



EMERSON[™]
Industrial Automation

User Guide

Flying Shear

Application Software



Option Software for:

- Unidrive-M

Part Number: 0471-0150-10

Issue Number: 2



www.controltechniques.com



Safety Information

Persons supervising and performing the electrical installation or maintenance of a Drive and/or an external Option Unit must be suitably qualified and competent in these duties. They should be given the opportunity to study and if necessary to discuss this User Guide before work is started.

The voltages present in the Drive and external Option Units are capable of inflicting a severe electric shock and may be lethal. The Stop function of the Drive does not remove dangerous voltages from the terminals of the Drive and external Option Unit. Mains supplies should be removed before any servicing work is performed.

The installation instructions should be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the Drive and external Option Unit, and the way in which they are operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom and applicable legislation and regulations and codes of practice in the UK or elsewhere.

The Drive software may incorporate an optional Auto-start facility. In order to prevent the risk of injury to personnel working on or near the motor or its driven equipment and to prevent potential damage to equipment, users and operators, all necessary precautions must be taken if operating the Drive in this mode.

The Stop and Start inputs of the Drive should not be relied upon to ensure safety of personnel. If a safety hazard could exist from unexpected starting of the Drive, an interlock should be installed to prevent the motor being inadvertently started.

General Information

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

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

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1 Introduction

1.1 Who should read this manual

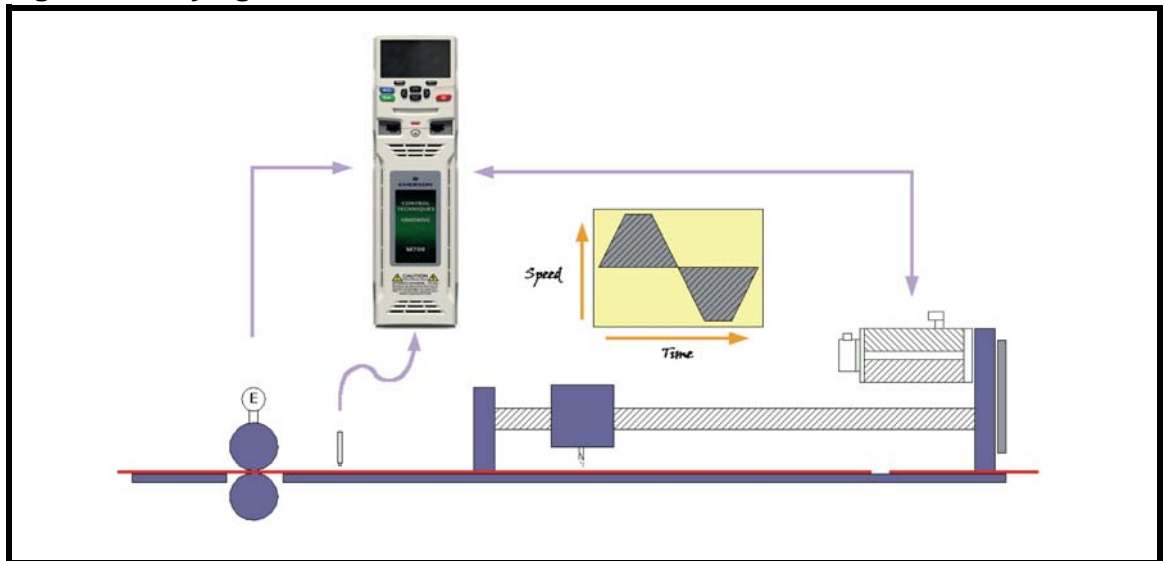
This manual is intended to assist the engineer with the commissioning / start up of the application software, and should be read in conjunction with the documentation that is supplied with the drive and other associated hardware.

The safety systems that are required to prevent risk of injury to persons operating or maintaining the machine are not discussed in this manual. The engineer must be familiar with and be able to implement the required safety systems. This manual assumes that the engineer is familiar with relevant Control Techniques products and understands the requirements for the application.

If in any doubt contact your local Control Techniques drive centre or distributor to obtain service or advice.

1.2 Application overview

Figure 1-1 Flying Shear overview



The Flying Shear is a common industrial application for cutting a product into smaller lengths without stopping the line. This means that the main production process is not interrupted, and so machine productivity is maximised.

The cutting tool is typically mounted on a carriage that moves either parallel to the product flow, or at an angle across the product flow.

The flying shear drive accelerates the carriage to synchronize with the line speed, and when synchronization is achieved the cut is made. The carriage then decelerates and returns to its original position in readiness for the next cut.

There are many other similar applications where a carriage must be synchronized at line speed, and most of these can also be accommodated using the flying shear application software.

The drive is configured using real engineering units of choice i.e. mm or inches. The configuration of the system is simplified using an operator interface or by entering configuration parameters directly on the drive.

The forward profile is optimized for each application by breaking the synchronized part of the profile down into three areas (entered in ms):

- settling time
- cut time
- tool rise time

The drive will then calculate the profile and perform checks to ensure that the parameters entered are achievable, given the length of motion available, and also the required cut length.

Typical applications include various types of cut to length machines, depositors, punches, product inspection, or any other process where synchronization at line speed is required.

A couple of possible applications are:

A machine extrudes plastic pipes that must be supplied to the customer in pre-cut lengths. The extrusion process requires the extruder to run at a continuous speed to maintain the quality of the product. The pipe is uniform along its length and provided the length is within a set tolerance then the pipe is fit for sale. The flying shear is used to cut the product cyclically.

The end product is a steel carton. In the first part of the process the steel is printed and must then be punched using a registration mark printed on the product. The flying shear is used to detect a mark and accurately synchronize the shear with reference to the mark.

