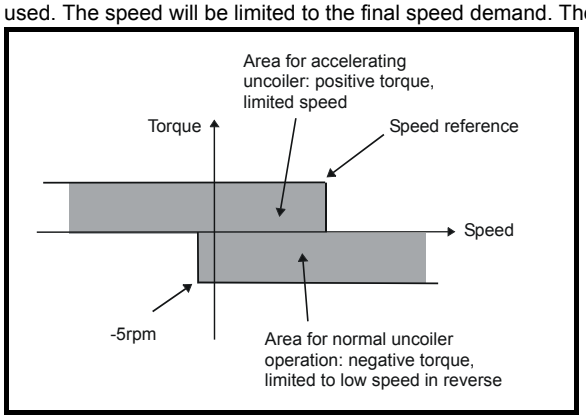
Example of coiler operation:

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 decelerate down to -5rpm until a stop is applied. The operating area is shown in the following diagram:



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 5 rpm 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:



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 1**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 25.0 ms															
Default	0.0															
Update rate	Background read															

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 position feedback quantisation 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. Alternative time constants can be selected depending on the value of the speed controller gain selector (Pr **3.16**). If Pr **3.16** = 0 Pr **4.12** is used, if Pr **3.16** = 1 Pr **4.23** is used.

4.13	**Current controller Kp gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 30,000															
Default	200 V drive: 75 400 V drive: 150															
Second motor parameter	Pr **21.22**															
Update rate	Background read															

4.14	**Current controller Ki gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 30,000															
Default	200 V drive: 1,000 400 V drive: 2,000															
Second motor parameter	Pr **21.23**															
Update rate	Background read															

The proportional gain Kp (Pr **4.13**) is the most critical value in controlling the performance of the current controllers. Either the value can be set by auto-tuning (see Pr **5.12**), or it can be set by the user so that

Kp = (L / T) x (Ifs / Vfs) x (256 / 5)

Where:

T is the sample time of the current controllers. The drive compensates for any change of sample time, and so it should be assumed that the sample time is equivalent to the lowest sample rate of 167 μs.
L is the motor inductance. This is half the phase to phase inductance that is normally specified by the manufacturer. This is the inductance value stored in Pr **5.24** after the auto-tune test is carried out.
I_{fs} is the peak full scale current feedback = Kc x √2 / 0.45. Where Kc is the current scaling for each size of drive.

V_{fs} is the maximum DC bus voltage.

Therefore:

Kp = (L / 167us) x (Kc x √2 / 0.45 / Vfs) x (256 / 5)
= K x L x Kc

Where:

K = √2 / (0.45 x V_{fs} x 167 μs) x (256 / 5)

There is one value of the scaling factor K for each drive voltage rating as shown in the table below

Drive voltage rating	V_{fs}	K
200 V	415 V	2,322
400 V	830 V	1,161

The integral gain Ki (Pr **4.14**) is less critical and should be set so that

Ki = Kp x 256 x T / τ_m

where

τ_m is the motor time constant (L / R).

R is the per phase stator resistance of the motor (i.e. half the resistance measured between two phases).

Therefore

Ki = (K x L x Kc) x 256 x 167 us x R / L
= 0.0427 x K x R x Kc

The above equations give the gain values that are calculated by the auto-tune system and these should give the best response at all switching frequencies with minimal overshoot. If required the gains can be adjusted to improve performance as follows:

1. The integral gain (Ki) can be used to improve the performance of the current controllers by reducing the effects of inverter non-linearity. These effects become more significant with higher switching frequency. These effects will be more significant for drives with higher current ratings and higher voltage ratings. If Ki is increased by a factor of 4 it is possible to get up to 10 % overshoot in response to a step change of current reference. For high performance applications, it is recommended that Ki is increased by a factor of 4 from the auto-tuned values. As the inverter non-linearity is worse with higher switching frequencies it is may be necessary to increase Ki by a factor of 8 for operation with 16 kHz switching frequency.
2. It is possible to increase the proportional gain (Kp) to reduce the response time of the current controllers. If Kpi is increased by a factor of 1.5 then the response to a step change of reference will give 12.5 % overshoot. It is recommended that Ki is increased in preference to Kpi.

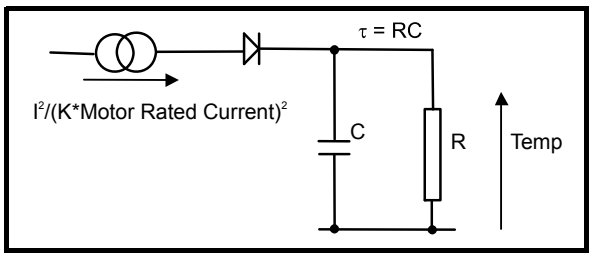
As already stated, the drive compensates for changes of switching frequency to give similar performance as the switching frequency changes. The following table gives the relationship between the user gain values and the values actually used by the drive.

Switching freq	Proportional gain	Integral gain
3 kHz	Pr **4.13**	Pr **4.14**
4 kHz	Pr **4.13** x 1.5	Pr **4.14**
6 kHz	Pr **4.13** x 2	Pr **4.14**
8 kHz	Pr **4.13** x 2	Pr **4.14** x 1.3
12 kHz	Pr **4.13** x 2.6	Pr **4.14** x 1.3

4.15	**Thermal time constant**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0.0 to 3000.0															
Default	20.0															
Second motor parameter	Pr **21.16**															
Update rate	Background read															

4.16	**Thermal protection mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1	1	
Range	0 to 1															
Default	0															
Update rate	Background read															

The motor is modelled thermally in a way that is equivalent to the electrical circuit shown as follows.

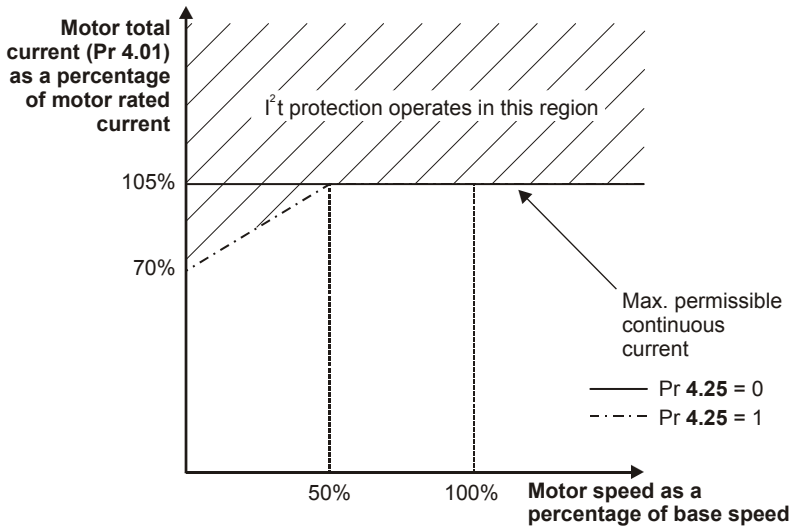


The temperature of the motor as a percentage of maximum temperature, with a constant current magnitude of I, constant value of K and constant value of motor rated current (set by Pr **5.07** or Pr **21.07**) after time t is given by

$$Temp = [I^2 / (K \times \text{Motor rated current})^2] (1 - e^{-t/\tau}) \times 100\ \%$$

This assumes that the maximum allowed motor temperature is produced by K x Motor rated current and that τ is the thermal time constant of the point in the motor that reaches its maximum allowed temperature first. τ is defined by Pr **4.15.** The estimated motor temperature is given by Pr **4.19** as a percentage of maximum temperature. If Pr **4.15** has a value between 0.0 and 1.0 the thermal time constant is taken as 1.0.

Pr **4.25** can be used to select 2 alternative protection characteristics (see diagram below). If Pr **4.25** is 0 the characteristic is for a motor which can operate at rated current over the whole speed range. If Pr **4.25** is 1 the characteristic is intended for motors where the cooling effect of motor fan reduces with reduced motor speed below half of rated speed. The maximum value for K is 1.05, so that above the knee of the characteristics the motor can operate continuously up to 105 % current.



Proportion of rated speed Pr **5.08**.

When the estimated temperature reaches 100 % the drive takes some action depending on the setting of Pr **4.16**. If Pr **4.16** is 0, the drive trips when the threshold is reached. If Pr **4.16** is 1, the current limit is reduced to (K - 0.05) x 100 % when the temperature is 100 %. The current limit is set back to the user defined level when the temperature falls below 95 %. The current magnitude and the active current controlled by the current limits should be similar, and so this system should ensure that the motor operates just below its thermal limit.

The time for some action to be taken by the drive from cold with constant motor current is given by:

T_{trip} = -(Pr **4.15**) x ln(1 - (K x Pr **5.07** / Pr **4.01**)^2)

Alternatively the thermal time constant can be calculated from the trip time with a given current from:

Pr **4.15** = -T_{trip} / ln(1 - (K / Overload)^2)

For example, if the drive should trip after supplying 150 % overload for 60 seconds with K = 1.05 then

Pr **4.15** = -60 / ln(1 - (1.05 / 1.50)^2) = 89

The thermal model temperature accumulator is reset to zero at power-up and accumulates the temperature of the motor while the drive remains powered-up. Each time Pr **11.45** is changed to select a new motor, or the rated current defined by Pr **5.07** or Pr **21.07** (depending on the motor selected) is altered, the accumulator is reset to zero. If Pr **4.15** is set to zero the motor thermal protection system is disabled and the accumulator remains at zero.

4.17	**Reactive current**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	2	1		1		1				
Range	±DRIVE_CURRENT_MAX A															
Update rate	4ms write															

The drive reactive current is shown in this parameter. This parameter is normally 0 unless operating in the field weakening range.

4.18	**Overriding current limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1	1		1		1			1	
Range	0 to TORQUE_PROD_CURRENT_MAX %															
Update rate	Background write															

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**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1		1		1			1	
Range	0 to 100.0 %															
Update rate	Background write															

See Pr **4.16** on page 75.

4.20	**Percentage load**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	1	1		1		1				
Range	±USER_CURRENT_MAX %															
Update rate	Background write															

This parameter displays the actual torque producing current (Pr **4.02**) as a percentage of rated active current. Positive values indicate motoring and negative values indicate regenerating.

4.22	**Inertia compensation enable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

If this parameter is set to one, the drive calculates a torque reference from the motor and load inertia (Pr **3.18**) and the rate of change of speed reference. The torque reference is added to the speed controller output to provide inertia compensation. This can be used in speed control applications to produce the torque required to accelerate or decelerate the load inertia.

4.23	**Current demand filter 2**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 25.0 ms															
Default	0.0															
Update rate	Background read															

The current demand filter time constant is defined by this parameter if the speed gain select (Pr **3.16**) is one.

4.24	**User current maximum scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1		1				1	1	1	
Range	0.0 to TORQUE_PROD_CURRENT_MAX %															
Default	300															
Update rate	Background read															

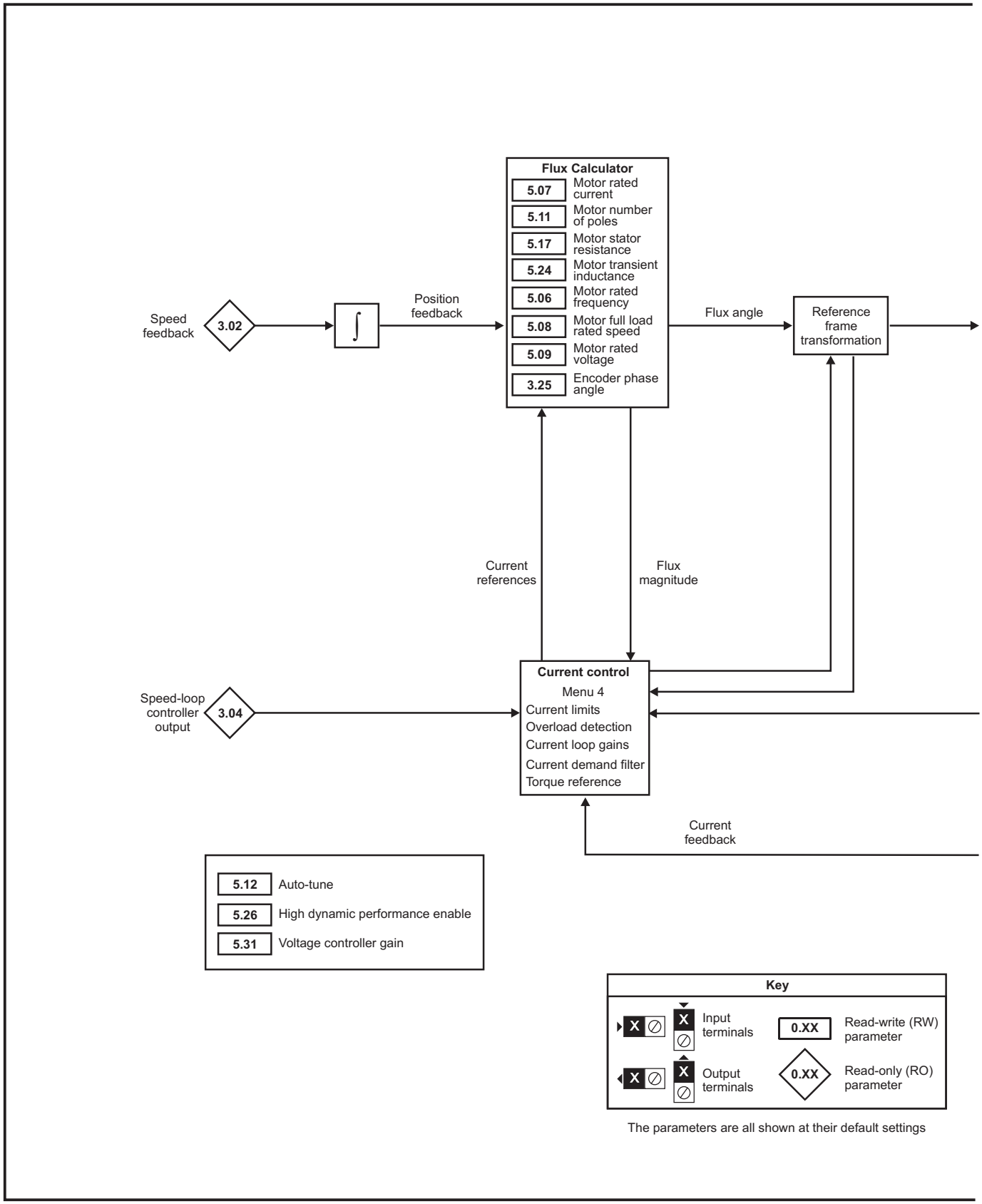
The maximum for Pr **4.08** and Pr **4.20** is defined by this parameter

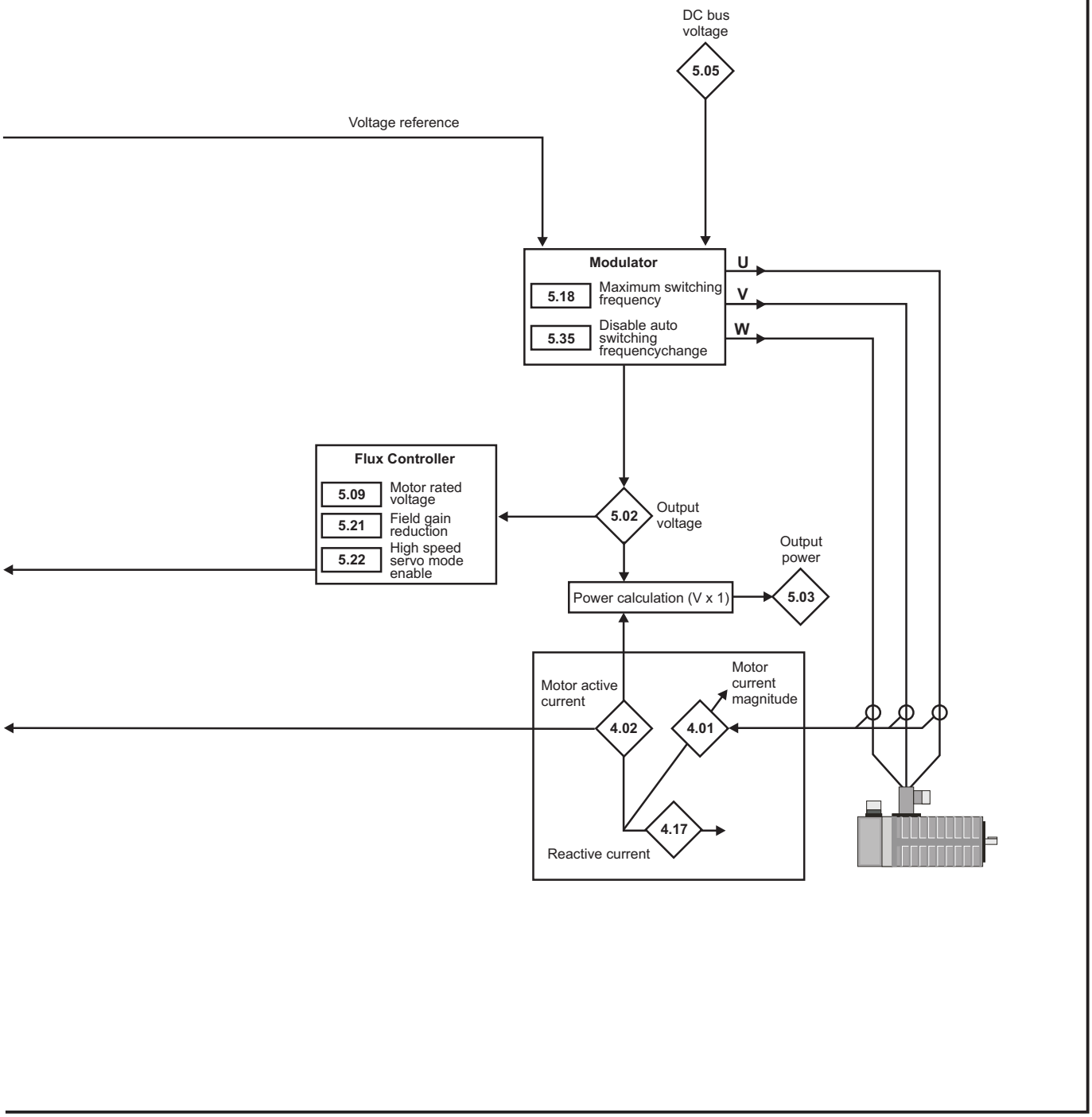
4.25	**Low speed thermal protection mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

See Pr **4.16** on page 75.

5.7 Menu 5: Motor control

Figure 5-5 Menu 5 Logic diagram




DC bus voltage
5.05
Voltage reference
Modulator
5.18
Maximum switching frequency
5.35
Disable auto switching frequencychange
U
V
W
Flux Controller
5.09
Motor rated voltage
5.21
Field gain reduction
5.22
High speed servo mode enable
5.02
Output voltage
Output power
Power calculation (V x 1)
5.03
Motor active current
Motor current magnitude
4.02
4.01
4.17
Reactive current

5.01	Output frequency															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			0	1	1		1		1				
Range	±1250.0 Hz															
Update rate	250 µs write															

The output frequency is not controlled directly, and so the output frequency displayed in this parameter is calculated by measuring the frequency of the controller reference frame.

5.02	Output voltage															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1		1		1		1				
Range	0 to AC_VOLTAGE_MAX V															
Update rate	Background write															

This is the modulus of the r.m.s. line to line voltage at the inverter output at the drive output frequency.

5.03	Output power															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1	2	1		1		1				
Range	±POWER_MAX kW															
Update rate	Background write															

The output power is the dot product of the output voltage and current vectors. Positive power indicates power flowing from the drive to the motor (motoring) and negative power indicates power flowing from the motor to the drive (regen).

5.05	DC bus voltage															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1			1		1		1		1			1	
Range	0 to +DC_VOLTAGE_MAX V															
Update rate	Background write															

Voltage across the internal DC bus of the drive.

5.07	Motor rated current															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	2		1				1	1	1	
Range	0 to RATED_CURRENT_MAX A															
Default	Maximum current (i.e. the value of Pr **11.32**)															
Second motor parameter	Pr **21.07**															
Update rate	Background read															

The rated current should be set at the motor nameplate value for rated current. The value of this parameter is used for current limits and motor thermal protection.

5.08	Rated speed															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 40,000.00 rpm															
Default	3,000.00															
Second motor parameter	Pr **21.08**															
Update rate	Background read															

The Rated load rpm defines the rated speed of the motor and is only used in the motor thermal protection scheme (see Pr **4.16** on page 75.) and to determine the speed used in the auto tuning inertia test (see Pr **5.12** on page 81).

5.09	**Rated voltage**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1			1				1	1	1	
Range	0 to AC_VOLTAGE_SET_MAX V															
Default	200 V rating drive: 230 V 400 V rating drive: EUR: 400 V, USA: 480 V 600 V rating drive: 575 V 690 V rating drive: 690 V															
Second motor parameter	Pr **21.09**															
Update rate	Level 4 read															

The rated voltage is used by the field controller to limit the voltage applied to the motor if high speed operation is required. Some headroom must be left for the current controllers to operate, and so the drive will use the voltage level set by this parameter or the headroom limit whichever is the lower.

5.11	**Number of motor poles**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 60 (Auto to 120 POLE)															
Default	3 (6 POLE)															
Second motor parameter	Pr **21.11**															
Update rate	Background read															

This parameter must be set correctly for the vector control algorithms to operate correctly. When auto is selected the number of poles is set to 6.

5.12	**Autotune**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1	1	
Range	0 to 6															
Default	0															
Update rate	Background read															

If this parameter is set to a non-zero value, the drive is enabled and a run command is applied in either direction the drive performs an auto-tune test. All tests that rotate the motor are carried out in the forward direction if Pr **1.12** = 0 or the reverse direction if Pr **1.12** = 1. For example, if the test is initiated by applying run reverse (Pr **6.32** = 1) the test is performed in the reverse direction. It should be noted however that the motor may jump in either direction by up to half an electrical revolution at the start of the phasing test and then move in the required direction for the remainder of the test. The test will not start unless the drive is disabled before the test is initiated by applying the enable or run, i.e. it will not start if the drive is in the stop state. It is not possible to go into the stop state if Pr **5.12** has a non-zero value. (If Pr **5.12** is set to 6 then no test is carried out, but the current loop gains are re-calculated. For these actions the drive does not need to be enabled.)

It is important that the motor is at standstill before the auto-tune test is performed if the correct results are to be obtained. The parameters modified by the auto-tune tests are defined below when the second motor parameters are not selected (i.e. Pr **11.45** = 0). If the second motor is selected for the duration of the tests (i.e. Pr **11.45** = 1), the second motor parameters in menu 21 are modified instead and not the parameters described below. When the test is completed successfully the drive is disabled and will enter the inhibit state. The motor can only be restarted if the enable is removed either from the enable input, or Pr **6.15** is set to zero or from the control word (Pr **6.42**). As the tests progresses the calculated parameters are saved to EEPROM as indicated. If for any reason the test fails, and the drive trips, no further parameters are calculated or stored in EEPROM. (If the drive is in Auto or Boot copying modes (Pr **11.42** = 3 or 4) the parameters are also saved to the SMARTCARD where it is indicated that parameters are saved to EEPROM.)

In this mode the following parameters are used in the vector control algorithm.

	Parameter	**Required for good performance**	**Required for excellent performance**
Encoder phase angle	Pr **3.25**	✓	✓
No. of poles	Pr **5.11**	✓	✓
Transient inductance (σL_s)	Pr **5.24**		✓
Stator resistance (Rs)	Pr **5.17**		✓

All these parameters can be set by the user. The motor set-up is constantly recalculated in the background task, therefore modifying these parameters even after auto-tune will affect the performance of the drive. The auto-tune test can be used to overwrite the user or default settings as described below. It should be noted that the current loop gains (Pr **4.13** and Pr **4.14**) are not updated as part of any test if either the stator resistance or the transient inductance for the active motor map are zero.

1: Short low speed test

- The motor is rotated by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the forward direction. The drive applies rated current to the motor during the test and measures the encoder phase angle (Pr **3.25**) only. The phase angle measurement is taken when the motor has stopped at the end of the test, therefore there must be no load on the motor when it is at rest for the correct angle to be measured. This test takes approximately 2 seconds to complete and can only be used where the rotor settles to a stable position in a short time.
- Pr **3.25** is saved to EEPROM.

2. Normal low speed test

- The motor is rotated by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the forward direction. The drive applies rated current to the motor during the test and measures the encoder phase angle (Pr **3.25**). The phase angle measurement is taken when the motor has stopped at the end of the test, therefore there must be no load on the motor when it is at rest for the correct angle to be measured.
- Pr **3.25** is saved to EEPROM.
- A stationary test is performed to measure the motor resistance (Pr **5.17**).
- Pr **5.17** is saved to EEPROM.
- A stationary test is performed to measure the motor inductance (Pr **5.24**). When this test is complete the current loop gains (Pr **4.13** and Pr **4.14**) are over-written with the correct values based on the calculations given in Menu 4. It should be noted that the inductance measured is the inductance in the flux axis. For many motors this will be 20 to 30 % less that the inductance in the other axis. The inductance for the other axis could be used to calculate the current controller proportional gain if required because there are no transient changes of current reference flux axis. Therefore the gain can be increased by the user if required. The inductance for the other axis should be used to obtain optimal cross coupling cancellation (see Pr **5.26** on page 85), and so the inductance parameter (Pr **5.24**) could also be increased by the user if required.
- Pr **4.13**, Pr **4.14** and Pr **5.24** are saved to EEPROM.

The whole test takes approximately 20 seconds and can be used with motors that take time to settle after the rotor has moved. During the motor inductance measurement the drive applies current pulses to the motor that produces flux that opposes the flux produced by the magnets. The maximum current applied is a quarter of rated current (Pr **5.07** or Pr **21.07**). This current is unlikely to affect the motor magnets, however, if this level of current could permanently de-magnetize the magnets the rated current should be set to a lower level for the tests to avoid this.

Either the short or normal low speed tests could be used with a servo motor that does not have an absolute encoder (i.e. incremental without UVW commutation signals, SINCOS without comms etc.) to control a servo motor. A phasing test would need to be performed after each power-up, or loss of encoder power supply if the motor rotates while the supply is not present before the motor could be controlled by the drive. If this method of control is used the drive cannot do any error checking to ensure that the absolute position has not been lost due to unwanted encoder counts due to noise.

Either the short or the normal low speed tests can be used with a servo type encoder (Ab.Servo, Fd.Servo or Fr.Servo) that has only commutation signals, i.e. the lines per revolution has been set to zero. When these tests are performed with this type of encoder the motor will continue to move in the same direction after the first two electrical revolutions. It will then stop for either 0.8s (short test) or 4s (normal test) and then continue to move again for part of an electrical revolution.

3: Inertia measurement

- The drive attempts to accelerate the motor in the forward direction up to $^{3}/_{4}$ x rated load rpm and then back to standstill. Several attempts may be made, starting with rated torque/16, and then increasing the torque progressively to $x^{1}/_{8}$, $x^{1}/_{4}$, $x^{1}/_{2}$ and x1 rated torque if the motor cannot be accelerated to the required speed. 5s acceleration time is allowed during the first four attempts and 60s on the final attempt. If the required speed is not achieved on the final attempt the test is aborted and a tuNE1 trip is initiated. If the test is successful the acceleration and deceleration times are used to calculate the motor and load inertia which is written to Pr **3.18**.
- Pr **3.18** is saved to EEPROM.

The calculated inertia depends on the value of motor torque per amp entered in Pr **5.32**. If this parameter is incorrect the inertia value will be incorrect. However, as explained in the inertia test description , this will not affect the accuracy of automatic speed loop gain set up because Kt is also used in these calculations and any inaccuracy cancels out.

The test algorithm attempts to remove the effect of any load on the motor other than the torque required to accelerate and decelerate the motor, i.e. friction and windage losses, static torque load etc. Provided the average torque during acceleration and the average torque during deceleration are the same the effect of the additional torque is removed and the inertia value is calculated correctly.

4. Stationary test to set up current controller gains only

- A stationary test is performed to measure the motor resistance (Pr **5.17**).
- Pr **5.17** is saved to EEPROM.
- A stationary test is performed to measure the motor inductance (Pr **5.24**). When this test is complete the current loop gains (Pr **4.13** and Pr **4.14**) are overwritten with the correct values based on the calculations given in Menu 4.
- Pr **4.13**, Pr **4.14** and Pr **5.24** are saved to EEPROM.

This test can only be used with a motor when the correct phasing angle has been set in Pr **3.25**, because rated current is applied in the flux axis during the resistance measurement. If the phasing angle is not correct the motor may move and the results may be incorrect.

5. Minimal movement phasing test

Short current pulses are applied to the motor to produce a small movement and then to move the motor back to the original position. The size and length of the pulses are gradually increased (up to a maximum of rated current defined by Pr **5.07**) until the movement is approximately at the level defined by Pr **5.38** electrical degrees.. The resulting movements are used to estimate the phase angle.

The test is carried out as follows:

- Current pulses are applied to determine the phasing angle
- An additional test is performed to ensure that the phasing angle is correct. If the test fails there is a delay and then test recommences. This is repeated twice after which a tunE2 trip is initiated. The delay before recommencing the test is 200 ms and then 400 ms. These delays allow the motor to stop moving if the test has initiated movement due to cogging torque.

- A test is performed to ensure that the feedback device direction is correct
- Pr **3.25** (phasing angle) is updated and saved to EEPROM.

This test will operate correctly when the load is an inertia, and although a small amount of cogging and stiction is acceptable, this test cannot be used for a loaded motor. The test can only be used where the total inertia is less than 0.715 x T_{rated} / Pr **5.38** kgm^2, assuming no additional stictional load, where Trated is the torque produced by rated current as defined by Pr **5.07** or Pr **21.07**. In most cases the motor only moves by the required angle, however, it is possible for the test to initiate additional movement due to cogging torque. The amount of movement depends on the design of the motor and is similar to the movement produced by cogging torque when the drive is disabled. If the motor is moving at a speed that is higher than the zero speed threshold (Pr **3.05**) when the test is initiated a tunE3 trip is initiated.

This test can be used with any type of encoder except a commutation only encoder i.e. Ab.Servo, Fd.Servo or Fr.Servo encoders with the lines per rev set to zero. However, it is also not recommended with Ab.Servo, Fd.Servo or Fr.Servo encoders because the absolute position is not defined until two valid changes of the commutation signals have occurred after power-up or an encoder trip. Therefore if the test is carried out before two valid changes have occurred, the movement produced during the test may be quite large and the result may be slightly inaccurate. Once two valid changes have occurred the test operates in the same way as for other encoder types.

The current controllers are used to perform this test, however, the default gains may be too high. It is not possible to carry out the necessary test to set up the current controllers before the phasing angle is known. If the gains are too high the minimal movement phasing test may cause an OI.AC trip. If this happens the current controller gains should be reduced progressively until the test is successful. Once the phasing angle is known, the stationary test to set up the current controller gains only (Pr **5.12**=4) may be used to obtain the correct gain values for the current controllers.

6. Current controller gain calculation only

- No current is applied to the motor.
- The current loop gains are calculated based on the value of the motor inductance (Pr **5.24**) and resistance (Pr **5.17**) and written to Pr **4.13** and Pr **4.14**.
- Pr **4.13** and Pr **4.14** are saved to EEPROM.

This is intended to be used as a method of setting up the current loop gains from user defined values of motor inductance and resistance. The drive should not be enabled to perform these calculations. If the parameter is set to 6 it is automatically cleared by the drive once the calculation is complete. It should be noted that the value changes back to zero within a few hundred milliseconds of being set to 6 by the user.

The auto-tune tests may be aborted by removing the run command or the enable or if a trip occurs. During the auto-tune tests the following trips can occur in addition to the other drive trips.

Trip code	Reason	Test which can cause trip
tunE1	The position feedback did not change (i.e. motor did not turn or feedback failed)	1,2,5
	The motor did not reach the required speed	3
tunE2	Position feedback direction incorrect	1,2
	The motor could not be stopped	3
	Minimal movement phasing test failed	5
tunE3	Drive encoder commutation signals connected incorrectly, i.e. direction incorrect. (Drive encoder only.)	1,2
	The motor was moving when the minimal movement phasing test was initiated	5
	The calculated inertia is out of range	3
tunE4	Drive encoder U commutation signal fail (Drive encoder only.)	1,2
tunE5	Drive encoder V commutation signal fail (Drive encoder only.)	1,2
tunE6	Drive encoder W commutation signal fail (Drive encoder only.)	1,2
tunE7	Motor poles or encoder lines set up incorrectly. A trip is initiated if the speed is not within ±6.25 % of the expected no load speed just after the motor has ramped up to speed. This trip will not occur if the motor poles are set to more than 12.	1,2
tunE	Auto-tune stopped before completion	All
rS*	Stator resistance too high	2

*The rS trip is produced if the drive cannot achieve the necessary current levels to measure the stator resistance during the test (i.e. there is no motor connected to the drive), or if the necessary current level can be achieved, but the calculated resistance exceeds the maximum values for the particular drive size or it exceeds the maximum of Pr **5.17**. The maximum measurable value for a particular drive size can be calculated from the following formula.

Rs_{max} = DC_VOLTAGE_MAX x 0.45 /(Kc x $\sqrt{2}$)

where Kc is the current scaling factor for the drive

5.14	Action on enable															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 2															
Default	0															
Update rate	Background read															

This parameter defines the action taken on enable as follows:

0: nonE
No action.

1: Ph Enl
A minimal movement phasing test is performed each time the drive is enabled (i.e. changes from the inhibit state to either the stop or run state). The test can be used to determine the phasing angle for an absolute or non-absolute type encoder. If the test is completed successfully the drive changes to the stop or run state as appropriate. The phasing angle parameter is updated to the correct value, but it is not saved to EEPROM or the SMARTCARD.

2: Ph Init
A minimal movement phasing test is performed the first time the drive is enabled after power-up. The test will only be performed again on enable if the position feedback device(s) have been re-initialized. Re-initialization occurs for example after a trip specifically related to an encoder where position information may have been lost. initialization occurs when Pr **3.48** changes from zero to one. The phasing angle parameter is updated to the correct value, but it is not saved to EEPROM or the SMARTCARD.

5.17	Stator resistance															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3		1				1	1	1	
Range	0.000 to 65.000 x 10 Ω															
Default	0.000															
Second motor parameter	Pr **21.12**															
Update rate	Background read															

Pr **5.17** shows the stator resistance of the motor divided by 10. Therefore 1.000 in this parameter represents the resistance of 10 Ω.

5.18	Maximum switching frequency															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1				1				1	1	1	
Range	0 to 4 (3, 4, 6, 8, 12 kHz)															
Default	2 (6 kHz)															
Update rate	Background read															

This parameter defines the required switching frequency. The drive may automatically reduce the actual switching frequency (without changing this parameter) if the power stage becomes too hot. The switching frequency can reduce from 12 kHz to 6 kHz to 3 kHz, or 8 kHz to 4 kHz. An estimate of the IGBT junction temperature is made based on the heatsink temperature and an instantaneous temperature drop using the drive output current and switching frequency. The estimated IGBT junction temperature is displayed in Pr **7.34**. Reducing the switching frequency reduces the drive losses and the junction temperature displayed in Pr **7.34** also reduces. If the load condition persists the junction temperature may continue to rise. If the temperature exceeds the values given in the description for Pr **7.34** on page 106, and the switching frequency cannot be reduced, the drive will initiate an O.ht1 trip (see Pr **5.35** on page 86 and Pr **7.34** on page 106). Every 20 ms the drive will attempt to restore the switching frequency if the higher switching frequency will not take the IGBT temperature above 135 °C. The following table gives the sampling rate for different sections of the control system for different switching frequencies.

	3, 6, 12 kHz	4, 8 kHz	Control system
Level 1	3 = 167 µs 6 = 83 µs 12 = 83 µs	125µs	Current controllers
Level 2	250 µs	250 µs	Speed controller and ramps
Level 3	1 ms	1 ms	Voltage controller
Level 4	4 ms	4 ms	Time critical user interface
Background	N/A	N/A	Non-time critical user interface

5.21	**Field gain reduction**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

A suitable field controller gain is automatically set by the drive from the motor parameters. However it is possible by setting this parameter to a 1 to reduce this gain by a factor of 2 if instability problems occur above base speed.

5.22	**Enable high speed servo mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

High speed servo mode is not enabled as default. Care must be taken when using this mode with servo motors to avoid damaging the drive. The voltage produced by the servo motor magnets is proportional to speed. For high speed operation the drive must apply currents to the motor to counter-act the flux produced by the magnets. It is possible to operate the motor at very high speeds that would give a very high motor terminal voltage, but this voltage is prevented by the action of the drive. If however, the drive is disabled (or tripped) when the motor voltages would be higher than the rating of the drive without the currents to counter-act the flux from the magnets, it is possible to damage the drive. If high speed mode is enabled the motor speed must be limited to the levels given in the table below unless an additional hardware protection system is used to limit the voltages applied to the drive output terminals to a safe level.

Drive voltage rating	**Maximum motor speed (rpm)**	**Maximum safe line to line voltage at the motor terminals (V rms)**
200	400 x 1000 / (Ke x √2)	400 / √2
400	800 x 1000 / (Ke x √2)	800 / √2

Ke is the ratio between r.m.s. line to line voltage produced by the motor and the speed in V/1000 rpm**.** Care must also be taken not to de-magnetize the motor. The motor manufacturer should always be consulted before using this mode.

5.24	**Transient inductance (σL_s)**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3		1				1	1	1	
Range	0.000 to 500.000 mH															
Default	0.000															
Second motor parameter	Pr **21.14**															
Update rate	Background read															

The transient inductance is the phase inductance for a servo motor. This is half the inductance measured from phase to phase. This value is used for cross-coupling compensation and to set the current controller gains.

5.26	**High dynamic performance enable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

When this bit is set the drive provides a cross-coupling feed forward voltage as produced by the transient inductance and a frequency based voltage feed forward term. These voltages improve the transient performance of the current controllers.

5.31	Voltage controller gain															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 30															
Default	1															
Update rate	Background read															

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 (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 torque per amp (Kt)															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 500.00 NmA^{-1}															
Default	1.60															
Update rate	Background (1s) read															

This parameter shows the motor torque per amp of active (torque producing) current used to calculate the speed controller gains when the automatic set-up methods are active (i.e. Pr **3.17** = 1 or 2).

The motor torque per amp (Kt) must be entered in this parameter by the user for the automatic gain calculation system to operate correctly, and to allow the drive to calculate the correct inertia during and inertia autotune.

5.33	Motor volts per 1000rpm (Ke)															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 10,000															
Default	98															
Second motor parameter	Pr **21.30**															
Update rate	Background read															

This parameter is used to set up the current controller integral terms when the drive is disabled to prevent current transients when the drive is enabled with a spinning motor. It is also used to provide a voltage feed forward term if high dynamic performance is selected with Pr **5.26**.

5.35	Disable auto-switching frequency change															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

The drive thermal protection scheme (see Pr **7.34** on page 106) reduces the switching frequency automatically when necessary to prevent the drive from overheating. It is possible to disable this feature by setting this bit parameter to one. If the feature is disabled the drive trips immediately when the IGBT temperature is too high.

5.36	Motor pole pitch															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0 to 655.35mm															
Default	0.00mm															
Second motor parameter	Pr **21.31**															
Update rate	Background read															

This parameter should be set up to give the pole pitch of a linear motor, i.e. the movement of the motor for one cycle of the drive power output waveforms, if auto-configuration with a linear EnDat encoder is required.

5.37	**Actual switching frequency**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1			1		1		1			1	
Range	0 to 7															
Update rate	Background write															

Pr **5.37** shows the actual switching frequency used by the inverter. The maximum switching frequency is set with parameter Pr **5.18**, but this may be reduced by the drive if automatic switching frequency changes are allowed (Pr **5.35**=1). Pr **5.37** also indicates if the sample time for the current controllers have been reduced to allow for SINCOS encoders with lines per revolution that are not a power of two.

Value	String	Switching frequency (kHz)	Current controller Sample time (us)
0	3	3	167
1	4	4	125
2	6	6	83
3	8	8	125
4	12	12	83
6	6 rEd	6	167
7	12 rEd	12	167

5.38	**Minimal movement phasing test angle**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0 to 25.5 degrees															
Default	5.0 degrees															
Update rate	Background read															

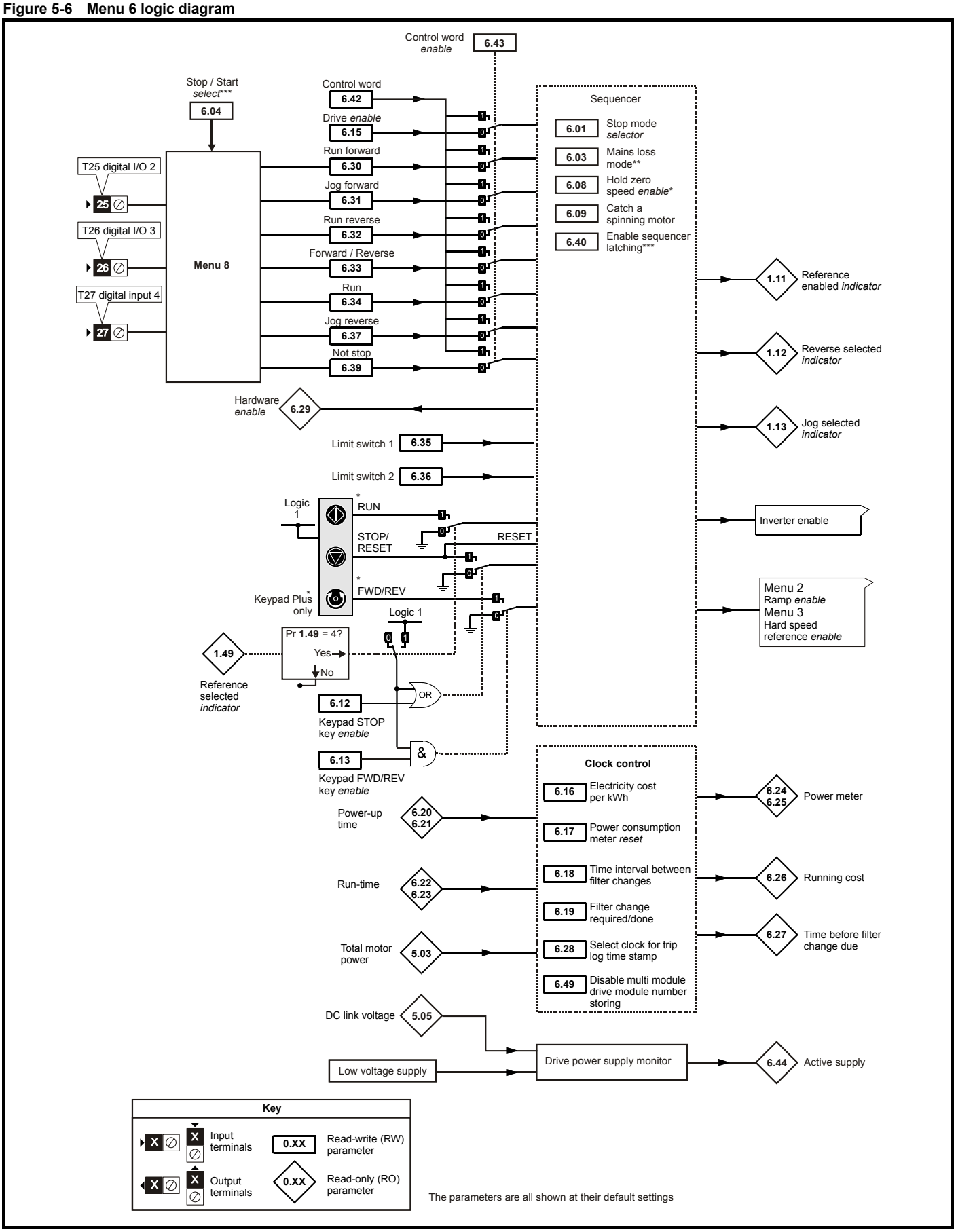
5.39	**Minimal movement phasing test pulse length**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 3															
Default	0															
Update rate	Background read															

By applying short current pulses to the motor and using the resulting movement the drive can calculate the phasing angle (Pr **3.25** or Pr **21.20**). These begin at as short low level pulses, which are increased in magnitude and length until the required electrical movement define by Pr **5.38** is achieved. The actual movement may be larger because motor cogging may cause additional unwanted movement. The required movement should only be reduced if this is necessary as the results become less accurate with less movement. Care should be taken to ensure that the minimum movement is large enough so that the change of position given by the feedback device can be registered by the drive. For example a 4096 line incremental device on a 6 pole motor will give a change of position count of 75 for a 5° electrical movement. It is suggested that this test should not be used with a change of position count of less than 50. Although Pr **5.38** can be reduced to zero the lowest value used by the drive is 1.0 degrees.