1.3 Features

- Easy configuration.
- Hardware and software limits.
- Fieldbus interfaces are available: Ethernet, CT-Net, Profibus, Devicenet, Interbus, Modbus plus, CANopen and EIA(RS) -485.
- Manual functions are available such as Jogging.
- High speed output can be used to fire the cutting tool.
- Registration can be used to initiate the cut.
- Batch counter and control.
- Dynamic motion profile changes such as cut lengths, etc.
- Real engineering units are used, defined as the number of Line or shear encoder counts per unit.
- Resolution of the cut length may be entered to within 0.001 units.
- Tool width compensation.
- Profile optimization reduces the machines mechanical stress: The return profile is calculated to operate at the slowest speed and acceleration rate, and yet with sufficient time to achieve the next cut, either triangular or trapezoidal profiles are used.
- A range of tool control modes.
- Gap Control - a typical requirement for log cutting applications.
- Parallel or angled shear carriages.
- Registration, with or without windowing.

2 Mechanical installation

NOTE Ensure the drive is correctly installed in accordance with the relevant Unidrive-M *User Guide*.

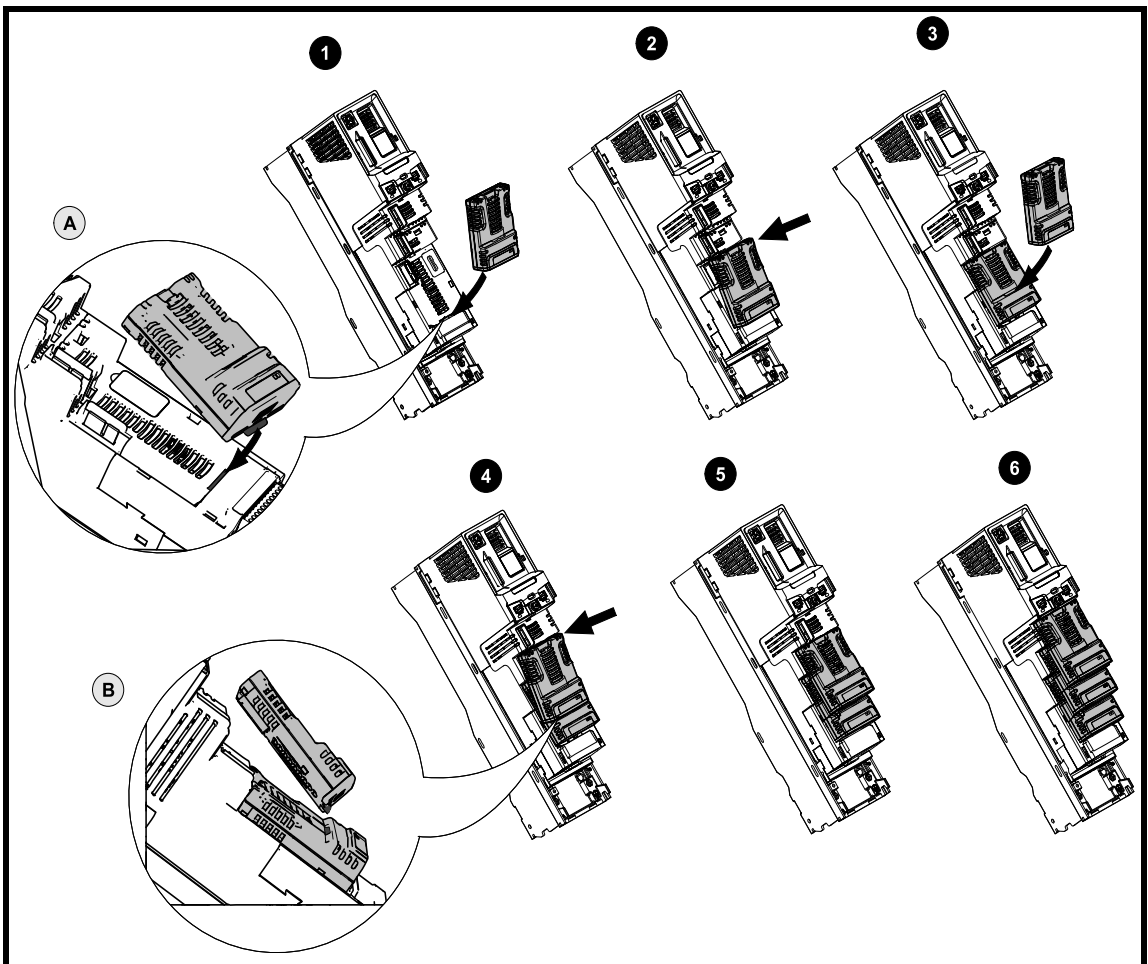
2.1 Installing Unidrive-M Solutions Modules

Unidrive-M has two size option modules, standard option modules and large option modules, they are be fitted in different ways..

2.1.1 Installing a standard option module

Installing the first option module

- Move the option module in direction shown (1).
- Align and insert the option module tab in to the slot provided (2), this is highlighted in the detailed view (A).
- Press down on the option module until it clicks into place.



Installing the second option module

- Move the option module in direction shown (3).
- Align and insert the option module tab in to the slot provided on the already installed option module (4), this is highlighted in the detailed view (B).
- Press down on the option module until it clicks into place. Image (5) shows two option modules fully installed.

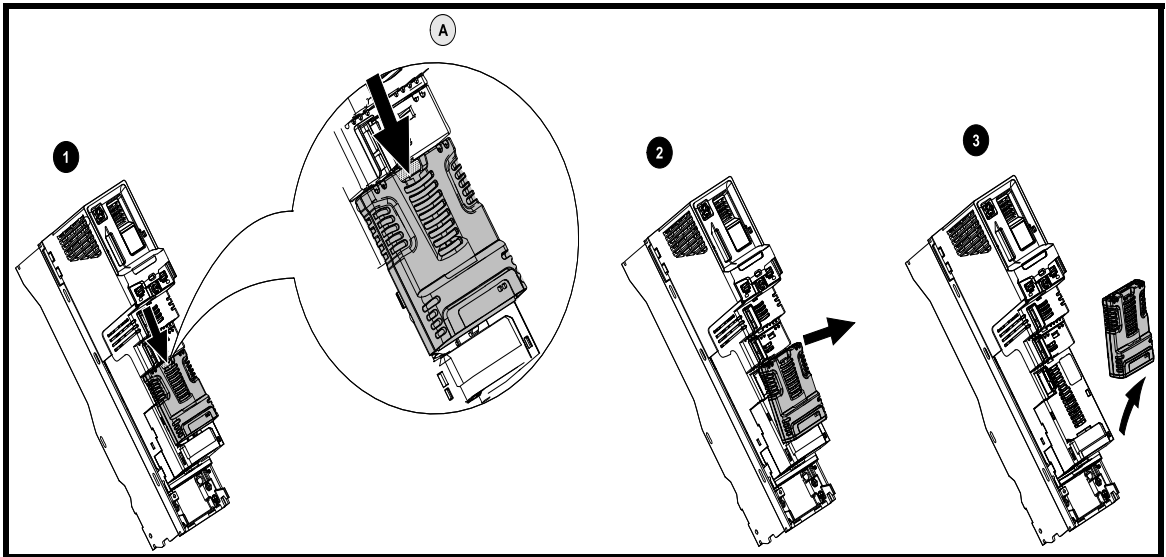
Installing the third option module

- Repeat the above process.

The drive has the facility for all three option module slots to be used at the same time, image (6) shows the three option modules installed.

Removal of the option modules

- Press down on the tab (1) to release the option module from the drive housing, the tab is highlighted in the detailed view (A).
- Tilt the option module towards you as shown (2).
- Totally remove the option module in direction shown (3).



2.1.2 Installing a large option module

Installing a large option module

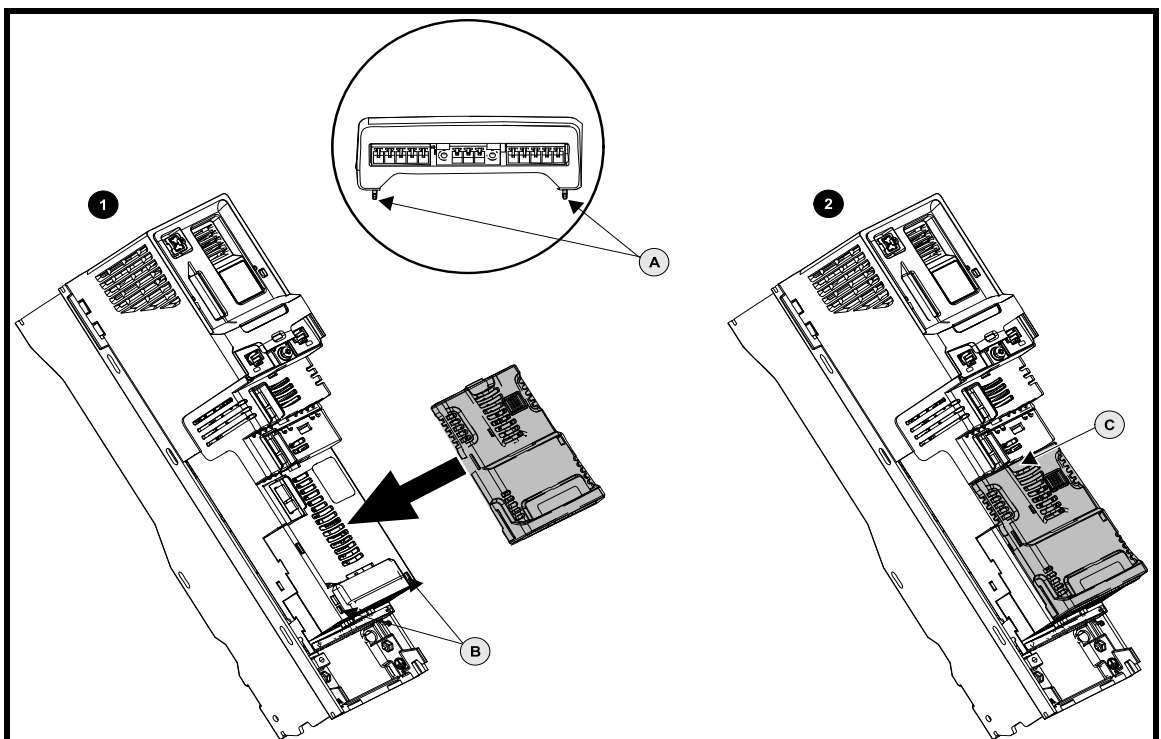
- Move the option module in direction shown (1).
- Align and insert the option module tabs (A) into the slot provided (B).
- Press down on the option module until it clicks into place.

Removing a large option module

- Press down on the tab (2C), tilt the option module towards you and remove.

NOTE

The large option module can only be inserted into slot 3. Additional standard option modules can still be installed and used in slot 2 and slot 1.



3 Electrical installation

3.1 Control

+24V digital supply (terminal 22)

Supply for external digital signal devices.

Voltage Tolerance:	±10%
Nominal output current:	100 mA combined with DIO3
Overload output current:	200 mA (total including all Digital I/O)
Protection:	Current limit and trip

+10V analog supply (Terminal 4)

Supply for external analog signal devices

Voltage tolerance:	±1%
Nominal output current:	10mA
Protection:	Current limit and trip @ 30 mA

3.2 Power / motor connections

Please refer to the relevant drive *User Guide* for information regarding:

- Voltage rating
- Current rating
- Motor connections
- Encoder / resolver connections