The necessary movement can be produced with a lower torque level if the test pulses are extended. If the pulses of torque are smaller then the acceleration is less, and so the noise and vibration produced by the test are less. The pulse length can be modified with Pr **5.39** (1 = pulse lengths x 2, 2 = x 3, and 3 = x 4). Longer pulses should only be used if noise and vibration are a problem and the motor has low friction and low cogging torque. As the torque level is reduced the measurement is likely to be affected by cogging and the results may not be accurate.

5.8 Menu 6: Sequencer and clock

Figure 5-6 Menu 6 logic diagram



6.01	**Stop mode**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 2															
Default	2															
Update rate	Background read															

Only one stopping phase exists and the ready state is entered as soon as the single stopping action is complete. It should be noted that the stop condition is detected when the speed feedback is below the zero speed threshold (Pr **3.05**) for at least 16ms. If the speed is not stable it is possible that the stop condition is not detected. In this case the system should be made more stable or the zero speed threshold should be raised.

Stopping Mode	Action
0: Coast	Inhibits the inverter
1: Ramp	Stop with ramp
2: No ramp	Stop with no ramp

If coast stop is selected the inverter is inhibited immediately when the run command is removed. If however, hold zero speed is also selected (Pr **6.08** = 1), then the inverter will be re-enabled to hold zero speed. The result is that the inverter is disabled for one sample and then enabled to ramp the motor to a stop. Therefore if coast stop is required Pr **6.08** should be set to zero to disable hold zero speed.

If stop with ramp is selected the relevant ramp rate is used to stop the motor even if Pr **2.02** is set to zero to disable ramps.

The motor can be stopped with position orientation after stopping. This mode is selected with the position controller mode (Pr **13.10**). When this mode is selected Pr **6.01** has no effect.

6.03	**Mains loss mode**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 2															
Default	0															
Update rate	Background read															

0: dis

There is no mains loss detection and the drive operates normally only as long as the DC bus voltage remains within specification (i.e. >Vuv). Once the voltage falls below Vuv a UV trip occurs and this will reset itself if the voltage rises again above Vuv Restart shown in the table below.

1: Stop

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 while the motor is stopping any run signal is ignored until the motor has stopped. If the current limit value is set at a very low level the drive may trip UV before the motor has stopped. If the mains is reapplied the drive restarts after it reaches the ready state provided the necessary controls are still active to initiate a start.

2: ride.th

The drive detects mains loss when the DC bus voltage falls below Vml_1. The drive then enters a mode where a closed-loop controller attempts to hold the DC bus level at Vml_2. 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 DC bus voltage above the detection threshold Vml_3 and the drive will continue to operate normally. The output of the mains loss controller is a current demand that is fed into the current control system and therefore the gain parameters Pr **4.13** and Pr **4.14** must be set up for optimum control. See Pr **4.13** and Pr **4.14** on page 74 for set-up details.

The following table shows the voltage levels used by drives with each voltage rating.

Voltage level	200V drive	400V drive	575V drive	690V drive
Vuv	175	330	435	435
Vml_1	205*	410*	540*	540*
Vml_2	Vml_1 - 10 V	Vml_1 - 20 V	Vml_1 - 25 V	Vml_1 - 25 V
Vml_3	Vml_1 + 10	Vml_1 + 15	Vml_1 + 50	Vml_1 + 50
Vuv Restart	215	425	590	590

* Vml_1 is defined by Pr **6.48**. The values given in the table are the default values.

6.04	Start/stop logic select															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 4															
Default	4															
Update rate	Background read															

This parameter is provided to allow the user to select several predefined digital input routing macros to control the sequencer. When a value between 0 and 3 is selected the drive processor continuously updates the destination parameters for digital I/O T25, T26 and T27, and the enable sequencer latching bit (Pr **6.40**). When a value of 4 is selected the destination parameters for these digital I/O and Pr **6.40** can be modified by the user. (Note any changes made to the destination parameters only become active after a drive reset).

Pr 6.04	T25 (Pr 8.22)	T26 (Pr 8.23)	T27 (Pr 8.24)	Pr 6.40
0	Pr **6.29***	Pr **6.30** Run Forward	Pr **6.32** Run Reverse	0 (non latching)
1	Pr **6.39** Not stop	Pr **6.30** Run Forward	Pr **6.32** Run Reverse	1 (latching)
2	Pr **6.29***	Pr **6.34** Run	Pr **6.33** Fwd /Rev	0 (non latching)
3	Pr **6.39** Not stop	Pr **6.34** Run	Pr **6.33** Fwd/Rev	1 (latching)
4	User prog	User prog	User prog	User prog

*Pr **6.29** reflects the state of the Safe Torque Off input and so it is not necessary to control this with a digital input, but the set up here is provided for compatibility with older products. Routing a digital input can be used for fast disabling, see Pr **6.29** for more details.

6.08	Hold zero speed															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	1															
Update rate	4 ms read															

When this bit is set the drive remains active even when the run command has been removed and the motor has reached standstill. The drive goes to the 'StoP' state instead of the 'rdy' state.

6.09	Catch a spinning motor															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	1															
Default	1															
Update rate	Background read															

When the drive is enabled with this bit at zero, the post ramp reference (Pr **2.01**) starts at zero and ramps to the required reference. When the drive is enabled with this parameter at one, the post ramp reference is set to the motor speed.

6.12	Enable stop key															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

This parameter permanently enables the Stop key on the drive such that the drive will always stop when the Stop key is pressed. If keypad mode is selected this has no effect because the Stop key is automatically enabled.

The sequencer logic has been designed so that pressing the Stop key, whether the Stop key is enabled or not, does not make the drive change from a stopped to a running condition. As the Stop key is also used to reset trips this means that if the Stop key is pressed when the drive is tripped, the trip will be reset, but the drive does not start. (This does not apply to the UV trip which cannot be reset by the user, but is automatically reset when the DC bus voltage is high enough.) Preventing the drive from starting when the stop key is pressed is implemented as follows.

Sequencer latching not enabled (Pr 6.40=0)

If the Stop key is pressed when the Stop key is enabled (Pr **6.12**=1) or when the drive is tripped the sequencer run is removed, and so the drive stops or remains stopped respectively. The sequencer run can only then be reapplied after at least one of the following conditions occurs.

1. Run forward, Run reverse and Run sequencing bits all zero
2. OR the drive is disabled via Pr **6.15** or Pr **6.29**
3. OR Run forward and Run reverse are both active and have been for 60ms.
4. The drive is in the UV state.

The drive can then be restarted by activating the necessary bits to give a normal start.

Sequencer latching enabled (Pr 6.40=1)

If the Stop key is pressed when the stop key is enabled (Pr **6.12**=1) or when the drive is tripped the sequencer run is removed, and so the drive stops or remains stopped respectively. The sequencer run can only then be reapplied after at least one of the following conditions occurs.

1. Run forward, Run reverse and Run sequencing bits all zero after the latches
2. OR Not stop sequencing bit is zero
3. OR the drive is disabled via Pr **6.15** or Pr **6.29**
4. OR Run forward and Run reverse are both active and have been for 60ms.
5. The drive is in the UV state.

The drive can then be restarted by activating the necessary bits to give a normal start. Note that Run forward and Run reverse together will reset the stop key condition, but the latches associated with Run forward and Run reverse must then be reset before the drive can be restarted. It should be noted holding the Run key and pressing the Stop key to reset the drive without stopping does not apply unless keypad reference mode is selected.

6.13	**Enable forward/reverse key**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

6.15	**Drive enable**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1	1	
Default	1															
Update rate																

Setting this parameter to 0 will disable the drive. It must be at 1 for the drive to run.

6.16	**Electricity cost per kWh**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 600.0 currency units per kWh															
Default	0															
Update rate	Background read															

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	**Reset energy meter**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	Background read															

If this parameter is one the energy meter (Pr **6.24** and Pr **6.25**) is reset and held at zero.

6.18	**Time between filter changes**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1			1	1	1	
Range	0 to 30,000 hrs															
Default	0															
Update rate	Background read															

6.19	**Filter change required / change done**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1											1		1		
Default	0															
Update rate	Background read/write															

To enable the feature that indicates to the user when a filter change is due Pr **6.18** should be set to the time between filter changes. When the drive is running, Pr **6.27** is reduced each time the runtime timer hour increments (Pr **6.23**) until Pr **6.27** reaches 0, at which point Pr **6.19** is set to 1 to inform the user that a filter change is required. When the user has changed the filter, resetting Pr **6.19** to 0 will indicate to the drive that the change has been done and Pr **6.27** will be reloaded 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. If Pr **6.18**=0, then Pr **6.27** is held at zero and so parameters should be saved after Pr **6.18** has been setup so that this system will function correctly after the drive is powered down and powered up again.

6.20	**Powered-up time: years.days**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3	1		1		1		1	1	
Range	0 to 9.364 Years.Days															
Update rate	Background write															

6.21	**Powered-up time: hours.minutes**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1		1	1	
Range	0 to 23.59 Hours.Minutes															
Update rate	Background write															

The powered-up clock always starts at zero each time the drive is powered-up. The time can be changed by the user from the keypad, serial comms or an application module. If the data is not written with the various parts in the correct range (i.e. minutes are greater than 59, etc.) the clock is set to zero on the next minute. This clock may be used for time stamping the trip log if Pr **6.28** = 0.

6.22	**Run time: years.days**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3	1		1		1			1	1
Range	0 to 9.364 Years.Days															
Update rate	Background write															

6.23	**Run time: hours.minutes**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1			1	1
Range	0 to 23.59 Hours.Minutes															
Update rate	Background write															

The run time clock increments when the drive inverter is active to indicate the number of minutes that the drive has been running since leaving the Control Techniques factory. This clock may be used for time stamping the trip log if Pr **6.28** = 1.

6.24	**Energy meter: MWh**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1		1		1				1
Range	±999.9 MWh															
Update rate	Background write															

6.25	**Energy meter: kWh**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				1
Range	±99.99 kWh															
Update rate	Background write															

Pr **6.24** and Pr **6.25** form the energy meter that indicates the net energy supplied to/from the drive in kWh. (i.e. energy supplied by the drive - energy fed back to the drive). For motor control modes a positive value indicates the net transfer of energy from the drive to the motor. If the maximum or minimum of Pr **6.24** is reached, the parameter does not roll over but is instead clamped to the maximum or minimum value.

6.26	**Running cost**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
			1					1		1		1				
Range	±32,000															
Update rate	Background write															

Instantaneous read out of the cost/hour of running the drive. This requires Pr **6.16** to be set up correctly.

6.27	**Time before filter change due**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	1
Range	0 to 30,000 hrs															
Update rate	Background read															

See Pr **6.18** on page 91.

6.28	**Select clock for trip log time stamping**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

The trip log includes time stamping for individual trips provided Pr **6.49** is set to one. If Pr **6.28** is zero, the powered-up clock is used for time stamping. If Pr **6.28** is one, the run time clock is used for time stamping. It should be noted that changing this parameter clears the trip and trip time logs.

6.29	**Hardware enable**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1		1				
Update rate	4ms write															

This bit shows whether the drive is in the enable state or not.
Generally this will reflect the state of the enable input and shows the same value as Pr **8.09**. However the disabled state can be forced by other functions within the drive. Pr **8.09** will always follow the enable input state but the Pr **6.29** will be held at zero, indicating that the drive is forced into the disable state by the following:

1. A digital input is routed to this parameter as described below to provide a fast disable and the input forces this parameter to zero.
2. Any of the following trips are active: OI.AC, PS.10V, PS.24V, OI.Br, OV.

If the destination of one of the drive digital I/O (Pr **8.21** to Pr **8.26**) is set to Pr **6.29** and the I/O is set as an input, it provides a fast disable function. The Safe Torque Off input to the drive (T31) disables the drive in hardware by removing the gate drive signals from the inverter IGBT's and also disables the drive via the software system. When the drive is disabled by de-activating the Safe Torque Off input there can be a delay of up to 20 ms. However, if a digital I/O is set up to provide the fast disable function it is possible to disable the drive within 600 us of de-activating the input. To do this the enable signal should be connected to both the Safe Torque Off (T31) and to the digital I/O selected for the fast disable function. The state of the digital I/O including the effect of its associated invert parameter is ANDed with the Safe Torque Off to enable the drive.

If the safety function of the Safe Torque Off input is required then there must not be a direct connection between the Safe Torque Off input (T31) and any other digital I/O on the drive. If the safety function of the Safe Torque Off input and the fast disable function is required then the drive should be given two separate independent enable signals. A safety related enable from a safe source connected to the Safe Torque Off input on the drive.

A second enable connected to the digital I/O on the drive selected for the fast disable function. The circuit must be arranged so that a fault which causes the fast input to be forced high cannot cause the Safe Torque Off input to be forced high, including the case where a component such as a blocking diode has failed.

6.30	**Sequencing bit: Run forward**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

6.31	**Sequencing bit: Jog**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

6.32	**Sequencing bit: Run reverse**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

6.33	**Sequencing bit: Forward/reverse**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

6.34	**Sequencing bit: Run**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

In normal operation the sequencer has been designed to operate with Run forward / Run reverse controls, or with a Run control and a forward reverse selector. If Run forward / Run reverse control is required then bits Pr **6.30** and Pr **6.32** should be used to control the drive (digital inputs should not be routed to bits Pr **6.33** and Pr **6.34**). If Run control with a forward reverse selector is required then bits Pr **6.33** and Pr **6.34** should be used to control the drive (digital inputs should not be routed to bits Pr **6.30** and Pr **6.32**).

The Run forward and Run reverse, or Run sequencing bits can be made latching by setting bit Pr **6.40**. The Not stop bit (Pr **6.39**) should be one to allow the sequencing bit to be latched. If the Not stop bit is zero all latches are cleared and held at zero. The jog or jog reverse sequencing bits can also cause the drive to run provided the motor is stopped when these bits are activated and the normal run sequencing bits are not providing a run signal.

6.35	**Forward limit switch**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	250 µs read															

6.36	**Reverse limit switch**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	250 µs read															

Digital inputs connected to limit switches should be routed to these parameters if fast stopping is required at a limit. The drive will respond in 750 µs (500 µs digital input filter delay + 250 µs software delay) and stop the motor with zero ramp rate (i.e. in current limit). The limit switches are direction dependant so that the motor can rotate in a direction that allows the system to move away from the limit switch.

Pre-ramp reference+hard speed reference > 0 rpm Forward limit switch active

Pre-ramp reference+hard speed reference < 0 rpm Reverse limit switch active

Pre-ramp reference+hard speed reference = 0 rpm Both limit switches active

6.37	**Sequencing bit: Jog reverse**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4 ms read															

6.39	**Sequencing bit: Not stop**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4 ms read															

6.40	**Enable sequencer latching**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4 ms read															

6.41	**Drive event flags**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1	1	
Range	0 to 65535															
Default	0															
Update rate	Background write															

The drive event flags indicate certain actions have occurred within the drive as described below.

Defaults loaded (Bit 0)

The drive sets bit 0 when defaults have been loaded and the associated parameter save has been completed. The drive does not reset this flag except at power-up. This flag is intended to be used by SM-Applications Solutions Module programs to determine when the default loading process is complete. For example an application may require defaults that are different from the standard drive defaults. These may be loaded and another parameter save initiated by the SM-Applications module when this flag is set. The flag should then be cleared so that the next event can be detected.

6.42	**Control word**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1	1	
Range	0 to 32,767															
Default	0															
Update rate	Bits 0 –7: 4 ms read, Bits 8-15: Background read															

6.43	**Control word enable**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Related to bits 0-7: 4 ms read, related to bits 8-15: Background read															

Pr **6.42** and Pr **6.43** provide a method of controlling the sequencer inputs and other functions directly from a single control word. If Pr **6.43** = 0 the control word has no effect, if Pr **6.43** = 1 the control word is enabled. Each bit of the control word corresponds to a sequencing bit or function as shown below.

Bit	Function	Equivalent parameter
0	Drive enable	Pr **6.15**
1	Run forward	Pr **6.30**
2	Jog	Pr **6.31**
3	Run reverse	Pr **6.32**
4	Forward/reverse	Pr **6.33**
5	Run	Pr **6.34**
6	Not stop	Pr **6.39**
7	Auto/manual	
8	Analog/Preset reference	Pr **1.42**
9	Jog reverse	Pr **6.37**
10	Reserved	
11	Reserved	
12	Trip drive	
13	Reset drive	Pr **10.33**
14	Keypad watchdog	

Bits 0-7 and bit 9: sequencing control

When the control word is enabled (Pr **6.43** = 1), and the Auto/manual bit (bit7) are both one, bits 0 to 6 and bit 9 of the control word become active. The equivalent parameters are not modified by these bits, but become inactive when the equivalent bits in the control word are active. When the bits are active they replace the functions of the equivalent parameters. For example, if Pr **6.43** = 1 and bit 7 of Pr **6.42** = 1 the drive enable is no longer controlled by Pr **6.15**, but by bit 0 of the control word. If either Pr **6.43** = 0, or bit 7 of Pr **6.42** = 0, the drive enable is controlled by Pr **6.15**.

Bit 8: Analog/preset reference

When the control word is enabled (Pr **6.43**) bit 8 of the control word becomes active. (Bit 7 of the control word has no effect on this function.) The state of bit 8 is written to Pr **1.42**. With default drive settings this selects analog reference 1 (bit8 = 0) or preset reference 1 (bit8 = 1). If any other drive parameters are routed to Pr **1.42** the value of Pr **1.42** is undefined.

Bit 12: Trip drive

When the control word is enabled (Pr **6.43**) bit 12 of the control word becomes active. (Bit 7 of the control word has no effect on this function.) When bit 12 is set to one a CL.bit trip is initiated. The trip cannot be cleared until the bit is set to zero

Bit 13: Reset drive

When the control word is enabled (Pr **6.43**) bit 13 of the control word becomes active. (Bit 7 of the control word has no effect on this function.) When bit 13 is changed from 0 to 1 the drive is reset. This bit does not modify the equivalent parameter (Pr **10.33**).

Bit 14: Keypad watchdog

When the control word is enabled (Pr **6.43**) bit 14 of the control word becomes active. (Bit 7 of the control word has no effect on this function.) A watchdog is provided for an external keypad or other device where a break in the communication link must be detected. The watchdog system can be enabled and/or serviced if bit 14 of the control word is changed from zero to one with the control word enabled. Once the watchdog is enabled it must be serviced at least once every second or an "SCL" trip occurs. The watchdog is disabled when an "SCL" trip occurs, and so it must be re-enabled when the trip is reset. It should be noted that when data is transferred from a SMARTCARD to the drive there may be a delay of up to 1.5 s for the comms to respond. Once the comms starts to respond again normally the watchdog will not time out for a further 2 s even if it is not serviced. This period is allowed for the system connected to the comms port to recover if required and to begin servicing the watchdog again.

6.44	**Active supply**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

The drive can operate from either a high voltage supply or a low voltage DC supply, usually from a battery. Different methods are used to connect the low voltage battery supply depending on the frame size of the drive. This parameter, which indicates which supply is active, is set up to the correct value just as the UV trip is reset. A low voltage DC supply should not be used without first consulting the appropriate documentation on the power and control connections required for this mode.

0: Normal high voltage supply

The drive is operating in normal high voltage supply mode.

The drive is using the main power terminals to derive its control supplies. The drive will operate normally. Parameters that are saved at power-down are saved when the supply is removed and a UV trip occurs.

1: Low voltage battery supply

The drive is operating in low voltage DC mode.

The drive is using the low voltage auxiliary power input to derive the power circuit supplies (i.e. gate drives, fans, etc.). The main power terminals can be connected to a different supply of any voltage up to the maximum normal supply level. All parameters voltage based parameters are calculated from the auxiliary supply level and not the supply from the main power terminals. If the auxiliary supply and the main supply are different then these parameters will not be correct. Parameters that are saved at power-down are not saved when the power is removed in this mode.

24V must also be supplied via the 24V control board power supply input. The drive will operate normally except that mains loss detection is disabled, the braking IGBT will only operate when the drive is enabled, and the voltage levels contained in the following table are used instead of the normal high voltage levels whatever the voltage rating of the drive.

Voltage level	
DC_VOLTAGE_MAX	Pr **6.46** x 1.45
Braking IGBT threshold voltage	Pr **6.46** x 1.325
Under voltage trip level	36 V
Restart voltage level after UV trip	40 V

Full scale voltage measurement and the over voltage trip level are defined by DC_VOLTAGE_MAX. However, the maximum level of the low voltage DC should not normally exceed 90 % of this value to avoid spurious over voltage trips.

6.45	**Force cooling fan to run at full speed**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Update rate	Background read															

The drive thermal model system normally controls the fan speed, however the fan can be forced to operate at full speed if this parameter is set to 1. When this is set to 1 the fan remains at full speed until 10 s after this parameter is set to zero.

When the drive is in the UV state the fan always runs at minimum.

6.46	**Nominal low voltage DC supply**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
												1	1	1	1	
Range	48 to 72 V															
Default	48															
Update rate	Background read															

This parameter defines the nominal supply voltage when operating in low voltage mode. The parameter is used to define the braking IGBT switching threshold and the over voltage trip level for low voltage battery mode (see Pr **6.44**).

6.47	**Disable mains/phase loss detection from input rectifier**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

Digitax ST has a diode rectifier input stage with no direct monitoring system. Mains loss and phase loss detection is derived from the DC bus voltage. This parameter has no effect.

6.48	**Mains loss ride through detection level**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1			1				1	1	1	
Range	0 to DC_VOLTAGE_SET_MAX V															
Default	200V rated drive 205 400V rated drive 410															
Update rate	Background read															

The mains loss detection level can be adjusted using this parameter. If the value is reduced below the default value the default value is used by the drive. If the level is set too high so that mains loss detection becomes active under normal operating conditions the motor will coast to a stop.

6.49	**Disable multi-module drive module number storing on trip**															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

If Pr **6.49** is zero the module number is stored in the module number and trip time log. If this parameter is one, either the powered-up clock or run time clock is stored in the module number and trip time log as defined by Pr **6.28**. It should be noted that changing this parameter clears the trip, and module number and trip time logs.

6.50	Drive comms state															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1			1		1		1			1	
Default	0 to 3															
Update rate	Background write															

The drive comms system 128 bytes buffer used with ANSI or Modbus rtu protocols via the 485 connector can be controlled by a Solutions Module under certain circumstances. This parameter shows which node has control of the buffer (0 (drv) = drive, 1 (Slot1) = Solutions Module in slot 1, etc. If a Solutions Module has control of the buffer the drive will use an alternative buffer for 485 comms and the following restrictions will apply:

1. Comms messages via the 485 port are limited to a maximum of 32 bytes
2. The 6 pin keypad port will operate correctly with an LED keypad, but it will no longer operate with an LCD keypad
3. Modbus messages using the CMP protocol can only route messages to nodes within the drive. It will not be possible for these to be routed further, i.e. via CT Net on an SM Applications module.

6.51	External rectifier not active															
Coding	Bit	SP	FI	DE	TE	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1													1		
Default	0															
Update rate	1ms read															

When a drive with an internal rectifier is used this parameter should be left at zero. For a drive with an active external rectifier (used to control DC bus charging) this parameter should be the destination of the output of a variable selector set up for external rectifier monitoring. This allows the monitoring block to prevent the drive from leaving the main loss ride through mode until the rectifier is fully active and phased forwards. If this feature is not used the mains loss ride through mode ends as soon as the DC Bus voltage is above the mains loss detection level. The rectifier may still be phasing forwards and the application of load at this point may cause the DC Bus voltage to fall back below the mains loss detection level again.

5.9 Menu 7: Analog I/O

Hardware

The drive has three analog inputs (AI1 to AI3) and two analog outputs (AO1 and AO2). Each input has a similar parameter structure and each output has a similar parameter structure. The nominal full scale level for inputs in voltage mode is 9.8V. This ensures that when the input is driven from a voltage produced from the drive's own 10V supply, the input can reach full scale.

Terminal	Input	Input modes	Resolution
5/6	AI1	Voltage only	12 bit plus sign (16 bit plus sign as a speed reference)
7	AI2	0 to 6	10 bit plus sign
8	AI3	0 to 9	10 bit plus sign

Terminal	Output	Output modes	Resolution
9	AO1	0 to 3	10 bit plus sign
10	AO2	0 to 3	10 bit plus sign

Update rate

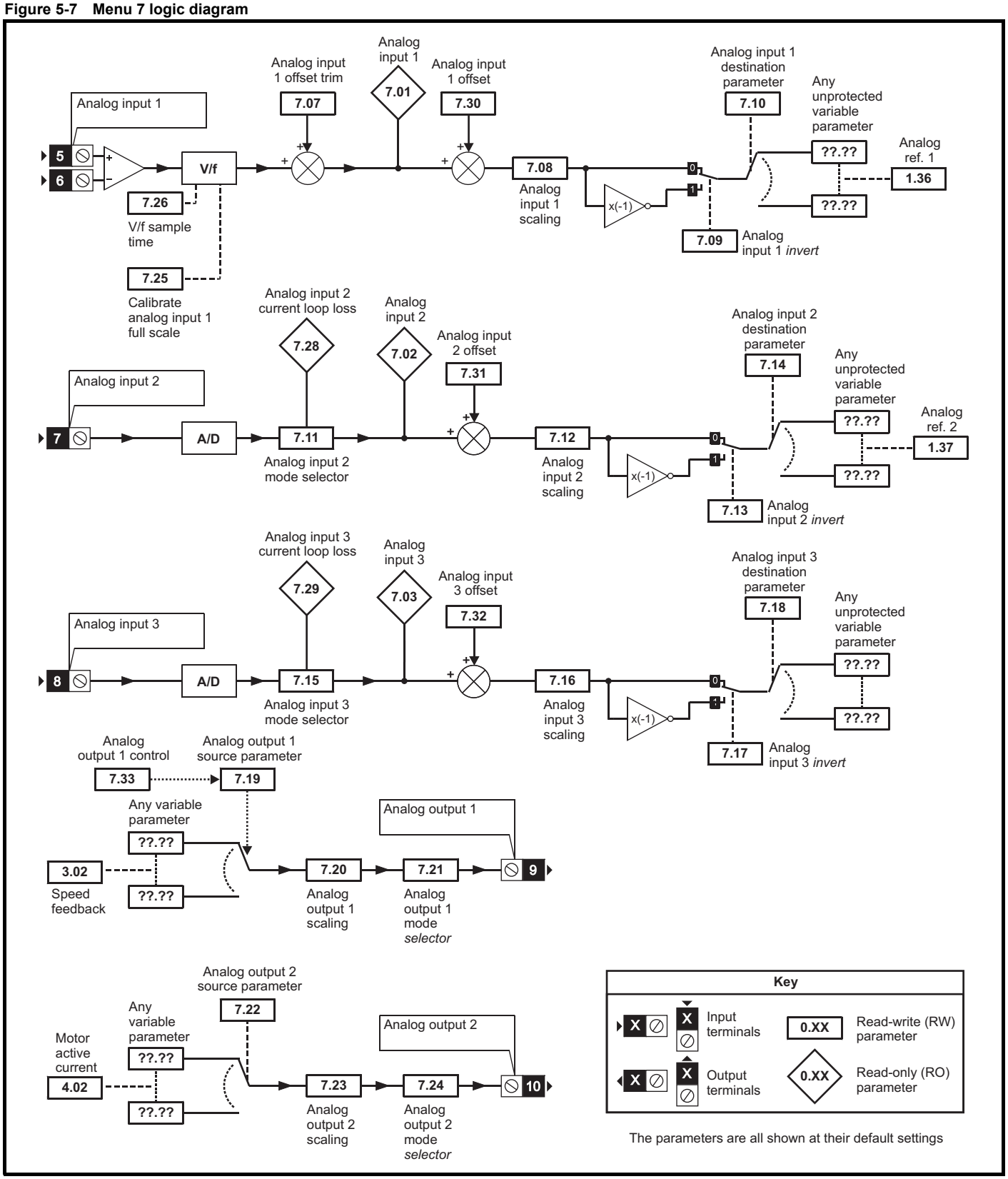
The analog inputs are sampled every 4ms except where the destinations shown in the table below are chosen, the input is in voltage mode and other conditions necessary for short cutting are met.

Input destination	Sample rate
Pr **1.36** - Analog reference	250 µs (AI1 subject to window filter. See Pr **7.26** on page 105)
Pr **1.37** - Analog reference	250 µs (AI1 subject to window filter. See Pr **7.26** on page 105)
Pr **3.22** - Hard speed reference	250 µs (AI1 subject to window filter. See Pr **7.26** on page 105)
Pr **4.08** - Torque reference	AI1 – 4 ms AI2 or 3 – 250 µs

Analog outputs are updated every 4ms except when the source is Pr **3.02**, Pr **4.02**, Pr **4.17** and Pr **5.03** and high speed update mode is selected. In high speed mode the output operates in voltage mode. It is updated every 250µs and special scaling is used as described in the table. User scaling is ignored.

Output source	Scaling
Pr **3.02** – speed	10.0 V = SPEED_MAX
Pr **4.02** - torque prod current	10.0 V = Kc / 0.45 where Kc is the current scaling factor for the drive
Pr **4.17** - magnetising current	10.0 V = Kc / 0.45
Pr **5.03** - output power	The output is the product of the active current and the voltage component in phase with the active current (vsy x isy). 10 V would be produced when: Active current = Kc / 0.45 Peak phase voltage in phase with the active current = DC_VOLTAGE_MAX / 2

Figure 5-7 Menu 7 logic diagram



7.01	T5/6 analog input 1 level															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				
Range	±100.00 %															
Update rate	4ms write															

This input operates in voltage mode only where -9.8 V and +9.8 V at the input correspond with -100.0 % and 100.0 % respectively in this parameter.

7.02	**T7 analog input 2 level**															
7.03	**T8 analog input 3 level**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1		1		1				
Range	±100.0 %															
Update rate	4ms write															

These inputs can operate in different modes defined by Pr **7.11** and Pr **7.15**.

In current modes (modes 0 to 5) the minimum and maximum current values given in mA correspond with 0.0 % and 100.0 % respectively in Pr **7.02** and Pr **7.03**. Therefore in modes 2 and 4 the parameter is at 0.0 % when the input current is less than 4mA, and in modes 3 and 5 the parameter is at 100.0 % when the input current is less than 4 mA.

In voltage mode (mode 6) -9.8 V and +9.8 V at the input correspond with -100.0 % and 100.0 % respectively in Pr **7.02** and Pr **7.03**.

When analog input 3 is in thermistor mode (modes 7 to 9) the display indicates the resistance of the thermistor as a percentage of 10 kΩ.

7.04	**Power circuit temperature 1**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	-128 to 127 °C															
Update rate	Background write															

This parameter shows the highest IGBT package temperature.

7.05	**Power circuit temperature 2**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	-128 to 127 °C															
Update rate	Background write															

This parameter shows the temperature of the main power board.

7.06	**Control board temperature**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	-128 to 127 °C															
Update rate	Background write															

Three temperatures are available from the power circuit, and these are displayed in Pr **7.04**, Pr **7.05** and Pr **7.36**.

If the temperature displayed in Pr **7.04**, Pr **7.05** or Pr **7.36** exceeds the trip threshold for the parameter, an Oht2 trip is initiated. This trip can only be reset if the parameter that has caused the trip falls below the trip reset level. If the temperature exceeds the alarm level a "hot" alarm is displayed. If the temperature for any of these monitoring points is outside the range -20 °C to 150 °C it is assumed that the monitoring thermistor has failed and a hardware fault trip is initiated (Pr **7.04** - HF27, Pr **7.05** and Pr **7.36** - HF28).

Table 5-4 Power stage temperature 1 (Pr 7.04) in °C

Trip temperature	Trip reset temperature	Alarm temperature
77	72	75

Table 5-5 Power stack temperature 2 (Pr 7.05) in °C

Trip temperature	Trip reset temperature	Alarm temperature
83	78	80

Table 5-6 Power stack temperature 3 (Pr 7.36) in °C

Trip temperature	Trip reset temperature	Alarm temperature
105	100	100

The control board temperature is also monitored and displayed in Pr **7.06**. If the temperature displayed exceeds 92 °C an O.Ctl trip is initiated, and this trip can only be reset if the temperature falls below 87 °C . If the temperature exceeds 85 °C a "hot" alarm is displayed. If the temperature is outside the range from -20°C to 150 °C it is assumed that the monitoring thermistor has failed and an HF29 hardware fault trip is initiated.

Drive cooling fan

The drive cooling fan is controlled by the temperature from monitoring points and other actions as follows:

1. If Pr **6.45** = 1 the fan is at full speed for at least 10 s.
2. If a Solutions Module indicates that it is too hot the fan is at full speed for at least 10 s.
3. The fan is always on when the drive or the braking IGBT are enabled and remains on for 10 s after the drive or braking IGBT is disabled.

7.07	**T5/6 analog input 1 offset trim**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1		
Range	±10.000 %															
Default	0.000															
Update rate	Background read															

This value can be used to trim out any offset from the user input signal

7.08	**T5/6 analog input 1 scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	Background read															

7.09	**T5/6 analog input 1 invert**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

7.10	**T5/6 analog input 1 destination**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **1.36**															
Update rate	Read on drive reset															

7.11	**T7 analog input 2 mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 6															
Default	6															
Update rate	Background read															

The following modes are available for the analog input 2. In modes 2 and 3 a current loop loss trip is generated if the input current falls below 3mA.

Parameter value	Parameter string	Mode	Comments
0	0-20	0 - 20 mA	
1	20-0	20 - 0 mA	
2	4-20.tr	4 -20 mA with trip on loss	Trip if I < 3 mA, Pr **7.02** = 0.0 % if I < 4 mA
3	20-4.tr	20 - 4 mA with trip on loss	Trip if I < 3 mA, Pr **7.02** = 100.0 % if I < 4 mA
4	4-20	4 - 20 mA with no trip on loss	Pr **7.02** = 0.0 % if I < 4 mA
5	20-4	20 - 4 mA with no trip on loss	Pr **7.02** = 100.0 % if I < 4 mA
6	VOLt	Voltage mode	

In modes 2 and 4 the destination parameter is at a value equivalent to 0.0 % when the input current is less than 4 mA. In modes 3 and 5 the destination parameter is at a value equivalent to 100.0% when the input current is less than 4 mA.

7.12	**T7 analog input 2 scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	Background read															

7.13	**T7 analog input 2 invert**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

7.14	**T7 analog input 2 destination**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **1.37**															
Update rate	Read on drive reset															

7.15	**T8 analog input 3 mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 9															
Default	8															
Update rate	Background read															

The following modes are available for the analog input 3. In modes 2 and 3 a current loop loss trip is generated if the input current falls below 3mA.

Parameter value	Parameter string	Mode	Comments
0	0-20	0 - 20 mA	
1	20-0	20 - 0 mA	
2	4-20.tr	4 -20 mA with trip on loss	Trip if I < 3 mA, Pr **7.03** = 0.0 % if I < 4 mA
3	20-4.tr	20 - 4 mA with trip on loss	Trip if I < 3 mA, Pr **7.03** = 100.0 % if I < 4 mA
4	4-20	4 - 20 mA with no trip on loss	Pr **7.03** = 0.0 % if I < 4 mA
5	20-4	20 - 4 mA with no trip on loss	Pr **7.03** = 100.0 % if I < 4 mA
6	VOLt	Voltage mode	
7	th.SC	Thermistor with short circuit detection	TH trip if R > 3k3 TH reset if R < 1k8 THS trip if R < 50R
8	th	Thermistor without short circuit detection	TH trip if R > 3k3 TH reset if R < 1k8
9	th.diSp	Thermistor display only with no trip	

In modes 2 and 4 the destination parameter is at a value equivalent to 0.0% when the input current is less than 4 mA. In modes 3 and 5 the destination parameter is at a value equivalent to 100.0 % when the input current is less than 4mA.

7.16	**T8 analog input 3 scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	Background read															

7.17	T8 analog input 3 invert															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

7.18	T8 analog input 3 destination															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on drive reset															

7.19	T9 analog output 1 source															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **3.02**															
Update rate	Background read															

7.20	T9 analog output 1 scaling															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	Background read															

7.21	T9 analog output 1 mode															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 3															
Default	0															
Update rate	Background read															

The following modes are available for the analog outputs.

Parameter value	Parameter string	Mode
0	VOLt	Voltage mode
1	0-20	0 - 20 mA
2	4-20	4 - 20 mA
3	H.SPd	High speed update mode

In voltage mode the output range is -10 V to 10 V. If the scaling parameter is 1.000 then -10 V and 10 V are produced when the source parameter is at -maximum and maximum respectively. Different scaling can be applied with Pr **7.23**. If the result of the scaling produces an output of more than +/- 100 % the output is clamped within the +/-10 V range.

In current modes with a scaling parameter of 1.000 the minimum and maximum current are produced when the source parameter is at 0 and maximum respectively. Therefore in 4 - 20 mA mode the output is 4 mA when the source parameter is zero. Different scaling can be applied with Pr **7.23**. If the result of the scaling produces an output of more than 100 % the output is clamped at 20 mA.

If high speed update mode is selected and the source for the output is one of the parameters designated for high speed analog output operation (see start of this section) the output is updated at a higher rate with special scaling. If the parameter selected is not designated for this mode the output is updated at the normal rate. If speed feedback or power is selected for high speed mode for both analog output 1 and analog output 2 the setting is ignored for analog output 2. If the high speed mode is selected the output is always a voltage signal.

7.22	**T10 analog output 2 source**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **4.02**															
Update rate	Read on drive reset															

7.23	**T10 analog output 2 scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	Background read															

7.24	**T10 analog output 2 mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 3															
Default	0															
Update rate	Background read															

See Pr **7.21** T9 analog output 1 mode on page 104

7.25	**Calibrate T5/6 analog input 1 full scale**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	Background read															

Setting this bit will cause the drive to re-calibrate the full scale level of analog input 1 provided the input voltage is below +1.5 V or above +2.5 V. This parameter is cleared by the software automatically when the calibration is complete. If the input voltage is above +2.5 V the input voltage itself is used for calibration, and so after calibration this level will be full scale for the input. If the input voltage is below +1.5 V the internal reference is used for calibration, and so the full scale will be nominally 9.8 V after calibration. The calibration level is automatically stored on power-down. It should be noted that the Analog input 1 offset trim is included in the input voltage when the input voltage itself is used for calibration, but this trim is not included when the internal reference is used for calibration.

7.26	**T5/6 analog input 1 sample time**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0 to 8.0 ms															
Default	4.0															
Update rate	Background read															

Analog input 1 is filtered using a window filter to remove quantization noise and adjust the resolution of this input. The length of the window can be adjusted with this parameter. The shortest possible window is 250 µs. It should be noted that if this input is not used as a speed reference (Pr **1.36**, Pr **1.37**) or as a hard speed reference (Pr **3.22**) the sample time affects the resolution. The nominal resolution is given by Pr **7.26** x 500 x 10, therefore the default setting gives approximately 11 bit resolution.

7.28	**T7 analog input 2 current loop loss**															
7.29	**T8 analog input 3 current loop loss**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

If an analog input is used with 4-20 mA or 20-4 mA current loop modes the respective bit (Pr **7.28** - analog input 2 and Pr **7.29** -analog input 3) is set to one if the current falls below 3 mA. If the current is above 3 mA with these modes or another mode is selected the respective bit is set to zero.

7.30	**T5/6 analog input 1 offset**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1		
Range	±100.00 %															
Default	0.00															
Update rate	Background read															

7.31	**T7 analog input 2 offset**															
7.32	**T8 analog input 3 offset**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1		
Range	±100.0 %															
Default	0.0															
Update rate	Background read															

An offset can be added to each analog input with a range from -100 % to 100 %. If the sum of the input and the offset exceeds ±100 % the results is limited to ±100 %.

7.33	**T9 analog output 1 control**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 2															
Default	2															
Update rate	Background read															

This offers a simple control of Pr **7.19** to change the source for the analog output for use from Menu 0. When this parameter is set to 0 or 1 the drive constantly writes Pr **5.01** or Pr **4.02** to Pr **7.19** respectively.

Parameter value	Parameter string	Action
0	Fr	Write Pr **7.19** = Pr **5.01**
1	Ld	Write Pr **7.19** = Pr **4.02**
2	AdV	No action

7.34	**IGBT junction temperature**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	±200 °C															
Update rate	Background write															

The IGBT junction temperature displayed in this parameter is the sum of the power circuit 1 temperature (Pr **7.04**) and a thermal model of the drive power stage.

Pr **7.34** gives the IGBT junction temperature that would be produced after the delay taken to trip the drive or reduce the switching frequency if the drive output current was increased to its maximum level. This means that Pr **7.34** may always show a temperature that is higher than the power circuit 1 temperature even when the drive is disabled. If the calculated IGBT temperature exceeds the levels shown in the table below the switching frequency is reduced provided this feature has not been disabled (by setting Pr **5.35** to 1) or the minimum switching frequency has not been reached. The switching frequency can be reduced from 12 kHz to 6 kHz to 3 kHz, or from 8 kHz to 4 kHz. If this feature has been disabled (i.e. Pr **5.35** is one) or the minimum switching frequency is reached the drive initiates an Oht1 trip. Once the switching frequency has been reduced the drive determines when the switching frequency can be switched back up again.

Drive size	Threshold for reducing the switching frequency or Oht1 trip ^{o}C
DST1201	145
DST1202	145
DST1203	145
DST1204	145
DST1401	145
DST1402	145
DST1403	145
DST1404	170
DST1405	170

7.35	**Drive thermal protection accumulator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1		1		1			1	
Range	0 to 100 %															
Update rate	Background write															

In addition to monitoring the IGBT junction temperatures the drive includes a thermal protection system to protect the other components within the drive. This includes the effects of drive output current and DC bus ripple. The estimated temperature is displayed as a percentage of the trip level in this parameter. If the parameter value reaches 100 % an Oht3 trip is initiated.

7.36	**Power circuit temperature 3**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	-128 to 127 °C															
Update rate	Background write															

This parameter shows the temperature of the rectifier heatsink. See **7.04**, **7.05** and **7.06** on page 101.