3.3 Unidrive-M connector locations

Figure 3-1 Unidrive-M control terminal connections

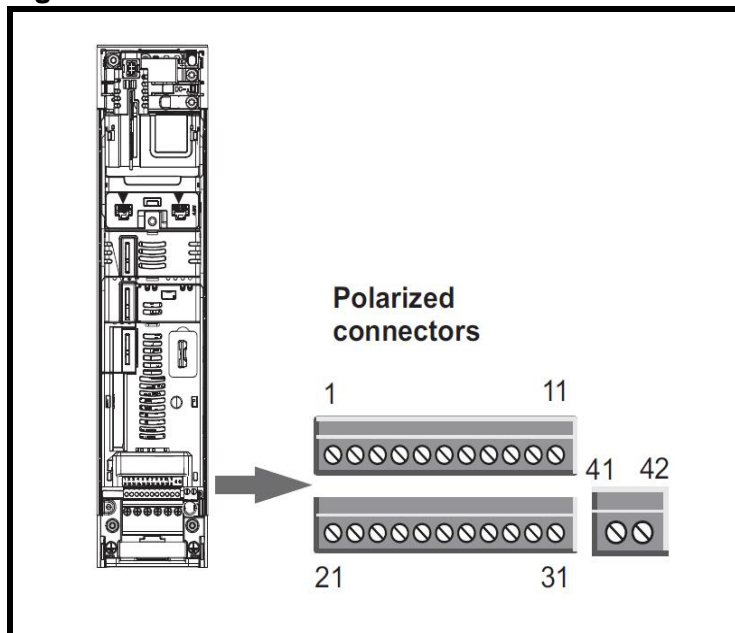
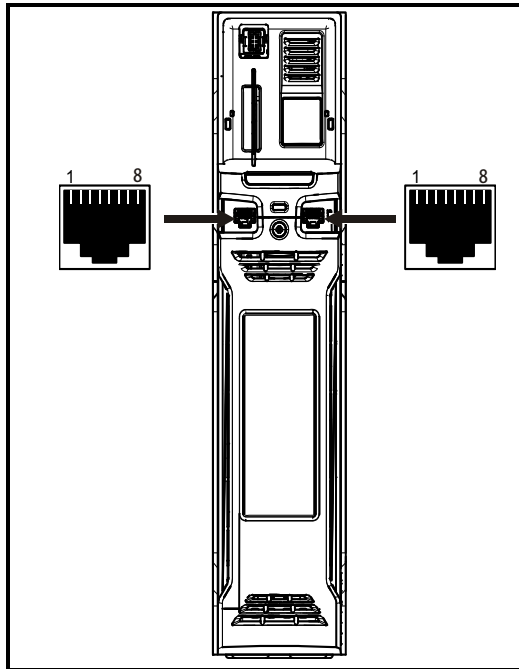


Table 3-1 Unidrive-M control terminal connections

Term	Function
1	0V common
2	24Vdc external Input supply
3	0v common
4	+10Vdc analog supply
5	Analog input 1 (non-inverting)
6	Analog input 1 (inverting)
7	Analog input 2
8	Analog input 3
9	Analog output 1
10	Analog output 1
11	0v common
21	0v common
22	24Vdc user output supply
23	0v common
24	Digital I/O 1
25	Digital I/O 2
26	Digital I/O 3
27	Digital input 1
28	Digital input 2
29	Digital input 3
30	0v common
31	SAFE TORQUE OFF / drive enable
41	Relay contacts
42	

3.3.1 Communication Connections

The Unidrive M700 drive offers Ethernet fieldbus communications and the Unidrive M701 drive offers a 2 wire 485 interface. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller if required.



- **Unidrive M700 Ethernet fieldbus communications**

The SI-Applications Plus module has 3 screw terminal blocks, where terminals 1 to 5 are The Ethernet option provides two RJ45 connections with an Ethernet switch for easy network creation. Standard UTP (unshielded twisted pair) or STP (shielded twisted pair)

cables are supported. It is recommended that a minimum specification CAT5e is used in new installations. As the drive supports the 'Auto cross-over detection' a cross-over cable is not required.

- **485 serial communications (Unidrive M701)**

The 485 option provides two parallel RJ45 connectors allowing easy daisy chaining. The drive only supports Modbus RTU protocol. See below Table for the connection details.

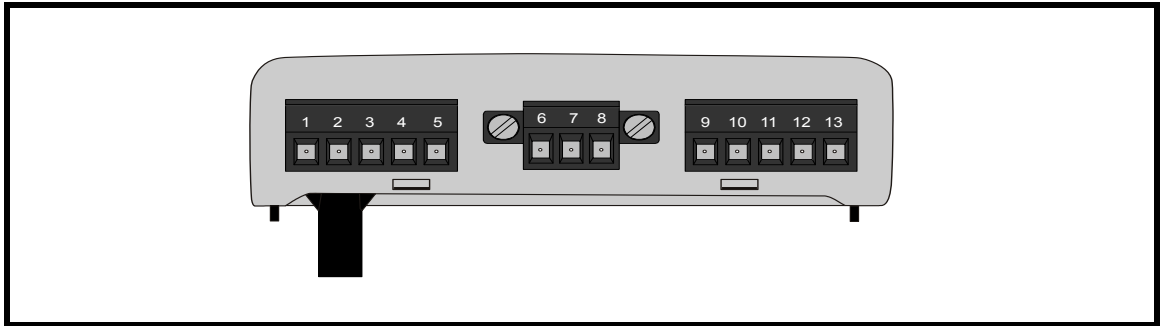
RJ45 Connector Pin out

Term	Function
1	Terminating Resistor
2	RX - TX
3	Isolated 0V
4	+24V(100mA)
5	Isolated 0V
6	Tx Enable
7	/Rx - /Tx
8	Rx\ Tx\ (if termination resistors are required, link to pin 1)

3.3.2 Application module connections

The SI-Applications Plus module has 3 screw terminal blocks, where Terminals 1 to 5 are on the left connector, Terminals 6 to 8 are on the middle connector, and Terminals 9 to 13 are on the right connector.