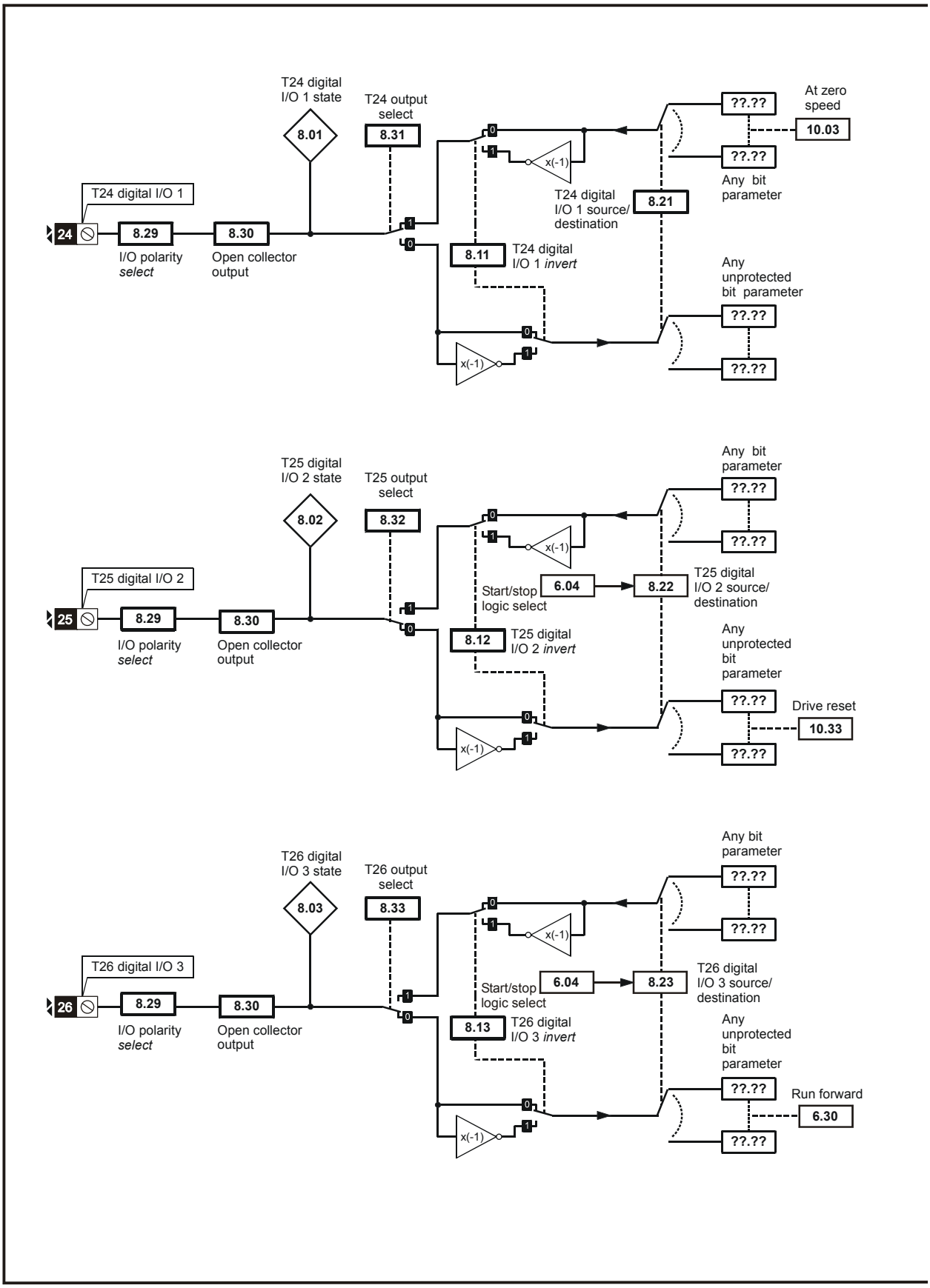
5.10 Menu 8: Digital I/O

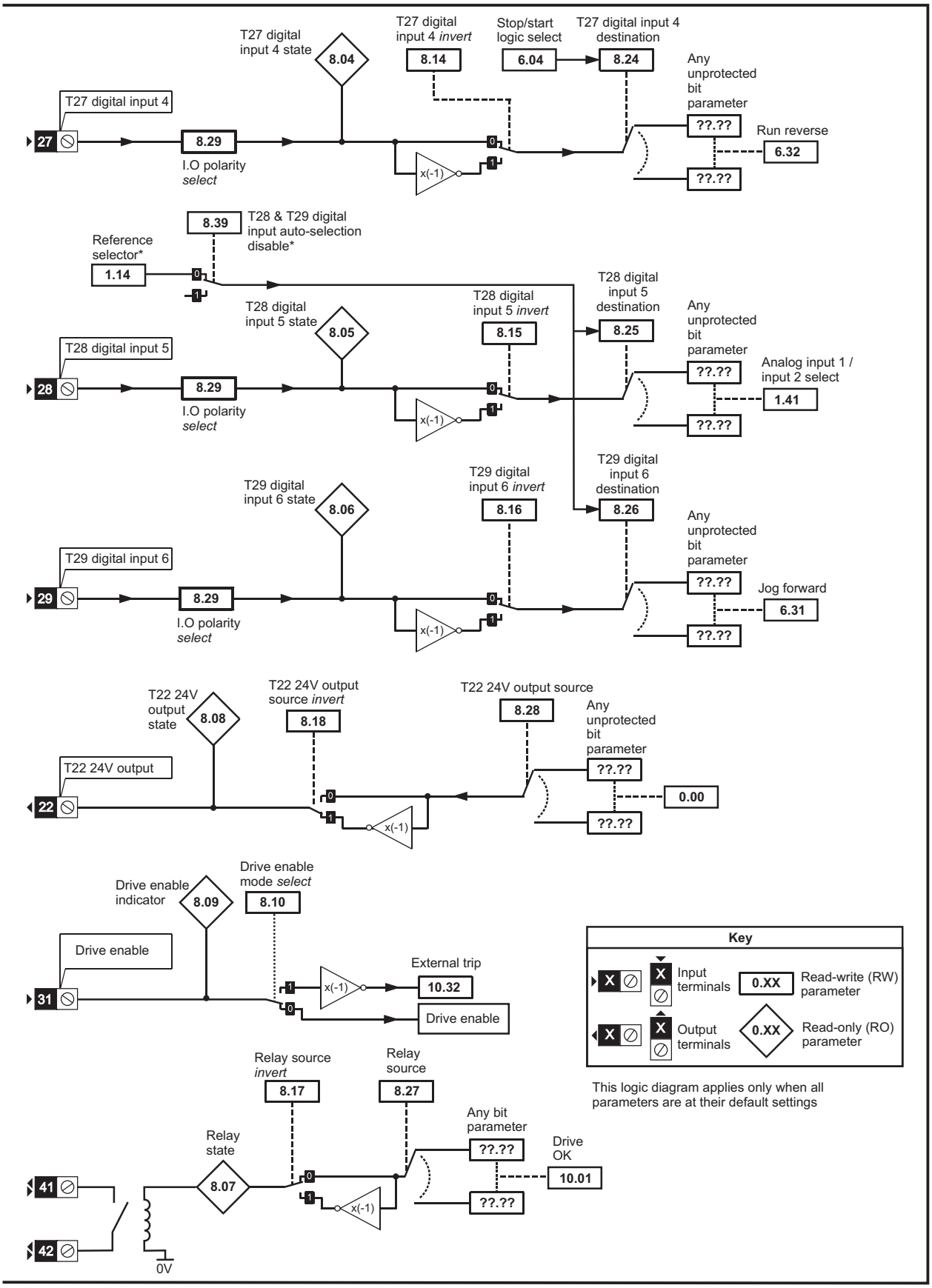
The drive has eight digital I/O terminals (T22, T24 to T29 and the relay) and an enable input. Each input has the same parameter structure. The digital inputs are sampled every 4 ms, except when inputs are routed to the limit switches Pr **6.35** and Pr **6.36** when the sample time is reduced to 250 μs. The digital input hardware (excluding the Safe Torque Off input) introduces a further 100 μs delay. The Safe Torque Off input hardware gives a typical delay of 8 ms (maximum 20 ms). The digital outputs are updated every 4 ms. Any changes to the source/destination parameters only become effective after drive reset is activated.

I/O	Sample rate	Function
T24 to T26	4 ms	Digital input or output
T27 to T29	4 ms	Digital input
Relay	Background	
T22	Background	24 V output

5.11 Menu 8: Digital I/O

Figure 5-8 Menu 8 logic diagram





*For more information, please refer to the User Guide.

Table 5-7 Drive digital I/O terminal, enable input and relay

Terminal + type	I/O state	Invert		Source / destination		Output select	
	Pr	Pr	Default	Pr	Default	Pr	Default
T24 input / output 1	Pr **8.01**	Pr **8.11**	0	Pr **8.21**	Pr **10.03** - Zero speed	Pr **8.31**	1
T25 input / output 2	Pr **8.02**	Pr **8.12**	0	Pr **8.22**	Pr **10.33** - Drive reset	Pr **8.32**	0
T26 input / output 3	Pr **8.03**	Pr **8.13**	0	Pr **8.23**	Pr **6.30** - Run forward	Pr **8.33**	0
T27 input 4	Pr **8.04**	Pr **8.14**	0	Pr **8.24**	Pr **6.32** - Run reverse		
T28 input 5	Pr **8.05**	Pr **8.15**	0	Pr **8.25**	Pr **1.41** – Local/remote		
T29 input 6	Pr **8.06**	Pr **8.16**	0	Pr **8.26**	Pr **6.31** – Jog		
T41 / 42 Relay	Pr **8.07**	Pr **8.17**	0	Pr **8.27**	Pr **10.01** – Drive ok		
T22 24V output	Pr **8.08**	Pr **8.18**	1	Pr **8.28**	Pr **0.00**		
T31 Safe Torque Off	Pr **8.09**						

8.01	**T24 digital I/O 1 state**															
8.02	**T25 digital I/O 2 state**															
8.03	**T26 digital I/O 3 state**															
8.04	**T27 digital input 4 state**															
8.05	**T28 digital input 5 state**															
8.06	**T29 digital input 6 state**															
8.07	**Relay status**															
8.08	**T22 24V output state**															
8.09	**Drive enable indicator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Default	See table															
Update rate	4 ms write															

OFF (0) = Terminal inactive

On (1) = Terminal active

8.10	**Drive enable mode select**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	OFF (0)															
Update rate	Background read															

Digitax ST has a dedicated hardware enable/Safe Torque Off input which always controls Pr **6.29**. If the enable is inactive the IGBT firing signals are turned off without software intervention. As default (Pr **8.10** = 0) the drive is in the inhibit mode when the enable is inactive. Setting this parameter to one causes the enable to behave as an Et trip input. When the input becomes inactive an Et trip is initiated. This does not affect Pr **10.32** (Et trip parameter), therefore an Et trip can be initiated in this mode either by making the enable inactive or setting Pr **10.32** to one.

8.11	**T24 digital I/O 1 invert**															
8.12	**T25 digital I/O 2 invert**															
8.13	**T26 digital I/O 3 invert**															
8.14	**T27 digital input 4 invert**															
8.15	**T28 digital input 5 invert**															
8.16	**T29 digital input 6 invert**															
8.17	**Relay source invert**															
8.18	**T22 24V output source invert**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	Pr **8.11** to Pr **8.17** = OFF (0), Pr **8.18** = On (1)															
Update rate	4ms read															

OFF (0) = Non-inverted

On (1) = Inverted

8.20	**Digital I/O read word**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 511															
Update rate	Background write															

This word is used to determine the status of the digital I/O by reading one parameter. The bits in this word reflect the state of Pr **8.01** to Pr **8.09**.

Bit	Digital I/O
0	T24 input / output 1
1	T25 input / output 2
2	T26 input / output 3
3	T27 input 4
4	T28 input 5
5	T29 input 6
6	Relay
7	T22 24V output
8	Safe Torque Off

8.21	**T24 digital I/O 1 source/destination**															
8.22	**T25 digital I/O 2 source/destination**															
8.23	**T26 digital I/O 3 source/destination**															
8.24	**T27 digital input 4 destination**															
8.25	**T28 digital input 5 destination**															
8.26	**T29 digital input 6 destination**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Default	See Table 5-7 on page 112															
Range	Pr **0.00** to Pr **21.51**															
Update rate	Read on drive reset															

8.27	**Relay source**															
8.28	**T22 24V output source**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Default	See Table 5-7 on page 112															
Range	Pr **0.00** to Pr **21.51**															
Update rate	Read on drive reset															

8.29	**Positive logic select**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1											1	1	1	1	
Default	On (1)															
Update rate	Background read															

This parameter changes the logic polarity for digital inputs and digital outputs, but not the enable input, the relay output or the 24V output.

	Pr 8.29 = 0 (negative logic)	**Pr 8.29 = 1 (positive logic)**
Inputs	<5 V = 1, >15 V = 0	<5 V = 0, >15 V = 1
Non-relay Outputs	On (1) = <5 V, OFF (0) = >15 V	OFF (0) = <5 V, On (1) = >15 V
Relay outputs	OFF (0) = open, On (1) = closed	OFF (0) = open, On (1) = closed
24V output (T22)	OFF (0) = 0V, On (1) = 24 V	OFF (0) = 0V, On (1) = 24 V

8.30	**Open collector output**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	OFF (0)															
Update rate	Background read															

When this parameter is zero digital outputs are in push-pull mode. When this parameter is one either the high-side drive (negative logic polarity) or the low-side driver (positive logic polarity) is disabled. This allows outputs to be connected in a wire-ORed configuration.

8.31	**T24 digital I/O 1 output select**															
8.32	**T25 digital I/O 2 output select**															
8.33	**T26 digital I/O 3 output select**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	Pr **8.31** = On (1), Pr **8.32** and Pr **8.33** = OFF (0)															
Update rate	Background read															

OFF (0) = Terminal is an input

On (1) = Terminal is an output

8.39	**T28 & T29 digital input auto-selection disable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	OFF (0)															
Update rate	Background read															

When this parameter is 0, Pr **8.25** and Pr **8.26** are set up automatically according to the setting of the reference select Pr **1.14**. Setting this parameter to 1 disables this function.

Reference select Pr 1.14		**Pr 8.25 set to:**	**Pr 8.26 set to:**
0, A1.A2	Reference selection by terminal input	Pr **1.41** - Analog ref 2 select	Pr **6.31** - Jog
1, A1.Pr	Analog reference 1 or presets selected by terminal input	Pr **1.45** - Preset select bit 0	Pr **1.46** - Preset select bit 1
2, A2.Pr	Analog reference 2 or presets selected by terminal input	Pr **1.45** - Preset select bit 0	Pr **1.46** - Preset select bit 1
3, Pr	Preset reference selected by terminal input	Pr **1.45** - Preset select bit 0	Pr **1.46** - Preset select bit 1
4, Pad	Keypad reference selected	Pr **1.41** - Analog ref 2 select	Pr **6.31** - Jog
5, Prc	Precision reference selected	Pr **1.41** - Analog ref 2 select	Pr **6.31** - Jog

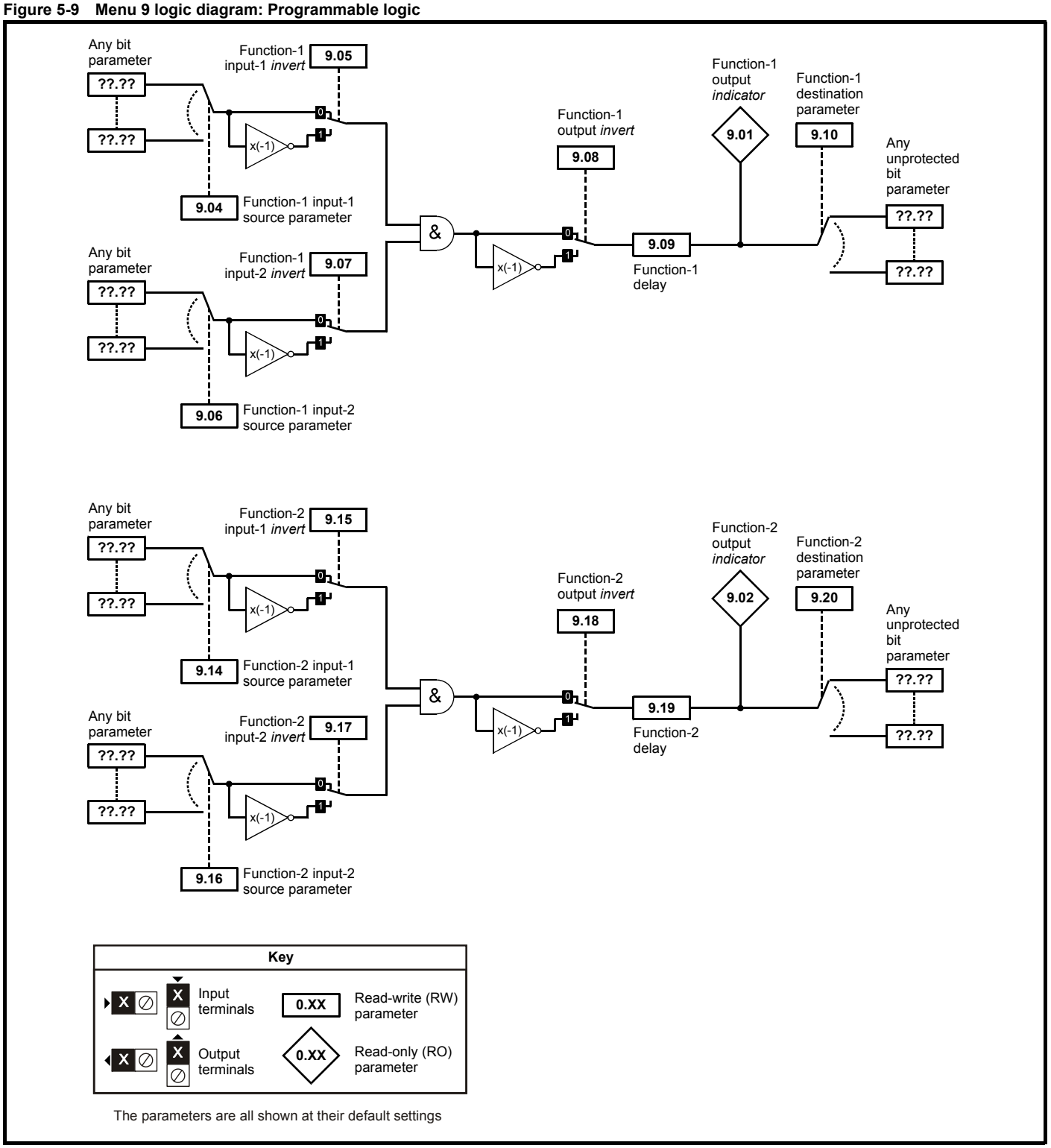
8.40	**Freeze flag**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1											1		1		
Default	0															
Update rate	4ms write															

If the destination for digital input 4 is set to Pr **8.40** the drive freeze function is activated. Pr **8.40** is protected (PT), and so the input cannot write directly to this parameter. However, if the drive freeze input is enabled in this way and the input changes from the inactive to active state the freeze event is registered. The drive has a common internal freeze line which is connected to the freeze function within the drive, and each Solutions Module which has a freeze function. When the freeze event is registered the common freeze line becomes active and the drive encoder position and the position within any position feedback Solutions Modules that include a freeze function are latched. The drive does not allow the user to access its stored freeze position directly, but this is accessed via menu 90 associated with an SM-Applications module. Pr **8.40** is simply an indication that a freeze event has occurred, and when this parameter is set it does not prevent further freeze events from storing the drive encoder position. Pr **8.40** can be cleared by the user as required. It should be noted that Pr **8.40** is set to one when the drive freeze is enabled and any freeze event occurs on the common freeze line.

If Pr **8.14** is set to zero a freeze event occurs when the input changes from low to high. If Pr **8.14** is set to one a freeze event occurs when the input changes from high to low. The threshold used by the freeze function and the system to derive the value in the input state (Pr **8.04**) are not identical and it is possible that there may be a slight difference between the levels at which Pr **8.04** changes state and the freeze flag becomes active.

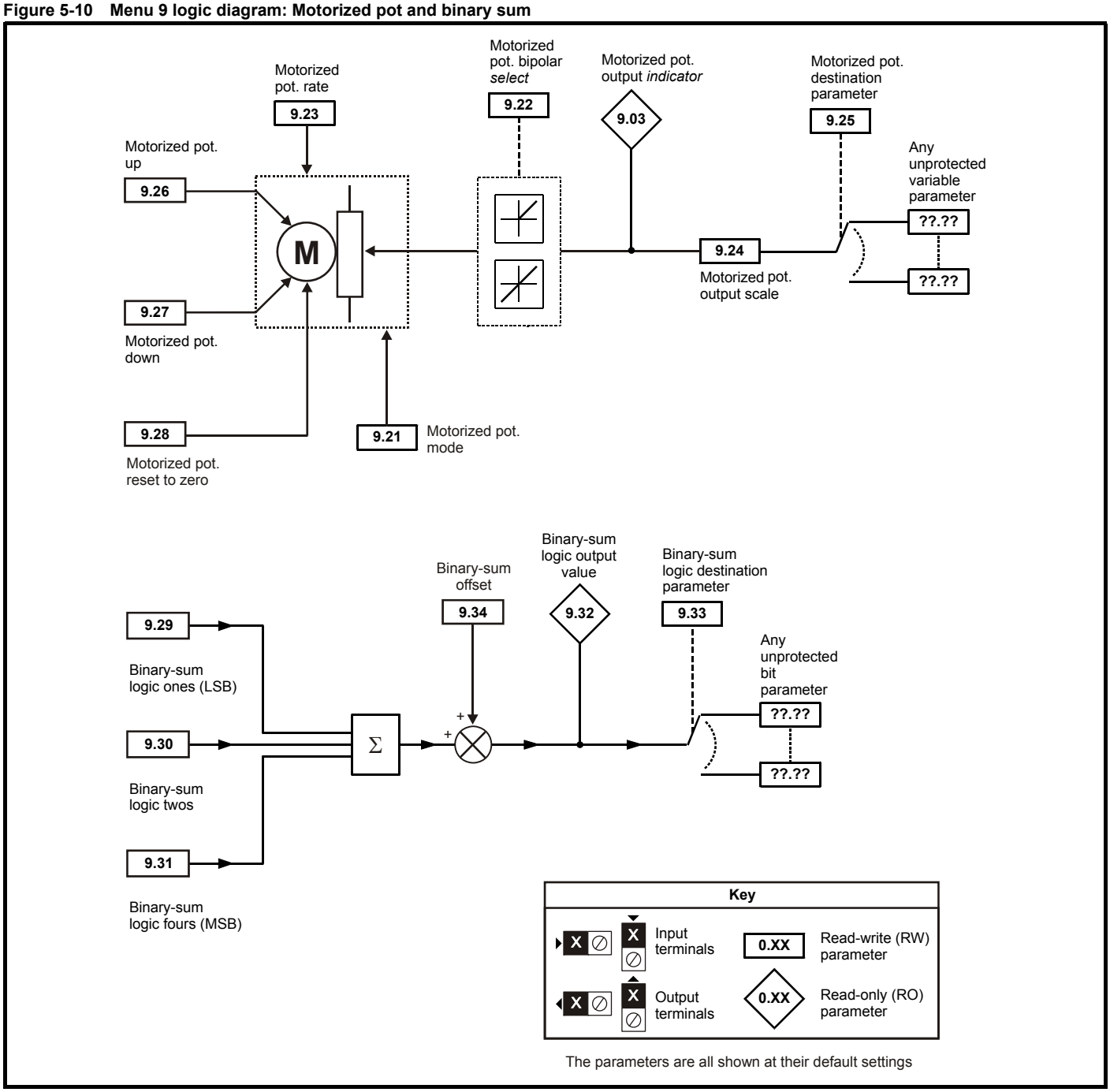
5.12 Menu 9: Programmable logic, motorized pot, binary sum and timers

Figure 5-9 Menu 9 logic diagram: Programmable logic



The parameters are all shown at their default settings

Figure 5-10 Menu 9 logic diagram: Motorized pot and binary sum



Menu 9 contains 2 logic block functions (which can be used to produce any type of 2 input logic gate, with or without a delay), a motorized pot function and a binary sum block. One menu 9 or one menu 12 function is executed every 4 ms. Therefore the sample time of these functions is 4 ms x number of menu 9 and 12 functions active. The logic functions are active if one or both the sources are routed to a valid parameter. The other functions are active if the output destination is routed to a valid unprotected parameter.

9.01	**Logic function 1 output**															
9.02	**Logic function 2 output**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4ms x number of menu 9 or 12 functions active write															

9.03	**Motorized pot output**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				1
Range	±100.00 %															
Update rate	4 ms x number of menu 9 or 12 functions active write															

Indicates the level of the motorized pot prior to scaling. If Pr **9.21** is set to 0 or 2 this parameter is set to 0 at power-up, otherwise it retains its value at the last power-down.

9.04	**Logic function 1 source 1**															
9.14	**Logic function 2 source 1**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

9.05	**Logic function 1 source 1 invert**															
9.15	**Logic function 2 source 1 invert**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms x number of menu 9 or 12 functions active read															

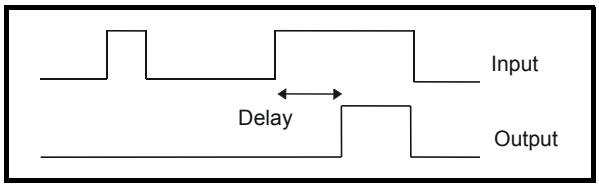
9.06	**Logic function 1 source 2**															
9.16	**Logic function 2 source 2**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

9.07	**Logic function 1 source 2 invert**															
9.17	**Logic function 2 source 2 invert**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms x number of menu 9 or 12 functions active read															

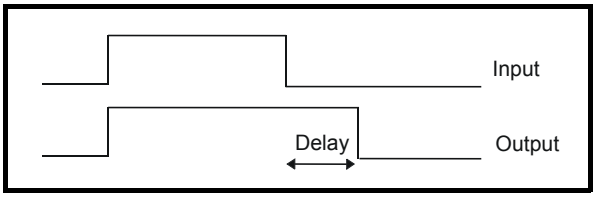
9.08	**Logic function 1 output invert**															
9.18	**Logic function 2 output invert**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms x number of menu 9 or 12 functions active read															

9.09	**Logic function 1 delay**															
9.19	**Logic function 2 delay**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1		
Range	±25.0 s															
Default	0.0															
Update rate	4 ms x number of menu 9 or 12 functions active read															

If the delay parameter is positive, the delay ensures that the output does not become active until an active condition has been present at the input for the delay time as shown below.



If the delay parameter is negative, the delay holds the output active for the delay period after the active condition has been removed as shown below. Therefore an active input that lasts for 4ms or more will produce an output that lasts at least as long as the delay time.



9.10	**Logic function 1 destination**															
9.20	**Logic function 2 destination**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

9.21	**Motorized pot mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 3															
Default	2															
Update rate	Background read															

The motorized pot modes are given in the following table.

Pr 9.21	Mode	Comments
0	Zero at power-up	Reset to zero at each power-up. Up, down and reset are active at all times.
1	Last value at power-up	Set to value at power-down when drive powered-up. Up, down and reset are active at all times.
2	Zero at power-up and only change when drive running	Reset to zero at each power-up. Up and down are only active when the drive is running (i.e. inverter active). Reset is active at all times.
3	Last value at power-up and only change when drive running	Set to value at power-down when drive powered-up. Up and down are only active when the drive is running (i.e. inverter active). Reset is active at all times.

9.22	Motorized pot bipolar select															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4 ms x number of menu 9 or 12 functions active read															

When this bit is set to 0 the motorized pot output is limited to positive values only (i.e. 0 to 100.0 %). Setting it to 1 allows negative outputs (i.e. ±100.0 %).

9.23	Motorized pot rate															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 250 s															
Default	20															
Update rate	Background read															

This parameter defines the time taken for the motorized 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	Motorized pot scale factor															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	4 ms x number of menu 9 or 12 functions active read															

This parameter can be used to restrict the output of the motorized pot to operate over a reduced range so that it can be used as a trim, for example.

9.25	Motorized pot destination															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

9.26	Motorized pot up															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4 ms x number of menu 9 or 12 functions active read															

9.27	Motorized pot down															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4 ms x number of menu 9 or 12 functions active read															

9.28	Motorized pot reset															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4 ms x number of menu 9 or 12 functions active read															

These three bits control the motorized pot. The up and down inputs increase and decrease the output at the programmed rate respectively. If both up

and down are active together the up function dominates and the output increases. If the reset input is one, the motorized pot output is reset and held at 0.0 %.

9.29	**Binary sum ones input**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms x number of menu 9 or 12 functions active read															

9.30	**Binary sum twos input**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4 ms x number of menu 9 or 12 functions active read															

9.31	**Binary sum fours input**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4 ms x number of menu 9 or 12 functions active read															

9.32	**Binary sum output**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 255															
Default	0															
Update rate	4ms x number of menu 9 or 12 functions active write															

9.33	**Binary sum destination**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

9.34	**Binary sum offset**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	0 to 248															
Default	0															
Update rate	4ms x number of menu 9 or 12 functions active write															

The binary sum output is given by:

Offset + ones input + (2 x twos input) + (4 x fours input)

The value written to the destination parameter is defined as follows:

If destination parameter maximum ≤ (7 + Offset):
Destination parameter = Binary sum output

If destination parameter maximum > (7 + Offset):
Destination parameter = Destination parameter maximum x Binary sum output / (7 + Offset)

5.13 Menu 10: Status and trips

10.01	Drive ok															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

Indicates the drive is not in the trip state. If Pr **10.36** is one and auto-reset is being used, this bit is not cleared until all auto-resets have been attempted and the next trip occurs. The control board LED reflects the state of this parameter: LED on continuously = 1, LED flashing = 0.

10.02	Drive active															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4 ms write															

Indicates that the drive inverter is active.

10.03	Zero speed															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

Indicates that the absolute value of speed feedback (Pr **3.02**) is at or below the zero speed threshold defined by Pr **3.05**.

10.04	Running at or below min speed															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

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 speed feedback (Pr **3.02**) is at or below (minimum speed + 5rpm). Minimum speed is defined by Pr **1.07**. The parameter is only set if the drive is running.

10.05	Below set speed															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

10.06	At speed															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

10.07	Above set speed															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

These flags are set by the speed detector in menu 3.

See Pr **3.06**, Pr **3.07** on page 45 and Pr **3.09** on page 46.

10.08	Load reached															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

Indicates that the modulus of the active current is greater or equal to the rated active current as defined in menu 4.

10.09	**Drive output is at current limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4 ms write															

Indicates that the current limits are active.

10.10	**Regenerating**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4 ms write															

Indicates that power is being transferred from the motor to the drive.

10.11	**Braking IGBT active**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4 ms write															

Indicates that the Braking IGBT is active. If the IGBT becomes active this parameter is held on for at least 0.5s so that it can be seen on the display.

10.12	**Braking resistor alarm**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

This parameter is set when the braking IGBT is active and the braking energy accumulator is greater than 75 %. This parameter is held on for at least 0.5s so that it can be seen on the display.

10.13	**Direction commanded**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

This parameter is one if the pre-ramp reference (Pr **1.03**) is negative, and zero if the pre-ramp reference is zero or positive.

10.14	**Direction running**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

This parameter is one if the speed feedback (Pr **3.02**) is negative, or zero if the speed feedback is zero or positive.

10.15	**Mains loss**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4ms write															

Indicates that the drive has detected mains loss from the level of the DC bus voltage. This parameter can only become active if mains loss ride through or mains loss stop modes are selected (see Pr **6.03** on page 89).

10.16	**Under voltage active**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

This parameter indicates that the under voltage condition is active. Normally this condition exists when the UV trip is also active. However, when the drive first powers up it remains in the under voltage state (i.e. this parameter is active) until the DC bus voltage exceeds the under voltage restart level (see Pr **6.03** on page 89). As the UV trip voltage level is lower than the under voltage restart level this parameter is active, but a UV trip is not active at power up until the DC bus voltage exceeds the under voltage restart level.

10.17	**Overload alarm**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

This parameter is set if the drive output current is larger than 105 % of motor rated current (Pr **5.07**) and the overload accumulator is greater than 75% to warn that if the motor current is not reduced the drive will trip on an I x t overload.

10.18	**Drive over temperature alarm**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

Indicates that any of the heat sink temperatures (Pr **7.04** or Pr **7.05**) or the control board temperature (Pr **7.06**) are above their alarm level.

10.19	**Drive warning**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background write															

Indicates that one of the drive alarms is active, i.e. Pr **10.19** = Pr **10.12** OR Pr **10.17** OR Pr **10.18**.

10.20	**Trip 0**															
10.21	**Trip 1**															
10.22	**Trip 2**															
10.23	**Trip 3**															
10.24	**Trip 4**															
10.25	**Trip 5**															
10.26	**Trip 6**															
10.27	**Trip 7**															
10.28	**Trip 8**															
10.29	**Trip 9**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1			1		1		1			1	1
Range	0 to 230															
Update rate	Background write															

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 Pr **10.20** and the oldest trip is lost off the bottom of the log. Descriptions of the trips are given in the table below. A time stamp can be stored for each trip (see Pr **10.41** to Pr **10.51**). All trips are stored, including HF trips numbered from 17 to 32. (HF trips with numbers from 1 to 16 are not stored in the trip log.) UV trips are not stored unless the drive is running when the trip occurs. Any trip can be initiated by the actions described or by writing the relevant trip number to Pr **10.38**. If any trips shown as user trips are initiated the trip string is "txxx", where xxx is the trip number.

Table 5-8 Trip indications

Trip	Diagnosis
br.th	**Braking resistor thermistor temperature monitoring fail**
10	If no brake resistor is installed, set Pr **0.51** (or Pr **10.37**) to 8 to disable this trip. If a brake resistor is installed: Ensure that the braking resistor thermistor is connected correctly Ensure that the fan in the drive is working correctly Replace the braking resistor
C.Acc	**SMARTCARD trip: SMARTCARD Read / Write fail**
185	Check SMARTCARD is installed / located correctly Ensure SMARTCARD is not writing data to data location 500 to 999 Replace SMARTCARD
C.boot	**SMARTCARD trip: The menu 0 parameter modification cannot be saved to the SMARTCARD because the necessary file has not been created on the SMARTCARD**
177	A write to a menu 0 parameter has been initiated via the keypad with Pr **11.42** set to auto(3) or boot(4), but the necessary file on the SMARTCARD has not bee created Ensure that Pr **11.42** is correctly set and reset the drive to create the necessary file on the SMARTCARD Re-attempt the parameter write to the menu 0 parameter
C.bUSY	**SMARTCARD trip: SMARTCARD can not perform the required function as it is being accessed by a Solutions Module**
178	Wait for the Solutions Module to finish accessing the SMARTCARD and then re-attempt the required function
C.Chg	**SMARTCARD trip: Data location already contains data**
179	Erase data in data location Write data to an alternative data location
C.cPr	**SMARTCARD trip: The values stored in the drive and the values in the data block on the SMARTCARD are different**
188	Press the red reset button
C.dAt	**SMARTCARD trip: Data location specified does not contain any data**
183	Ensure data block number is correct
C.Err	**SMARTCARD trip: SMARTCARD data is corrupted**
182	Ensure the card is located correctly Erase data and retry Replace SMARTCARD
C.Full	**SMARTCARD trip: SMARTCARD full**
184	Delete a data block or use different SMARTCARD
cL2	**Analog input 2 current loss (current mode)**
28	Check analog input 2 (terminal 7) current signal is present (4-20 mA, 20-4 mA)
cL3	**Analog input 3 current loss (current mode)**
29	Check analog input 3 (terminal 8) current signal is present (4-20 mA, 20-4 mA)
CL.bit	**Trip initiated from the control word (Pr 6.42)**
35	Disable the control word by setting Pr **6.43** to 0 or check setting of Pr **6.42**
C.OPtn	**SMARTCARD trip: Solutions Modules installed are different between source drive and destination drive**
180	Ensure correct Solutions Modules are installed Ensure Solutions Modules are in the same Solutions Module slot Press the red reset button
C.Prod	**SMARTCARD trip: The data blocks on the SMARTCARD are not compatible with this product**
175	Erase all data on the SMARTCARD by setting Pr **xx.00** to 9999 and pressing the red reset button Replace SMARTCARD
C.rdo	**SMARTCARD trip: SMARTCARD has the Read Only bit set**
181	Enter 9777 in Pr **xx.00** to allow SMARTCARD Read / Write access Ensure card is not writing to data locations 500 to 999

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>C.rtg</td><td>SMARTCARD trip: The voltage and/or current rating of the source and destination drives are different</td></tr>
<tr><td>186</td><td>Drive rating dependent parameters (parameters with the RA coding) are likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by SMARTCARDs when the rating of the destination drive is different from the source drive and the file is a parameter file. Drive rating dependent parameters will be transferred if only the current rating is different and the file is a differences from default type file.
Press the red reset button
Drive rating parameters are:
<table>
<tr><th>Parameter</th><th>Function</th></tr>
<tr><td>2.08</td><td>Standard ramp voltage</td></tr>
<tr><td>4.05/6/7, 21.27/8/9</td><td>Current limits</td></tr>
<tr><td>4.24</td><td>User current maximum scaling</td></tr>
<tr><td>5.07, 21.07</td><td>Motor rated current</td></tr>
<tr><td>5.09, 21.09</td><td>Motor rated voltage</td></tr>
<tr><td>5.17, 21.12</td><td>Stator resistance</td></tr>
<tr><td>5.18</td><td>Switching frequency</td></tr>
<tr><td>5.24, 21.14</td><td>Transient inductance</td></tr>
<tr><td>6.48</td><td>Line power supply loss ride through detection level</td></tr>
</table>
The above parameters will be set to their default values.</td></tr>
<tr><td>C.SLX</td><td>An error has occurred when attempting to transfer a user program from a Solutions Module to a SMARTCARD and vice versa</td></tr>
<tr><td>172,173,174</td><td>See Pr 11.37 for more details</td></tr>
<tr><td>C.TyP</td><td>SMARTCARD trip: SMARTCARD parameter set not compatible with drive</td></tr>
<tr><td>187</td><td>Press the reset button
Ensure destination drive type is the same as the source parameter file drive type</td></tr>
<tr><td>dESt</td><td>Two or more parameters are writing to the same destination parameter</td></tr>
<tr><td>199</td><td>Set Pr xx.00 = 12001 check all visible parameters in the menus for duplication</td></tr>
<tr><td>EEF</td><td>EEPROM data corrupted - Serial comms will timeout with remote keypad on the drive RS485 comms port.</td></tr>
<tr><td>31</td><td>This trip can only be cleared by loading default parameters and saving parameters</td></tr>
<tr><td>EnC1</td><td>Drive encoder trip: Encoder power supply overload</td></tr>
<tr><td>189</td><td>Check encoder power supply wiring and encoder current requirement
Maximum current = 200 mA @ 15 V, or 300 mA @ 8 V and 5 V</td></tr>
<tr><td>EnC2</td><td>Drive encoder trip: Wire break (Drive encoder terminals 1 & 2, 3 & 4, 5 & 6)</td></tr>
<tr><td>190</td><td>Check cable continuity
Check wiring of feedback signals is correct
Check encoder power is set correctly
Check that the encoder cable is connected to the right encoder port on the drive (not to the buffered encoder output port)
Replace feedback device
If wire break detection on the main drive encoder input is not required, set Pr 3.40 = 0 to disable the EnC2 trip</td></tr>
<tr><td>EnC3</td><td>Drive encoder trip: Phase offset incorrect While running</td></tr>
<tr><td>191</td><td>Check the encoder signal for noise
Check encoder shielding
Check the integrity of the encoder mechanical mounting
Repeat the offset measurement test</td></tr>
<tr><td>EnC4</td><td>Drive encoder trip: Feedback device comms failure</td></tr>
<tr><td>192</td><td>Ensure encoder power supply is correct
Ensure baud rate is correct
Check encoder wiring
Replace feedback device</td></tr>
<tr><td>EnC5</td><td>Drive encoder trip: Checksum or CRC error</td></tr>
<tr><td>193</td><td>Check the encoder signal for noise
Check the encoder cable shielding
With EnDat encoders, check the comms resolution and/or carry out the auto-configuration Pr 3.41
SSI not ready at start of position transfer (i.e. data input not one)</td></tr>
</table>

Trip	Diagnosis
EnC6	**Drive encoder trip: Encoder has indicated an error**
194	Replace feedback device With SSI encoders, check the wiring and encoder supply setting
EnC7	**Drive encoder trip: initialization failed**
195	Re-set the drive Check the correct encoder type is entered into Pr **3.38** Check encoder wiring Check encoder power supply is set correctly Carry out the auto-configuration Pr **3.41** Replace feedback device
EnC8	**Drive encoder trip: Auto configuration on power up has been requested and failed**
196	Change the setting of Pr **3.41** to 0 and manually enter the drive encoder turns (Pr **3.33**) and the equivalent number of lines per revolution (Pr **3.34**) Check the comms resolution
EnC9	**Drive encoder trip: Position feedback selected is selected from a Solutions Module slot which does not have a speed / position feedback Solutions Module installed**
197	Check setting of Pr **3.26** (or Pr **21.21** if the second motor parameters have been enabled)
EnC10	**Drive encoder trip: Phasing failure because encoder phase angle (Pr 3.25 or Pr 21.20) is incorrect**
198	Check the encoder wiring. Perform an autotune to measure the encoder phase angle or manually enter the correct phase angle into Pr **3.25** (or Pr **21.20**). Spurious EnC10 trips can be seen in very dynamic applications. This trip can be disabled by setting the overspeed threshold in Pr **3.08** to a value greater than zero. Caution should be used in setting the over speed threshold level as a value which is too large may mean that an encoder fault will not be detected.
Enc11	**Drive encoder trip: A failure has occurred during the alignment of the analog signals of a SINCOS encoder with the digital count derived from the sine and cosine waveforms and the comms position (if applicable). This fault is usually due to noise on the sine and cosine signals.**
161	Check encoder cable shield. Examine sine and cosine signals for noise.
Enc12	**Drive encoder trip: Hiperface encoder - The encoder type could not be identified during auto-configuration**
162	Check encoder type can be auto-configured. Check encoder wiring. Enter parameters manually.
Enc13	**Drive encoder trip: EnDat encoder - The number of encoder turns read from the encoder during auto-configuration is not a power of 2**
163	Select a different type of encoder.
Enc14	**Drive encoder trip: EnDat encoder - The number of comms bits defining the encoder position within a turn read from the encoder during auto-configuration is too large.**
164	Select a different type of encoder. Faulty encoder.
Enc15	**Drive encoder trip: The number of periods per revolution calculated from encoder data during auto-configuration is either less than 2 or greater than 50,000.**
165	Linear motor pole pitch / encoder ppr set up is incorrect or out of parameter range i.e. Pr **5.36** = 0 or Pr **21.31** = 0. Faulty encoder.
Enc16	**Drive encoder trip: EnDat encoder - The number of comms bits per period for a linear encoder exceeds 255.**
166	Select a different type of encoder. Faulty encoder.
Enc17	**Drive encoder trip: The periods per revolution obtained during auto-configuration for a rotary SINCOS encoder is not a power of two.**
167	Select a different type of encoder. Faulty encoder.
EnP.Er	**Data error from electronic nameplate stored in selected position feedback device**
176	Replace feedback device