Figure 3-2 SI-Applications Plus Module - Front View



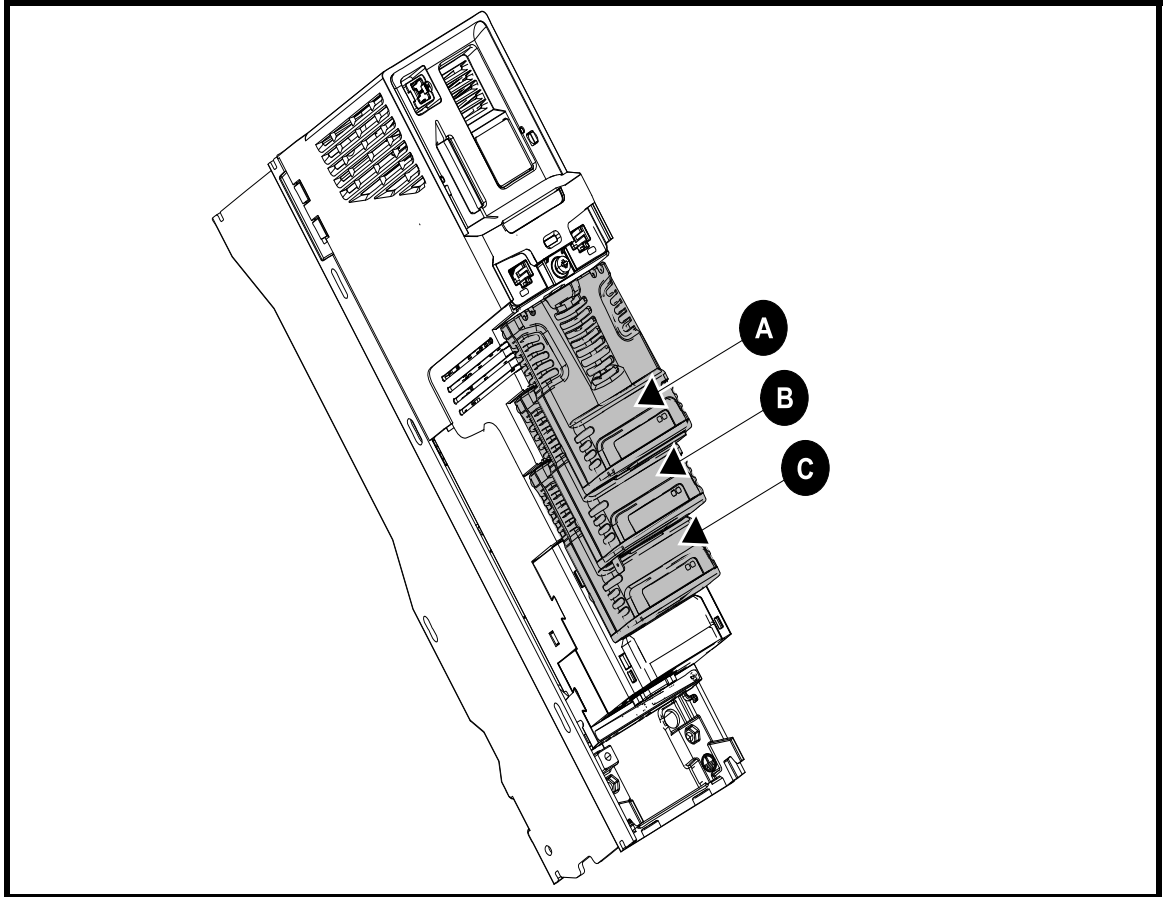
The terminals are numbered from Terminal 1 on the left hand side to Terminal 13 on the right. The terminal functions are detailed in Table 3-2 below.

Table 3-2 Connection detail SI-Applications Plus module

Term	Function	Description
1	0V SC	0V connection for RS485 port
2	/RX EIA-RS485	Receive line - incoming
3	RX EIA-RS485	Receive line + incoming
4	/TX EIA-RS485	Transmit line - outgoing
5	TX EIA-RS485	Transmit line + outgoing
6	CTNET A	CTNet data line
7	CTNet Shield	Shield connection for CTNet
8	CTNET B	CTNet data line
9	0V	0V connection for digital I/O
10	DIO	Digital input 0
11	DI1	Digital input 1
12	DO0	Digital output 0
13	DO1	Digital output 1

3.3.3 Slot menus

Figure 3-3 Unidrive-M slot menus



3.4 Analog I/O

3.4.1 Specification

Table 3-3 Analog inputs

Specification	Input output
Type of Input	1 x Differential 2 x Single-ended
Full scale Input voltage	$\pm 10\text{ V} \pm 2\%$
Input resistance	$\geq 100\text{ k}\Omega$
Absolute Maximum Input	$\pm 36\text{ V}$ with respect to 0V
Resolution	12 bits (11 bits plus sign)
Update period	250 μs with destinations Pr 01.036 , Pr 01.037 , Pr 03.022 or Pr 04.008 in RFC-A and RFC-S modes. 4 ms for open loop mode and all other destinations in RFC-A or RFC-S modes.

Table 3-4 Analog outputs

Specification	Input output
Type of output	Single-ended
Max. Output voltage	$\pm 10\text{ V} \pm 5\%$
Load resistance	$\geq 1\text{ k}\Omega$
Protection	20 mA max. Short circuit protection
Resolution	10-bit plus sign
Update period	250 μs

3.4.2 Analog signal types

Analog inputs

The Unidrive-M analog inputs 2(term 7) ,3(term 8), can accept current or voltage signals as tabulated below,. Analog input 3 can be also configured for motor thermistor input, (types 7-9).

Table 3-5 Analog input detail

Number	Parameter mnemonic	Signal type
-4	4-20 mA Low	4-20mA switching to equivalent of 4mA input current on loss
-3	20-4 mA Low	20-4mA switching to equivalent of 20mA input current on loss
-2	4-20 mA Hold	4-20mA hold at level before loss on loss
-1	20-4 mA Hold	20-4mA hold at level before loss on loss
0	0-20 mA	0 – 20mA
1	20-0 mA	20 – 0mA
2	4-20 mA Trip	4-20mA trip on lost7
3	20-4 mA Trip	20-4mA trip on loss
4	4-20 mA	4-20mA no action on loss
5	20-4 mA	20-4mA no action on loss
6	Volt	+/- 10V input
7	Therm Short Cct	Motor Thermistor with trip on short circuit detection
8	Thermistor	Motor Thermistor without short circuit detection
9	Therm No Trip	Thermistor mode with display only and no trip
0	0 - 20	0 – 20mA
1	20 - 0	20 – 0mA
2	4-20.tr	4 – 20mA (Trip on <3mA)

3	20-4.tr	20 – 4mA (Trip on loss <3mA)
4	4-20	4 – 20mA (No trip on loss)
5	20-4	20 – 4mA (No trip on loss)
6	VOLt	+/- 10V input
7	th.SC	Motor Thermistor with trip on short circuit detection*
8	th	Motor Thermistor without short circuit detection*
9	Th.diSp	Thermistor mode with display only and no trip

The above are configured by the following parameters:

07.007 – Analog Input 1, Terminal 5&6 (types -4-6)

07.011 – Analog Input 2, Terminal 7 (types -4-6)

07.015 – Analog Input 3, Terminal 8 (types 6-9)

To maintain maximum flexibility no specific assignments of analog inputs are provided. All these signals are available and can be re-directed to the required analog input parameter.

Table 3-6 Analog outputs

Number	Parameter mnemonic	Signal type
0	Volt	Output range $\pm 10V$.

The Unidrive-M Analog Outputs can only derive voltage signal.

Other industrial signals

Interfacing to the drive analog inputs with other industrial feedback sources, i.e. resistive sensing PT100, thermocouples, etc requires the use of an external signal converter.

NOTE

If additional I/O is required for your application, then fit an SI-I/O Plus module. See the relevant manuals for more details.

3.5 Digital I/O

3.5.1 Specification

Table 3-7 Digital input output

Specification	Input output
Type of Input/output	Positive or negative logic digital inputs, positive logic voltage source outputs.
Voltage range	- 0V to +24V
Absolute max. Voltage range	-3V to +30V
Input current @ +24V	>2mA @ 15Vdc
Output current	100mA (DIO1 & 2 combined)
Overload	200mA (total including all Digital I/O)
Update period	2 ms when configured as an output (output will only change at the update rate of the source parameter)

Table 3-8 Digital inputs

Specification	Input
Type of Input	*Negative or Positive logic
Voltage range	- 0V to +24V
Absolute max. Voltage range	-3V to +30V
Input current @ +24V	>2mA @ 15Vdc
Update period	250 µs when configured as an input with destinationsnPr 06.035 or Pr 06.036 . 600 µs when configured as an input with destination Pr 06.029 . 2 ms in all other cases.

Table 3-9 Relay outputs

Specification	Output
Contact Voltage Rating	240 Vac, Installation over-voltage category II
Max Current	2 A AC 240 V 4 A DC 30 V resistive load 0.5 A DC 30 V inductive load (L/R = 40 ms)
Contact minimum recommended rating	12V 100mA
Update period	4mS

3.5.2 Polarity of logic and I/O address parameters

The logic polarity can be configured for 'Positive Logic (Sink)' or 'Negative Logic (Source)', where 24Vdc supply can be sourced locally from the drive (Terminal 22) or from an external power supply.

Positive Logic Select Parameters

Standard Digital I/O = Pr **8.029**.

Table 3-10 Standard digital input / output

Term number	Specification		Output select	Parameters	
	I/O	Ind		Invert	Dest./ Source
41, 42	Relay	Pr 8.007		Pr 8.017	Pr 8.027
22	24Vdc				
23	0Vdc				
24	I/O	Pr 8.001	Pr 8.031	Pr 8.011	Pr 8.021
25	I/O	Pr 8.002	Pr 8.032	Pr 8.012	Pr 8.022
26	I/O	Pr 8.003	Pr 8.033	Pr 8.013	Pr 8.023
27	Input	Pr 8.004		Pr 8.014	Pr 8.024
28	Input	Pr 8.005		Pr 8.015	Pr 8.025
29	Input	Pr 8.006		Pr 8.016	Pr 8.026
30	0v				
31	Input	Pr 8.009			Enable

3.5.3 Isolation / suppression

If the Digital inputs are to be switched from locations outside the control cabinet on long cables, relays with a separate power supply should be used to isolate the drive from harmful reflected or induced voltages.

To help reduce magnetic transient interference, it is recommended that all contactor, relay and actuator coils are suppressed, with diodes on dc circuits, or RC configurations on an ac circuit.

3.5.4 Digital I/O allocation

There are two different default digital I/O terminal allocations, depending on which option modules have been installed in the application. Almost All of the Inputs (Except Registration Sensor Input) may be re-assigned to suit the individual application. The following terminal allocations are only effective after a default (Pr 18.044 = 1).

Configuration 1

This configuration is selected when only an SI-Applications Plus Module is used.