Trip	Diagnosis
Et	**External trip from input on terminal 31**
6	Check terminal 31 signal Check value of Pr **10.32** Enter 12001 in Pr **xx.00** and check for parameter controlling Pr **10.32** Ensure Pr **10.32** or Pr **10.38** (=6) are not being controlled by serial comms
HF01	**Data processing error: CPU address error**
	Hardware fault - return drive to supplier
HF02	**Data processing error: DMAC address error**
	Hardware fault - return drive to supplier
HF03	**Data processing error: Illegal instruction**
	Hardware fault - return drive to supplier
HF04	**Data processing error: Illegal slot instruction**
	Hardware fault - return drive to supplier
HF05	**Data processing error: Undefined exception**
	Hardware fault - return drive to supplier
HF06	**Data processing error: Reserved exception**
	Hardware fault - return drive to supplier
HF07	**Data processing error: Watchdog failure**
	Hardware fault - return drive to supplier
HF08	**Data processing error: Level 4 crash**
	Hardware fault - return drive to supplier
HF09	**Data processing error: Heap overflow**
	Hardware fault - return drive to supplier
HF10	**Data processing error: Router error**
	Hardware fault - return drive to supplier
HF11	**Data processing error: Access to EEPROM failed**
	Hardware fault - return drive to supplier
HF12	**Data processing error: Main program stack overflow**
	Hardware fault - return drive to supplier
HF13	**Data processing error: Software incompatible with hardware**
	Hardware or software fault - return drive to supplier
HF17	**Multi-module system thermistor short circuit or open circuit**
217	Hardware fault - return drive to supplier
HF18	**Multi-module system interconnect cable error**
218	Hardware fault - return drive to supplier
HF19	**Temperature feedback multiplexing failure**
219	Hardware fault - return drive to supplier
HF20	**Power stage recognition: serial code error**
220	Hardware fault - return drive to supplier
HF21	**Power stage recognition: unrecognized frame size**
221	Hardware fault - return drive to supplier
HF22	**Power stage recognition: multi module frame size mismatch**
222	Hardware fault - return drive to supplier
HF23	**Power stage recognition: multi module voltage rating mismatch**
223	Hardware fault - return drive to supplier
HF24	**Power stage recognition: unrecognized drive size**
224	Hardware fault - return drive to supplier

Trip	Diagnosis
HF25	**Current feedback offset error**
225	Hardware fault - return drive to supplier
HF26	**Soft start relay failed to close, soft start monitor failed or braking IGBT short circuit at power up**
226	Hardware fault - return drive to supplier
HF27	**Power stage thermistor 1 fault**
227	Hardware fault - return drive to supplier
HF29	**Control board thermistor fault**
229	Hardware fault - return drive to supplier
HF30	**DCCT wire break trip from power module**
230	Hardware fault - return drive to supplier
It.AC	**Output current overload timed out (I^2t) - accumulator value can be seen in Pr 4.19**
20	Ensure the load is not jammed / sticking Ensure that the motor rated current is not set to zero Check the load on the motor has not changed If seen during an autotune, ensure that the motor rated current Pr **0.46** (Pr **5.07**) or Pr **21.07** is current rating of the drive Tune the rated speed parameter Check feedback device signal for noise Check the feedback device mechanical coupling
It.br	**Braking resistor overload timed out (I^2t) – accumulator value can be seen in Pr 10.39**
19	Ensure the values entered in Pr **10.30** and Pr **10.31** are correct Increase the power rating of the braking resistor and change Pr **10.30** and Pr **10.31** If an external thermal protection device is being used and the braking resistor software overload is not required, set Pr **10.30** or Pr **10.31** to 0 to disable the trip
O.CtL	**Drive control board over temperature**
23	Check enclosure / drive fans are still functioning correctly Check enclosure ventilation paths Check enclosure door filters Check ambient temperature Reduce drive switching frequency
O.ht1	**Power device over temperature based on thermal model**
21	Reduce drive switching frequency Reduce duty cycle Decrease acceleration / deceleration rates Reduce motor load
O.ht2	**Heatsink over temperature**
22	Check enclosure / drive fans are still functioning correctly Check enclosure ventilation paths Check enclosure door filters Increase ventilation Decrease acceleration / deceleration rates Reduce drive switching frequency Reduce duty cycle Reduce motor load
O.ht3	**Drive over-temperature based on thermal model**
27	The drive will attempt to stop the motor before tripping. If the motor does not stop in 10 s the drive trips immediately Check DC bus ripple Decrease acceleration / deceleration rates Reduce duty cycle Reduce motor load

Trip	Diagnosis
OI.AC	**Instantaneous output over current detected**
3	Over current threshold is Kc / 0.45 (see Table 4-2 *Maximum motor rated current* on page 17 for Kc values) Acceleration /deceleration rate is too short. If seen during autotune reduce voltage boost Pr **5.15** Check for short circuit on output cabling Check integrity of motor insulation Check feedback device wiring Check feedback device mechanical coupling Check feedback signals are free from noise Is motor cable length within limits Reduce the values in speed loop gain parameters – Pr **3.10**, Pr **3.11** and Pr **3.12** Has offset measurement test been completed? Reduce the values in current loop gain parameters - Pr **4.13** and Pr **4.14**
OI.br	**Braking transistor over-current detected: short circuit protection for the braking transistor activated**
4	Check braking resistor wiring Check braking resistor value is greater than or equal to the minimum resistance value Check braking resistor insulation
O.Ld1	**Digital output overload: total current drawn from 24V supply and digital outputs exceeds 200mA**
26	Check total load on digital outputs (terminals 24,25,26)and +24V rail (terminal 22)
O.SPd	**Motor speed has exceeded the over speed threshold**
7	Increase the over speed trip threshold in Pr **3.08** Reduce the speed loop P gain (Pr **3.10**) to reduce the speed overshoot
OV	**DC bus voltage has exceeded the peak level or the maximum continuous level for 15 seconds**
2	Increase deceleration ramp (Pr **0.04**) Decrease braking resistor value (staying above the minimum value) Check nominal AC supply level Check for supply disturbances which could cause the DC bus to rise – voltage overshoot after supply recovery from a notch induced by DC drives. Check motor insulation **Drive voltage rating** / **Peak voltage** / **Maximum continuous voltage level (15 s)** 200 / 415 / 400 400 / 830 / 800 If the drive is operating in low voltage DC mode the overvoltage trip level is 1.45 x Pr **6.46**.
PAd	**Keypad has been removed when the drive is receiving the speed reference from the keypad**
34	Instal keypad and reset Change speed reference selector to select speed reference from another source
PH	**AC voltage input phase loss or large supply imbalance detected**
32	Ensure all three phases are present and balanced Check input voltage levels are correct (at full load) **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.
PS	**Internal power supply fault**
5	Remove any Solutions Modules and reset Hardware fault - return drive to supplier
PS.10V	**10V user power supply current greater than 10mA**
8	Check wiring to terminal 4 Reduce load on terminal 4
PS.24V	**24V internal power supply overload**
9	The total user load of the drive and Solutions Modules has exceeded the internal 24 V power supply limit. The user load consists of the drive's digital outputs, the SM-I/O Plus digital outputs, the drive's main encoder supply and the SM-Universal Encoder Plus encoder supply. • Reduce load and reset • Provide an external 24 V >50 W power supply • Remove any Solutions Modules and reset
PSAVE.Er	**Power down save parameters in the EEPROM are corrupt**
37	Indicates that the power was removed when power down save parameters were being saved. The drive will revert back to the power down parameter set that was last saved successfully. Perform a user save (Pr **xx.00** to 1000 or 1001 and reset the drive) or power down the drive normally to ensure this trip does or occur the next time the drive is powered up.

Trip	Diagnosis
SAVE.Er	**User save parameters in the EEPROM are corrupt**
36	Indicates that the power was removed when user parameters were being saved. The drive will revert back to the user parameter set that was last saved successfully. Perform a user save (Pr **xx.00** to 1000 or 1001 and reset the drive) to ensure this trip does or occur the next time the drive is powered up.
SCL	**Drive RS485 serial comms loss to remote keypad**
30	Re-instal the cable between the drive and keypad Check cable for damage Replace cable Replace keypad
SLX.dF	**Solutions Module slot X trip: Solutions Module type installed in slot X changed**
204,209	Save parameters and reset

Trip	Diagnosis
SLX.Er	**Solutions Module slot X trip: Solutions Module in slot X has detected a fault**

202,207,212

Feedback module category

Check value in Pr **15**/**16.50**. The following table lists the possible error codes for the SM-Universal Encoder Plus, SM-Encoder Plus and SM-Resolver. See the *Diagnostics* section in the relevant Solutions Module User Guide for more information.

Error code	Module	Trip Description	Diagnostic
0	All	No trip	No fault detected
1	SM-Universal Encoder Plus	Encoder power supply overload	Check encoder power supply wiring and encoder current requirement Maximum current = 200 mA @ 15 V, or 300 mA @ 8 V and 5V
	SM-Resolver	Excitation output short circuit	Check the excitation output wiring.
2	SM-Universal Encoder Plus & SM-Resolver	Wire break	Check cable continuity Check wiring of feedback signals is correct Check supply voltage or excitation output level Replace feedback device
3	SM-Universal Encoder Plus	Phase offset incorrect while running	Check the encoder signal for noise Check encoder shielding Check the integrity of the encoder mechanical mounting Repeat the offset measurement test
4	SM-Universal Encoder Plus	Feedback device communications failure	Ensure encoder power supply is correct Ensure baud rate is correct Check encoder wiring Replace feedback device
5	SM-Universal Encoder Plus	Checksum or CRC error	Check the encoder signal for noise Check the encoder cable shielding
6	SM-Universal Encoder Plus	Encoder has indicated an error	Replace encoder
7	SM-Universal Encoder Plus	Initialization failed	Check the correct encoder type is entered into Pr **15**/**16**/**17.15** Check encoder wiring Check supply voltage level Replace feedback device
8	SM-Universal Encoder Plus	Auto configuration on power up has been requested and failed	Change the setting of Pr **15**/**16**/**17.18** and manually enter the number of turns (Pr **15**/**16**/**17.09**) and the equivalent number of lines per revolution (Pr **15**/**16**/**17.10**)
9	SM-Universal Encoder Plus	Motor thermistor trip	Check motor temperature Check thermistor continuity
10	SM-Universal Encoder Plus	Motor thermistor short circuit	Check motor thermistor wiring Replace motor / motor thermistor
11	SM-Universal Encoder Plus	Failure of the sincos analog position alignment during encoder initialization	Check encoder cable shield. Examine sine and cosine signals for noise.
	SM-Resolver	Poles not compatible with motor	Check that the correct number of resolver poles has been set in Pr **15**/**16**/**17.15**.
12	SM-Universal Encoder Plus	Encoder type could not be identified during auto-configuration	Check encoder type can be auto-configured. Check encoder wiring. Enter parameters manually.
13	SM-Universal Encoder Plus	Number of encoder turns read from the encoder during auto-configuration is not a power of 2	Select a different type of encoder.
14	SM-Universal Encoder Plus	Number of comms bits defining the encoder position within a turn read from the encoder during auto-configuration is too large.	Select a different type of encoder. Faulty encoder.
15	SM-Universal Encoder Plus	The number of periods per revolution calculated from encoder data during auto-configuration is either <2 or >50,000.	Linear motor pole pitch / encoder ppr set up is incorrect or out of parameter range i.e. Pr **5.36** = 0 or Pr **21.31** = 0. Faulty encoder.
16	SM-Universal Encoder Plus	The number of comms bits per period for a linear encoder exceeds 255.	Select a different type of encoder. Faulty encoder.
74	SM-Universal Encoder Plus & SM_Resolver	Solutions Module has overheated	Check ambient temperature Check enclosure ventilation

Trip	Diagnosis
SLX.Er	**Solutions Module slot X trip: Solutions Module in slot X or Digitax ST Plus/Indexer has detected a fault**
202,207,212	**Automation (Applications) module category** Check value in Pr **17.50**. The following table lists the possible error codes for the Digitax ST Plus and Digitax ST Indexer. See the *Diagnostics* section in the Advanced User Guide for more information.

Error Code	Trip Description
39	User program stack overflow
40	Unknown error - please contact supplier
41	Parameter does not exist
42	Attempt to write to a read-only parameter
43	Attempt to read from a write-only parameter
44	Parameter value out of range
45	Invalid synchronisation modes
46	Unused
47	Synchronisation lost with CTSync Master
48	RS485 not in user mode
49	Invalid RS485 configuration
50	Maths error - divide by zero or overflow
51	Array index out of range
52	Control word user trip
53	DPL program incompatible with target
54	DPL task overrun
55	Unused
56	Invalid timer unit configuration
57	Function block does not exist
58	Flash PLC Storage corrupt
59	Drive rejected application module as Sync master
60	CTNet hardware failure. Please contact your supplier
61	CTNet invalid configuration
62	CTNet invalid baud-rate
63	CTNet invalid node ID
64	Digital Output overload
65	Invalid function block parameter(s)
66	User heap too large
67	RAM file does not exist or a non-RAM file id has been specified
68	The RAM file specified is not associated to an array
69	Failed to update drive parameter database cache in Flash memory
70	User program downloaded while drive enabled
71	Failed to change drive mode
72	Invalid CTNet buffer operation
73	Fast parameter initialization failure
74	Over-temperature
75	Hardware unavailable
76	Module type cannot be resolved. Module is not recognised.
77	Inter-Solutions Module comms error with module in slot 1
78	Inter-Solutions Module comms error with module in slot 2
79	Inter-Solutions Module comms error with module in slot 3
80	Inter-Solutions Module comms error with module unknown slot
81	APC internal error
82	Communications to drive faulty

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>SLX.Er</td><td>Solutions Module slot X trip: Solutions Module in slot X has detected a fault</td></tr>
<tr><td>202,207,212</td><td>
Automation (I/O Expansion) module category
Check value in Pr 15/16.50. The following table lists the possible error codes for the SM-I/O Plus, SM-I/O Lite, SM-I/O Timer, SM-I/O PELV, SM-I/O 120V and SM-I/O 24V Protected. See the Diagnostics section in the relevant Solutions Module User Guide for more information.
<table>
<tr><th>Error code</th><th>Module</th><th>Reason for fault</th></tr>
<tr><td>0</td><td>All</td><td>No errors</td></tr>
<tr><td>1</td><td>All</td><td>Digital output overload</td></tr>
<tr><td rowspan="2">2</td><td>SM-I/O Lite, SM-I/O Timer</td><td>Analog input 1 current input too high (>22 mA) or too low (<3 mA)</td></tr>
<tr><td>SM-I/O PELV, SM-I/O 24V Protected</td><td>Digital input overload</td></tr>
<tr><td rowspan="2">3</td><td>SM-I/O PELV, SM-I/O 24V Protected</td><td>Analog input 1 current input too low (<3 mA)</td></tr>
<tr><td>SM-I/O 24V Protected</td><td>Communications error</td></tr>
<tr><td>4</td><td>SM-I/O PELV</td><td>User power supply absent</td></tr>
<tr><td>5</td><td>SM-I/O Timer</td><td>Real time clock communication error</td></tr>
<tr><td>74</td><td>All</td><td>Module over temperature</td></tr>
</table>
</td></tr>
<tr><td>SLX.Er</td><td>Solutions Module slot X trip: Solutions Module in slot X has detected a fault</td></tr>
<tr><td>202,207,212</td><td>
Fieldbus module category
Check value in Pr 15/16.50. The following table lists the possible error codes for the Fieldbus modules. See the Diagnostics section in the relevant Solutions Module User Guide for more information.
<table>
<tr><th>Error code</th><th>Module</th><th>Trip Description</th></tr>
<tr><td>0</td><td>All</td><td>No trip</td></tr>
<tr><td>52</td><td>SM-PROFIBUS-DP, SM-Interbus, SM-DeviceNet, SM-CANOpen</td><td>User control word trip</td></tr>
<tr><td>61</td><td>SM-PROFIBUS-DP, SM-Interbus, SM-DeviceNet, SM-CANOpen, SM-SERCOS</td><td>Configuration error</td></tr>
<tr><td>64</td><td>SM-DeviceNet</td><td>Expected packet rate timeout</td></tr>
<tr><td>65</td><td>SM-PROFIBUS-DP, SM-Interbus, SM-DeviceNet, SM-CANOpen, SM-SERCOS</td><td>Network loss</td></tr>
<tr><td rowspan="2">66</td><td>SM-PROFIBUS-DP</td><td>Critical link failure</td></tr>
<tr><td>SM-CAN, SM-DeviceNet, SM-CANOpen</td><td>Bus off error</td></tr>
<tr><td>69</td><td>SM-CAN</td><td>No acknowledgement</td></tr>
<tr><td rowspan="2">70</td><td>All (except SM-Ethernet)</td><td>Flash transfer error</td></tr>
<tr><td>SM-Ethernet</td><td>No valid menu data available for the module from the drive</td></tr>
<tr><td>74</td><td>All</td><td>Solutions module over temperature</td></tr>
<tr><td>75</td><td>SM-Ethernet</td><td>The drive is not responding</td></tr>
<tr><td>76</td><td>SM-Ethernet</td><td>The Modbus connection has timed out</td></tr>
<tr><td>80</td><td>All (except SM-SERCOS)</td><td>Inter-option communications error</td></tr>
<tr><td>81</td><td>All (except SM-SERCOS)</td><td>Communications error to slot 1</td></tr>
<tr><td>82</td><td>All (except SM-SERCOS)</td><td>Communications error to slot 2</td></tr>
<tr><td>83</td><td>All (except SM-SERCOS)</td><td>Communications error to slot 3</td></tr>
<tr><td>84</td><td>SM-Ethernet</td><td>Memory allocation error</td></tr>
<tr><td>85</td><td>SM-Ethernet</td><td>File system error</td></tr>
<tr><td>86</td><td>SM-Ethernet</td><td>Configuration file error</td></tr>
<tr><td>87</td><td>SM-Ethernet</td><td>Language file error</td></tr>
<tr><td>98</td><td>All</td><td>Internal watchdog error</td></tr>
<tr><td>99</td><td>All</td><td>Internal software error</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>SLX.Er</td><td>Solutions Module slot X trip: Solutions Module in slot X has detected a fault</td></tr>
<tr><td>202,207,212</td><td>SLM module category
Check value in Pr 15/16.50. The following table lists the possible error codes for the SM-SLM. See the Diagnostics section in the SM-SLM User Guide for more information.
<table>
<tr><th>Error Code</th><th>Trip Description</th></tr>
<tr><td>0</td><td>No fault detected</td></tr>
<tr><td>1</td><td>Power supply overloaded</td></tr>
<tr><td>2</td><td>SLM version is too low</td></tr>
<tr><td>3</td><td>DriveLink error</td></tr>
<tr><td>4</td><td>Incorrect switching frequency selected</td></tr>
<tr><td>5</td><td>Feedback source selection incorrect</td></tr>
<tr><td>6</td><td>Encoder error</td></tr>
<tr><td>7</td><td>Motor object number of instances error</td></tr>
<tr><td>8</td><td>Motor object list version error</td></tr>
<tr><td>9</td><td>Performance object number of instances error</td></tr>
<tr><td>10</td><td>Parameter channel error</td></tr>
<tr><td>11</td><td>Drive operating mode incompatible</td></tr>
<tr><td>12</td><td>Error writing to the SLM EEPROM</td></tr>
<tr><td>13</td><td>Motor object type incorrect</td></tr>
<tr><td>14</td><td>Digitax ST object error</td></tr>
<tr><td>15</td><td>Encoder object CRC error</td></tr>
<tr><td>16</td><td>Motor object CRC error</td></tr>
<tr><td>17</td><td>Performance object CRC error</td></tr>
<tr><td>18</td><td>Digitax ST object CRC error</td></tr>
<tr><td>19</td><td>Sequencer timeout</td></tr>
<tr><td>74</td><td>Solutions module over temperature</td></tr>
</table></td></tr>
<tr><td>SLX.HF</td><td>Solutions Module slot X trip: Solutions Module X hardware fault</td></tr>
<tr><td>200,205,210</td><td>Ensure Solutions Module is installed correctly
Return Solutions Module to supplier</td></tr>
<tr><td>SLX.nF</td><td>Solutions Module slot X trip: Solutions Module has been removed</td></tr>
<tr><td>203,208,213</td><td>Ensure Solutions Module is installed correctly
Re-instal Solutions Module
Save parameters and reset drive</td></tr>
<tr><td>SL.rtd</td><td>Solutions Module trip: Drive mode has changed and Solutions Module parameter routing is now incorrect</td></tr>
<tr><td>215</td><td>Press reset.
If the trip persists, contact the supplier of the drive.</td></tr>
<tr><td>SLX.tO</td><td>Solutions Module slot X trip: Solutions Module watchdog timeout</td></tr>
<tr><td>201,206,211</td><td>Press reset.
If the trip persists, contact the supplier of the drive.</td></tr>
<tr><td>t038</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>38</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t040 to t089</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>40 to 89</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t099</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>99</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t101</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>101</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t112 to t160</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>112 to 160</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t168 to t171</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>168 to 171</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
</table>

Trip	Diagnosis
t216	**User trip defined in 2nd processor Solutions Module code**
216	SM-Applications program must be interrogated to find the cause of this trip
th	**Motor thermistor trip**
24	Check motor temperature Check thermistor continuity Set Pr **7.15** = VOLt and reset the drive to disable this function
thS	**Motor thermistor short circuit**
25	Check motor thermistor wiring Replace motor / motor thermistor Set Pr **7.15** = VOLt and reset the drive to disable this function
tunE*	**Autotune stopped before completion**
18	The drive has tripped out during the autotune The red stop key has been pressed during the autotune The Safe Torque Off signal (terminal 31) was active during the autotune procedure
tunE1*	**The position feedback did not change or required speed could not be reached during the inertia test (see Pr 5.12)**
11	Ensure the motor is free to turn i.e. brake was released. Check feedback device wiring is correct Check feedback parameters are set correctly Check encoder coupling to motor
tunE2*	**Position feedback direction incorrect or motor could not be stopped during the inertia test (see Pr 5.12)**
12	Check motor cable wiring is correct. Check feedback device wiring is correct
tunE3*	**Drive encoder commutation signals connected incorrectly or measured inertia out of range (see Pr 5.12)**
13	Check motor cable wiring is correct. Check feedback device U,V and W commutation signal wiring is correct
tunE4*	**Drive encoder U commutation signal fail during an autotune**
14	Check feedback device U phase commutation wires continuity Replace encoder
tunE5*	**Drive encoder V commutation signal fail during an autotune**
15	Check feedback device V phase commutation wires continuity Replace encoder
tunE6*	**Drive encoder W commutation signal fail during an autotune**
16	Check feedback device W phase commutation wires continuity Replace encoder
tunE7*	**Motor number of poles set incorrectly**
17	Check lines per revolution for feedback device Check the number of poles in Pr **5.11** is set correctly
UP ACC	**Onboard PLC program: cannot access Onboard PLC program file on drive**
98	Disable drive - write access is not allowed when the drive is enabled Another source is already accessing Onboard PLC program - retry once other action is complete
UP div0	**Onboard PLC program attempted divide by zero**
90	Check program
UP OFL	**Onboard PLC program variables and function block calls using more than the allowed RAM space (stack overflow)**
95	Check program
UP ovr	**Onboard PLC program attempted out of range parameter write**
94	Check program
UP PAr	**Onboard PLC program attempted access to a non-existent parameter**
91	Check program
UP ro	**Onboard PLC program attempted write to a read-only parameter**
92	Check program
UP So	**Onboard PLC program attempted read of a write-only parameter**
93	Check program
UP udF	**Onboard PLC program un-defined trip**
97	Check program

Trip	Diagnosis
UP uSEr	**Onboard PLC program requested a trip**
96	Check program
UV	**DC bus under voltage threshold reached**
1	Check AC supply voltage level **Drive voltage rating (Vac)** / **Under voltage threshold (Vdc)** / **UV reset voltage (Vdc)** 200 / 175 / 215 400 / 330 / 425

*If a tunE through tunE trip occurs, then after the drive is reset the drive cannot be made to run unless it is disabled via the Safe Torque Off input (terminal 31), drive enable parameter (Pr **6.15**) or the control word (Pr **6.42** and Pr **6.43**).

Table 5-9 Serial communications look-up table

No.	Trip	No.	Trip	No.	Trip
1	UV	91	UP PAr	181	C.RdO
2	OV	92	UP ro	182	C.Err
3	OI.AC	93	UP So	183	C.dAt
4	OI.br	94	UP ovr	184	C.FULL
5	PS	95	UP OFL	185	C.Acc
6	Et	96	UP uSEr	186	C.rtg
7	O.SPd	97	UP udF	187	C.TyP
8	PS.10V	98	UP ACC	188	C.cPr
9	PS.24V	99	t099	189	EnC1
10	br.th	100		190	EnC2
11	tunE1	101	Reserved	191	EnC3
12	tunE2	103	Reserved	192	EnC4
13	tunE3	104	Reserved	193	EnC5
15	tunE5	105	Reserved	194	EnC6
16	tunE6	106	Reserved	196	EnC8
17	tunE7	107	Reserved	197	EnC9
18	tunE	108	Reserved	198	EnC10
19	It.br	109	Reserved	199	DESt
20	It.AC	110	Reserved	200	SL1.HF
21	O.ht1	111	Reserved	201	SL1.tO
24	th	112 to 160	t112 to t160	202	SL1.Er
25	thS	161	Enc11	205	SL2.HF
26	O.Ld1	162	Enc12	206	SL2.tO
27	O.ht3	163	Enc13	207	SL2.Er
28	cL2	164	Enc14	208	SL2.nF
29	cL3	165	Enc15	209	SL2.dF
30	SCL	166	Enc16	210	SL3.HF
31	EEF	167	Enc17	211	SL3.tO
32	PH	168 to 171	t168 to t171	212	SL3.Er
33	rS	172	C.SL1	213	SL3.nF
34	PAd	173	C.SL2	214	SL3.dF
35	CL.bit	174	C.SL3	215	SL.rtd
36	SAVE.Er	175	C.Prod	216	t216
37	PSAVE.Er	176	EnP.Er	217 to 232	HF17 to HF32
38	t038	177	C.boot		
39	Reserved	178	C.bUSY		
40 to 89	t040 to t089	179	C.Chg		
90	UP div0	180	C.OPtn		

Trips can be grouped into the following categories. It should be noted that a trip can only occur when the drive is not tripped or is already tripped but with a trip with a lower priority number.

Priority	Category	Trips	Comments
1	Hardware faults	HF01 to HF16	These indicate serious internal problems and cannot be reset. The drive is inactive after one of these trips and the display shows HFxx.
2	Non-resetable trips	HF17 to HF32, SL1.HF, SL2.HF, SL3.HF	Cannot be reset.
3	EEF trip	EEF	Cannot be reset unless a code to load defaults is first entered in Pr **x.00** or Pr **11.43**.
4	SMARTCARD trips	C.Boot, C.Busy, C.Chg, C.Optn, C.RdO, C.Err, C.dat, C.FULL, C.Acc, C.rtg, C.Typ, C.cpr, C.Prod	SMARTCARD trips have priority 5 during power up.
4	Encoder power supply trips	PS.24V, EnC1	These trips can only override the following priority 5 trips: EnC2 - EnC8 or Enc11 - En17
5	Normal trips with extended reset	OI.AC, OI.br, OIAC.P, OIbr.P, OidC.P	Can be reset after 10.0 s
5	Normal trips	All other trips not included in this table	
5	Non-important trips	Old1, cL2, cL3, SCL	If bit 0 of Pr **10.37** is 1 the drive will stop before tripping.
5	Phase loss	PH	The drive attempts to stop before tripping.
5	Drive over-heat based on thermal model	O.ht3	The drive attempts to stop before tripping, but if it does not stop within 10s the drive will automatically trip.
6	Self resetting trips	UV	Under voltage trip cannot be reset by the user, but is automatically reset by the drive when the supply voltage is with specification.

Unless otherwise stated trips cannot be reset until 1.0s after the trip has been accepted by the drive.

Braking IGBT control

The braking IGBT continues to operate even when the drive is not enabled (except if the active supply is a low voltage supply, see Pr **6.44**), but is only disabled if any of the following trips occurs or would occur if another trip had not already become active: OIbr.P, PS, It.br, OV or any HFxx trip.

UV trip

It should be noted that although the UV trip operates in a similar way to all other trips, all drive functions can still operate, but the drive cannot be enabled. The following differences apply to the UV trip:

1. Power down save user parameters are saved when UV trip is activated except when the main high voltage supply is not active (Pr **6.44** = 1).
2. The UV trip is self-resetting when the DC bus voltage rises above the drive restart voltage level. If another trip is active instead of UV at this point, the trip is not reset.
3. The drive can change between using the main high voltage supply and low voltage battery supply only when the drive is in the under voltage condition (Pr **10.16** = 1). The UV trip can only be seen as active if another trip is not active in the under voltage condition.
4. When the drive is first powered up a UV trip is initiated if the supply voltage is below the restart voltage level and another trip is not active. This does not cause save power down save parameters to be saved at this point.

Table 5-10 Hardware fault trips

HF fault code	Reason for trip
01	CPU address error
02	DMAC address error
03	Illegal instruction
04	Illegal slot instruction
05	Undefined exception
06	Reserved exception
07	Watchdog failure
08	Level 4 crash
09	Heap overflow
10	Router error
11	Access to the EEPROM failed or incorrect EEPROMs installed.
12	Main program stack overflow
13	The drive firmware is not compatible with the drive hardware
14-16	Not used
17	Power circuit - Multi-module system thermistor short circuit
18	Power circuit - Multi-module system interconnect cable error
19	Power circuit temperature feedback multiplexor failure
20	Power circuit - identification code error
21	Power circuit - unrecognized frame size
22	Power circuit - multi-module frame size mismatch
23	Power circuit - multi-module voltage rating mismatch
24	Power circuit - unrecognized drive size
25	Current feedback offset error
26	Soft start relay failed to close, or soft start monitor failed, or braking IGBT short circuit at power-up
27	Power circuit thermistor 1 fault
28	Power circuit thermistor 2 or 3 fault / Internal fan fault for some drive sizes.
29	Control board thermistor fault
30	DCCT wired break trip from power module
31	Aux fan failure from power module
32	Identification and trip information serial code

10.30	**Full power braking time**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 400.00 s															
Default	See table below															
Update rate	Background read															

This parameter defines the time period that the braking resistor installed can stand full braking volts without damage. The setting of this parameter is used in determining the braking overload time.

For DST1xxxx drives the default value is a suitable value for standard braking resistors that can be mounted within the drive as given in the table below.

Drive voltage rating	Parameter default	Full braking volts
200 V	0.06 s	390 V
400 V	0.01 s	780 V

If Pr **10.30** is set to zero then the braking resistor thermal protection system is disabled.

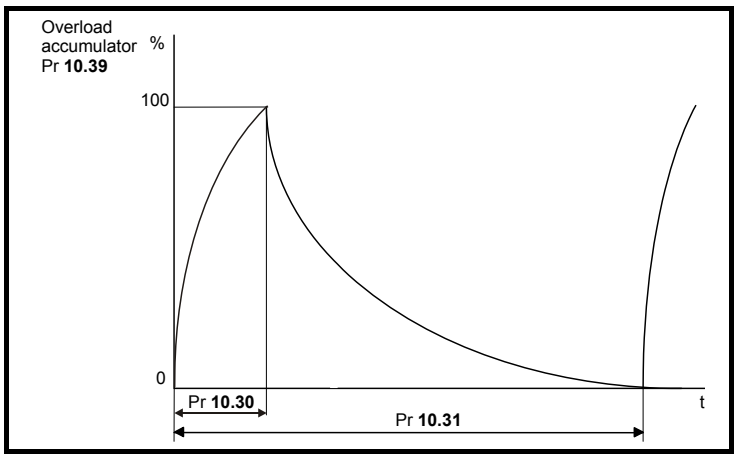
10.31	**Full power braking period**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 1500.0 s															
Default	Refer to table below															
Update rate	Background read															

This parameter defines the time between periods when the braking IGBT is on for the full power braking time so that the average power in the resistor does not exceed the rating of the resistor.

For DST1xxxx, the default value is a suitable value for standard braking resistors that can be mounted within the drive as given in the table below.

Drive voltage rating	Parameter default
200 V	2.6 s
400 V	1.7 s

The braking resistor temperature is modelled by the drive as shown below. The temperature rises in proportion to the power flowing into the resistor and falls in proportion to the difference between the resistor temperature and ambient. Under the conditions shown the resistor is heating up just to 100 % of its rated temperature during each braking period.



Assuming that the full power braking time is much shorter than the full power braking period i.e. Pr **10.30** < Pr **10.31** / 10 (which is normally the case) the values for Pr **10.30** and Pr **10.31** can be calculated as follows:

Power flowing into the resistor when the braking IGBT is on, P_{on} = Full braking volts^2 / R

Where:

Full braking volts is defined in the table and R is the resistance of the braking resistor.

Full power braking time (Pr **10.30**), $T_{on} = E / P_{on}$

Where:

E is the total energy that can be absorbed by the resistor when its initial temperature is ambient temperature.

Therefore full power braking time (Pr **10.30**), T_{on} = E x R / Full braking volts^2

If the average power rating of the resistor is not to be exceeded in the cycle shown in the diagram above, the average power in the resistor is given by, $P_{av} = P_{on} \times T_{on} / Tp$

Where:

Tp is the full power braking period

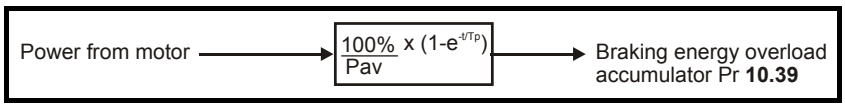
Also, $P_{on} = E / T_{on}$

Therefore $P_{av} = E / Tp$

Therefore full power braking period (Pr **10.31**), $Tp = E / P_{av}$

The resistance of the braking resistor R, the total energy E and the average power P_{av} can normally be obtained for the resistor and used to calculate Pr **10.30** and Pr **10.31**.

If the profile of the power flowing from the motor is know then the instantaneous temperature can be calculated at any point by simulating the braking resistor with the model shown below.



The temperature of the resistor is monitored by the braking energy accumulator (Pr **10.39**). When this parameter reaches 100 % the drive will trip if bit 1 of Pr **10.37** is 0, or will disable the braking IGBT until the accumulator falls below 95 % if bit 1 of Pr **10.37** is 1. The second option is intended for applications with parallel connected DC bus where there are several braking resistors, each of which cannot withstand full DC bus voltage continuously. The braking load will probably not be shared equally between the resistors because of voltage measurement tolerances within the individual drives. However, once a resistor reaches its maximum temperature its load will be reduced, and be taken up by another resistor.

10.32	**External trip**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	Background read															

If this flag is set to one then the drive will trip (Et). If an external trip function is required, a digital input should be programmed to control this bit.

10.33	**Drive reset**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	Background read															

A zero to one change in 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.

10.34	**No. of auto-reset attempts**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 5															
Default	0															
Update rate	Background read															

10.35	**Auto-reset delay**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 25.0 s															
Default	1.0															
Update rate	Background read															

If Pr **10.34** 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. Note that this time could be a minimum of 10 s for some trips (see Pr **10.20** to Pr **10.29**). 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 a UV, Et, EEF, SLX.HF or HFxx trips. When a manual reset occurs the auto reset counter is reset to zero.

10.36	**Hold drive ok until last attempt**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

If this parameter is 0 then Pr **10.01** (Drive ok) is cleared every time the drive trips regardless of any auto-reset that may occur. When this parameter is set the 'Drive ok' indication is not cleared on a trip if an auto-reset is going to occur.

10.37	**Action on trip detection**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 15															
Default	0															
Update rate	Background read															

Each bit in this parameter has the following functions:

Bit	Function
0	Stop on non-important trips
1	Disable braking IGBT trips
2	Disable phase loss trip
3	Disable braking resistor temperature monitoring failure detection

Stop on non-important trips

If bit 0 is set to zero then the drive simply trips when a non-important trip occurs. Non-important trips are: th, ths, Old1, cL2, cL3, SCL. If bit 0 is set to one the drive will stop before tripping when one of these trips is initiated.

Disable braking IGBT trips

For details of braking IGBT trip mode see Pr **10.31**.

Disable phase loss trip

The user can disable the phase loss trip in 200V drives as these are allowed to operate from a single phase supply. If bit 2 is set to zero the phase loss trip is enabled. If bit 2 is set to one the phase loss trip is disabled in 200 V drives only.

Disable braking resistor temperature monitoring failure detection

Digitax ST has an internal user fit braking resistor with a thermistor to detect overheating of the resistor. As default bit 3 of Pr **10.37** is set to zero, and so if the braking resistor and its thermistor is not installed the drive will produce a trip (br.th) because the thermistor appears to be open circuit. This trip can be disabled so that the drive can run by setting bit 3 of Pr **10.37** to one. If the resistor is installed then no trip is produced unless the thermistor fails, and so bit 3 of Pr **10.37** can be left at zero.

Example: For a single phase drive with no internal brake resistor installed, this parameter should be set to 12 (Binary 1100).

10.38	**User trip**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255															
Default	0															
Update rate	Background read															

When a value other than zero is written to the user trip parameter the actions described in the following table are performed. The drive immediately writes the value back to zero. If the value is not included in the table a trip is initiated with the same trip number as the value provided the drive is not already tripped.

Action	Values written to 10.38	Trip code
No action	1 31 200 205 210 217-245	UV EEF SL1.HF SL2.HF SL3.HF HFx
Drive reset	100	
Clear trip and trip time logs	255	

10.39	**Braking energy overload accumulator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1		1		1			1	
Range	0.0 to 100.0 %															
Update rate	Background read															

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 140. Zero indicates the resistor is close to ambient and 100 % is the maximum temperature (trip level). A br.rS warning is given if this parameter is above 75 % and the braking IGBT active.

10.40	**Status word**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 32,767															
Update rate	Background write															

The bits in this parameter correspond to the status bits in menu 10 as follows.

15	14	13	12	11	10	9	8
Not used	Pr **10.15**	Pr **10.14**	Pr **10.13**	Pr **10.12**	Pr **10.11**	Pr **10.10**	Pr **10.09**

7	6	5	4	3	2	1	0
Pr **10.08**	Pr **10.07**	Pr **10.06**	Pr **10.05**	Pr **10.04**	Pr **10.03**	Pr **10.02**	Pr **10.01**

10.41	**Trip 0 time: years.days**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3	1		1		1			1	1
Range	0.000 to 9.364 Years.Days															
Update rate	Background write															

10.42	**Trip 0 time**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
		1					2	1		1		1			1	1
Range	00.00 to 23.59 Hours.Minutes															
Update rate	Background write															

10.43	**Trip 1 time**
10.44	**Trip 2 time**
10.45	**Trip 3 time**
10.46	**Trip 4 time**
10.47	**Trip 5 time**
10.48	**Trip 6 time**
10.49	**Trip 7 time**
10.50	**Trip 8 time**
10.51	**Trip 9 time**

Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1			1	1
Range	0 to 600.00 Hours.Minutes															
Update rate	Background write															

When Pr 6.49 = 0

The trip time log Pr **10.42** to Pr **10.51** is disabled and these parameters will always remain zero.

When Pr 6.49 = 1

When a trip occurs the reason for the trip is put into the top location in the trip log (Pr **10.20**). At the same time either the time from the powered-up clock (if Pr **6.28** = 0) or from the run time clock (if Pr **6.28** = 1) is put into Trip 0 time (Pr **10.41** and Pr **10.42**). The times for earlier trips (Trip 1 to 9) are moved to the next parameter in the same way that trips move down the trip log. The time for Trips 1 to 9 are stored as the time difference between when Trip 0 occurred and the relevant trip in hours and minutes. The maximum time difference that can be stored is 600 hours. If this time is exceeded the value stored is 600.00.

If the powered-up clock is used as the source for this function all the times in the log are reset to zero at power-up because they were related to the time since the drive was powered-up last time. If the runtime clock is used the times are saved at power-down and then retained when the drive powers up again. If Pr **6.28**, which defines the clock source, is changed by the user the whole trip and trip time logs are cleared. It should be noted that the powered-up time can be modified by the user at any time. If this is done the values in the trip time log remain unchanged until a trip occurs. The new values put in the log for earlier trips (Trip 1 to 9) will become the time difference between the value of the power-up clock when the trip occurred and the value of the powered-up clock when the latest trip occurred. It is possible that this time difference may be negative, in which case the value will be zero

5.14 Menu 11: General drive set-up

11.01	**Parameter 0.11 set-up**
11.02	**Parameter 0.12 set-up**
11.03	**Parameter 0.13 set-up**
11.04	**Parameter 0.14 set-up**
11.05	**Parameter 0.15 set-up**
11.06	**Parameter 0.16 set-up**
11.07	**Parameter 0.17 set-up**
11.08	**Parameter 0.18 set-up**
11.09	**Parameter 0.19 set-up**
11.10	**Parameter 0.20 set-up**
11.11	**Parameter 0.21 set-up**
11.12	**Parameter 0.22 set-up**
11.13	**Parameter 0.23 set-up**
11.14	**Parameter 0.24 set-up**
11.15	**Parameter 0.25 set-up**
11.16	**Parameter 0.26 set-up**
11.17	**Parameter 0.27 set-up**
11.18	**Parameter 0.28 set-up**
11.19	**Parameter 0.29 set-up**
11.20	**Parameter 0.30 set-up**

Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **1.00** to Pr **21.51**															
Default	See Table 5-11															
Update rate	Background read															

These parameters define the parameters that reside in the programmable area in menu 0. The default settings are given in the table below.

Table 5-11 Default settings:

Parameter	Menu 0	Default setting
Pr **11.01**	Pr **0.11**	Pr **3.29**
Pr **11.02**	Pr **0.12**	Pr **4.01**
Pr **11.03**	Pr **0.13**	Pr **7.07**
Pr **11.04**	Pr **0.14**	Pr **4.11**
Pr **11.05**	Pr **0.15**	Pr **2.04**
Pr **11.06**	Pr **0.16**	Pr **2.02**
Pr **11.07**	Pr **0.17**	Pr **4.12**
Pr **11.08**	Pr **0.18**	Pr **8.29**
Pr **11.09**	Pr **0.19**	Pr **7.11**
Pr **11.10**	Pr **0.20**	Pr **7.14**
Pr **11.11**	Pr **0.21**	Pr **7.15**
Pr **11.12**	Pr **0.22**	Pr **1.10**
Pr **11.13**	Pr **0.23**	Pr **1.05**
Pr **11.14**	Pr **0.24**	Pr **1.21**
Pr **11.15**	Pr **0.25**	Pr **1.22**
Pr **11.16**	Pr **0.26**	Pr **3.08**
Pr **11.17**	Pr **0.27**	Pr **3.34**
Pr **11.18**	Pr **0.28**	Pr **6.13**
Pr **11.19**	Pr **0.29**	Pr **11.36**
Pr **11.20**	Pr **0.30**	Pr **11.42**

11.21	**Parameter 0.30 scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 9.999															
Default	1.000															
Update rate	Background read															

This parameter may be used to scale the value of Pr **0.30** seen via the LED keypad (not via serial comms). Any parameter routed to Pr **0.30** may be scaled. Scaling is only applied in the status and view modes. If the parameter is edited via the keypad it reverts to its un-scaled value during editing.

11.22	**Parameter displayed at power-up**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **0.59**															
Default	Pr **0.10**															
Update rate	Background read															

This parameter defines which menu 0 parameter is displayed on power-up.

11.23	**Serial address**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	00 to 247															
Default	1															
Update rate	Background read															

Used to define the unique address for the drive for the serial interface. The drive is always a slave.

ANSI

When the ANSI protocol is used the first digit is the group and the second digit is the address within a group. The maximum permitted group number is 9 and the maximum permitted address within a group is 9. Therefore, Pr **11.23** is limited to 99 in this mode. The value 00 is used to globally address all slaves on the system, and x0 is used to address all slaves of group x, therefore these addresses should not be set in this parameter.

Modbus RTU

When the Modbus RTU protocol is used addresses between 0 and 247 are permitted. Address 0 is used to globally address all slaves, and so this address should not be set in this parameter.

11.24	**Serial mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 2															
Default	1															
Update rate	Background read															

This parameter defines the communications protocol used by the 485 comms port on the drive. This parameter can be changed via the drive keypad, via a Solutions Module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original protocol. The master should wait at least 20 ms before sending a new message using the new protocol. (Note: ANSI uses 7 data bits, 1 stop bit and even parity; Modbus RTU uses 8 data bits, 2 stops bits and no parity.)

Parameter value	String	Comms mode
0	AnSI	ANSIx3.28 protocol
1	rtU	Modbus RTU protocol
2	Lcd	Modbus RTU protocol, but only with an LCD keypad

ANSIx3.28 protocol

Full details of the CT implementation of ANSIx3.28 are given in Chapter 6 *Serial communications protocol* on page 210.

Modbus RTU protocol

Full details of the CT implementation of Modbus RTU are given in Chapter 6 *Serial communications protocol* on page 210.

The protocol provides the following facilities:

- Drive parameter access with basic Modbus RTU
- The protocol supports access to 32 bit floating point parameters

The following product specific limitations apply:

- Maximum slave response time when accessing the drive is 100 ms
- Maximum number of 16 bit registers that can be written to, or read from, the drive itself is limited to 16
- Maximum number of 16 bit registers that can be written to, or read from, a Solutions Module or via a Solutions Module - see Solutions Module User Guide
- The communications buffer can hold a maximum of 128 bytes

Modbus RTU protocol, but with SM-Keypad Plus only

This setting is used for disabling comms access when the SM-Keypad Plus is used as a hardware key. See the *SM-Keypad Plus User Guide* for more information.

11.25	Baud rate															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 9															
Default	6															
Update rate	Background read															

Used in all comms modes to define the baud rate.

Parameter value	String/baud rate
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	38400
8*	57600
9*	115200

*Modbus RTU only

This parameter can be changed via the drive keypad, via a Solutions Module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original baud rate. The master should wait at least 20 ms before sending a new message using the new baud rate.

11.26	Minimum comms transmit delay															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 250 ms															
Default	2															
Update rate	Background read															

There will always be a finite delay between the end of a message from the host (master) and the time at which the host is ready to receive the response from the drive (slave). The drive does not respond until at least 1ms after the message has been received from the host allowing 1ms for the host to change from transmit to receive mode. This initial delay can be extended using Pr **11.26** if required for both ANSI and Modbus RTU protocols.

Pr 11.26	Action
0	The transmit buffers are turned on and data transmission begins immediately after the initial delay (≥ 1 ms)
1	The transmit buffers are turned on after the initial delay (≥ 1 ms) and data transmission begins after 1ms.
2 or more	The transmit buffers are turned on after the initial delay (≥ 1 ms) a delay of at least the time specified in Pr **11.26** and data transmission begins 1 ms later.

Note that the drive holds its own transmitters active for up to 1ms after it has transmitted data before switching to the receive mode, the host should not send any data during this time.

Modbus RTU uses a silent period detection system to detect the end of a message. This silent period is either the length of time for 3.5 characters at the present baud rate or the length of time set in Pr **11.26**, whichever is the longest.

11.28	**Drive derivative**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 16															
Update rate	Write at power-up															

If this parameter is zero the drive is a standard product. If this parameter is non-zero then the product is a derivative product. Derivatives can have different defaults from the standard product and restrictions on the values allowed for some parameters.

11.29	**Software version**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1			1	
Range	1.00 to 99.99															
Update rate	Write at power-up															

The drive software version consists of three numbers xx.yy.zz. Pr **11.29** displays xx.yy and zz is displayed in Pr **11.34**. Where xx specifies a change that affects hardware compatibility, yy specifies a change that affects product documentation, and zz specifies a change that does not affect the product documentation.

11.30	**User security code**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1		1	1	1
Range	0 to 999															
Default	0															
Update rate	Background read															

If any number other than 0 is programmed into this parameter user security is applied so that no parameters except Pr **11.44** can be adjusted with the LED keypad. When this parameter is read via an LED keypad and security is locked it appears as zero. The security code can be modified via serial comms etc. by setting this parameter to the required value, setting Pr **11.44** to 2 and initiating a reset by setting Pr **10.38** to 100. However security can only be cleared via the LED keypad.

11.31	**User drive mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1			1		1		1			1	
Default	3 (Servo)															
Update rate	Background read															

The value of this parameter is fixed at 3. This is a read only parameter.

11.32	**Maximum rated current**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1			1	
Range	0.00 to 9999.99 A															
Update rate	Write at power-up															

See section 5.6 *Menu 4: Torque and current control* on page 68 for more details.

11.33	**Drive voltage rating**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1			1		1		1			1	
Range	0 (200) to 1 (400)															
Update rate	Write at power-up															

This parameter has two possible values (200 or 400) and indicates the voltage rating of the drive.

11.34	**Software sub-version**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 99															
Update rate	Write at power-up															

The drive software version consists of three numbers xx.yy.zz. Pr **11.29** displays xx.yy and zz is displayed in Pr **11.34**. Where xx specifies a change that affects hardware compatibility, yy specifies a change that affects product documentation, and zz specifies a change that does not affect the product documentation.

11.35	**Number of modules**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
												1	1	1	1	
Range	0 to 10															
Default	0															
Update rate	Background read															

This parameter is not used on Digitax ST and its value is fixed at 0.

11.36	**SMARTCARD parameter data previously loaded**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1		1	1		1	
Range	0 to 999															
Default	0															
Update rate	Background write															

This parameter shows the number of the data block last parameter or difference from default data block transferred from a SMARTCARD to the drive.

11.37	**SMARTCARD data number**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1	1	
Range	0 to 1003															
Default	0															
Update rate	Background read															

Data blocks are stored on a SMARTCARD with header information including a number to identify the block .The header information also includes the type of data stored in the block (i.e. the file type), the drive mode if this is parameter or difference from default data, the version number and a checksum. This data can be viewed through Pr **11.38** to Pr **11.40** by increasing or decreasing Pr **11.37**. This parameter jumps between the data numbers of the data blocks present on the card. If this parameter is increased above the highest data block on the card it can have the special values given below:

1000 - shows the space left on the card for data blocks in 16 byte pages

1001 - shows the total space available on the card for data blocks in 16 byte pages

1002 - shows the state of the read-only (bit 0) and warning suppression flags (bit 1)

1003 - shows the product identifier

It should be noted that 16 bytes are reserved at the beginning and the end of the card that cannot be used to hold data. Therefore a 4096 byte card has 4064 bytes (254 x 16 byte pages) available to hold data. Compatible cards from 4 kB to 512 kB may be used with the drive. The first 16 bytes on the card hold the card header information including the read-only flag, which can be set to make the whole card read-only, and the warning suppression flag, which can be set to prevent C.rtg and C.Optn trips when data is transferred to the drive from a card. The card header also contains the product identifier which is described later.

The actions of erasing a card, erasing a file, creating a new file, changing a menu 0 parameter, or inserting a new card will set Pr **11.37** to 0.

Various SMARTCARD actions can be initiated via Pr **x.00** or the copying (Pr **11.42**) and resetting the drive as given in the table below:

Code	Action
Pr **x.00** = 2001	Transfer drive parameters as difference from defaults to a bootable SMARTCARD block with block number 1. (This will clear data block 1 on the card if it already exists.)
Pr **x.00** = 3yyy	Transfer drive parameters to a SMARTCARD block number yyy as a parameter file
Pr **x.00**= 4yyy	Transfer drive data to a SMARTCARD block number yyy as difference from defaults file
Pr **x.00** = 5yyy	Transfer drive user program to SMARTCARD block number yyy
Pr **x.00** = 6yyy	Transfer SMARTCARD data block yyy to the drive
Pr **x.00** = 7yyy	Erase SMARTCARD data block yyy
Pr **x.00** = 8yyy	Compare drive parameters with block yyy
Pr **x.00**= 9555	Clear SMARTCARD warning suppression flag
Pr **x.00** = 9666	Set SMARTCARD warning suppression flag
Pr **x.00** = 9777	Clear SMARTCARD read-only flag
Pr **x.00** = 9888	Set SMARTCARD read-only flag
Pr **x.00**= 9999	Erase SMARTCARD
Pr **x.00** = 15yyy	Transfer the user program in the applications module in slot 1 to data block number yyy on a SMARTCARD
Pr **x.00** = 16yyy	Transfer the user program in the applications module in slot 2 to data block number yyy on a SMARTCARD
Pr **x.00** = 17yyy	Transfer the user program in the applications module in slot 3 to data block number yyy on a SMARTCARD
Pr **x.00** = 18yyy	Transfer a user program in data block number yyy on a SMARTCARD to the applications module in slot 1
Pr **x.00** = 19yyy	Transfer a user program in data block number yyy on a SMARTCARD to the applications module in slot 2
Pr **x.00** = 20yyy	Transfer a user program in data block number yyy on a SMARTCARD to the applications module in slot 3
Pr **11.42** = Read	Transfer SMARTCARD data block 1 to the drive provided it is a parameter file
Pr **11.42** = Prog	Transfer drive parameters to a SMARTCARD block number one as a parameter file
Pr **11.42** = Auto Pr **11.42** = boot	Transfer drive parameters to a SMARTCARD block with data block number 1 as a parameter file provided Pr **11.42** has been changed since power-up.

The data, and the format of the data, is different depending on the method used to store it on a SMARTCARD. The different formats are described below. In addition to data transfers a compare function is provided.

If 8yyy is entered in Pr **x.00** and the drive is reset data block yyy on the SMARTCARD is compared with the data in the drive. If the compare is successful Pr **x.00** is simply set to 0. If the compare fails a trip is initiated and Pr **x.00** is not cleared. This function can be used with all data block types except the option type (18) and Opt.Prg (19) type of data blocks.

Parameter file type data block

This type of data block is created when 3xxx in Pr **x.00**, the copying parameter (Pr **11.42**) or auto/boot mode is used to initiate the transfer. The data block (referred to as a parameter file) contains the complete data from all user save (US) parameters except those with the NC coding bit set. Parameter RAM is used as the source of this information. Power-down save (PS) are not saved to the SMARTCARD. When the data is transferred back to a drive, it is transferred to the drive RAM and then the drive EEPROM. A parameter save is not required to retain the data after power-down. Before the data is taken from the card, defaults are loaded in the destination drive using the same default code as was last used in the source drive.

Difference from defaults type data block

This type of data block is created when 4xxx in Pr **x.00** is used to initiate the transfer. This data block format (referred to a difference from defaults file) transfer parameters with the following attributes: NC=0 (copyable) and US=1 (user save), and menu 20 parameters except Pr **20.00** if they are different from their default value. If a parameter is user save (US), but has no default (ND) it is saved on the card whatever its value.

It is possible to transfer parameters between drives with each of the software version dependant formats, however, the data block compare function does not work with data produced by the different formats.

The data density is not as high as a parameter file type data block, but in most cases the number of differences from default is small and the data blocks are therefore smaller. This method can be used, for example, for creating drive macros. Parameter RAM is used as the source of this information.

When the data is transferred back to a drive, using 6yyy in Pr **x.00**, it is transferred to the drive RAM and then to the drive EEPROM. A parameter save is not required to retain the data after power-down.

Onboard Application Lite user program data blocks

This type of data block is created when 5xxx in Pr **x.00** is used to initiate the transfer. The Onboard Application Lite user program from a drive may be transferred to/from internal flash memory from/to a SMARTCARD. If the user program is transferred from a drive with no program loaded the block is still created on the card, but contains no data. If this is then transferred to a drive the drive will then have no user program.

Option type data block

This type of data block is created by an applications module and contains user defined data.

Option program (Opt.Prg) type data block

This type of data block contains a user program from an applications module. Data transfers to copy data to and from a SMARTCARD in this format are initiated with values from 15yyy to 20yyy in Pr **x.00**. If the action is not possible because there is no applications category module in the requested slot then Pr **x.00** remains at the value set by the user. If the action is not possible for any other reason a C.SLx trip is produced where x is the slot number. The possible reasons are:

1. The data block to be read from the card does not exist or the data block is of the wrong type.
2. The data block to be written to the card already exists. Either the data block to be written to the card already exists or the program in the module is identical to that on the SMARTCARD.
3. A failure has occurred within the Solutions Module and it has stopped the transfer process.
4. The data block written to the SMARTCARD is not clonable. Allow cloning within CTSoft and SyPTPro.

When transferring data between drives the following should be noted:

Parameter transfer failure

When parameter or default difference data is transferred to the drive the parameters are automatically saved to drive EEPROM. If the transfer from the card fails for any reason the drive produces the appropriate trip. If the failure occurs after the transfer has begun, it is possible that some, but not all the parameters will have been updated with the card data. However, if the transfer fails the parameters are not saved to drive EEPROM, therefore only the RAM values will be incorrect. If the drive is powered down and then powered up again the original drive parameters will be restored.

Read-only function

Data blocks with numbers from 1 to 499 can be created or erased by the user. Data block with numbers 500 and above are read-only and cannot be created or erased by the user. The whole card may also be protected from writing or erasing by setting the read-only flag. If the card or a data block on the card is read-only, then the operation to erase the whole card is disabled.

Different voltage ratings

If the voltage rating of the source and destination drive are different then the parameters are transferred with the exception of rating dependent parameters (RA attribute set, see table below), which are left at their default values. In this case a C.rtg trip is given as a warning that this has happened. It is possible to suppress this warning trip for any data transfer to the drive, including a boot transfer at power-up by setting the warning suppression flag for the whole card.

Parameter number	Function
Pr **2.08**	Standard ramp voltage
Pr **3.05**	Regen unit voltage set point
Pr **4.05** - Pr **4.07**, Pr **21.27**- Pr **21.29**	Current limits
Pr **4.24**	User current maximum scaling
Pr **5.07**, Pr **21.07**	Motor rated current
Pr **5.09**, Pr **21.09**	Motor rated voltage
Pr **5.10**, Pr **21.10**	Rated power factor
Pr **5.17**, Pr **21.12**	Stator resistance
Pr **5.18**	Switching frequency
Pr **5.24**, Pr **21.14**	Transient inductance
Pr **5.25**, Pr **21.24**	Stator inductance
Pr **6.48**	Mains loss ride through detection level

Different Solutions Modules installed

If the categories of the Solutions Modules installed to the source drive are different to the destination drive then the parameters are transferred with the exception of the parameters in the menus of the modules that are different. These parameters are left at their default values. In this case a C.Optn trip is given as a warning. It is possible to suppress this warning trip for any data transfer to the drive, including a boot transfer at power-up by setting the warning suppression flag for the whole card.

Different current rating with a parameter file type data block

If the current ratings of the source and destination drive are different and the parameters stored as a parameter file (not differences from default) then rating dependant parameters are set to their defaults and a C.rtg trip is produced as described above where the voltage ratings are different. It is possible to suppress this warning trip for any data transfer to the drive, including a boot transfer at power-up by setting the warning suppression flag for the whole card.

Different current rating with difference from defaults type data block

If the current ratings of the source and destination drives are different, but the parameters are stored as a difference from defaults file, the rating dependant parameters are transferred from the card to the drive and the appropriate maximums are applied. The C.rtg is still produced unless it is suppressed. To ensure that the performance of the destination drive is similar to that of the source drive, the speed controller gains and current controller gains are scaled as shown in the table below. Note that the gain scaling is only applied when the data block number is less than 500.

Gains	Scaling applied
Speed controller gains	x Source Pr **11.32** / Destination Pr **11.32**
Current controller gains	x Destination Pr **11.32** / Source Pr **11.32**

Effects of variable maximums if ratings or options are different

It should be noted that if ratings of the source and destination drives are different, or the Solutions Modules installed to the source and destination drives are different, it is possible that some parameters with variable maximums may be limited and not have the same values as on the card. For example the user current maximum scaling (Pr **4.24**) is rating dependent and could be set to its default value when it is transferred between drives of different ratings, but this could also affect the torque reference (Pr **4.08**) as this uses Pr **4.24** as its maximum. Also different position feedback Solutions Modules can apply different limits on the speed references, therefore these can be affected when parameters are transferred between drives with different position feedback Solutions Modules installed where the Solutions Module is being used for the drive position feedback.

Product identifier

When a SMARTCARD is used with Digitax ST it must have the correct product identifier in the card header to give full functionality with the drive. The product identifier is written to the card. When the whole card is erased for Digitax ST the product identifier is set to 2.

Product	Product identifier
Unidrive SP	**255**
Commander GP20	**1**
Digitax ST	**2**
Affinity	**3**
Mentor MP	**4**

If the identifier does not match the drive product and the card contains any data blocks a C.Prod trip is produced. Also if the following functions are initiated a C.Acc trip is produced and the card or drive data is not affected: erase file, transfer data block from card to drive, or transfer data block from drive to card. It is still possible to use Pr **11.37** to browse information about the whole card (i.e. Pr **11.37** = 1000 to 1003), but it is not possible to see the data block information (i.e. Pr **11.37** < 1000). It is also possible to change the card header information (i.e. read-only flag and warning suppression flag). This feature allows the read-only flag to be cleared so that a card can be erased to be used with the product that performs the card erase.

If the card does not contain any data blocks (i.e. an erased card) and the identifier does not match that of the drive then the drive will automatically change the identifier on the card to match when it is first inserted.

11.38	**SMARTCARD data type/mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1			1		1		1			1	
Range	0 to 18															
Update rate	Background write															

Gives the type/mode of the data block selected with Pr **11.37** as shown below.

Pr 11.38	String	Type/mode
0	FrEE	Value when Pr **11.37** = 0
1		Reserved
2		Reserved
3		Reserved
4	3SErVO	Servo mode parameter file
5		Reserved
6-8	3Un	Unused
9		Reserved
10		Reserved
11		Reserved
12		Reserved
13		Reserved
14-16	4Un	Unused
17	LAddEr	Onboard Application Lite user program file
18	Option	A file containing user defined data (normally created by an SM-Applications Solutions Module)
19	Opt.Prg	Applications module user program

11.39	SMARTCARD data version															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1	1	
Range	0 to 9,999															
Default	0															
Update rate	Background read/write															

Gives the version number of the data block. This is intended to be used when data blocks are used as drive macros. If a version number is to be stored with a data block this parameter should be set to the required version number before the data is transferred. Each time Pr **11.37** is changed by the user the drive puts the version number of the currently viewed data block in this parameter.

11.40	SMARTCARD data checksum															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 65,335															
Update rate	Background write															

Gives the checksum of the data block, space left on the card, the total space on the card for the card flags see Pr **11.37** for details.

11.41	Status mode time-out															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 250 s															
Default	240															
Update rate	Background read															

Sets the timeout for the drive display to revert to status mode from edit mode following no key presses. Although this parameter can be set to less than 2 s, the minimum timeout is 2 s.

11.42	Parameter copying															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1					1			*	1	1	
Range	0 to 4															
Default	0															
Update rate	Background read															

* Modes 1 and 2 are not US (i.e. not saved when drive parameters are saved), mode 3 and 4 are US.

Therefore this parameter can only be saved to EEPROM if it has a value of 0, 3 or 4.

Reading (1)

Setting Pr **11.42** to 1 and resetting the drive will transfer the data from the card into the drive parameters and then the drive EEPROM, provided data block 1 exists and is a parameter file for the current drive mode. All SMARTCARD trips apply. When the action is complete this parameter is automatically reset to zero.

Programming (2)

Setting Pr **11.42** to 2 and resetting the drive will save the parameters to a card, i.e. equivalent to writing 3001 to Pr **x.00**. If the data block already exists it is automatically over-written. When the action is complete this parameter is automatically reset to zero.

Auto (3)

Changing Pr **11.42** to 3 and resetting the drive will save the complete parameter set from the drive parameters to the card, i.e. equivalent to writing 3001 to Pr **x.00**. If the data block already exists it is automatically overwritten. If the card is removed when Pr **11.42** is set to 3, Pr **11.42** will be set to 0. The action of setting Pr **11.42** to 0 when a card is removed forces the user to change Pr **11.42** back to 3 if auto mode is still required. The user will need to set Pr **11.42** to 3 and reset the drive to write the complete parameter set to the new card.

When a parameter in menu zero is changed via the keypad and a card is installed the parameter is saved both to the drive EEPROM and the card. Only the new value of the modified parameter is written to the EEPROM and the card. If Pr **11.42** was not cleared automatically when a card is removed, then when a new card is inserted that contains data block 1 the modified parameter would be written to the existing data block 1 on the new card and the rest of the parameters in this data block may not be the same as those in the drive.

When Pr **11.42** is equal to 3 and the parameters in the drive are saved, the card is also updated, therefore the card becomes a copy of the drive parameters. At power up, if Pr **11.42** is set to 3, the drive will save the complete parameter set to the card. This is done to ensure that if a card is inserted while the drive is powered down the new card will have the correct data after the drive is powered up again.

Boot (4)

When Pr **11.42** is set to 4 the drive operates in the same way as with Pr **11.42** set to 3 and automatically creates a copy of its parameters on a SMARTCARD. Pr **11.42** has the NC (not clonable) attribute, and so it does not have a value stored on a SMARTCARD in the normal way. However, when data is transferred to a card from the source drive the value of this parameter is held in the header of parameter or difference from default file type data blocks so that the destination drive can detect when boot transfer is required on power-up (i.e. the source drive had this parameter set to 4). If a card is present at power up, and it has Pr **11.42** stored as 4 in the header of a parameter file or difference from default file as data block 1 then the following actions are taken.

1. The parameters from data block 1 are transferred to the drive and then saved in drive EEPROM.
2. If data block 2 exists and it is an onboard user program (i.e type 17 LAddEr) the user program from this data block is transferred to the drive.
3. If the card contains application module user program data block (i.e. type 19 Opt.Prg) number 3 and an application module is present in slot 1 the drive will then attempt to initiate a transfer to the module. The same system is then applied to applications module data block with number 4 and 5 for the Solutions Modules in slots 2 and 3 respectively. If any of the transfers to the Solutions Modules fail no further Solutions Module transfers will be initiated and the drive will produce a C.SLx trip to indicate the failure.
4. Parameter Pr **11.42** is set to zero after the data transfer is complete.

It is possible to create a difference from default bootable file by setting parameter Pr **x.00** to 2001 and resetting the drive. This type of file causes the drive to behave in the same way at power-up as a file created with boot mode set up with Pr **11.42**. The difference from default file has the added advantage of including menu 20 parameters. A bootable difference from default file can only be created in one operation and parameters cannot be added as they are saved via menu zero.

When the drive is powered up it detects which Solutions Modules are installed before loading parameters from a SMARTCARD which has been set up for boot mode. If a new Solutions Module has been installed since the last time the drive was powered up, the drive produces a SLx.dF trip and then proceeds to transfer the parameters from the SMARTCARD. If the parameter data in the card includes the parameters for the newly installed Solutions Module then these are also transferred to the drive. Once the transfer is complete the drive parameters are automatically saved to the drive EEPROM. The SLx.dF trip can be reset either by resting the drive or powering down and then powering up again. Because the parameters are transferred to the drive after detecting the Solutions Modules it is possible to fit the required Solutions Modules to a drive (corresponding to the modules installed when the SMARTCARD data was stored) and transfer the parameters to the drive including those for the Solutions Modules.

11.43	**Load defaults**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1					1				1	1	
Range	0 to 2															
Default	0															
Update rate	Background read															

Setting this parameter to a non-zero value and resetting the drive loads defaults as follows. This parameter is automatically reset to zero when the action is complete.

Parameter value	Equivalent Pr x.00 value	Defaults loaded
1 (Eur)	1233	Normal defaults
2 (USA)	1244	US defaults

11.44	**Security status**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1			1				1	1	1	1	
Range	0 to 2															
Update rate	Background read															

This parameter controls access via the keypad as follows:

Value	String	Action
0	L1	Only menu 0 can be accessed
1	L2	All menus can be accessed
2	Loc	Lock user security when drive is reset. (This parameter is set to L1 after reset.)

The keypad can adjust this parameter even when user security is set.

11.45	Motor 2 parameters select															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

When this bit is set to one the motor 2 parameters in menu 21 become active instead of the equivalent parameters in other menus. Changes will only be implemented when the drive is disabled. When the motor 2 parameters are active the decimal point that is second from the right on the 1st row of the display is lit. If this parameter is one when an autotune is carried out (Pr **5.12** = 1), the results of the autotune are written to the equivalent second motor parameters instead of the normal parameters. Each time this parameter is changed the accumulator for motor thermal protection is reset to zero.

11.46	Defaults previously loaded															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
												1	1		1	
Range	0 to 2,000															
Default	Number of defaults loaded, i.e. 1,233 etc.															
Update rate	Background write															

Displays the number of the last set of defaults loaded, i.e. 1233, 1244, etc.

11.47	Drive Onboard Application Lite Ladder Program Enable															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 2															
Default	2															
Update rate	Background read															

This parameter is used to start and stop the Drive Onboard PLC program.

Value	Description
0	Halt the Drive Onboard Application Lite ladder Program.
1	Run the Drive Onboard Application Lite ladder Program (if installed). Any out-of-range parameter writes attempted will be clipped to the maximum / minimum values valid for that parameter before being written.
2	Run the Drive Onboard Application Lite ladder Program (if installed). Any out-of-range parameter writes attempted will cause a drive trip.

11.48	Drive Onboard PLC program status															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	-128 to +127															
Update rate	Background write															

The Drive Onboard Application Lite Ladder Program Status parameter indicates to the user the actual state of the Drive Onboard Application Lite Ladder Program (not installed / running / stopped / tripped).

Value	Description
-n	Onboard Application Lite Ladder Program caused a drive trip due to an error condition while running rung n. Note that the rung number is shown on the display as a negative number.
0	Onboard Application Lite Ladder Program is not installed.
1	Onboard Application Lite Ladder Program is installed but stopped.
2	Onboard Application Lite Ladder Program is installed and running.

11.49	**Drive Onboard Application Lite Ladder Programming Events**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	1
Range	0 to 65,535															
Update rate	Background write															

The Drive Onboard Application Lite Ladder Programming Events parameter holds the number of times a Onboard Application Lite Ladder program download has taken place and is 0 on dispatch from the factory. If the Drive Onboard Application Lite Ladder Programming Events is greater than the maximum value which may be represented by this parameter the value will be clipped to the maximum value. This parameter is not altered when defaults are loaded.

11.50	**Drive Onboard Application Lite Ladder Program Average Scan Time**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 65,535 ms															
Update rate	Onboard Application Lite Ladder program execution period															

This parameter is updated once per second or once per Onboard PLC program scan whichever is the longest. If more than one program scan occurs within the one second update period the parameter shows the average scan time. If the program scan time is longer than one second the parameter shows the time for the last program scan.

11.51	**Drive Onboard Application Lite Ladder Program first run**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Range	0 or 1															
Update rate	Onboard Application Lite Ladder program execution period															

The Drive Onboard Application Lite Ladder Program first run parameter is set for the duration of the first ladder diagram scan from the ladder diagram stopped state. This enables the user to perform any required initialization every time the ladder diagram is run. This parameter is set every time the ladder is stopped.

5.15 Menu 12: Threshold detectors, variable selectors and brake control function

Menu 12 includes two threshold detectors which produce logic signals depending on the level of a variable value with respect to a threshold, and two variable selectors which allow two input parameters to be selected or combined to produce a variable output. One menu 9 or one menu 12 function is executed every 4 ms. Therefore the sample time of these functions is 4 ms x number of menu 9 and 12 functions active. A function is active if one or more sources are routed to a valid parameter.

Figure 5-11 Menu 12 logic diagram

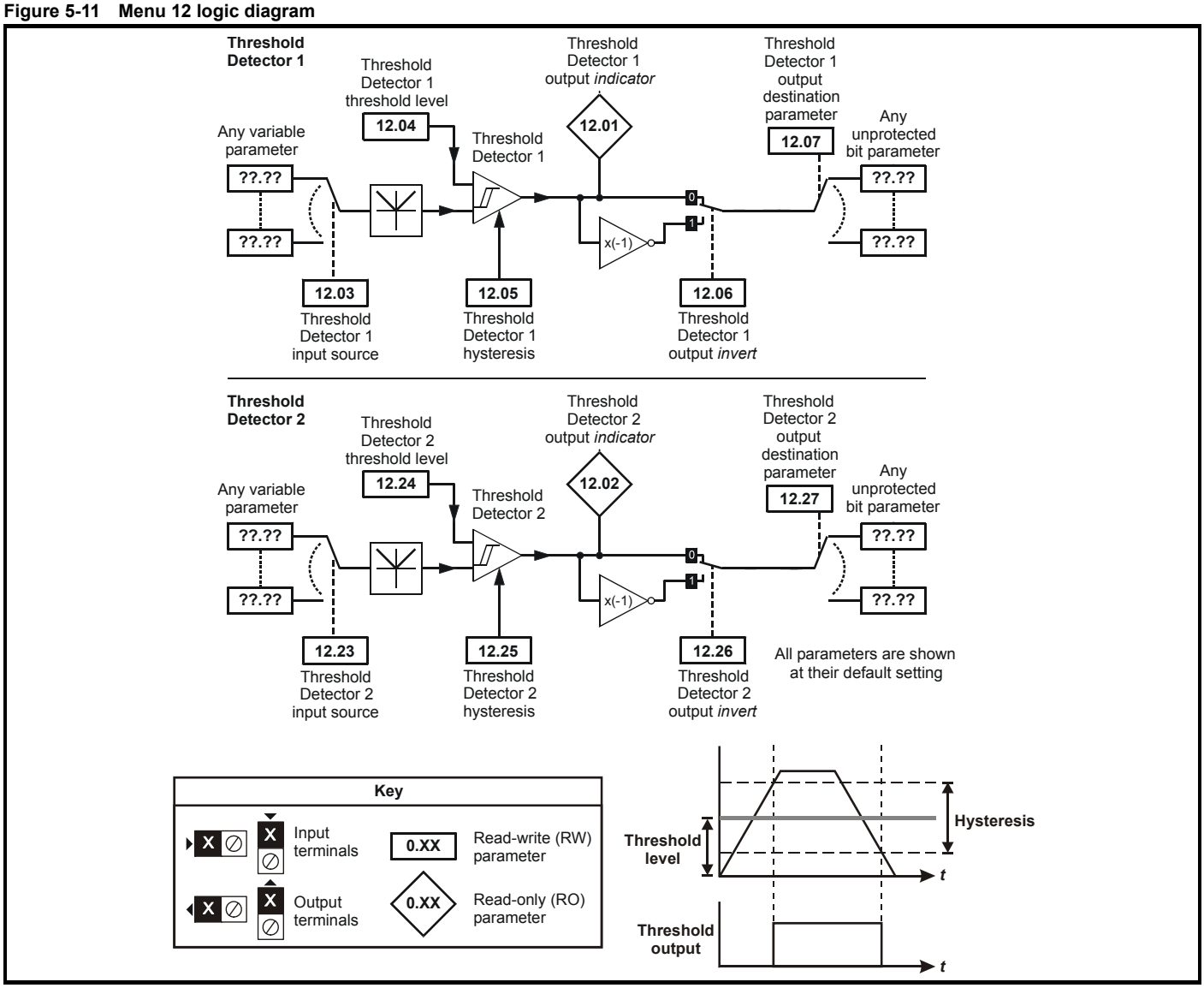
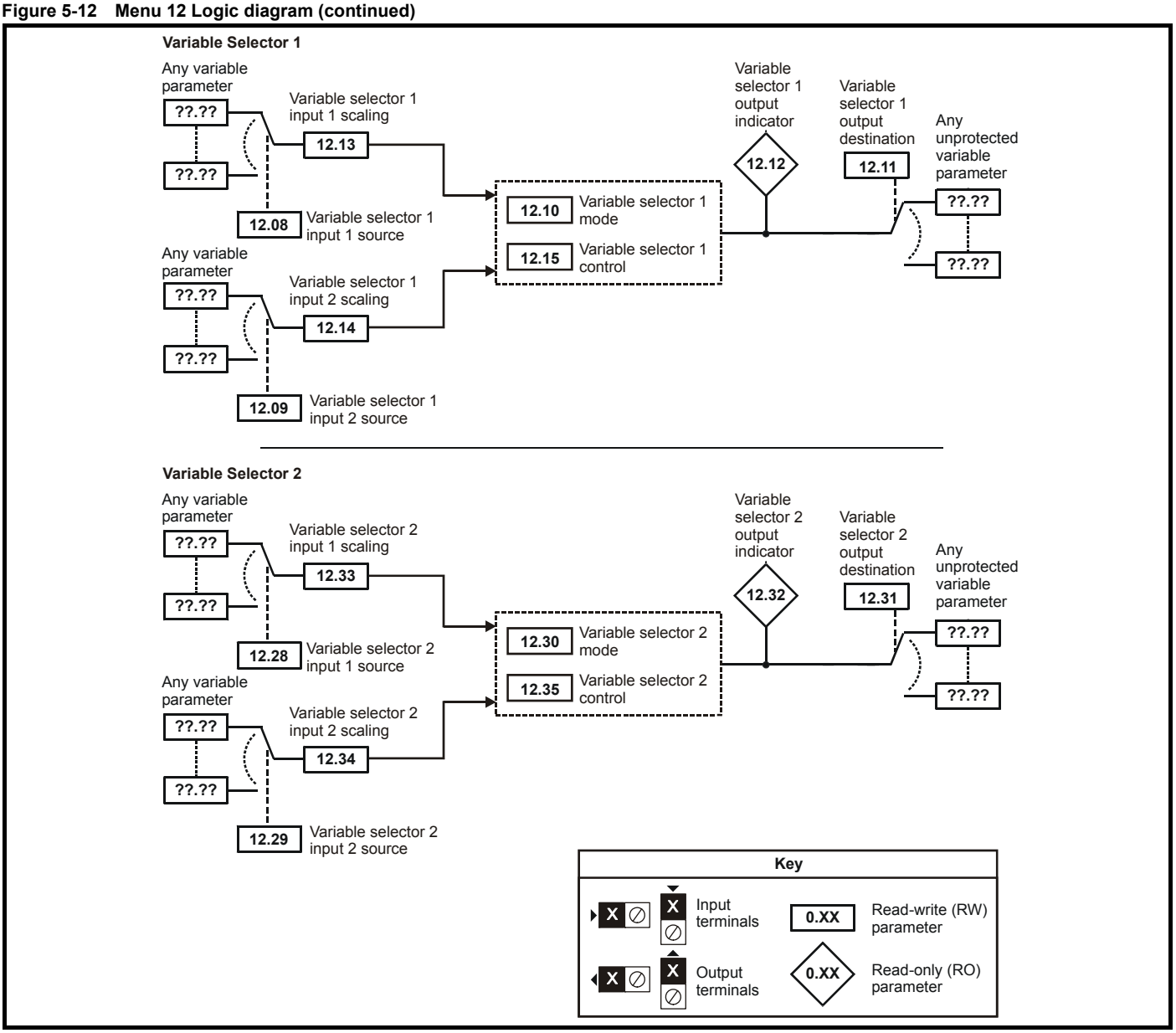


Figure 5-12 Menu 12 Logic diagram (continued)



12.01	**Threshold detector 1 output**															
12.02	**Threshold detector 2 output**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4ms x number of menu 9 or 12 functions active write															

12.03	**Threshold detector 1 source**															
12.23	**Threshold detector 2 source**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

12.04	**Threshold detector 1 level**															
12.24	**Threshold detector 2 level**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 100.00 %															
Default	0.00															
Update rate	4ms x number of menu 9 or 12 functions active read															

12.05	**Threshold detector 1 hysteresis**															
12.25	**Threshold detector 2 hysteresis**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 25.00 %															
Default	0.00															
Update rate	4ms x number of menu 9 or 12 functions active read															

12.06	**Threshold detector 1 output invert**															
12.26	**Threshold detector 2 output invert**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms x number of menu 9 or 12 functions active read															

12.07	**Threshold detector 1 destination**															
12.27	**Threshold detector 2 destination**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

The threshold detector compares the modulus of the source input value (defined by Pr **12.03**, Pr **12.23**), converted to a percentage of its maximum value, with the threshold level (Pr **12.04**, Pr **12.24**). If the value is greater or equal to the threshold plus half the hysteresis band (Pr **12.05**, Pr **12.25**) the output becomes active, or if the value is less than the threshold minus half the hysteresis band the output becomes inactive. The output may be inverted if required by setting the invert flag (Pr **12.06**, Pr **12.26**). The result is routed to the destination (defined by Pr **12.07**, Pr **12.27**).

12.08	**Variable selector 1 source 1**															
12.28	**Variable selector 2 source 1**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

12.09	**Variable selector 1 source 2**															
12.29	**Variable selector 2 source 2**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

12.10	**Variable selector 1 mode**															
12.30	**Variable selector 2 mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 11															
Default	0															
Update rate	4 ms x number of menu 9 or 12 functions active read															

12.11	**Variable selector 1 destination**															
12.31	**Variable selector 2 destination**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

12.12	**Variable selector 1 output**															
12.32	**Variable selector 2 output**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				
Range	±100.00 %															
Update rate	4 ms x number of menu 9 or 12 functions active write															

12.13	**Variable selector 1 source 1 scaling**															
12.33	**Variable selector 2 source 1 scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1		
Range	±4.000															
Default	1.000															
Update rate	4 ms x number of menu 9 or 12 functions active read															

12.14	**Variable selector 1 source 2 scaling**															
12.34	**Variable selector 2 source 2 scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1		
Range	±4.000															
Default	1.000															
Update rate	4 ms x number of menu 9 or 12 functions active read															

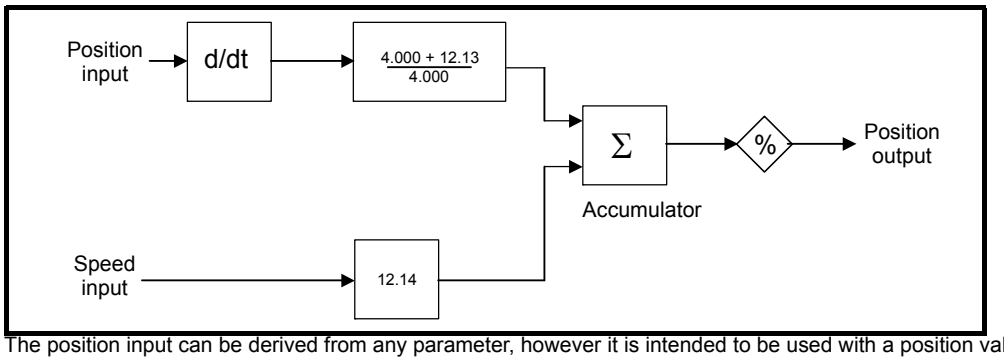
12.15	**Variable selector 1 control**															
12.35	**Variable selector 2 control**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 100.00															
Default	0.00															
Update rate	Background															

The variable selectors allow two source values (defined by Pr **12.08**, Pr **12.28** and Pr **12.09**, Pr **12.29**) to be combined as defined by the mode (Pr **12.10**, Pr **12.30**) to produce an output (Pr **12.12**, Pr **12.32**) which can be routed to the destination parameter (defined by Pr **12.11**, Pr **12.31**). The actions of the variable selector are defined by the mode parameter as given below. If the mode parameter is changed or the variable selector is disabled because neither source is routed to a valid parameter all the internal state variables (i.e. time constant accumulator, etc.) within the selector are reset. When the Sectional control mode is selected the function is also reset, and the output is held at zero, when the control (Pr **12.15** or Pr **12.35**) is zero. It is active when the control has a non-zero value.

Mode value	Action	Result
0	Select input 1	output = input1
1	Select input 2	output = input2
2	Add	output = input1 + input2
3	Subtract	output = input1 - input 2
4	Multiply	output = (input1 x input2) / 100.0
5	Divide	output = (input1 x 100.0) / input2
6	Time constant	output = input1 / ((control param)s + 1)
7	Linear ramp	output = input1 via a ramp with a ramp time of (control param) seconds from 0 to 100 %
8	Modulus	output = | input1 |
9	Powers	control = 0.02: output = $input1^2$ / 100.0 control = 0.03: output = $input1^3$ / 100.0^2 control has any other value: output = input1
10	Sectional control	control = 0.00: disabled, accumulator reset and output zero control <> 0.00: output as defined below
11	External rectifier monitor	See below.

Sectional control

The sectional control function is intended to apply scaling and a speed offset to a 16 bit position value to generate a new 16 bit position value. The output can be used as an input to the position controller (menu 13) or to generate an encoder simulation output via the SM-Universal Encoder Plus module. This function can be selected for either variable selector, but the description below relates to variable selector 1.



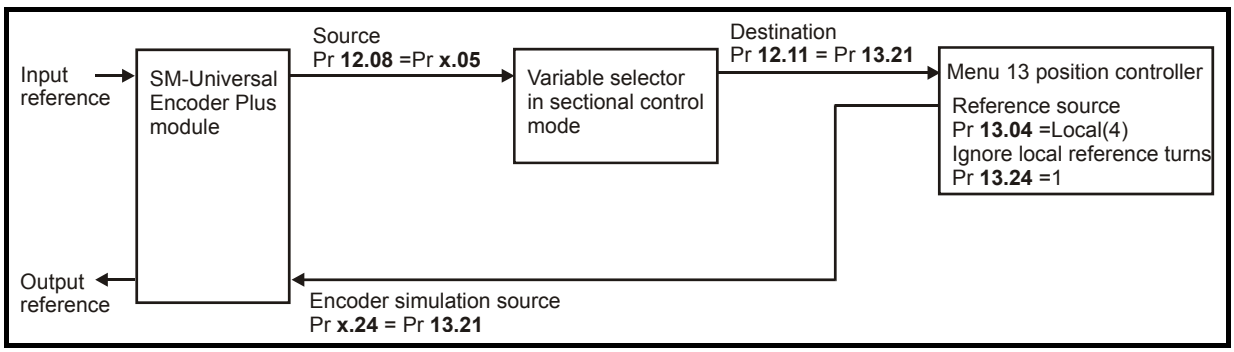
The position input can be derived from any parameter, however it is intended to be used with a position value that has a range from 0 to 65535. The input is scaled so that as Pr **12.13** is varied between -4.000 and 4.000 the proportion of the input position change added to the accumulator varies from 0.000 to 2.000 (the change of position input value is added without scaling if Pr **12.13** is 0.000). The remainder from the scaling division is stored and then added at the next sample to maintain an exact ratio between the position input and the position output, provided the speed input is zero. The controller only takes the change of position from the input source parameter, and not the absolute value, so that when the controller is first made active the output does not jump to the source position, but only moves with any changes of source position after that point in time.

The range of the output of the accumulator is 0.00 % and 100.00 %. Unlike other functions the value is not simply limited, but rolls under or over respectively. Although the output destination can be any parameter it is intended to be used with a position value that has a range from 0 to 65535.

The speed input defines a speed offset with a resolution of 0.1 rpm. Full scale of the source parameter corresponds to 1000.0 rpm. Scaling may be applied using Pr **12.14** to give a full scale value of 4000.0 rpm. The speed input is added to the accumulator to move the output position forwards or backwards with respect to the position input.