Table 3-11 Standard input / output

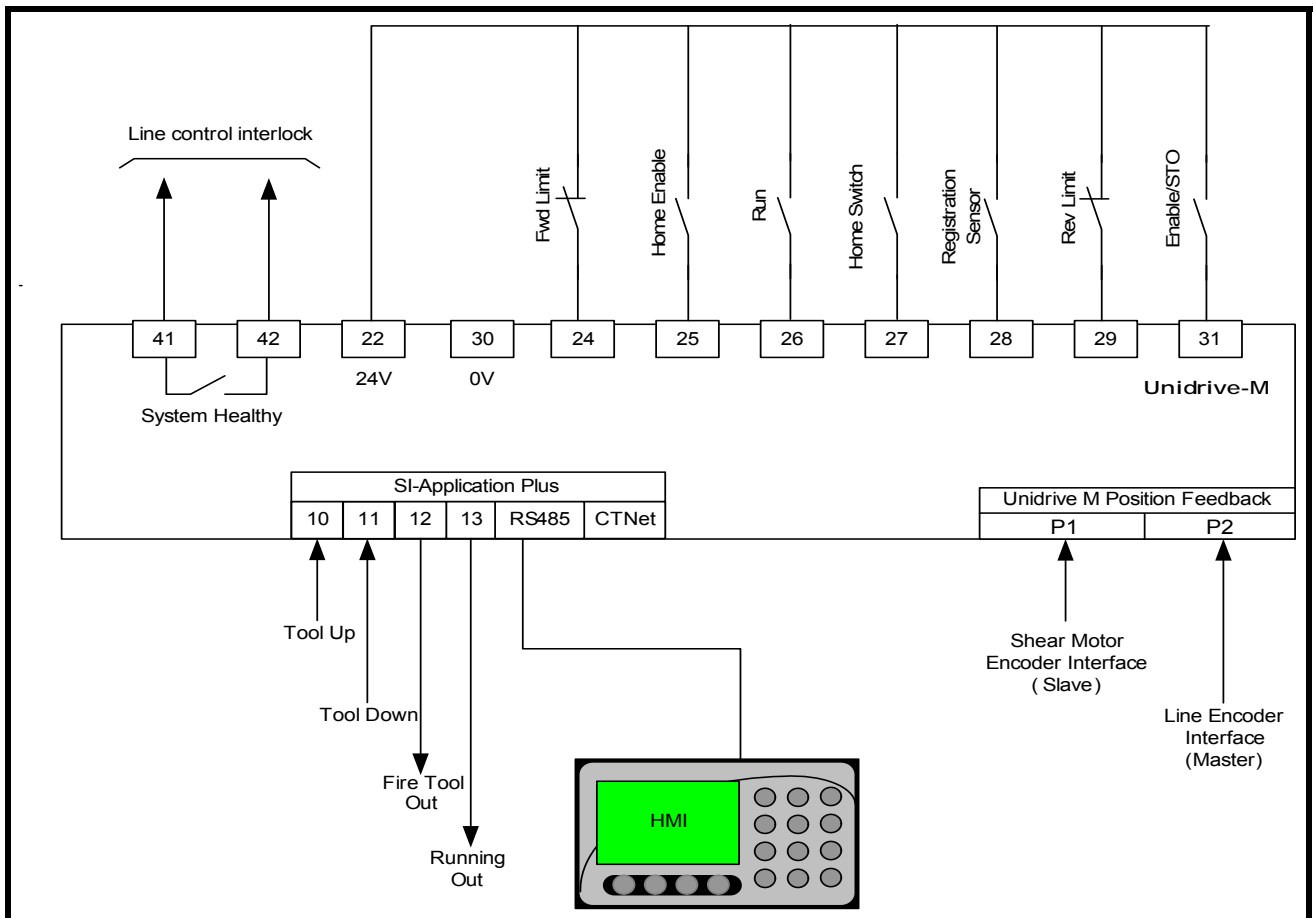
No	Description	Parameter	Terminal	I/O
DI 01	Forward Hardware Limit	Pr. 19.040	24	Input
DI 02	Home Enable	Pr. 19.038	25	Input
DI 03	Run	Pr. 19.033	26	Input
DI 04	Home Switch	Pr. 18.032	27	Input
DI 05	Registration Sensor (Freeze)		28	Input
DI 06	Reverse Hardware Limit	Pr. 19.041	29	Input
STO IN	Inhibit		31	Input
RELAY	System Healthy	Pr. 18.049	41 & 42	Relay output
	+24Vdc, 200mA Supply		22	
	0V Supply		21, 23 & 30	

Table 3-12 SI-Applications Plus Module

No	Description	Parameter	Terminal	I/O
DI0	Tool up	3.86.01	10	Input
DI1	Tool down	3.86.02	11	Input
DO0	Fire tool	3.86.03	12	Output
DO1	Flying Shear Running	3.86.04	13	Output

NOTE If additional I/O capacity is required, then it will be necessary to fit an SI-I/O Plus module. Reference should be made to the SI-I/O Plus *User Guide*.

Figure 3-4 Configuration 1 example wiring



In Configuration 1, the shear motor encoder (Slave) should be connected to Drive P1 Interface, and line encoder should be connected to Drive P2 interface. There are some limitations in terms of availability of the P2 position feedback type depending on which P1 Encoder type has been used:

Table 3-13 Availability of Drive P2 position feedback interface

P1 Position feedback interface	P2 Position interface
AB Servo FD Servo FR Servo SC Servo	
AB ,FD,FR	AB, FD, FR EnDat BiSS SSI
SC EnDat SC SSI	AB,FD,FR (No Z marker freeze input)
SC EnDat SC SSI	EnDat, BiSS, SSI (with freeze input)
ENDat, BiSS ,SSI	AB,FD,FR,EnDat,BiSS,SSI

Configuration 2

This configuration is selected when an SI-Applications Plus is used with an SI-Universal Encoder module.

Table 3-14 Standard input / output

No	Description	Parameter	Terminal	I/O
DI 01	Forward Hardware Limit	Pr. 19.040	24	Input
DI 02	Home Enable	Pr. 19.038	25	Input
DI 03	Run	Pr. 19.033	26	Input
DI 04	Home Switch	Pr. 18.032	27	Input
DI 05	Not configured		28	Input
DI 06	Reverse Hardware Limit	Pr. 19.041	29	Input
STO IN	Inhibit		31	Input
RELAY	System Healthy	Pr. 18.049	41 & 42	Relay output
	+24Vdc, 200mA Supply		22	
	0V Supply		21, 23 & 30	