This sample time for this function is 4 ms x number of menu 9 and 12 functions active. Extending the sample time does not cause any overflow errors within the function, however, care must be taken to ensure that the input or output positions do not change by more than half a revolution within the sample time, i.e for a sample time of 4 ms the input or output speed should not exceed 7500 rpm, for a sample time of 8 ms the speed should not exceed 3750 rpm, etc. If the output of this function is to supply a reference to the position controller in menu 13 it must be the only user function in menu 9 or 12 enabled. **If another function is enabled the input to the position controller will only change every 8 ms (i.e. every 2 samples of the position controller) and the speed reference applied to the drive could be very noisy.**

The diagram below shows how the variable selector in Sectional control mode can be used to provide a position reference for the drive and act as a source for encoder simulation to give the position reference for the next drive in the system.



The input reference is provided by the previous drive in the system via the SM-Universal Encoder Plus module and is used as the position source (Pr **12.08**) for the variable selector. The destination of the variable selector is the local position reference for the menu 13 position controller (Pr **13.21**). Pr **13.21** counts up or down based on the delta position from the variable selector and rolls over or under at 65535 or 0. If the controller is set up to ignore the local reference turns then Pr **13.21** can be used as the position controller reference. If Pr **13.21** is also used as the encoder simulation source the local reference can also be used to give the reference for the next drive in the system. With this arrangement a ratio is provided between the input reference and output reference within the variable selector. An addition ratio can be provided within the position controller between the position in Pr **13.21** and the position reference used by the position controller. The variable selector speed reference can be used to move the position reference forwards or backwards with respect to the input reference.

11. External Rectifier (SPMC/U) Monitor

This mode is intended to monitor an external rectifier system (SPMC/U) to provide over temperature monitoring, phase loss detection and mains loss detection. The variable selector inputs should be routed to digital inputs on the drive or a Solutions Module, which are connected to the (SPMC/U) rectifier status outputs. The external rectifier monitor produces a number of actions depending on the state of the inputs as given in the table below. The ok state becomes active immediately both inputs are high, but the other states only become active when the required inputs have been active for at least 0.5 s. The high state is defined as a value greater than or equal to half the source maximum and the low state is defined as a value less than half the source maximum (with the scaling parameters set to 1.000). If digital inputs are used as the sources and the scaling parameters are 1.000, high is therefore defined as 1, and low is defined as 0. The variable selector output gives 0 % if the rectifier is ok otherwise it gives 100 %. The output should be routed to Pr **6.51** (rectifier not active) so that the drive is not allowed to leave the main loss condition if the rectifier is not fully phased forwards.

Input 1 (Pr **12.08,** Pr **12.28**)	Input 2 (Pr **12.09,** Pr **12.29**)	State	Trip	Output (Pr **12.12,** Pr **12.32**)
High	High	OK	None	0%
High	Low	Over temperature	Oht4.P trip*	100%
Low	High	Phase loss	PH.P trip*	100%
Low	Low	Mains Loss	None	100%

* For more information on Oht4.P and PH.P trips, and SPMC see *Unidrive SPM User Guide.*

5.15.1 Brake control function

The brake control function can be used to control an electro-mechanical brake via the drive digital I/O.

WARNING

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

WARNING

The control terminal relay can be selected as an output to release a brake. If a drive is set up in this manner and a drive replacement takes place, prior to programming the drive on initial power up, the brake may be released.
When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered. The use of a SMARTCARD in boot mode or an SM-Applications module can ensure drive parameters are immediately programmed to avoid this situation.

Figure 5-13 Brake function

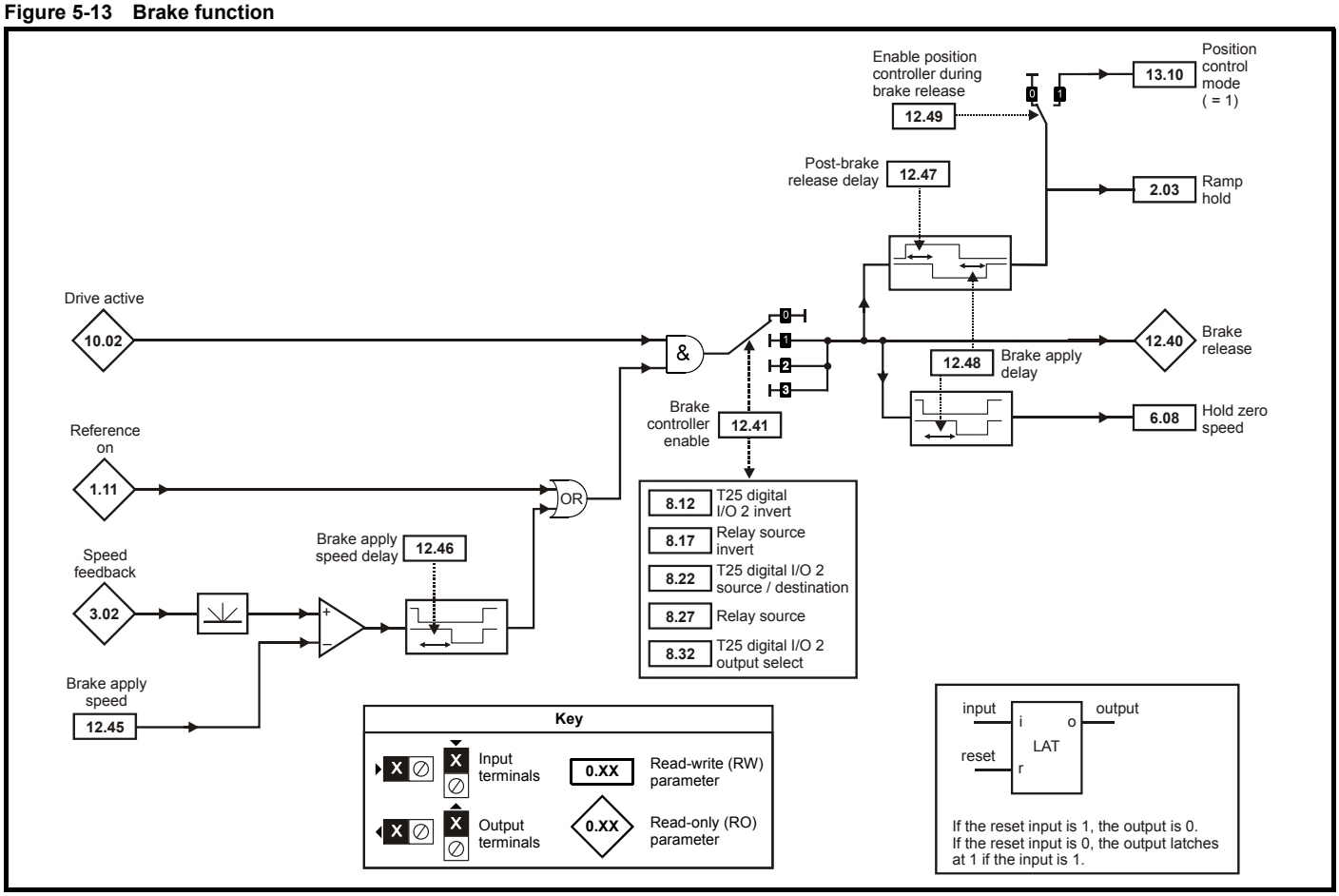
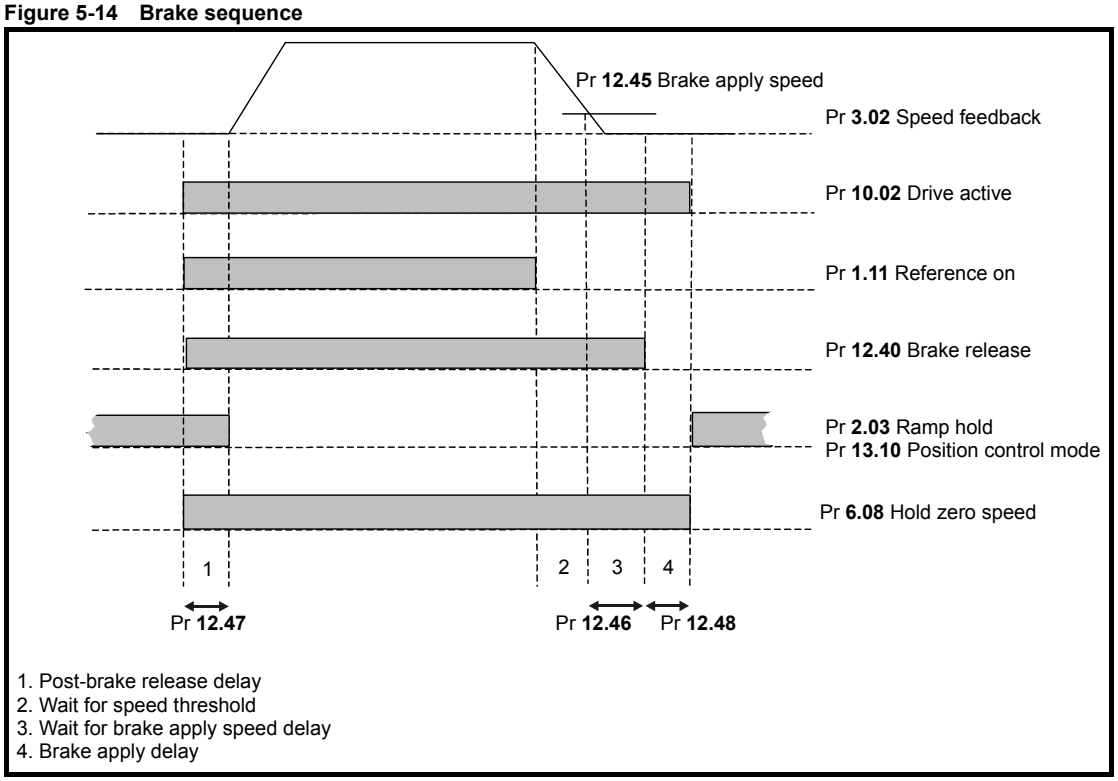


Figure 5-14 Brake sequence



1. Post-brake release delay
2. Wait for speed threshold
3. Wait for brake apply speed delay
4. Brake apply delay

12.40	Brake release															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Background read															

This parameter should be used as a source for a digital output to control an electro-mechanical brake. This parameter is one to release the brake and zero to apply the brake. Digital I/O can be automatically configured to use this parameter as a source (see Pr **12.41**).

12.41	Brake controller enable															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 3															
Default	0															
Update rate	Read on drive reset															

0 = dis

The brake controller is disabled and no other drive parameters are affected by the brake controller. When this parameter is changed from a non-zero value to zero the following parameters are set to zero: Pr **2.03**, Pr **6.08**, Pr **13.04**, Pr **13.10** and Pr **12.49** = 1.

1 = rel

The brake controller is enabled with I/O set up to control the brake via the relay output T41/42. Drive ok is re-routed to digital I/O 2 (T25).

2 = d IO

The brake controller is enabled with I/O set up to control the brake via digital I/O 2 (T25).

3 = User

The brake controller is enabled, but no parameters are set to select the brake output.

The following tables show the automatic parameter changes that occur to set up digital I/O2 (T25) and the relay output (T41/42) after drive reset when Pr **12.41** has been changed. The changes are done in two stages: the first stage restores the I/O used as defined by the initial setting of Pr **12.41** and the second stage sets up the I/O as defined by the new setting of Pr **12.41**.

Stage 1: Restore I/O

Initial setting in Pr 12.41	Pr 8.12 (Invert)	Pr 8.22 (Source / destination)	Pr 8.32 (Input/ output)	Pr 8.17 (Invert)	Pr 8.27 (Source)
0	No action				
1	0	Pr **10.33**	0	0	Pr **10.01**
2	0	Pr **10.33**	0	No action	
3	No action				

Stage 2: Set-up I/O

Initial setting in Pr 12.41	Pr 8.12 (Invert)	Pr 8.22 (Source / destination)	Pr 8.32 (Input/ output)	Pr 8.17 (Invert)	Pr 8.27 (Source)
0	No action				
1	0	Pr **10.01**	1	0	Pr **12.40**
2	0	Pr **12.40**	1	No action	
3	No action				

WARNING

The control terminal relay can be selected as an output to release a brake. If a drive is set up in this manner and a drive replacement takes place, prior to programming the drive on initial power up, the brake may be released.When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered. The use of a SMARTCARD in boot mode or an SM-Applications module can ensure drive parameters are immediately programmed to avoid this situation.

12.43	Low current threshold															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 200 %															
Default	10															
Update rate	Background read															

If the current magnitude falls below the lower current threshold the brake is applied immediately. The lower threshold should be set to the required level to detect the condition where the motor has been disconnected from the drive. If this parameter is set to zero the loss of current will not cause the brake to be applied. However, the flux detection and current threshold latch will be reset when the drive is disabled.

12.45	Brake apply speed															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 200 rpm															
Default	5															
Update rate	Background read															

When stopping, the drive reference can be removed (i.e. Pr **1.11** = 0), but the brake will remain energized (open) until the motor has remained at a speed below the brake apply speed for the delay defined by Pr **12.46**. The delay prevents rapid activation and de-activation of the brake when fine control of a motor is required close to zero speed.

12.46	Brake apply speed delay															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 25.0 s															
Default	1.0															
Update rate	Background read															

See Pr **12.45**.

12.47	**Post-brake release delay**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 25.0 s															
Default	1.0															
Update rate	Background read															

The post-brake release time is used to allow for the brake release time. From the time that the drive is enabled and then during this period the speed reference is held constant at zero, so that there is no sudden increase in motor speed when the brake actually releases.

12.48	**Brake-apply delay**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1		
Range	0.0 to 25.0 s															
Default	1.0															
Update rate	Background read															

The brake apply delay is used to allow for the brake application time. During this period the Hold zero speed parameter (Pr **6.08**) is one, and so the drive is enabled with zero speed reference. This ensures that the motor remains stationary while the brake is being applied.

12.49	**Enable position controller during brake release**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

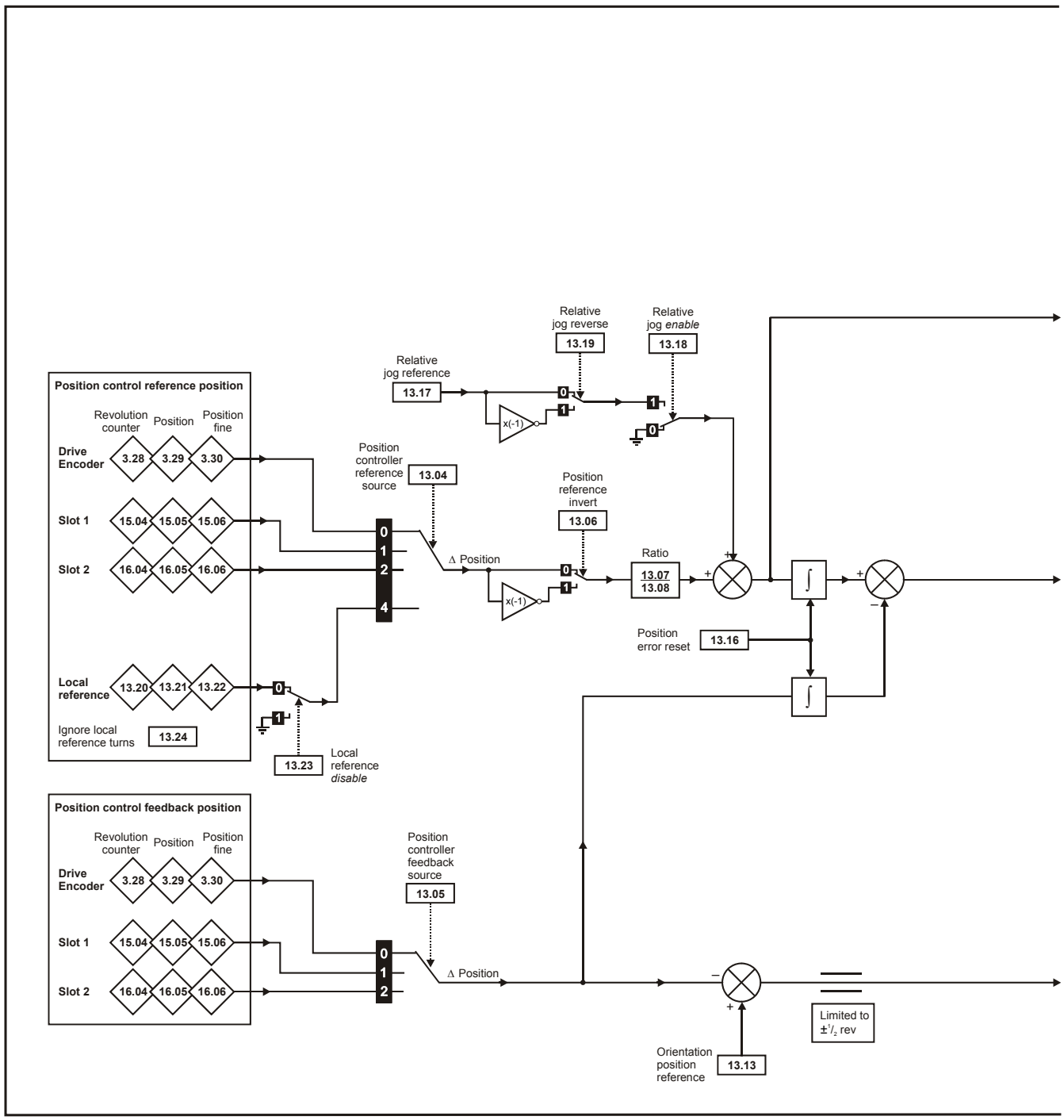
If this parameter is zero then ramp hold only is applied when the drive is not active and until the end of the post-brake release delay to ensure that the speed reference remains at zero until the brake has released. If this parameter is set to one the position controller (see menu 13) is also enabled (Pr **13.10** = 1) and the local position reference source is selected (Pr **13.04** = 4(LocAL)) during the period when ramp hold is active. Provided the default, non-absolute mode, is selected the position controller can help to limit the movement of the motor when the brake is released. When Pr **12.49** is changed from one to zero Pr **13.04** and Pr **13.10** are automatically set to zero.

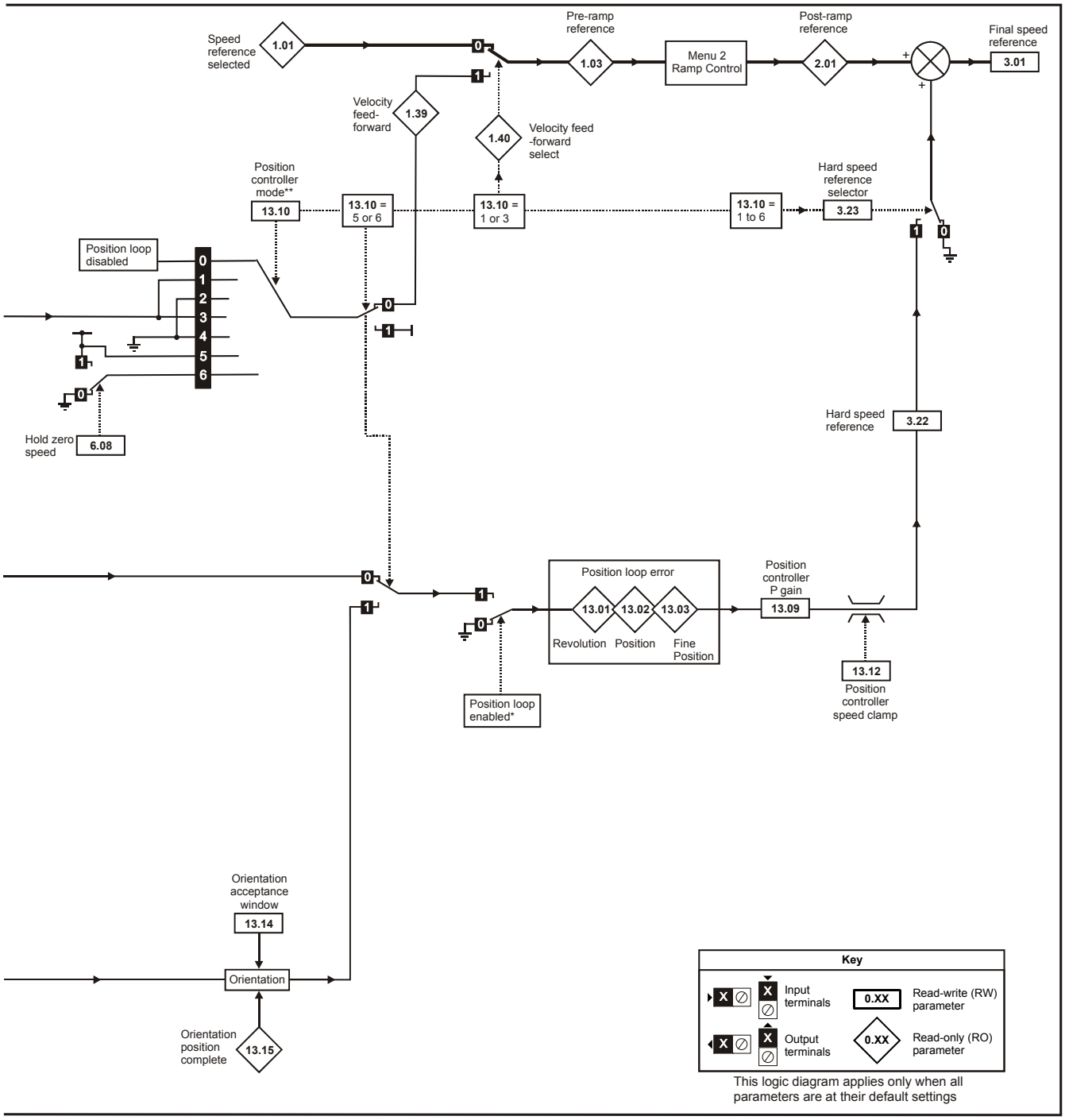
5.16 Menu 13: Position control

Menu 13 provides a position control system for the drive. The position reference can be taken from the drive encoder, from a position feedback module or from a local reference defined in this menu. The reference includes a relative jog function that can be used to advance or retard the position reference at a defined speed and a ratio that can scale the reference. The feedback position can be taken from the drive encoder or from a position feedback module. As well as giving position control the controller can provide shaft orientation within one revolution in conjunction with the drive sequencer (see section 5.8 *Menu 6: Sequencer and clock* on page 88). The sample time for the position controller is 4ms and the output is supplied to the speed reference every 4ms.

The position controller outputs are a velocity feed forward and a speed reference (both in 0.1 rpm units). When the position controller is selected (i.e. Pr **13.10** is non-zero) these values are written directly to the velocity feed forward (Pr **1.39**) and hard speed reference (Pr **3.22**) respectively. Also the hard speed reference select (Pr **3.23**) is forced to a one and the velocity feed forward select (Pr **1.40**) is set to one when a controller mode giving velocity feed forward is selected. When the position controller is de-selected (i.e. Pr **13.10** is changed to zero) Pr **1.39**, Pr **1.40**, Pr **3.22** and Pr **3.23** are set to zero.

Figure 5-15 Menu 13 Logic diagram





* The position controller is disabled and the error integrator is also reset under the following conditions:

1. If the drive is disabled (i.e. inhibited, ready or tripped)
2. If the position controller mode (Pr **13.10**) is changed. The position controller is disabled transiently to reset the error integrator.
3. The absolute mode parameter (Pr **13.11**) is changed. The position controller is disabled transiently to reset the error integrator.
4. One of the position sources is invalid.
5. The position feedback initialised parameter (Pr **3.48**) is zero.

13.01	Revolutions error															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	-32,768 to 32,767															
Update rate	4ms write															

13.02	Position error															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	-32,768 to 32,767															
Update rate	4ms write															

13.03	Fine position error															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1				
Range	-32,768 to 32,767															
Update rate	4ms write															

For normal position control the position changes from the reference and the feedback are accumulated in an integrator during each sample. The integrator is large enough to guarantee that the position controller will operate with a position error within the range -32,768 revolutions to +32,767 revolutions before rolling over. The position error is displayed in Pr **13.01**, Pr **13.02** and Pr **13.03**. Pr **13.01** shows the turns error, Pr **13.02** shows the error within a revolution in $1/2^{16}$ counts per revolution units and Pr **13.03** shows the fine position error in $1/2^{32}$ counts per revolution units. These values are both positive and negative and so they can be used to show the following error with different levels of resolution.

For orientation mode the error between the orientation position and the position feedback source is shown in Pr **13.02**.

13.04	Position controller reference source															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 4															
Default	0															
Update rate	Background read															

13.05	Position controller feedback source															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 3															
Default	0															
Update rate	Background read															

Source parameter	Source
0 (drv)	Drive encoder
1 (slot1)	Slot 1
2 (slot2)	Slot 2
3 (slot3)	Slot 3
4 (locAI)	Local reference

The reference and feedback positions can be taken from the drive encoder or a position feedback Solutions Module in one of the Solutions Module slots. The reference can also be taken from the local reference parameters. If the reference and feedback sources are the same the position controller cannot be enabled. If a Solutions Module slot is selected as a source, but the module is not a position feedback category Solutions Module the position controller cannot be enabled. Orientation mode can always be enabled.

13.06	**Position reference invert**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

13.07	**Ratio numerator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	Background read															

13.08	**Ratio denominator**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 1.000															
Default	1.000															
Update rate	Background read															

An exact ratio can be applied to the position reference with these two parameters. The ratio cannot be changed when the drive is enabled without causing abrupt changes of position. Although it is possible to set up ratios with a high gain or even with a denominator of zero, the drive limits the resultant gain of the ratio block to 4.000.

13.09	**Position controller P gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 100.00 rads $^{-1}$/rad															
Default	25.00															
Update rate	Background read															

The gain of the position controller is controlled with this parameter. The standard units within the drive for position are in 2^{32} counts per revolution and the standard units for speed are 0.1 rpm, however the position controller gain is given in rads^{-1}/rad. These units are consistent with units such as mms^{-1}/mm or ms^{-1}/m often used for linear control applications. An error of 1 radian (10430 counts in the position error (Pr **13.02**)) gives a speed reference of 1rads^{-1} (9.5 rpm) when this gain is 1.00.

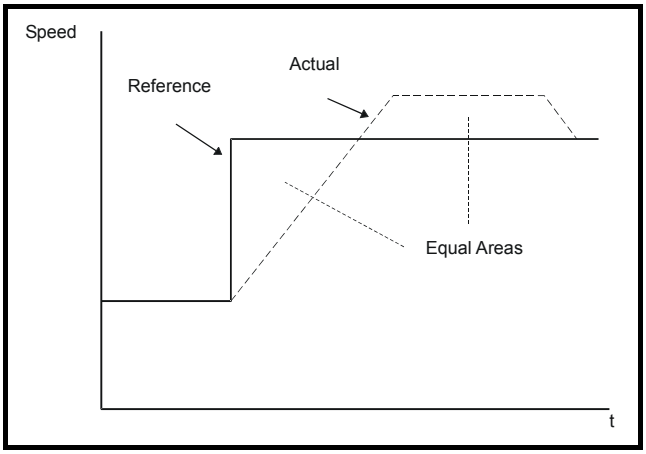
13.10	**Position controller mode**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 6															
Default	0															
Update rate	Background read															

This parameter is used to set the position controller mode as shown in the following table.

Parameter value	Mode	Feed forward active
0	Position controller disabled	
1	Rigid position control	✓
2	Rigid position control	
3	Non-rigid position control	✓
4	Non-rigid position control	
5	Orientation on stop	
6	Orientation on stop and when drive enabled	

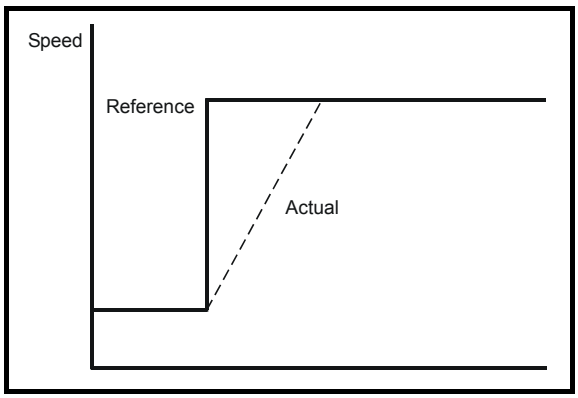
Rigid position control

In rigid position control the position error is always accumulated. This means that, if for example, 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.



Non-rigid position control

In non-rigid position control the position loop is only active when the 'At Speed' condition is met (see Pr **3.06** on page 53). This allows slippage to occur while the speed error is high. It may be necessary to increase the 'At Speed' window in Pr **3.06** and Pr **3.07** with some lower resolution feedback devices.



Velocity feed forward

The position controller can generate a velocity feed forward value from the speed of the reference encoder. The feed-forward value is passed to menu 1, and so ramps may be included if required. Because the position controller only has a proportional gain, it is necessary to use velocity feed-forward to prevent a constant position error that would be proportional to the speed of the reference position.

If for any reason the user wishes to provide the velocity feed forward from a source other than the reference position, the feed forward system can be made inactive, i.e. Pr **13.10** = 2 or 4. The external feed forward can be provided via Menu 1 from any of the speed references. However, if the feed forward level is not correct a constant position error will exist.

Relative jogging

If relative jogging is enabled the feedback position can be made to move relative to the reference position at the speed defined by Pr **13.17**.

Orientation

If Pr **13.10** is 5 the drive orientates the motor following a stop command. If hold zero speed is enabled (Pr **6.08** = 1) the drive remains in position control when orientation is complete and holds the orientation position. If hold zero speed is not enabled the drive is disabled when orientation is complete.

If Pr **13.10** is 6 the drive orientates the motor following a stop command and whenever the drive is enabled provided that hold zero speed is enabled (Pr **6.08** = 1). This ensures that the spindle is always held in the same position following the drive being enabled.

When orientating from a stop command the drive goes through the following sequence:

1. The motor is decelerated or accelerated to the speed limit programmed in Pr **13.12**, using ramps if these are enabled, in the direction the motor was previously running.
2. When the ramp output reaches the speed set in Pr **13.12**, ramps are disabled and the motor continues to rotate until the position is found to be close to the target position (i.e. within 1/32 of a revolution). At this point the speed demand is set to 0 and the position loop is closed.
3. When the position is within the window defined by Pr **13.14**, the orientation complete indication is given in Pr **13.15**.

The stop mode selected by Pr **6.01** has no effect if orientation is enabled.

Orientation is only possible with a suitable feedback device such as an absolute encoder (sincos encoder with communications or communications only encoder), incremental encoder with a marker pulse or a 2 pole resolver.

13.11	**Absolute mode enable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

When this parameter is set to one and the position controller mode (Pr **13.10**) is 1 or 2, the position error integrator is loaded with the absolute position error defined by the position sources when the position controller is disabled. (The position controller is disabled under the following conditions: when the drive is in the inhibit, ready or tripped states; either the reference or feedback position sources from Solutions Modules are invalid; the position feedback is not correctly initialized (Pr **3.48** = 0); the position control mode (Pr **13.10**) is changed; this parameter (Pr **13.11**) is changed; or the position error reset (Pr **13.16**) is set to one.) Therefore when this parameter is one the position controller operates on the absolute position from the reference and feedback. If the feedback device is not absolute then the absolute position is the change of position since the drive was powered-up.

When this parameter is zero or the position control mode is not 1 or 2 the error integrator is loaded with zero when the position controller is disabled therefore the position controller operates on the relative position changes of the reference and feedback from the point when the position controller is re-enabled.

It should be noted that the value of this parameter does not affect the operation of the marker reset for any position source. If the marker position reset disable (Pr **3.31** for the drive encoder, or similar for Solutions Modules) is zero, the position controller takes the position source including the effect of the marker. When a marker event occurs the position and fine position are reset to zero, but the turns are not affected. If the marker position reset disable is one then the marker events have no effect on the position source used by the position controller.

13.12	**Position controller speed clamp**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 250 rpm															
Default	150															
Update rate	Background read															

This parameter limits the velocity correction applied by the position controller. This value is also used as the reference during orientation.

13.13	**Orientation position reference**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 65,535															
Default	0															
Update rate	Background read															

13.14	**Orientation acceptance window**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 4,096															
Default	256															
Update rate	Background read															

13.15	**Orientation position complete**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	4ms write															

Pr **13.13** defines the position as a $1/2^{16}$ of a revolution for orientation. Pr **13.14** defines the position acceptance window either side of the position reference for orientation in $1/2^{16}$ of a revolution. When the position is within the window defined by Pr **13.14**, Pr **13.15** indicates orientation is complete.

13.16	Position error reset															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

The position error integrator is preset to the absolute error (Pr **13.10** is 1 or 2, and Pr **13.11** is one) otherwise it is set to zero when this parameter is set to one.

The position controller is disabled and the error integrator is also reset under the following conditions:

1. If the drive is disabled (i.e. inhibited, ready or tripped).
2. If the position controller mode (Pr **13.10**) is changed. The position controller is disabled transiently to reset the error integrator.
3. The absolute mode (Pr **13.11**) is changed. The position controller is disabled transiently to reset the error integrator.
4. One of the position sources is invalid.
5. The position feedback initialised (Pr **3.48**) is zero.

13.17	Relative jog reference															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 4,000.0rpm															
Default	0.0															
Update rate	Background read															

13.18	Relative jog enable															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

13.19	Relative jog reverse															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	Background read															

Relative jog can be used to move the feedback position relative to the reference position at a speed defined by Pr **13.17**.

13.20	Local reference turns															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1	1	
Range	0 to 65,535															
Default	0															
Update rate	4ms read															

13.21	Local reference position															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1	1	
Range	0 to 65,535															
Default	0															
Update rate	4ms read															

13.22	**Local reference fine position**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1	1	
Range	0 to 65,535															
Default	0															
Update rate	4ms read															

13.23	**Local reference disable**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

The local reference can be used to control the position of the motor shaft. If the local reference disable parameter is one the previously written value is used. This allows all three parts of the local reference position to be changed without data skew problems.

13.24	**Ignore local reference turns**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

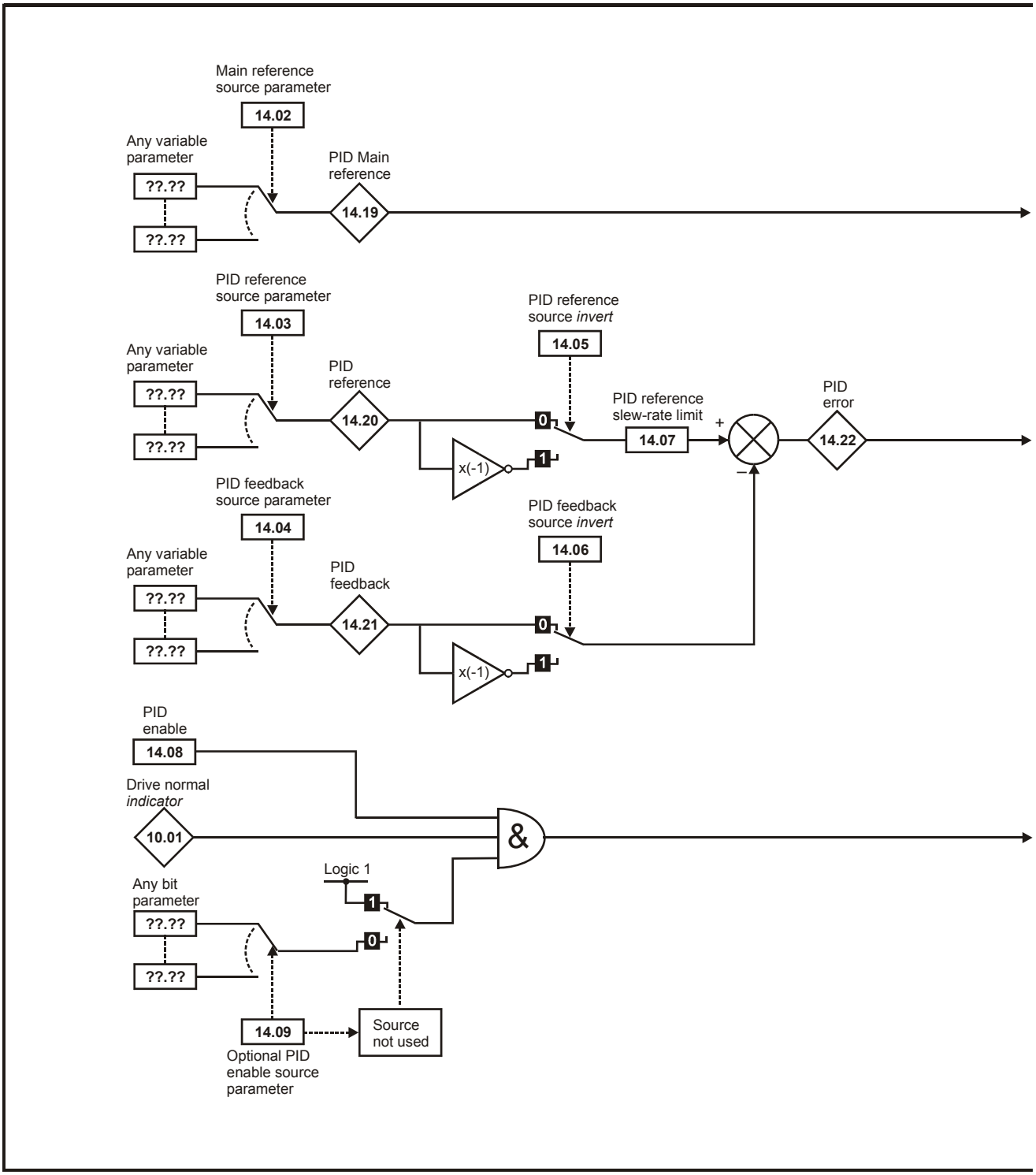
The local reference consists of a turns, a position and a fine position value. When Pr **13.24** is zero the reference is a 48bit position made from these three values.

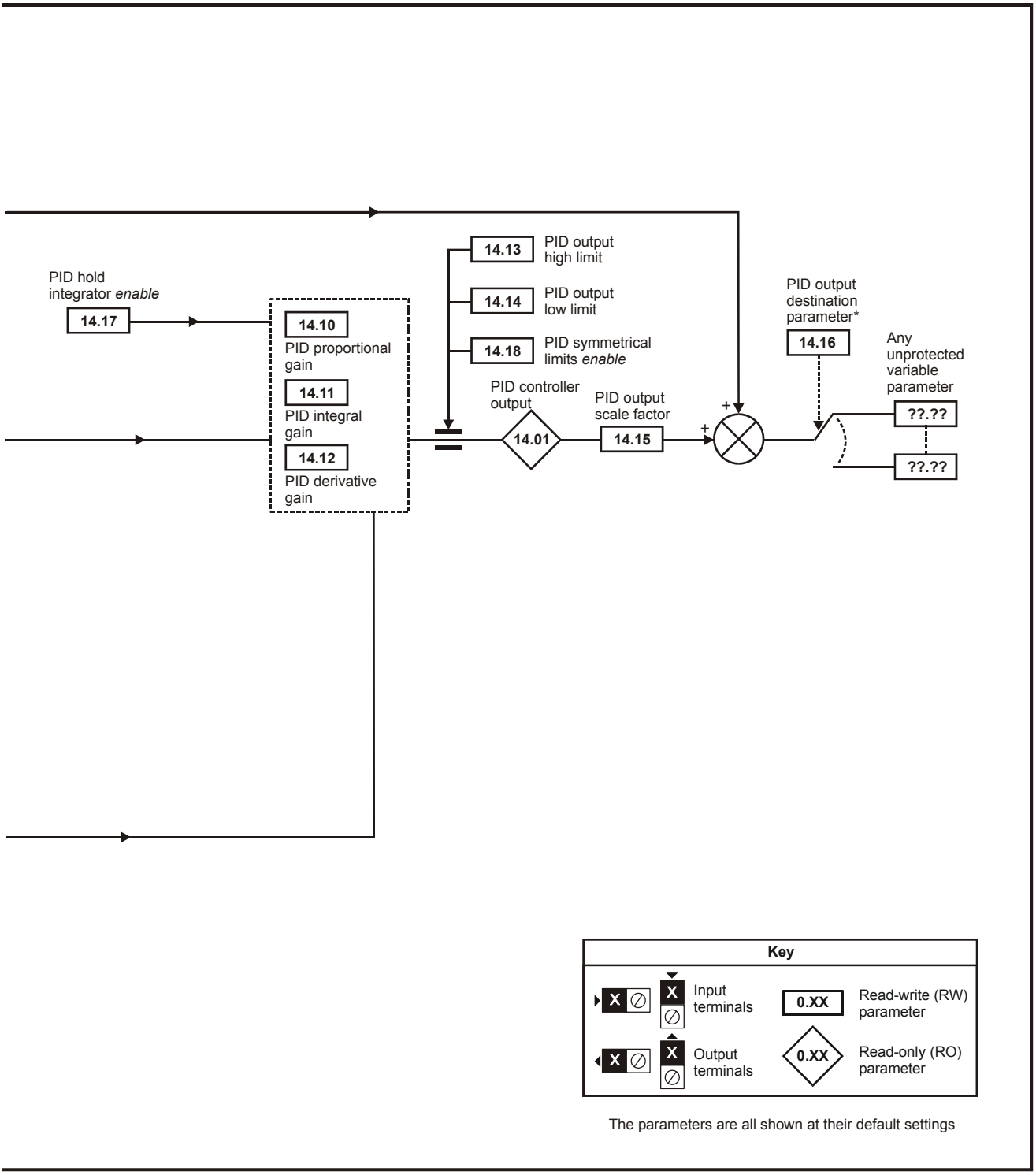
If Pr **13.24** is set to one the local reference is a 32 bit position made from the position and fine position values. The position delta, used as the input to the position controller, is calculated correctly even when the turns are ignored as the 32bit position is treated as a roll-over/roll-under counter. This feature can be used, for example, with the local reference when only the position (and not the turns or fine position) is available. This feature is not available when absolute mode is selected (Pr **13.11** = 1).

5.17 Menu 14: User PID controller

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. The sample rate of the PID controller is 4 ms.

Figure 5-16 Menu 14 logic diagram





The parameters are all shown at their default settings

*The PID controller is only enabled if Pr **14.16** is set to a non Pr **xx.00** and unprotected destination parameter.

14.01	PID output															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				
Range	±100.00 %															
Update rate	4ms write															

Subject to the limits the PID controller output is given by

output = error x [P + I/s + Ds/(0.064s + 1)]

Where:

error = reference - feedback
P = proportional gain = Pr **14.10**
I = integral gain = Pr **14.11**
D = differential gain = Pr **14.12**

Therefore with an error of 100 % and P = 1.000 the output produced by the proportional term is 100%. With an error of 100 % and 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 and D = 1.000 the output produced by the D term will be 100 %.

14.02	PID main reference source															
14.03	PID reference source															
14.04	PID feedback source															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

14.05	PID reference source invert															
14.06	PID feedback source invert															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

14.07	PID reference slew rate limit															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 3,200.0 s															
Default	0.0															
Update rate	Background read															

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.

14.08	PID enable															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	4ms read															

14.09	PID optional enable source															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

To enable the PID controller the drive must be ok (Pr **10.01** = 1) and the PID enable (Pr **14.08**) must be one. If the option enable source (Pr **14.09**) is 00.00 or routed to a non-existent parameter the PID controller is still enabled provided Pr **10.01** = 1 and Pr **14.08** = 1. If the optional enable source (Pr **14.09**) is routed to an existing parameter the source parameter must be one before the PID controller can be enabled. If the PID controller is disabled the output is zero and the integrator is set to zero.

14.10	**PID P gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	Background read															

14.11	**PID I gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	0.500															
Update rate	Background read															

14.12	**PID D gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	0.000															
Update rate	Background read															

14.13	**PID upper limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 100.00 %															
Default	100.00															
Update rate	Background read															

14.14	**PID lower limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1		
Range	±100.00 %															
Default	-100.00															
Update rate	Background read															

If Pr **14.18** = 0, the upper limit (Pr **14.13**) defines the maximum positive output for the PID controller and the lower limit (Pr **14.14**) defines the minimum positive or maximum negative output. If Pr **14.18** = 1, the upper limit defines the maximum positive or negative magnitude for the PID controller output. When any of the limits are active the integrator is held.

14.15	**PID scaling**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 4.000															
Default	1.000															
Update rate	4ms read															

14.16	PID destination															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
				1			2					1	1	1	1	
Range	Pr **0.00** to Pr **21.51**															
Default	Pr **0.00**															
Update rate	Read on reset															

The value written to the destination parameter is (PID controller output x scaling) + PID main reference.

14.17	PID hold integrator															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Default	0															
Update rate	4ms read															

When this parameter is set to 0 the integrator operates normally. Setting this parameter to 1 will cause the integrator value to be held. Setting this parameter does not prevent the integrator from being reset to zero if the PID controller is disabled.

14.18	PID symmetrical limit enable															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	Background read															

See Pr **14.13** and Pr **14.14**.

14.19	PID main reference															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				
Range	±100.00 %															
Update rate	4ms write															

14.20	PID reference															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				
Range	±100.00 %															
Update rate	4ms write															

14.21	PID feedback															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				
Range	±100.00 %															
Update rate	4ms write															

14.22	PID error															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1				
Range	±100.00 %															
Update rate	4ms write															

5.18 Menus 15 and 16: Solutions Module slots

Pr **x.00** and Pr **x.01** are always present in menus 15 and 16. Pr **x.01** indicates which type of module is present (0 = no module installed). When a module is installed the drive provides the relevant menu (menu 15 for slot 1 and 16 for slot 2) depending on the Solutions Module installed. The possible categories are shown below.

Solutions Module ID	Module	Category
0	No module installed	
101	SM-Resolver	Feedback
102	SM-Universal Encoder Plus	
104	SM-Encoder Plus SM-Encoder Output Plus	
201	SM-I/O Plus	Automation (I/O Expansion)
203	SM-I/O Timer	
204	SM-I/O PELV	
205	SM-I/O 24V Protected	
206	SM-I/O120V	
207	SM-I/O Lite	
208	SM-I/O 32	
301	SM-Applications	Automation (Applications)
302	SM-Applications Lite	
303	SM-EZMotion	
304	SM-Applications Plus	
305	SM-Applications Lite V2	
306	SM-Register	
401	SM-LON	Fieldbus
403	SM-PROFIBUS-DP	
404	SM-INTERBUS	
406	SM-CAN	
407	SM-DeviceNet	
408	SM-CANopen	
409	SM-SERCOS	
410	SM-Ethernet	
421	SM-EtherCAT	
501	SM-SLM	SLM

Most modules include a processor and parameters are updated by the processor in the Solutions Module. However, dumb modules do not contain a processor and all parameters are updated by the drive processor. Dumb Solutions Modules are SM-Encoder Plus, SM-Encoder Output Plus, SM-Resolver and SM-I/O Plus.

Dumb Solutions Module parameters are read/written by the drive background task or at the combined update time for time critical parameters. The combined update time depends on the number and type of dumb Solutions Modules installed to the drive. For each Solutions Module the update rate of these parameters is specified as 4 ms, 8 ms, etc. The combined update time is the total of the update times for all dumb Solutions Modules installed.

For example, if a module with 4 ms update time and a module with 8 ms are installed to the drive, then the combined update time for the time critical parameters of each module is 12 ms.

In the parameter tables the update time added by the type of module is given, for example 4 ms for the SM-Encoder Plus or 8 ms for the SM-I/O Plus.

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

Parameters common to all categories

Parameter		Range	Default	Type					
x.**01**	Solutions Module ID	0 to 599		RO	Uni			PT	US
x.**50**	Solutions Module error status	0 to 255		RO	Uni		NC	PT	

5.19 Menu 17: Motion Processors

Menu 17 parameter functions are dependant on the Digitax ST variant.

5.19.1 Digitax ST Base

Menu 17 not available.

5.19.2 Digitax ST Indexer and Digitax ST Plus

17.01	Motion Processor ID															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
												1	1		1	
Range	0 to 599															
Update rate	4 ms write															

17.02	Motion Processor software version															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1		1			1	
Range	0.00 to 99.99															
Update rate	4 ms write															

17.03	DPL program status															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1					1		1				
Range	None (0), Stop (1), Run (2), Trip (3)															
Update rate	4 ms write															

Provides the run status of the user DPL program in the Motion Processor. The following values are defined:

Display	Value	Description
nonE	0	No DPL program present
StoP	1	DPL program is stopped
run	2	DPL program is running
triP	3	Run-time error. ERROR task running or DPL program stopped

17.04	Available system resource															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1		1			1	
Range	0 to 100															
Update rate	4 ms write															

Displays the free CPU resource as a percentage of the current background execution time calculated over 200 ms.

17.05	RS485 address															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255															
Default	11															
Update rate	4 ms write															

Defines the address of this node for ANSI and Modbus communications protocols. For the ANSI protocol the address range is 11 to 99 where the first digit is the group address and the second digit is the unit number. Both digits must be in the range of 1-9. Zero is not permitted since it is used by the master for addressing groups of nodes. This parameter has no effect if the EIA-RS485 mode is 25 (CTSync) or 26 (CTSync).

17.06	**RS485 mode**															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255															
Default	1															
Update rate	4ms write															

Defines the mode of operation (or protocol) for the on-board EIA-RS485 port.
For details of these modes, refer to Table 5-12 below.

Table 5-12 Serial modes - Pr 17.06

Mode	Description
1	4-wire CT-ANSI Slave The port is set to 1 start bit, 7 data bits, even parity and 1 stop bit.
2	Reserved
3	Reserved
4	Reserved
5	2-wire CT-ANSI Slave The port is set to 1 start bit, 7 data bits, even parity and 1 stop bit.
6	User mode. 1 start bit, 7 data bits, EVEN parity, 1 stop bit (10 bits total)
7	User mode. 1 start bit, 8 data bits, EVEN parity, 1 stop bit (11 bits total)
8	User mode. 1 start bit, 8 data bits, NO parity, 1 stop bit (10 bits total)
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13,43,73	4-wire Modbus RTU slave The EIA-RS485 port is set for: Mode 13: 1 start bit, 8 data bits, NO parity, 2 stop bits. Mode 43: 1 start bit, 8 data bits, EVEN parity, 1 stop bit. Mode 73: 1 start bit, 8 data bits, ODD parity, 1 stop bit.
14, 44, 74	4-wire Modbus ASCII slave The EIA-RS485 is set for: Mode 14: 1 start bit, 7 data bits, NO parity, 2 stop bits Mode 44: 1 start bit, 7 data bits, EVEN parity, 1 stop bit Mode 74: 1 start bit, 7 data bits, ODD parity, 1 stop bit
15, 45, 75	2-wire Modbus RTU slave The EIA-RS485 port is set for: Mode 15: 1 start bit, 8 data bits, NO parity, 2 stop bits. Mode 45: 1 start bit, 8 data bits, EVEN parity, 1 stop bit. Mode 75: 1 start bit, 8 data bits, ODD parity, 1 stop bit.
16, 46, 76	2-wire Modbus ASCII slave The EIA-RS485 is set for: Mode 16: 1 start bit, 7 data bits, NO parity, 2 stop bits Mode 46: 1 start bit, 7 data bits, EVEN parity, 1 stop bit Mode 76: 1 start bit, 7 data bits, ODD parity, 1 stop bit
17, 47, 77	4-wire Modbus RTU master The EIA-RS485 port is set for: Mode 17: 1 start bit, 8 data bits, NO parity, 2 stop bits. Mode 47: 1 start bit, 8 data bits, EVEN parity, 1 stop bit. Mode 77: 1 start bit, 8 data bits, ODD parity, 1 stop bit.
18, 48, 78	4-wire Modbus ASCII master The EIA-RS485 is set for: Mode 18: 1 start bit, 7 data bits, NO parity, 2 stop bits Mode 48: 1 start bit, 7 data bits, EVEN parity, 1 stop bit Mode 78: 1 start bit, 7 data bits, ODD parity, 1 stop bit
19, 49, 79	2-wire Modbus RTU master The EIA-RS485 port is set for: Mode 19: 1 start bit, 8 data bits, NO parity, 2 stop bits. Mode 49: 1 start bit, 8 data bits, EVEN parity, 1 stop bit. Mode 79: 1 start bit, 8 data bits, ODD parity, 1 stop bit.
20, 50, 80	2-wire Modbus ASCII master The EIA-RS485 is set for: Mode 20: 1 start bit, 7 data bits, NO parity, 2 stop bits Mode 50: 1 start bit, 7 data bits, EVEN parity, 1 stop bit Mode 80: 1 start bit, 7 data bits, ODD parity, 1 stop bit
25	Motion Processor CT-Sync Master The baud rate is fixed at 896875bps
26	Motion Processor CT-Sync Slave The baud rate is fixed at 896875bps

17.07	RS485 baud rate															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1		
Range	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 115200 (9) baud															
Default	4800 (4)															
Update rate	4ms write															

Defines the baud-rate (or bits-per-second) for the on-board EIA-RS485 port. The following are supported:

Note that this parameter is not relevant when the EIA-RS485 port mode is set to 25 (CTSync Master) or 26 (CTSync Slave).

Display	Value	Desc
300	0	300 bps
600	1	600 bps
1200	2	1200 bps
2400	3	2400 bps
4800	4	4800 bps
9600	5	9600 bps
19200	6	19200 bps
38400	7	38400 bps
57600	8	57600 bps
115200	9	115200 bps

17.08	RS485 Turnaround delay															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255 ms															
Default	2															
Update rate	4 ms write															

Defines a fixed delay between receiving a message on the EIA-RS485 port and the response being transmitted. This can be useful in 2-wire configurations where it takes a finite time for the master (host) to switch from transmit mode to receive mode. There is always at least a 1ms delay and this parameter can be used to extend it.

17.09	RS485 Tx enable delay															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 1 ms															
Default	0															
Update rate	4 ms write															

This parameter allows a 1 ms delay to be introduced between the Motion Processor enabling the EIA-RS485 transmitter and actually commencing the transmission. This should only be required if it is found that the recipient of the transmission is receiving a corrupted start of message.

17.10	DPL Print Routing															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	SYPT: OFF (0), RS485: On (1)															
Default	SYPT: OFF (0)															
Update rate	4ms write															

This parameter is available on Digitax ST Indexer but is not allowed to be set to a 1 (On). Controls where the output of the DPL PRINT command is sent. If set to zero (Off), the output is sent to the programming client (SyPTPro) and if set to 1 (On) it will be sent to the EIA-RS485 port.

17.11	**Clock tick time (ms)**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 200															
Default	10															
Update rate	4 ms write															

Defines the scheduling period (tick-time), in milliseconds, for the DPL CLOCK task. A value of zero will disable the CLOCK task.

17.12	**Motion engine sample rate**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1		
Range	dISAbLEd (0), 0.25 ms (1), 0.5 ms (2), 1 ms (3), 2 ms (4), 4 ms (5), 8 ms (6)															
Default	dISAbLEd (0)															
Update rate	4ms write															

Defines the scheduling rate for the POS tasks to suit the application performance and the resource needed to run the user DPL program. The following values are defined:

Display	Value	Description
diSAbled	0	Disabled
0.25	1	250 μs
0.5	2	500 μs
1	3	1 ms
2	4	2 ms
4	5	4 ms
8	6	8 ms

Set this parameter in order for the user DPL program to automatically run at power-on/ reset. If this is changed and the new setting needs to be used on power-up ensure that a drive parameter save is performed.

17.13	**Enable autorun**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	On (1)															
Update rate	4ms write															

17.14	**Global run time trip enable**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4ms write															

Setting this parameter to 1 will cause the drive to trip when certain run-time errors occur within the Motion Processor user DPL program.

For more information, see *Section 11.1 Run-time Errors in the SM-Applications Modules and Motion Processors User Guide.*

17.15	Disable reset on trip cleared															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4 ms write															

When this parameter is 0, the Motion Processor will be reset when a drive trip is cleared. When set to 1, the Motion Processor will be unaffected by a drive trip reset (i.e. continue running)

17.16	Encoder data update rate															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	0 to 3															
Default	0															
Update rate	4 ms write															

Display	Description
0	APC data and menu 90 encoder parameters are updated every 250 μs.
1	APC data and menu 90 encoder parameters are updated immediately prior to every POS task.
2	APC data and menu 90 encoder parameters are updated immediately prior to every CLOCK task.
3	APC data and menu 90 encoder parameters are never updated. If these are never updated, more processor resource will become free.

17.17	Enable parameter over range trips															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4 ms write															

Defines the action taken if a user DPL program attempts to write an out of range value to a parameter. When set at 1, a run-time trip will occur (number 44); when set at zero the value will automatically be limited to the maximum/minimum of that parameter.

17.18	**Watchdog enable**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4 ms write															

When set it enables the DPL program watchdog function. The DPL WDOG command must then be executed every 200 ms. This can be used to protect the program against malfunction. If the command is not executed within a 200 ms time period the drive will trip on **SL3.tO.** Please note that the WDOG command must also be executed once for the watchdog to be enabled. This is normally executed at the end of the Initial task.

17.19	**Save request**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1				1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4ms write															

Setting this parameter to 1 will initiate an immediate save of all non-volatile Motion Processor data. This consists of the P/Q/T/U PLC register sets and optionally menu 20 (depending upon the setting of Pr **81.21**).

NOTE

Note that this will also cause a reset of the Motion Processor and this parameter will return back to zero automatically. Also if the drive is tripped, it will be reset. Menu 17 will not be saved.

17.20	**Enable under voltage save**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4ms write															

Setting this parameter to 1 signals that all non-volatile data of the Motion Processor will be automatically saved upon an under voltage (UV) trip of the drive.

NOTE

Note that when a 'UV' save occurs the Motion Processor will be reset.

17.21	**Enable menu 20 save and restore**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4 ms write															

If set to 1, menu 20 will be saved/restored along with other non-volatile parameters upon a save request (Pr **17.19**=1) or under voltage save (Pr **17.20**=1). If menu 20 is to be restored on power-up the user must ensure that this parameter is saved in the drive before powering down.

Since menu 20 is a global drive menu, only one option installed to the drive should be used to store and restore menu 20, therefore if more than one Motion Processor is installed to the drive only one should have this parameter set otherwise menu 20 will not be restored correctly on power-up.

NOTE

Unlike other setup parameters, parameters Pr **17.20** and Pr **17.21** are not cached, which means a change to the parameter takes immediate effect.

17.22	CTNet Token Ring ID															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255															
Default	0															
Update rate	4ms write															

This parameter allows the user to specify the identity of the CTNet token ring to which a Motion Processor is connected. In a system incorporating a single token ring this parameter can be left at its default value. In a system incorporating multiple token rings, separate ID's should be set for each ring. The combination of CTNet Token Ring ID and CTNet node address should be unique.

17.23	CTNet node address															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255															
Default	0															
Update rate	4ms write															

Defines the node address for CTNet. Every node on a CTNet network must have a unique address. Setting this to zero will disable CTNet on this node.

17.24	CTNet baud rate															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1		
Range	5.000 (0), 2.500 (1), 1.250 (2), 0.625 (3)															
Default	2.500 (1)															
Update rate	4 ms write															

Specifies the data rate for CTNet. All nodes on the network must be set to the same data rate. The rates are defined as follows:

Display	Value	Description
5.000	0	5 Mbit/s
2.500	1	2.5 Mbit/s
1.250	2	1.25 Mbit/s
0.625	3	625 kbit/s

17.25	CTNet sync setup															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0,000 to 9,999															
Default	0,000															
Update rate	4ms write															

Specifies the synchronization message generation rate for CTNet. This message is used to tell all nodes when to transmit cyclic data. Only one node on the CTNet network should have this parameter set. The format of the update parameter is SSFF, where FF defines the Fast Cyclic data channel update rate, and SS defines the slow cyclic data rate in multiples of FF. So if the parameter value is 1510, fast cyclic data is set every 10 ms and slow every 150 ms. When using easy mode (see below) it is only necessary to set up the FF (fast cyclic rate).

17.26	**CTNet easy mode - first cyclic parameter destination node**															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 25,503															
Default	0															
Update rate	4 ms write															

17.27	**CTNet easy mode - first cyclic source parameter**															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0,000 to 9,999															
Default	0															
Update rate	4 ms write															

17.28	**CTNet easy mode - second cyclic parameter destination node**															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 25,503															
Default	0															
Update rate	4 ms write															

17.29	**CTNet easy mode - second cyclic source parameter**															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 9,999															
Default	0															
Update rate	4 ms write															

17.30	**CTNet easy mode - third cyclic parameter destination node**															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 25,503															
Default	0															
Update rate	4 ms write															

17.31	**CTNet easy mode - third cyclic source parameter**															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 9,999															
Default	0															
Update rate	4 ms write															

17.32	CTNet easy mode set-up - Transfer slot 1 destination parameter															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 9,999															
Default	0															
Update rate	4 ms write															

17.33	CTNet easy mode set-up - Transfer slot 2 destination parameter															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 9,999															
Default	0															
Update rate	4 ms write															

17.34	CTNet easy mode set-up - Transfer Motion Processor destination parameter															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 9,999															
Default	0															
Update rate	4 ms write															

Pr **17.26** to Pr **17.34** define the source and destinations for CTNet easy-mode cyclic data.

Parameter	Format	Channel	Description
Pr **17.26**	NNNSS	1	Defines the destination node number and slot NNN = Node number (0-255) SS = Slot number (1-3) e.g. A value of 201 means node ID 2, slot 1.
Pr **17.27**	MMPP	1	Defines the source drive parameter which is to be transmitted MM = Menu number PP = Parameter number e.g. A value of 302 means **Pr 3.02** (speed)
Pr **17.28**	NNNSS	2	Destination node number and slot for channel 2
Pr **17.29**	MMPP	2	Source drive parameter for channel 2
Pr **17.30**	NNNSS	3	Destination node number and slot for channel 3
Pr **17.31**	MMPP	3	Source drive parameter for channel 3
Pr **17.32**	MMPP	1	Slot 1 destination parameter for incoming data
Pr **17.33**	MMPP	2	Slot 2 destination parameter for incoming data
Pr **17.34**	MMPP	3	Motion Processor destination parameter for incoming data

17.35	CTNet sync event task ID															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1		
Range	Disabled (0), Event (1), Event1 (2), Event2 (3), Event3 (4)															
Default	Disabled (0)															
Update rate	4ms write															

Identifies which of the EVENT tasks will be scheduled when a CTNet synchronization message is received or generated. This sync. is generated by a master node (which can be this node) on the CTNet network at a fixed time-base. The following values are defined:

Display	Value	Description
Disabled	0	No event task scheduled
Event	1	EVENT task scheduled
Event1	2	EVENT1 task scheduled
Event2	3	EVENT2 task scheduled
Event3	4	EVENT3 task scheduled

17.36	**CTNet diagnostic parameter**															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1		1	1		1	
Update rate	4 ms write															

The status of the CTNet network is displayed in the CTNet diagnostic parameter. When the Motion Processor is communicating successfully on the CTNet network the number of messages per second is displayed.

Table 5-13 CTNet diagnostics

Pr 17.36	Status	Description
>0	Network OK	Indicates the number of messages per second be processed every second.
0	Network OK, No Data Transfer	The low-level token ring has been established and is active, but the node is not receiving any CTNet data messages.
-1	RECON	A network reconfiguration has been detected.
-2	Initialization Error	The Motion Processor was unable to configure the CTNet interface. Check that the node address and data rate are set correctly.
-3	MYRECON	The Motion Processor forced a CTNet network reconfiguration

17.37	**Reject download if drive enabled**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4 ms write															

If this parameter is set, then if the user attempts to download a new user DPL program or operating system to the Motion Processor and the drive is enabled the download will be rejected and a run-time trip 70 will occur, if the global run-time trip parameter (Pr **17.14**) is set.

Since downloading stops normal operations of the Motion Processor it may be considered unsafe to do this if the drive system is running, therefore setting this parameter will prevent downloading under this condition.

17.38	**Do not trip drive on APC run-time error**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4 ms write															

When this parameter is 0 the drive will trip with runtime error 81 if an APC non-recoverable error occurs, such as use of an un-initialized CAM function. When this parameter is 1 the drive will not trip when an APC non-recoverable error occurs

17.39	Inter-UT70 synchronization status															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1			1		1	
Range	0 to 3															
Default	0															
Update rate	4ms write															

This parameter displays the current Motion Processor's synchronization status.

Synchronisation Status	Status
0	The synchronisation master request is zero or another Solutions Module is synchronisation master.
1	The Motion Processor is synchronisation master.
3	The Motion Processor is synchronisation master, but the synchronisation frequency is out of specification or not present.

17.40	Inter-UT70 master transfer mode															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 10															
Default	1															
Update rate	4 ms write															

17.42	Freeze main drive position															
Digitax ST Variant	Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4 ms write															

When this parameter is ON (1), the voltage on the Motion Processor digital input 0 (zero) is passed through to the drive's internal Freeze line. This can be seen by other classes of SM-Solutions modules. For further information on Freeze input, refer to *Chapter 8 Freeze and Marker in the SM-Applications Modules and Motion Processors User Guide.*

17.43	Freeze invert															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Range	OFF (0) or On (1)															
Default	OFF (0)															
Update rate	4ms write															

When this parameter is set to zero a freeze occurs on the rising edge of the freeze signal. When it is set to 1 a freeze occurs on the falling edge of freeze signal. For further information on Freeze input, refer to *Chapter 8 Freeze and Marker in the SM-Applications Modules and Motion Processors User Guide.*

When this parameter is set to zero the Motion Processor will freeze data when it sees a rising edge of a freeze pulse from the drive. When it is set to a 1 the Motion Processor will freeze data when it sees a falling edge of a freeze pulse from the drive. For further information on Freeze input, refer to *Chapter 8 Freeze and Marker in the SM-Applications Modules and Motion Processors User Guide.*

17.44	**Task priority level**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 255															
Default	0															
Update rate	4 ms write															

The priority levels of different tasks may be changed with this parameter. The parameter is accessed in a bit-wise manner:

Bit	Value	Meaning
0	0	CTNet task priority is higher than Pos tasks priority.
	1	CTNet task priority is lower than Pos tasks priority. This will reduce the jitter of the POS tasks but could lead to the CTNet task being starved
1	0	Inter-option communication task priority is higher than the POS tasks.
	1	Inter option communication task priority lower than the POS tasks.
2	0	Turbo CTNet Disabled
	1	Turbo CTNet Enabled

17.48	**DPL line number in error**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1		1			1	
Range	0 to 2,147,483,647															
Default	0															
Update rate	4 ms write															

Specifies the DPL program line number that caused a run-time error. This is valid only when:

- The user program has been compiled with the debug option set.
- The error is one that can be generated by user code, for example divide by zero (50) or parameter does not exist (41).

If both of these conditions are not met, the line number parameter will display zero (0).

17.49	**User program ID**															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1									1		1				
Range	-32,767 to +32,768															
Default	0															
Update rate	4 ms write															

This parameter is available for the user to put in an ID code of their program. This may, for example, be the software version number. Use the function block SETUSERID() to write to this parameter.

17.50	**Motion Processor error status***															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1		1			1	
Range	0 to 255															
Update rate	4 ms write															

When a run-time error occurs the error number is placed into this parameter.

For more information, see *Section 11.1 Run-time Errors in the SM-Applications Modules and Motion Processors User Guide.*

*See trip SLX.Er, *Automation (I/O Expansion) module category on page 134.*

17.51	Motion Processor software sub-version															
Digitax ST Variant	Indexer, Plus															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1		1			1	
Range	0 to 99															
Update rate	4ms write															

Specifies the minor revision number of the operating system of the Motion Processor. Use in conjunction with Pr **17.02** to form the complete version number.

5.19.3 Digitax ST EZMotion

17.01	Motion Processor ID															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1				1	1		1	
Range	0 to 599															
Update rate	Write on power-up															

17.02	Motion Processor software version															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2	1		1		1			1	
Range	00.00 to 99.99															
Update rate	Write on power-up															

17.13	EZOutput 1 Status															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Trajectory update rate (user configured)															

This parameter shows the status of digital output 1 on the Motion Processor. A value of 1 indicates that the output is active. A value of 0 indicates that the output is inactive. This equates Pin 6 on the EZMotion I/O Connector.

17.14	EZOutput 2 Status															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Trajectory update rate (user configured)															

This parameter shows the status of digital output 2 on the Motion Processor. A value of 1 indicates that the output is active. A value of 0 indicates that the output is inactive. This equates Pin 7 on the EZMotion I/O Connector.

17.17	EZInput 1 Status															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Trajectory update rate (user configured)															

This parameter shows the status of digital input 1 on the Motion Processor. A value of 1 indicates that the input is active. A value of 0 indicates that the input is inactive. This equates Pin 2 on the EZMotion I/O Connector.

17.18	EZInput 2 Status															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Trajectory update rate (user configured)															

This parameter shows the status of digital input 2 on the Motion Processor. A value of 1 indicates that the input is active. A value of 0 indicates that the input is inactive. This equates Pin 3 on the EZMotion I/O Connector.

17.19	**EZInput 3 Status**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Trajectory update rate (user configured)															

This parameter shows the status of digital input 3 on the Motion Processor. A value of 1 indicates that the input is active. A value of 0 indicates that the input is inactive. This equates Pin 4 on the EZMotion I/O Connector.

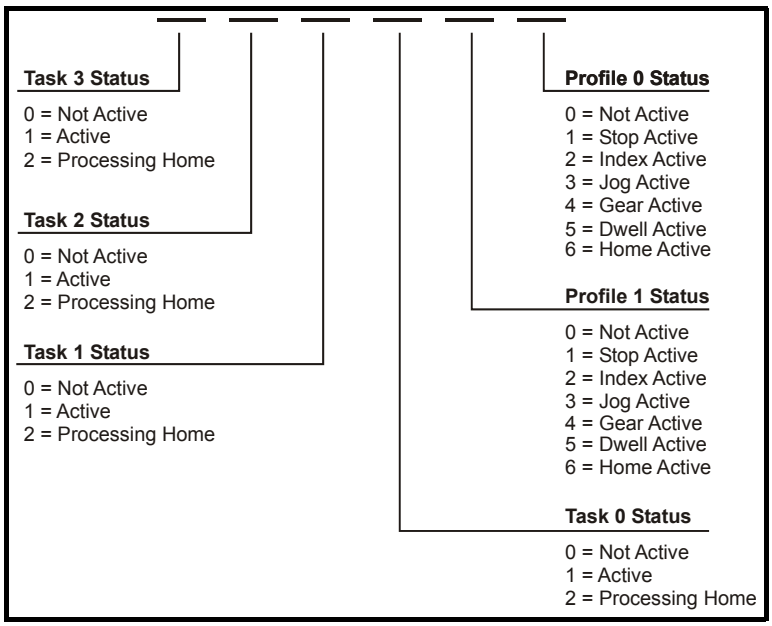
17.20	**EZInput 4 Status**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Trajectory update rate (user configured)															

This parameter shows the status of digital input 4 on the Motion Processor. A value of 1 indicates that the input is active. A value of 0 indicates that the input is inactive. This equates Pin 5 on the EZMotion I/O Connector.

17.48	**System status**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Update rate	Trajectory update rate (user configured)															

The system status parameter is used to indicate the status of each of the user program tasks and motion profiles. This parameter can give the user some idea of what the Motion Processor is commanding without being online using PowerTools Pro EZ.

There are six individual digits that indicate the status of different processes. This parameter will display a six digit number that can be used in conjunction with the graphic below to determine the status of each process. Leading zeros in the value are not displayed.



Examples:

Pr **17.48** = 11023 would signify that user programs are currently running on Task 2 and Task 1, and that a Index is running on Profile 1 while a Jog is running on Profile 0.

Pr **17.48** = 104 would signify that a user program is running on Task 0 and Gearing motion is running on Profile 0.

17.50	Motion Processor error status															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 255															
Update rate	Background write															

If an error occurs the reason for the error is written to this parameter and the drive may produce a SL3.Er trip. A value of zero indicates that the Motion Processor has not detected an error, a non-zero value indicates that an error has been detected. (See Table 5-14 on page 196 for the meaning of the values in this parameter.) When the drive is reset this parameter is cleared.

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

17.51	Motion Processor software sub-version															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
								1		1		1			1	
Range	0 to 99															
Update rate	Write on power-up															

The software version is displayed in these parameters in the form Pr **17.02** = xx.yy and Pr **17.50** = zz. Where xx specifies a change that affects hardware compatibility, yy specifies a change that affects product documentation, and zz specifies a change that does not affect the product documentation.

Table 5-14 Error status values for the Motion Processor

Error Code (Pr 17.50)	Cause Trip?	Error	Possible Reason	Possible Solution
41	Y	Digitax ST Parameter Access Error - Parameter Doesn't Exist	The Digitax ST Menu Parameter that you are trying to read from or write to does not exist.	Please double check the parameter number
42	Y	Digitax ST Parameter Access Error - Parameter is Read Only	The Digitax ST Menu Parameter that you are trying to write to is a Read Only parameter	Avoid writing to Read Only parameters. Use Drive Menu Watch view in PowerTools Pro, or Digitax ST User Guide to verify parameter accessibility
43	Y	Digitax ST Parameter Access Error - Parameter is Write Only	The Digitax ST Menu Parameter that you are trying to read from is Write Only	Avoid reading from Write Only parameters. Use Drive Menu Watch view in PowerTools Pro, or Digitax ST User Guide to verify parameter accessibility
44	Y	Digitax ST Parameter Access Error - Written Value Out of Range	The value you are trying to write to the Digitax ST Menu Parameter is out of range.	Modify value that you are trying to write so that it is within valid range of the parameter. Use the Digitax ST User Guide to verify the range of the parameter and try again
73	Y	Digitax ST Database Setup Error		
74	Y	Module Overheat Error	Motion Processor module temperature has exceeded 83 degrees Fahrenheit	Select lower switching frequency in PowerTools Pro configuration, or reduce motion performance (i.e. lower accel/decel, lengthen dwells). If problem persists, please contact factory
101	Y	Invalid Configuration Error		
102	Y	NVM Invalid Error		
103	Y	Power Up Test Failure Error	Motion Processor Power Up Test failed	Cycle power to the system. If problem persists, please contact factory
104	Y	Following Error	Amount of following error exceeded following error limit set in PowerTools Pro software.	Increase Following Error Limit in PowerTools Pro configuration. Increase Velocity Loop Bandwidth and/or Position Loop Bandwidth in PowerTools Pro configuration. Lower Acceleration/Deceleration ramp values. Make sure that programmed velocity is within maximum operating speed of the given motor.

Error Code (Pr 17.50)	Cause Trip?	Error	Possible Reason	Possible Solution
105	N	Travel Limit Plus	Hardware Travel Limit Plus switch has activated, or Software Travel Limit Plus position has been exceeded	Verify motion profiles/programs to make sure that motion is not configured to exceed desired travel positions
106	N	Travel Limit Minus	Hardware Travel Limit Minus switch has activated, or Software Travel Limit Minus position has been exceeded	Verify motion profiles/programs to make sure that motion is not configured to exceed desired travel positions
107	Y	No Program Error	Motion Processor has no configuration loaded in it	Download a configuration to the Motion Processor using PowerTools Pro software
108	Y	Motion Trajectory Error	Maximum allowable position change within one control loop update has been exceeded	If using the "Using Capture.#" instruction after an Index.#.Initiate instruction in your user program, make sure that the captured data is recent enough so that the motor can actually achieve the necessary acceleration
109	Y	Trajectory Update Overrun Error	Control Loop processing time has taken longer than the user selected Trajectory Update Rate	Select a longer Trajectory Update Rate in the PowerTools Pro configuration. A longer Trajectory Update Rate gives the control loop more time to process. Be sure not to enable any PLS's, Captures, or Queues that are not being used.
120	Y	File Corruption Error - Consult Factory		
121	Y	File Corruption Error - Consult Factory		
122	Y	File Corruption Error - Consult Factory		
123	Y	Program Error - Buffer Overrun		
124	Y	Program Error - Call Stack Overflow	Too many "Call Program" instructions have been processed without returning to original "calling" program	Do not nest more than four "Call Program" operations. To avoid this, return to the original calling programs before calling another program. (See Call Program instruction explanation in *Section 8.4.1 Call Program of the SM-EZMotion User Guide* for more information).
125	Y	File Corruption Error - Consult Factory		
126	Y	File Corruption Error - Consult Factory		
127	Y	Flash Error	Loading from Flash Memory has failed	Re-download original PowerTools Pro configuration file. If problem persists, please contact factory.
128	Y	File Corruption Error - Consult Factory		
129	Y	Program Error - Illegal Command	User Program has processed an illegal command	Re-download original PowerTools Pro configuration file. If problem persists, please contact factory.
130	Y	File Corruption Error - Consult Factory		
131	Y	File Corruption Error - Consult Factory		
132	Y	File Corruption Error - Consult Factory		
133	Y	File Corruption Error - Consult Factory		
134	Y	File Corruption Error - Consult Factory		
135	Y	Program Error - Math Addition Overflow	Math addition operation in user program has resulted in an overflow of the resultant parameter	Verify that the sum of all the operands in addition formulas will not result in a value in the following range: $-2^{31} \leq SUM \leq 2^{31}-1$
136	Y	Program Error - Math Divide By Zero	Formula in user program causes a divide by zero	Make sure that the denominator in all division formulas is not equal to zero.
137	Y	Program Error - Math Divide Operand Too Large		
138	Y	Program Error - Math Multiplication Normalization Failed	Normalization of multiplication parameters in user program has failed	
139	Y	Program Error - Math Multiplication Operand Too Large		

Error Code (Pr 17.50)	Cause Trip?	Error	Possible Reason	Possible Solution
140	Y	Program Error - Overflow		
141	Y	Program Error - Math Subtraction Overflow		
142	Y	Program Error - Math Stack Overflow	User Program math process stack has overflowed	
143	Y	File Corruption Error - Consult Factory		
144	Y	File Corruption Error - Consult Factory		
145	Y	File Corruption Error - Consult Factory		
146	Y	File Corruption Error - Consult Factory		
147	Y	Program Error - Flash Memory Size Exceeded	User configuration exceeds available flash memory size	Eliminate any unused Indexes or Programs and re-download the PowerTools Pro configuration
148	Y	Program Error - RAM Memory Size Exceeded	User configuration exceeds available RAM memory size	Eliminate any unused Indexes or Programs and re-download the PowerTools Pro configuration
153	Y	File Corruption Error - Consult Factory		
154	Y	File Corruption Error - Consult Factory		
155	Y	File Corruption Error - Consult Factory		
156	Y	Program Error - Too Many Wait For Instructions	No more than nine arguments in Wait for Instruction	Limit # of arguments and redownloads
157	Y	File Corruption Error - Consult Factory		
158	Y	File Corruption Error - Consult Factory		
159	Y	File Corruption Error - Consult Factory		
160	Y	File Corruption Error - Consult Factory		
161	Y	File Corruption Error - Consult Factory		
162	Y	File Corruption Error - Consult Factory		
163	Y	File Corruption Error - Consult Factory		
164	Y	File Corruption Error - Consult Factory		
165	Y	File Corruption Error - Consult Factory		
166	Y	Program Error - EZMotion Parameter Write Out of Range	Value written to Motion Processor parameter in user program is out of range	
171	Y	Invalid Slot 1 Selection	Solutions Module selected for Slot 1 in PowerTools Pro file does not match actual module type installed	Switch module located in Slot 1 to match module type selected in PowerTools Pro file. Alternatively, update the PowerTools Pro configuration to match the module type actually installed, and then re-download the configuration.
172	Y	Invalid Slot 2 Selection	Solutions Module selected for Slot 2 in PowerTools Pro file does not match actual module type installed	Switch module located in Slot 2 to match module type selected in PowerTools Pro file. Alternatively, update the PowerTools Pro configuration to match the module type actually installed, and then re-download the configuration.
173	Y	Invalid Motion Processor	PowerTools Pro file does not match the Motion Processor	Motion Processor fault or incorrect configuration
174	Y	File Corruption Error - Consult Factory		
175	Y	Module Output Overload	Motion Processor can only supply 20mA maximum total output current. If this fault occurs, the digital output device attached to the Motion Processor outputs is drawing too much current.	Modify circuitry of devices connected to the Motion Processor digital outputs so that they draw no more than 20 mA total.

5.20 Menu 18: Application menu 1

Menu 18 contains parameters that do not affect the operation of the drive. These general purpose parameters are intended for use with fieldbus and application Solutions Modules. The read write parameters in this menu can be saved in the drive.

18.01	**Application menu 1 power-down saved integer**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1		1
Range	-32,768 to 32,767															
Default	0															
Update rate	N/A															

18.02 to 18.10	**Application menu 1 read-only integer**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1						
Range	-32,768 to 32,767															
Default	0															
Update rate	N/A															

18.11 to 18.30	**Application menu 1 read-write integer**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1		
Range	-32,768 to 32,767															
Default	0															
Update rate	N/A															

18.31 to 18.50	**Application menu 1 read-write bit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	N/A															

5.21 Menu 19: Application menu 2

Menu 19 contains parameters that do not affect the operation of the drive. These general purpose parameters are intended for use with fieldbus and application Solutions Modules. The read write parameters in this menu can be saved in the drive.

19.01	Application menu 2 power-down saved integer															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1				1		1
Range	-32,768 to 32,767															
Default	0															
Update rate	N/A															

19.02 to 19.10	Application menu 2 read-only integer															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1						
Range	-32,768 to 32,767															
Default	0															
Update rate	N/A															

19.11 to 19.30	Application menu 2 read-write integer															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1		
Range	-32,768 to 32,767															
Default	0															
Update rate	N/A															

19.31 to 19.50	Application menu 2 read-write bit															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1												1	1		
Default	0															
Update rate	N/A															

5.22 Menu 20: Application menu 3

Menu 20 contains parameters that do not affect the operation of the drive. These general purpose parameters are intended for use with fieldbus and application Solutions Modules. The read write parameters in this menu cannot be saved in the drive.

20.01 to 20.20	**Application menu 3 read-write integer**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1*				1		
Range	-32,768 to 32,767															
Default	0															
Update rate	N/A															

20.21 to 20.40	**Application menu 3 read-write long integer**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
										1*				1		
Range	-2^{31} to $2^{31}-1$															
Default	0															
Update rate	N/A															

*Menu 20 parameters are saved in a difference from defaults type data block if they are not at their default value.

5.23 Menu 21: Second motor parameters

The following parameters are used instead of the normal motor set-up parameters when Pr **11.45** = 1.

When the alternative parameter set is being used by the drive the decimal point after the right hand digit in the 1st row is on.

For more information about a particular parameter, see the equivalent normal motor map 1 parameter.

21.01	**Maximum reference clamp**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1						1	1	1	
Range	SPEED_LIMIT_MAX rpm															
Default	3,000.0															
Normal parameter	Pr **1.06**															
Update rate	Background read															

21.02	**Minimum reference clamp**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1					1	1	1		
Range	±SPEED_LIMIT_MAX rpm															
Default	0.0															
Normal parameter	Pr **1.07**															
Update rate	Background read															

* The range shown for Pr **1.07** shows the range used for scaling purposes (i.e. for routing to an analog output etc.). Further range restrictions are applied as given below.

01.08 (Neg min ref enable)	**01.10 (Bipolar mode enable)**	**Range**
0	0	0 to 21.01
0	1	0
1	0	-SPEED_LIMIT_MAX to 0 rpm
1	1	-SPEED_LIMIT_MAX to 0 rpm

21.03	**Reference selector**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 5															
Default	0 (A1.A2)															
Normal parameter	Pr **1.14**															
Update rate	4 ms read															

Unlike the motor 1 (Pr **1.14**) this parameter is not used for T28 and T29 digital input auto-selection (see Pr **8.39** on page 115).

Pr **21.03** defines how the value of Pr **1.49** is derived as follows:

Value of Pr 21.03	**Display String**	**Pr 1.49**
0	A1.A2	*Selected by terminal input
1	A1.Pr	1
2	A2.Pr	2
3	Pr	3
4	Pad	4
5	Prc	5

*The bit Pr **1.41** to Pr **1.44** can be controlled to force the value of Pr **1.49**:

all bits equal to zero gives 1,

Pr **1.41** = 1 then Pr **1.49** = 2
Pr **1.42** = 1 then Pr **1.49** = 3
Pr **1.43** = 1 then Pr **1.49** = 4
Pr **1.44** = 1 then Pr **1.49** = 5

The bit parameters with lower numbers have priority over those with higher numbers.

Pr **1.49** and Pr **1.50** then define the reference as follows:

Pr 1.49	Pr 1.50	Reference
1	1	Analog reference 1
1	>1	Preset defined by Pr **1.50**
2	1	Analog reference 2
2	>1	Preset defined by Pr **1.50**
3	x	Preset defined by Pr **1.50**
4	x	Keypad reference
5	x	Precision reference

Keypad reference
If Keypad reference is selected the drive sequencer is controlled directly by the keypad keys and the keypad reference parameter (Pr **1.17**) is selected. The sequencing bits, Pr **6.30** to Pr **6.34**, have no effect and jog is disabled.

Reference selected by timer
The presets are selected automatically in turn. Pr **1.16** defines the time between each change.

21.04	**Acceleration rate**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 3200.000 s/1000 rpm															
Default	0.200															
Normal parameter	Pr **2.11**															
Update rate	Background read															

21.05	**Deceleration rate**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3						1	1	1	
Range	0.000 to 3200.000 s/1000 rpm															
Default	0.200															
Normal parameter	Pr **2.21**															
Update rate	Background read															

21.07	**Rated current**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	2		1				1	1	1	
Range	0 to RATED_CURRENT_MAX A															
Default	Maximum current (i.e. the value of Pr **11.32**)															
Normal parameter	Pr **5.07**															
Update rate	Background read															

21.08	**Rated speed**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 40,000.00 rpm															
Default	3000.00															
Normal parameter	Pr **5.08**															
Update rate	Background read															

21.09	**Rated voltage**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1			1				1	1	1	
Range	0 to AC_VOLTAGE_SET_MAX V															
Default	200 V rating drive: 230 V 400 V rating drive: EUR: 400 V, USA: 460 V															
Normal parameter	Pr **5.09**															
Update rate	Level 4 read															

21.11	**Number of motor poles**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 60 (Auto to 120 POLE)															
Default	3 (6 POLE)															
Normal parameter	Pr **5.11**															
Update rate	Background read															

21.12	**Stator resistance**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3		1				1	1	1	
Range	0.000 to 65.000 x10 Ω															
Default	0.000															
Normal parameter	Pr **5.17**															
Update rate	Background read															

Pr **21.12** shows the stator resistance of the motor divided by 10. Therefore 1.000 in this parameter represents the resistance of 10 Ω.

21.14	**Transient inductance (σL_s)**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							3		1				1	1	1	
Range	0.000 to 500.000 mH															
Default	0.000															
Normal parameter	Pr **5.24**															
Update rate	Background read															

21.15	**Motor 2 active**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
	1							1		1		1				
Default	1															
Normal motor parameter	Pr **21.15**															
Update rate	Background write															

Pr **21.15** does not have an equivalent normal motor parameter, but shows when motor 2 is active.

21.16	**Thermal time constant**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1						1	1	1	
Range	0.0 to 3000.0															
Default	20.0															
Normal motor parameter	Pr **4.15**															
Update rate	Background read															

21.17	**Speed controller Kp gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							4						1	1	1	
Range	0.00 to 6.5535 (1/rad s^{-1})															
Default	0.0100															
Normal motor parameter	Pr **3.10**															
Update rate	Background read															

21.18	**Speed controller Ki gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0.00 to 655.35 s/rad s^{-1}															
Default	1.00															
Normal motor parameter	Pr **3.11**															
Update rate	Background read															

21.19	**Speed controller Kd gain**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							5						1	1	1	
Range	0.00000 to 0.65535 s^{-1} / rad s^{-1}															
Default	0.00000															
Normal motor parameter	Pr **3.12**															
Update rate	Background read															

When the second motor is selected the gains defined in Pr **21.17** to Pr **21.19** are used directly by the speed controller. The speed controller set-up method defined by Pr **3.13** is ignored.

21.20	**Encoder phase angle**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							1	1					1	1	1	
Range	0.0 to 359.9 ° electrical															
Default	0.0															
Normal motor parameter	Pr **3.25**															
Update rate	Background read															

21.21	Speed feedback selector															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
					1								1	1	1	
Range	0 to 3															
Default	0															
Normal motor parameter	Pr **3.26**															
Update rate	Background read															

0, drv: Drive encoder

The position feedback from the encoder connected to the drive itself is used to derive the speed feedback for the speed controller and to calculate the motor rotor flux position.

1, Slot1: Solutions Module in slot 1

The position feedback from the Solutions Module in Solutions Module slot 1 is used to derive the speed feedback for the speed controller and to calculate the motor rotor flux position. If a position feedback category Solutions Module is not installed in slot 1 the drive produces an EnC9 trip.

2, Slot2: Solutions Module in slot 2

3, Slot3: Solutions Module in slot 3

21.22	Current controller Kp gain															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 30,000															
Default	200 V drive: 75 400 V drive: 150															
Normal parameter	Pr **4.13**															
Update rate	Background read															

21.23	Current controller Ki gain															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 30,000															
Default	200 V drive: 1,000 400 V drive: 2,000															
Normal parameter	Pr **4.14**															
Update rate	Background read															

21.27	Motoring current limit															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1		1				1	1	1	
Range	0 to MOTOR2_CURRENT_LIMIT_MAX %															
Default	300.0															
Normal parameter	Pr **4.05**															
Update rate	Background read															

21.28	**Regen current limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1		1				1	1	1	
Range	0 to MOTOR2_CURRENT_LIMIT_MAX %															
Default	300.0															
Normal parameter	Pr **4.06**															
Update rate	Background read															

21.29	**Symmetrical current limit**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
						1	1		1				1	1	1	
Range	0 to MOTOR2_CURRENT_LIMIT_MAX %															
Default	300.0															
Normal parameter	Pr **4.07**															
Update rate	Background read															

21.30	**Motor volts per 1000rpm (Ke)**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
													1	1	1	
Range	0 to 10,000															
Default	98															
Normal parameter	Pr **5.33**															
Update rate	Background read															

21.31	**Motor pole pitch**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2						1	1	1	
Range	0 to 655.35 mm															
Default	0.00 mm															
Normal parameter	Pr **5.36**															
Update rate	Background read															

5.24 Menu 22: Additional menu 0 set-up

Menu 22 contains parameters that are used to set up the source parameters for menu 0 in addition to those that are set up from within Menu 11.

22.01 to 22.07 22.10 to 22.11 22.18 22.20 to 22.29	**Parameter 00.xy set-up**															
Coding	Bit	SP	FI	DE	Txt	VM	DP	ND	RA	NC	NV	PT	US	RW	BU	PS
							2					1	1	1	1	
Range	Pr **1.00** to Pr **21.51**															
Default	See Table 5-15															
Update rate	Background read															

These parameters define the parameters that reside in the programmable area in menu 0.

Table 5-15 Menu 22 default settings

Parameter	Menu 0 parameter	Default setting
Pr **22.01**	Pr **031**	Pr **11.33**
Pr **22.02**	Pr **0.32**	Pr **11.32**
Pr **22.03**	Pr **0.33**	Pr **0.00**
Pr **22.04**	Pr **0.34**	Pr **11.30**
Pr **22.05**	Pr **0.35**	Pr **11.24**
Pr **22.06**	Pr **0.36**	Pr **11.25**
Pr **22.07**	Pr **0.37**	Pr **11.23**
Pr **22.10**	Pr **0.40**	Pr **5.12**
Pr **22.11**	Pr **0.41**	Pr **5.18**
Pr **22.18**	Pr **0.48**	Pr **11.31**
Pr **22.20**	Pr **0.50**	Pr **11.29**
Pr **22.21**	Pr **0.51**	Pr **10.37**
Pr **22.22**	Pr **0.52**	Pr **0.00**
Pr **22.23**	Pr **0.53**	Pr **0.00**
Pr **22.24**	Pr **0.54**	Pr **0.00**
Pr **22.25**	Pr **0.55**	Pr **0.00**
Pr **22.26**	Pr **0.56**	Pr **0.00**
Pr **22.27**	Pr **0.57**	Pr **0.00**
Pr **22.28**	Pr **0.58**	Pr **0.00**
Pr **22.29**	Pr **0.59**	Pr **0.00**

It should be noted that if the parameter values saved in the drive EEPROM or on a SMARTCARD are all zero for menu 22 the drive will automatically load defaults for this menu when the drive is powered up or the parameters are transferred from the SMARTCARD. This ensures that defaults are used for this menu if the saved parameters are from a software version which did not include this menu.

5.25 32 bit parameters

All parameters in the drive are 1 bit, 16 bit or 32 bit. This section identifies all the 32 bit parameters in the drive and Solutions Modules.

5.25.1 Drive parameters

The table below contains all the 32 bit parameters present in the drive.

Table 5-16 32 bit drive parameters

Menu	32-bit parameters							
Menu 1	Pr **1.01**	Pr **1.02**	Pr **1.03**	Pr **1.04**	Pr **1.06**	Pr **1.07**	Pr **1.17**	Pr **1.18**
	Pr **1.21**	Pr **1.22**	Pr **1.23**	Pr **1.24**	Pr **1.25**	Pr **1.26**	Pr **1.27**	Pr **1.28**
	Pr **1.36**	Pr **1.37**	Pr **1.39**					
Menu 2	Pr **2.01**	Pr **2.07**	Pr **2.11**	Pr **2.12**	Pr **2.13**	Pr **2.14**	Pr **2.15**	Pr **2.16**
	Pr **2.17**	Pr **2.18**	Pr **2.19**	Pr **2.21**	Pr **2.22**	Pr **2.23**	Pr **2.24**	Pr **2.25**
	Pr **2.26**	Pr **2.27**	Pr **2.28**	Pr **2.29**				
Menu 3	Pr **3.01**	Pr **3.02**	Pr **3.03**	Pr **3.18**	Pr **3.22**	Pr **3.27**		
Menu 4	Pr **4.01**	Pr **4.02**	Pr **4.08**	Pr **4.17**				
Menu 5	Pr **5.01**	Pr **5.03**	Pr **5.07**	Pr **5.08**	Pr **5.24**			
Menu 11	Pr **11.32**							
Menu 20	Pr **20.21**	Pr **20.22**	Pr **20.23**	Pr **20.24**	Pr **20.25**	Pr **20.26**	Pr **20.27**	Pr **20.28**
	Pr **20.29**	Pr **20.30**	Pr **20.31**	Pr **20.32**	Pr **20.33**	Pr **20.34**	Pr **20.35**	Pr **20.36**
	Pr **20.37**	Pr **20.38**	Pr **20.39**	Pr **20.40**				
Menu 21	Pr **21.01**	Pr **21.02**	Pr **21.04**	Pr **21.05**	Pr **21.07**	Pr **21.08**	Pr **21.14**	

5.25.2 Solutions Module parameters

Some Solutions Modules contain 32 bit parameters. Below is a table listing these parameters and the modules in which they are 32 bit parameters

Table 5-17 32 bit Solutions Module parameters

Parameter	Solutions modules in which the parameter is 32 bit
Pr **x.03**	SM-Universal Encoder Plus, SM-Resolver, SM-Encoder Plus, SM-SLM
Pr **x.20**	SM-Universal Encoder Plus
Pr **x.35**	All Fieldbus modules
Pr **x.48**	SM-Applications Plus, SM-Applications, SM-Applications Lite and SM-Applications Lite V2

The SM-Applications and SM-Applications Lite modules contain their own parameter database. Some of the parameters within these modules are 32 bit, and are listed in the table below.

Table 5-18 32 bit SM-Applications Plus, SM-Applications, SM-Applications Lite and SM-Applications Lite V2 parameters

Menu	32-bit parameters							
Menu 70 to Menu 75	Pr **70.00** to Pr **70.99**	Pr **71.00** to Pr **71.99**	Pr **72.00** to Pr **72.99**	Pr **73.00** to Pr **73.99**	Pr **74.00** to Pr **74.99**	Pr **75.00** to Pr **75.99**		
Menu 90	Pr **90.01**	Pr **90.03**	Pr **90.19**	Pr **90.25**	Pr **90.29**	Pr **90.31**	Pr **90.32**	Pr **90.33**
	Pr **90.34**	Pr **90.35**	Pr **90.37**	Pr **90.38**	Pr **90.49**			
Menu 91	Pr **91.02**	Pr **91.03**	Pr **91.04**	Pr **91.05**	Pr **91.06**	Pr **91.17**	Pr **91.18**	Pr **91.19**
	Pr **91.20**							
Menu 100 to Menu 105	Pr **100.00** to Pr **100.99**	Pr **101.00** to Pr **101.99**	Pr **102.00** to Pr **102.99**	Pr **103.00** to Pr **103.99**	Pr **104.00** to Pr **104.99**	Pr **105.00** to Pr **105.99**		
Menu 130 to Menu 135	Pr **130.00** to Pr **130.99**	Pr **131.00** to Pr **131.99**	Pr **132.00** to Pr **132.99**	Pr **133.00** to Pr **133.99**	Pr **134.00** to Pr **134.99**	Pr **135.00** to Pr **135.99**		
Menu 160 to Menu 165	Pr **160.00** to Pr **160.99**	Pr **161.00** to Pr **161.99**	Pr **162.00** to Pr **162.99**	Pr **163.00** to Pr **163.99**	Pr **164.00** to Pr **164.99**	Pr **165.00** to Pr **165.99**		

6 Serial communications protocol

6.1 ANSI communications protocol

6.1.1 Introduction

Digitax ST supports an ANSIx3.28 type comms protocol as supported by previous Control Techniques products with some modification to allow access to 32 bit parameters. This chapter describes the implementation of the protocol for Digitax ST.

6.1.2 Physical layer and UART

Attribute	Description
Physical layer	2 wire EIA485
Bit stream	Standard UART asynchronous symbols with Non Return to Zero (NRZ)
Symbol	Each symbol consists of: 1 start bit 7 data bits (ASCII) 1 parity bit (even parity) 1 stop bit
Baud rates	300, 600, 1200, 2400, 4800, 9600, 19200, 38400

6.1.3 Reading a parameter

The command to read a parameter is:

EOT	End of transmission (Ctl D)
A1	Drive address: 1st digit
A1	Drive address: 1st digit
A2	Drive address: 2nd digit
A2	Drive address: 2nd digit
M1	Menu number: 1st digit
M2	Menu number: 2nd digit
P1	Parameter number: 1st digit
P2	Parameter number: 2nd digit
ENQ	Enquiry (Ctl E)

If the message is correct and the parameter exists the response is:

STX	Start of text (Ctl B)
M1	Menu number: 1st digit
M2	Menu number: 2nd digit
P1	Parameter number: 1st digit
P2	Parameter number: 2nd digit
D1	Data: 1st digit
D2	Data: 2nd digit
-	
-	
Dn	Data: nth digit
ETX	End of text (Ctl C)
	Checksum

The length of the data field varies depending on the number of significant digits required to represent the value of the parameter. The maximum length is 12 digits including the sign and decimal point if present. The data field always starts with a sign, minus sign for negative numbers, or a plus sign for zero and positive numbers. The field may contain a decimal point, but this will not be before all the numbers in the field or after all the numbers in the field. The following examples demonstrate some possible data fields.

Value	Data field
0	+0 (parameter with no decimal places)
0	+0.00 (parameter with 2 decimal places)
1.2	+1.2
-345.78	-345.78
123456	+123456

If the parameter to be read does not exist the End of transmission character (Ctl D) is returned.

The checksum is derived by exclusive ORing the message byte together excluding the STX and the checksum, i.e. Checksum = M1 ^ M2 ^ P1^ P2 ^ D1 ^ D2 ^ ..... Dn ^ ETX. The checksum is an unsigned 8 bit value and if the checksum is less than 32 then 32 is added to the calculated checksum.

6.1.4 Writing to a parameter

The command to write to a parameter is:

EOT	End of transmission (Ctl D)
A1	Drive address: 1st digit
A1	Drive address: 1st digit
A2	Drive address: 2nd digit
A2	Drive address: 2nd digit
STX	Start of text (Ctl B)
M1	Menu number: 1st digit
M2	Menu number: 2nd digit
P1	Parameter number: 1st digit
P2	Parameter number: 2nd digit
D1	Data: 1st digit
D2	Data: 2nd digit
-	
-	
Dn	Data: nth digit
ETX	End of text (Ctl C)
	Checksum

The following rules apply to the data field:

1. The maximum length is 12 characters.
2. The field may contain leading spaces, but not after any other character.
3. A sign character is optional. No sign indicates positive.
4. A decimal point is optional. This can appear at any point in the data field, but not before the sign or before 10 numbers (i.e. the value written should not have more than 9 decimal places). If the decimal point is not in the same position as used by the parameter some accuracy may be lost or extra decimal places added (i.e. if +1.2345 is written to a parameter with one decimal place the result is +1.2, if +1.2 is written to a parameter with three decimal places the result is +1.200). It should be noted that parameters can only have 0, 1, 2, 3, 4, 5, or 6 decimal places.
5. The data field can contain up to 10 numbers, but the value even ignoring decimal points must not exceed the range -2^{31} to $2^{31}-1$.

If the parameter is written successfully an Acknowledge character (Ctl F) is returned. If the parameter does not exist, the value written exceeds the allowed parameter range or the data field rules are not obeyed an Not acknowledge character (Ctl U) is returned.

The checksum is derived by exclusive ORing the message byte together excluding the STX and the checksum, i.e. Checksum = M1 ^ M2 ^ P1^ P2 ^ D1 ^ D2 ^ ..... Dn ^ ETX. The checksum is an unsigned 8 bit value and if the checksum is less than 32 then 32 is added to the calculated checksum.

6.1.5 Drive address

The drive only acts on messages received that contain a drive address if the whole drive address or drive group address match the whole address or the group address in the message, or if the address in the message is 0 (i.e. a global message). Global or group addressing allows data to be written to more than one drive with one command. The drive does not give a response to a global or group write message. Although it is possible to perform a global or group read, this would result in messages crashing if more than one drive responds to the command.

Drive address	Message address	Command	Action
7.8	7.8	Read	Read
7.8	7.8	Write	Write
7.8	7.0	Read	Read
7.8	7.0	Write	Write with no response
7.8	0.0	Read	Read
7.8	0.0	Write	Write with no response

6.1.6 Short commands

The following short commands can be used:

NAK	Not acknowledge (Ctl U)

This is the same as requesting the value of the last parameter to be read or written to. The response is the same as for a normal read.

ACK	Acknowledge (Ctl F)

This is the same as requesting the value of the parameter after the last parameter to be read or written to. The response is the same as for a normal read.

BS	Back space (Ctl H)

This is the same as requesting the value of the parameter before the last parameter to be read or written to. The response is the same as for a normal read.

STX	Start of text (Ctl B)
M1	Menu number: 1st digit
M2	Menu number: 2nd digit
P1	Parameter number: 1st digit
P2	Parameter number: 2nd digit
D1	Data: 1st digit
D2	Data: 2nd digit
-	
-	
Dn	Data: nth digit
ETX	End of text (Ctl C)
	Checksum

Writes to the specified parameter at the same drive address as used by the last read or write.

All the short commands will only read from the drive or write to the drive if a valid address has already been sent to the drive in a previous command. The address is registered as being valid once a read or write command has been completed provide the address was valid for the drive even if the parameter does not exist. The valid address is cancelled if a message is received for a non-valid address or one of the following occurs:

1. The command is aborted because a non-numerical value is received in the drive address, menu or parameter numbers.
2. The command is aborted because the two digits for drive address 1st digit, drive address 2nd digit, menu number or parameter number are not the same as each other.
3. EOT is received.
4. A character other than NAK, ACK, BS or STX is sent as a short command.
5. A character other than ENQ is sent at the end of a read command.

6.1.7 Summary of control characters

		ASCII code	Ctl code
STX	Start of text	02	B
ETX	End of text	03	C
EOT	End of transmission	04	D
ENQ	Enquiry	05	E
ACK	Acknowledge	06	F
BS	Back space	08	H
NAK	Not acknowledge	15	U

6.2 CT Modbus RTU specification

This section describes the adaptation of the MODBUS RTU protocol offered on Control Techniques' products. The portable software class which implements this protocol is also defined.

MODBUS RTU is a master slave system with half-duplex message exchange. The Control Techniques (CT) implementation supports the core function codes to read and write registers. A scheme to map between MODBUS registers and CT parameters is defined. The CT implementation also defines a 32bit extension to the standard 16bit register data format.

6.2.1 MODBUS RTU

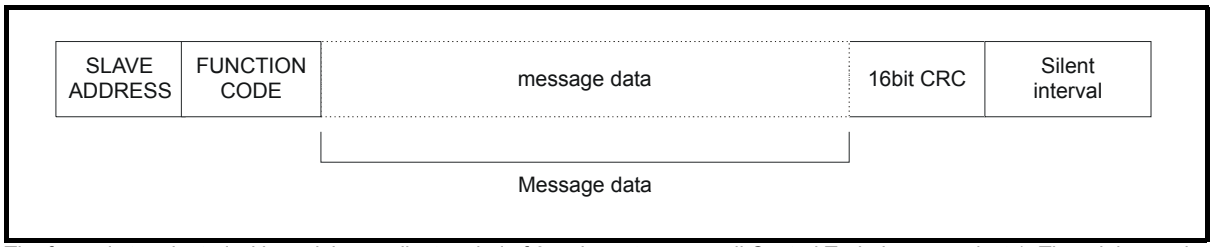
Physical layer

Attribute	Description
Normal physical layer for multi-drop operation	EIA485 2 wire
Bit stream	Standard UART asynchronous symbols with Non Return to Zero (NRZ)
Symbol	Each symbol consists of:- 1 start bit 8 data bits (transmitted least significant bit first) 2 stop bits*
Baud rates	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

*The drive will accept a packet with 1 or 2 stop bits but will always transmit 2 stop bits.

RTU framing

The frame has the following basic format

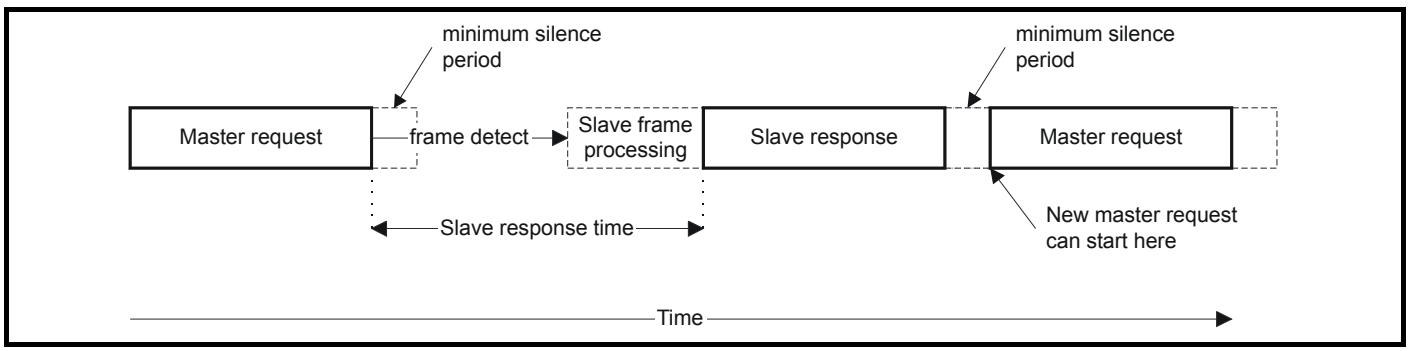


The frame is terminated with a minimum silent period of 3.5 character times (for example, at 19200 baud the minimum silent period is 2 ms). Nodes use the terminating silence period to detect the end of frame and begin frame processing. All frames must therefore be transmitted as a continuous stream without any gaps greater or equal to the silence period. If an erroneous gap is inserted then receiving nodes may start frame processing early in which case the CRC will fail and the frame will be discarded.

MODBUS RTU is a master slave system. All master requests, except broadcast requests, will lead to a response from an individual slave. The slave will respond (i.e. start transmitting the response) within the quoted maximum slave response time (this time is quoted in the data sheet for all Control Techniques products). The minimum slave response time is also quoted but will never be less that the minimum silent period defined by 3.5 character times.

If the master request was a broadcast request then the master may transmit a new request once the maximum slave response time has expired.

The master must implement a message time out to handle transmission errors. This time out period must be set to the maximum slave response time + transmission time for the response.



6.2.2 Slave address

The first byte of the frame is the slave node address. Valid slave node addresses are 1 through 247 decimal. In the master request this byte indicates the target slave node; in the slave response this byte indicates the address of the slave sending the response.

Global addressing

Address zero addresses all slave nodes on the network. Slave nodes suppress the response messages for broadcast requests.

6.2.3 MODBUS registers

The MODBUS register address range is 16bit (65536 registers) which at the protocol level is represented by indexes 0 through 65535.

PLC registers

Modicon PLCs typically define 4 register 'files' each containing 65536 registers. Traditionally, the registers are referenced 1 through 65536 rather than 0 through 65535. The register address is therefore decremented on the master device before passing to the protocol.

File type	Description
1	Read only bits ("coil")
2	Read / write bits ("coil")
3	Read only 16bit register
4	Read / write 16bit register

The register file type code is NOT transmitted by MODBUS and all register files can be considered to map onto a single register address space. However, specific function codes are defined in MODBUS to support access to the "coil" registers.

All standard CT drive parameters are mapped to register file '4' and the coil function codes are not required.

CT parameter mapping

All CT products are parameterized using the #menu.param notation. Indexes 'menu' and 'param' are in the range 0 through 99. The #menu.param is mapped into the MODBUS register space as menu*100 + param.

To correctly map the parameters at the application layer, the slave device increments the received register address. The consequence of this behavior is that #0.0 cannot be accessed.

CT parameter	MODBUS PLC register	Register address (protocol level)	Comments
#X.Y	40000 + X x 100 + Y	X x 100 + Y - 1	#0.0 cannot be accessed
Examples:			
#1.02	40102	101	
#1.00	40100	99	
#0.01	40001	0	
#20.0	42000	1999	

Data types

The MODBUS protocol specification defines registers as 16bit signed integers. All CT devices support this data size.

Refer to the section 6.2.7 *Extended data types* on page 214 for detail on accessing 32bit register data.

6.2.4 Data consistency

All CT devices support a minimum data consistency of one parameter (16bit or 32bit data). Some devices support consistency for a complete multiple register transaction.

6.2.5 Data encoding

MODBUS RTU uses a 'big-endian' representation for addresses and data items (except the CRC, which is 'little-endian'). This means that when a numerical quantity larger than a single byte is transmitted, the MOST significant byte is sent first. So for example

16 - bits 0x1234 would be 0x12 0x34

32 - bits 0x12345678 would be 0x12 0x34 0x56 0x78

6.2.6 Function codes

The function code determines the context and format of the message data. Bit 7 of the function code is used in the slave response to indicate an exception.

The following function codes are supported:

Code	Description
3	Read multiple 16 bit registers
6	Write single register
16	Write multiple 16 bit registers
23	Read and write multiple 16 bit registers

FC03 Read multiple

Read a contiguous array of registers. The slave imposes an upper limit on the number of registers, which can be read. If this is exceeded the slave will issue an exception code 2.

Table 6-1 Master request

Byte	Description
0	Slave destination node address 1 through 247, 0 is global
1	Function code 0x03
2	Start register address MSB
3	Start register address LSB
4	Number of 16bit registers MSB
5	Number of 16bit registers LSB
6	CRC LSB
7	CRC MSB

Table 6-2 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x03
2	Length of register data in read block (in bytes)
3	Register data 0 MSB
4	Register data 0 LSB
3+byte count	CRC LSB
4+byte count	CRC MSB

FC06 Write single register

Writes a value to a single 16 bit register. The normal response is an echo of the request, returned after the register contents have been written. The register address can correspond to a 32 bit parameter but only 16 bits of data can be sent.

Table 6-3 Master request

Byte	Description
0	Slave node address 1 through 247 0 is global
1	Function code 0x06
2	Register address MSB
3	Register address LSB
4	Register data MSB
5	Register data LSB
6	CRC LSB
7	CRC MSB

Table 6-4 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x06
2	Register address MSB
3	Register address LSB
4	Register data MSB
5	Register data LSB
6	CRC LSB
7	CRC MSB

FC16 Write multiple

Writes a contiguous array of registers. The slave imposes an upper limit on the number of registers which can be written. If this is exceeded the slave will discard the request and the master will time out.

Table 6-5 Master request

Byte	Description
0	Slave node address 1 through 247, 0 is global
1	Function code 0x10
2	Start register address MSB
3	Start register address LSB
4	Number of 16 bit registers MSB
5	Number of 16 bit registers LSB
6	Length of register data to write (in bytes)
7	Register data 0 MSB
8	Register data 0 LSB
7+byte count	CRC LSB
8+byte count	CRC MSB

Table 6-6 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x10
2	Start register address MSB
3	Start register address LSB
4	Number of 16 bit registers written MSB
5	Number of 16 bit registers written LSB
6	CRC LSB
7	CRC MSB

FC23 Read/Write multiple

Writes and reads two contiguous arrays of registers. The slave imposes an upper limit on the number of registers which can be written. If this is exceeded the slave will discard the request and the master will time out.

Table 6-7 Master request

Byte	Description
0	Slave node address 1 through 247, 0 is global
1	Function code 0x17
2	Start register address to read MSB
3	Start register address to read LSB
4	Number of 16 bit registers to read MSB
5	Number of 16 bit registers to read LSB
6	Start register address to write MSB
7	Start register address to write LSB
8	Number of 16 bit registers to write MSB
9	Number of 16 bit registers to write LSB
10	Length of register data to write (in bytes)
11	Register data 0 MSB
12	Register data 0 LSB
11+byte count	CRC LSB
12+byte count	CRC MSB

Table 6-8 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x17
2	Length of register data in read block (in bytes)
3	Register data 0 MSB
4	Register data 0 LSB
3+byte count	CRC LSB
4+byte count	CRC MSB

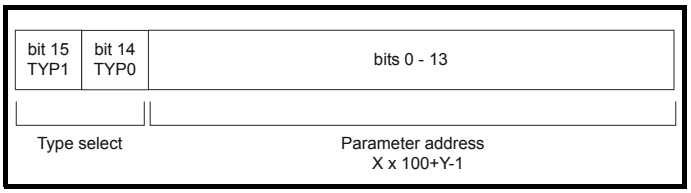
6.2.7 Extended data types

Standard MODBUS registers are 16bit and the standard mapping maps a single #X.Y parameter to a single MODBUS register. To support 32bit data types (integer and float) the MODBUS multiple read and write services are used to transfer a contiguous array of 16 bit registers.

Slave devices typically contain a mixed set of 16 bit and 32 bit registers. To permit the master to select the desired 16 bit or 32 bit access the top two bits of the register address are used to indicate the selected data type.

NOTE

The selection is applied for the whole block access.



The 2bit type field selects the data type according to the table below:

Type field bits 15-14	Selected data type	Comments
00	INT16	backward compatible
01	INT32	
10	Float32	IEEE754 standard Not supported on all slaves
11	Reserved	

If a 32 bit data type is selected then the slave uses two consecutive 16 bit MODBUS registers (in 'big endian'). The master must also set the correct 'number of 16 bit registers'.

Example, read #20.21 through #20.24 as 32 bit parameters using FC03 from node 8:

Table 6-9 Master request

Byte	Value	Description
0	0x08	Slave destination node address
1	0x03	FC03 multiple read
2	0x47	Start register address #20.21 (16384 + 2021 - 1) = 18404 = 0x47E4
3	0xE4	
4	0x00	Number of 16bit registers to read #20.21 through #20.24 is 4x32 bit registers = 8x16 bit registers
5	0x08	
6	CRC LSB	
7	CRC MSB	

Table 6-10 Slave response

Byte	Value	Description
0	0x08	Slave destination node address
1	0x03	FC03 multiple read
2	0x10	Length of data (bytes) = 4x32 bit registers = 16 bytes
3-6		#20.21 data
7-10		#20.22 data
11-14		#20.23 data
15-18		#20.24 data
19	CRC LSB	
20	CRC MSB	

Reads when actual parameter type is different from selected

The slave will send the least significant word of a 32 bit parameter if that parameter is read as part of a 16 bit access.

The slave will sign extend the least significant word if a 16 bit parameter is accessed as a 32 bit parameter. The number of 16 bit registers must be even during a 32 bit access.

Example, If #1.28 is a 32 bit parameter with a value of 0x12345678, #1.29 is a signed 16 bit parameter with a value of 0xABCD, and #1.30 is a signed 16 bit parameter with a value of 0x0123.

Read	Start register address	Number of 16 bit registers	Response	Comments
#1.28	127	1	0x5678	Standard 16 bit access to a 32 bit register will return low 16 bit word of truncated data
#1.28	16511*	2	0x12345678	Full 32 bit access
#1.28	16511*	1	Exception 2	Number of words must be even for 32 bit access
#1.29	128	1	0xABCD	Standard 16 bit access to a 32 bit register will return low 16 bit word of data
#1.29	16512*	2	0xFFFFABCD	32 bit access to a 16 bit register will return 32 bit sign extended data
#1.30	16513*	2	0x00000123	32 bit access to a 16 bit register will return 32 bit sign extended data
#1.28 - #1.29	127	2	0x5678, 0xABCD	Standard 16 bit access to a 32 bit register will return low 16 bit word of truncated data
#1.28 - #1.29	16511*	4	0x12345678, 0xFFFFABCD	Full 32 bit access

*Bit 14 is set to allow 32 bit access

Writes when actual parameter type is different from selected

The slave will allow writing a 32 bit value to a 16 bit parameter as long as the 32 bit value is within the normal range of the 16 bit parameter.

The slave will allow a 16 bit write to a 32 bit parameter. The slave will sign extend the written value, therefore, the effective range of this type of write will be ±32767.

Examples, if #1.28 has a range of ±100000, and #1.29 has a range of ±10000.

Write	Start register address	Number of 16 bit registers	Data	Comments
#1.28	127	1	0x1234	Standard 16 bit write to a 32 bit register. Value written = 0x00001234
#1.28	127	1	0xABCD	Standard 16 bit write to a 32 bit register. Value written = 0xFFFFABCD
#1.28	16511*	2	0x00001234	Value written = 0x00001234
#1.29	128	1	0x0123	Value written = 0x0123
#1.29	16512*	2	0x00000123	Value written = 0x00000123

*Bit 14 is set to allow 32 bit access

6.2.8 Exceptions

The slave will respond with an exception response if an error is detected in the master request. If a message is corrupted and the frame is not received or the CRC fails then the slave will not issue an exception. In this case the master device will time out. If a write multiple (FC16 or FC23) request exceeds the slave maximum buffer size then the slave will discard the message. No exception will be transmitted in this case and the master will time out.

Exception message format

The slave exception message has the following format.

Byte	Description
0	Slave source node address
1	Original function code with bit7 set
2	Exception code
3	CRC LSB
4	CRC MSB

Exception codes

The following exception codes are supported.

Code	Description
1	Function code not supported
2	Register address out of range, or request to read too many registers

Parameter over range during block write FC16

The slave processes the write block in the order the data is received. If a write fails due to an out of range value then the write block is terminated. However, the slave does not raise an exception response, rather the error condition is signalled to the master by the number of successful writes field in the response.

Parameter over range during block read/write FC23

There will be no indication that there has been a value out of range during a FC23 access.

6.2.9 CRC

The CRC is a 16 bit cyclic redundancy check using the standard CRC-16 polynomial x16 + x15 + x2 + 1. The 16 bit CRC is appended to the message and transmitted LSB first.

The CRC is calculated on ALL the bytes in the frame.

6.2.10 Device compatibility parameters

All devices have the following compatibility parameters defined:

Parameter	Description
Device ID	Unique device identification code
Minimum slave response time	The minimum delay between the end of a message from the master and the time at which the master is ready to receive a response from the slave. Refer to Pr **11.26**
Maximum slave response time	When global addressing, the master must wait for this time before issuing a new message. In a network of devices, the slowest time must be used
Maximum baud rate	115, 200
32bit float data type supported	If this data type is not supported then an over range error will be raised if this data type is used
Maximum buffer size	Determines the maximum block size.

7 Electronic nameplate

The electronic nameplate system is a means of storing some specific drive parameters within the EEPROM of a Stegmann or Heidenhain encoder attached to the drive. The system used is similar to that implemented in other Control Techniques products. The parameters stored in the encoder are in two categories: motor object parameters, and performance object parameters.

Motor object parameters

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

Performance object parameters

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

Loading/storing object parameters

Parameters may be transferred to or from the drive to a suitable encoder attached to the drive or one of its Solutions Modules by entering a code into Pr **x.00** and then resetting the drive as shown in the table below. The z in the request defines the location of the encoder for the transfer (0=drive, 1=Solutions Module slot 1, etc.)

Parameter x.00 code	Data transferred	Direction
110z0	Motor object parameters	Drive to encoder
110z1	Motor object parameters	Encoder to drive
110z2	Performance object block 1 parameters	Drive to encoder
110z3	Performance object block 1 parameters	Encoder to drive
110z4	Performance object block 2 parameters	Drive to encoder
110z5	Performance object block 2 parameters	Encoder to drive

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

It should be noted that the data within the objects in the encoder is undefined until it has been written and that the manufacturer's data is undefined until it has been written by a complete motor object write with Pr **3.49** set to one.

The tables given below show the motor and performance objects. For HIPERFACE encoders the data block and the byte address within the block is given. For EnDat encoders the data is stored as words in the OEM parameter area at the addresses shown. (Byte 0 indicates LS byte).

NOTE

The function only works with SC.Hiper and SC.Endat encoders.

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

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

7.1 Motor object

Table 7-1 Motor object

HIPERFACE		EnDat		Parameter	Parameter description	Byte
Block	Address	Address	Byte			
0	0	0	0		Checksum	0
0	1	0	1			1
0	2	1	0		Number of bytes	0
0	3	1	1			1
0	4	2	0	**(18.11)**	Motor object version number	0
0	5	2	1			1
0	6	3	0	**(18.12)**	Motor type (LSW)	0
0	7	3	1			1
0	8	4	0	**(18.13)**	Motor type (MSW)	0
0	9	4	1			1
0	10	5	0	**(18.14)**	Motor manufacturer	0
0	11	5	1			1
0	12	6	0	**(18.15)**	Motor serial number (LSW)	0
0	13	6	1			1
0	14	7	0	**(18.16)**	Motor serial number	0
0	15	7	1			1
0	16	8	0	**(18.17)**	Motor serial number (MSW)	0
0	17	8	1			1
0	18	9	0	**1.06**	Maximum speed	0
0	19	9	1			1
0	20	10	0			2
0	21	10	1	**3.18**	Motor and load inertia	0
0	22	11	0			1
0	23	11	1			2
0	24	12	0	**3.25**	Encoder phase angle	0
0	25	12	1			1
0	26	13	0	**4.15**	Motor thermal time constant	0
0	27	13	1			1
0	28	14	0	**4.25**	Low speed thermal protection mode	0
0	29	14	1		Reserved	0
0	30	15	0		Reserved	1
0	31	15	1	**5.07**	Rated current	0
0	32	16	0			1
0	33	16	1			2
0	34	17	0	**5.08**	Rated load rpm	0
0	35	17	1			1
0	36	18	0			2
0	37	18	1	**5.09**	Rated voltage	0
0	38	19	0			1
0	39	19	1	**5.10**	Rated power factor	0
0	40	20	0			1
0	41	20	1	**5.11**	Motor poles	0
0	42	21	0	**5.17**	Stator resistance (Rs)	0
0	43	21	1			1
0	44	22	0	**5.24**	Transient inductance (Ls')	0
0	45	22	1			1
0	46	23	0			2
0	47	23	1		Reserved	0
0	48	24	0		Reserved	1
0	49	24	1		Reserved	2
0	50	25	0		Reserved	0
0	51	25	1		Reserved	0
0	52	26	0	**5.32**	Motor torque per amp (Kt)	0

HIPERFACE		EnDat		Parameter	Parameter description	Byte
Block	Address	Address	Byte			
0	53	26	1			1
0	54	27	0	**5.33**	Motor volts per 1,000 rpm (Ke)	0
0	55	27	1			1
0	56	28	0		Spare 0	0
0	57	28	1		Spare 1	0
0	58	29	0		Spare 2	0
0	59	29	1		Spare 3	0
0	60	30	0		Spare 4	0
0	61	30	1		Spare 5	0
0	62	31	0		Spare 6	0
0	63	31	1		Spare 7	0

7.2 Performance objects

Table 7-2 Performance object 1

HIPERFACE		EnDat		Parameter	Parameter description	Byte
Block	Address	Address	Byte			
1	0	32	0		Checksum	0
1	1	32	1			1
1	2	33	0		Number of bytes	0
1	3	33	1			1
1	4	34	0	**3.10**	Speed controller Kp gain	0
1	5	34	1			1
1	6	35	0	**3.11**	Speed controller Ki gain	0
1	7	35	1			1
1	8	36	0	**3.12**	Speed controller Kd gain	0
1	9	36	1			1
1	10	37	0	**3.17**	Speed controller set-up method	0
1	11	37	1	**3.19**	Compliance angle	0
1	12	38	0			1
1	13	38	1	**3.20**	Bandwidth	0
1	14	39	0	**3.21**	Damping factor	1
1	15	39	1	**4.05**	Motoring current limit	0
1	16	40	0			1
1	17	40	1	**4.06**	Regen current limit	0
1	18	41	0			1
1	19	41	1	**4.12**	Torque demand filter	0
1	20	42	0	**4.13**	Current controller Kp gain	0
1	21	42	1			1
1	22	43	0	**4.14**	Current controller Ki gain	0
1	23	43	1			1
1	24	44	0		Spare 0	0
1	25	44	1		Spare 1	0
1	26	45	0		Spare 2	0
1	27	45	1		Spare 3	0
1	28	46	0		Spare 4	0
1	29	46	1		Spare 5	0
1	30	47	0		Spare 6	0
1	31	47	1		Spare 7	0

Table 7-3 Performance object 2

HIPERFACE		EnDat		Parameter	Parameter description	Bytes
Block	**Address**	**Address**	**Byte**			
2	0	48	0		Checksum	0
2	1	48	1			1
2	2	49	0		Number of bytes	0
2	3	49	1			1
2	4	50	0	**3.10**	Speed controller Kp gain	0
2	5	50	1			1
2	6	51	0	**3.11**	Speed controller Ki gain	0
2	7	51	1			1
2	8	52	0	**3.12**	Speed controller Kd gain	0
2	9	52	1			1
2	10	53	0	**3.17**	Speed controller set-up method	0
2	11	53	1	**3.19**	Compliance angle	0
2	12	54	0			1
2	13	54	1	**3.20**	Bandwidth	0
2	14	55	0	**3.21**	Damping factor	1
2	15	55	1	**4.05**	Motoring current limit	0
2	16	56	0			1
2	17	56	1	**4.06**	Regen current limit	0
2	18	57	0			1
2	19	57	1	**4.12**	Torque demand filter	0
2	20	58	0	**4.13**	Current controller Kp gain	0
2	21	58	1			1
2	22	59	0	**4.14**	Current controller Ki gain	0
2	23	59	1			1
2	24	60	0		Spare 0	0
2	25	60	1		Spare 1	0
2	26	61	0		Spare 2	0
2	27	61	1		Spare 3	0
2	28	62	0		Spare 4	0
2	29	62	1		Spare 5	0
2	30	63	0		Spare 6	0
2	31	63	1		Spare 7	0

8 Performance

8.1 Digital speed reference

Table 8-1 Accuracy and resolution

	Preset	Precision
Accuracy	0.01 %*	0.01 %*
Resolution	0.1 rpm	0.001 rpm

*0.01 % of the reference

8.2 Analog reference

Table 8-2 Update rates

Analog input	Pr 1.36 & Pr 1.37	Pr 4.08	Pr 3.22	Other
1	250 µs*	4 ms*	250 µs*	4 ms*
2 and 3	250 µs	250 µs	250 µs	4 ms

* Analog input 1 is subject to a window filter as defined in Pr **7.26**.

Table 8-3 Resolution

Analog input	Resolution
1	16 bits plus sign*
2 and 3	10 bit plus sign

*16 bit plus sign as a speed reference, resolution = Pr **7.26** x 500 x 10^3 .

8.3 Analog outputs

Table 8-4 Resolution and update rate

Resolution (voltage mode)	10 bit plus sign
Resolution (current mode)	10 bit
Update rate	4 ms
Update rate (high speed update - voltage mode only)*	250 µs

*When sourced from Pr **3.02,** Pr **4.02**, Pr **4.17** and Pr **5.03**.

8.4 Digital inputs and outputs

Table 8-5 Response times

Switching frequency	Terminals	Pr 6.35 / Pr 6.36 (Limit switches)	Other
All	24-26 as input	250 µs	4 ms
All	24-26 as output	4 ms	4 ms
All	27-29	250 µs	4 ms
All	31 (enable)	-	4 ms*
All	31 (disable)	-	<100 µs
All	Relay output closing	4 ms*	4 ms*
All	Relay output opening	4 ms*	4 ms*

* Software only

8.5 Current feedback

Accuracy: 5 % worst case, 2 % typical
Resolution: 10 bit plus sign
Full scale resolution is equivalent to the OI.AC trip level of 381 % of Maximum rated current or 222 % of the Current Scaling value Kc. For information on the values of the Maximum rated current and Current Scaling value for a drive, see Table 5-3 on page 68.

8.6 Bandwidth

The following bandwidth values are for 12 kHz PWM switching frequency:

8.6.1 Speed loop

The speed loop bandwidth is 160 Hz

8.6.2 Current loop

The current loop bandwidth is 1100 Hz for the 3 dB point, and 400 Hz for the 45 °point.

1. The gain characteristic and associated 3 dB point is most useful where drive is used in an application where the current controller is not included within an outer control loop.
2. The phase characteristic and associated 45 ° point is most useful where the current controller is used within an outer control loop such as a speed controller. The phase delay of the current controller has a limiting effect on the response of the outer loop.

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