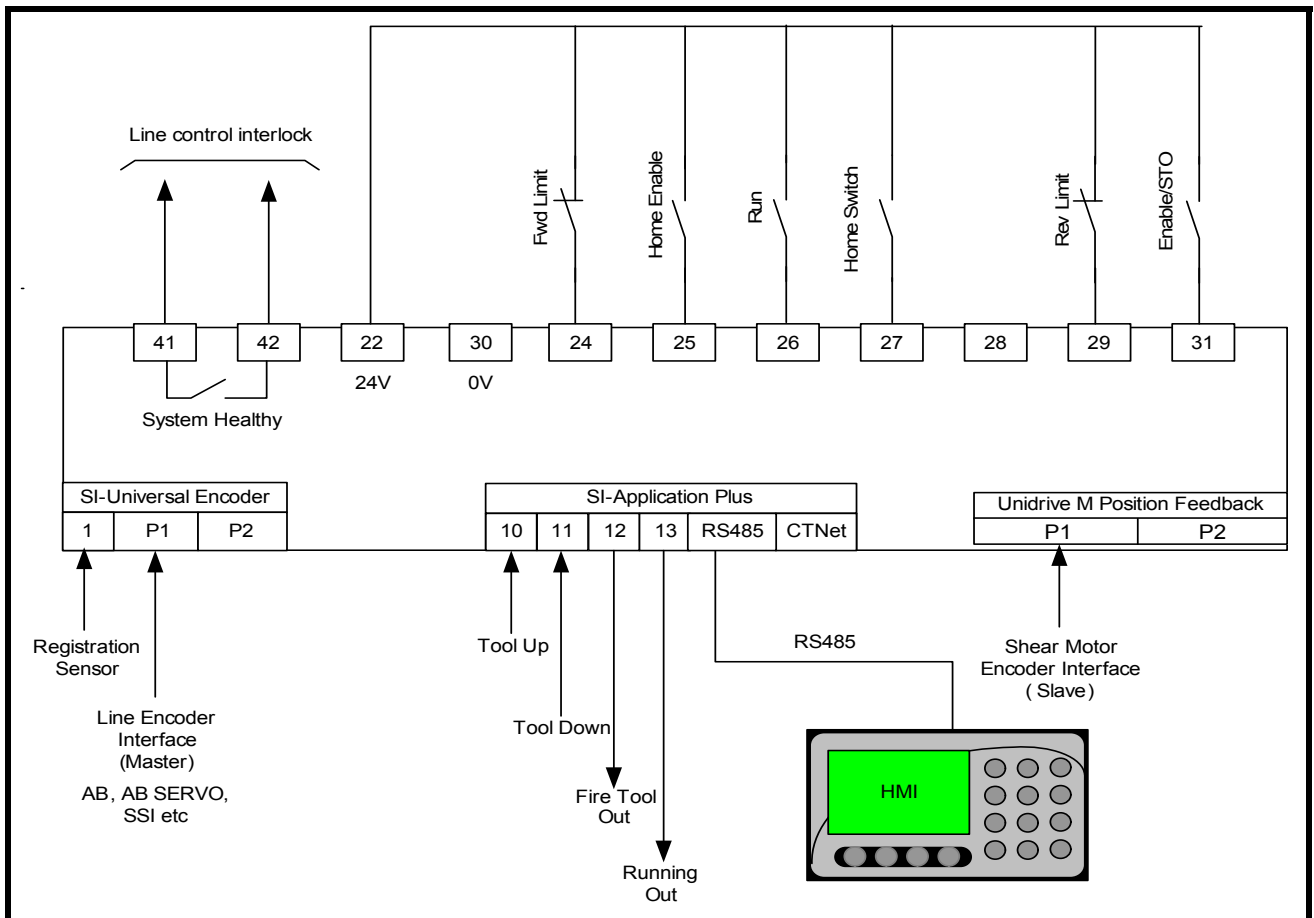
Table 3-15 SI-Applications Plus Module

No	Description	Parameter	Terminal	I/O
DI0	Tool up	3.86.01	10	Input
DI1	Tool down	3.86.02	11	Input
DO0	Fire tool	3.86.03	12	Output
DO1	Flying Shear Running	3.86.04	13	Output

Table 3-16 SI-Universal Encoder Module

No	Description	Terminal	I/O
DI 01	24V Registration Sensor input	1	Input

Figure 3-5 Configuration 2 example wiring



In Configuration 2, the shear motor encoder (Slave) should be connected to Drive P1 interface, and line encoder is connected to SI-Universal Encoder P1 interface. This is the recommended hardware configuration.

It is technically possible to use SI-Universal Encoder P2 interface as the line encoder interface, however, there are some limitations in terms of availability of the P2 position feedback type depending on P1 Encoder type has been used:

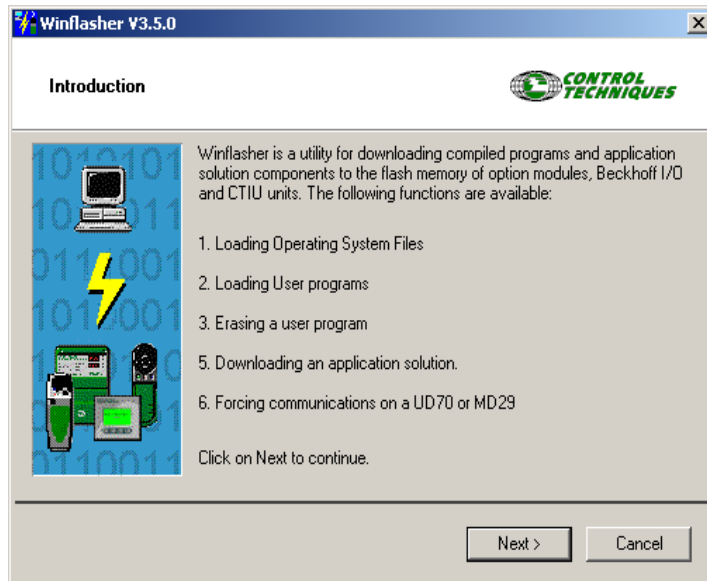
Table 3.17 Availability of SI-Universal encoder P2 position feedback interface

P1 Position feedback interface	P2 Position interface
AB Servo FD Servo FR Servo SC Servo	
AB , FD	AB, FD, FR EnDat BiSS SSI
SC EnDat	AB,FD,FR (No Z marker pulse input)
SC SSI	EnDat, BiSS, SSI (with freeze input)
ENDat, BiSS	AB,FD,FR,EnDat,BiSS,SSI
SSI	EnDat, BiSS, SSI

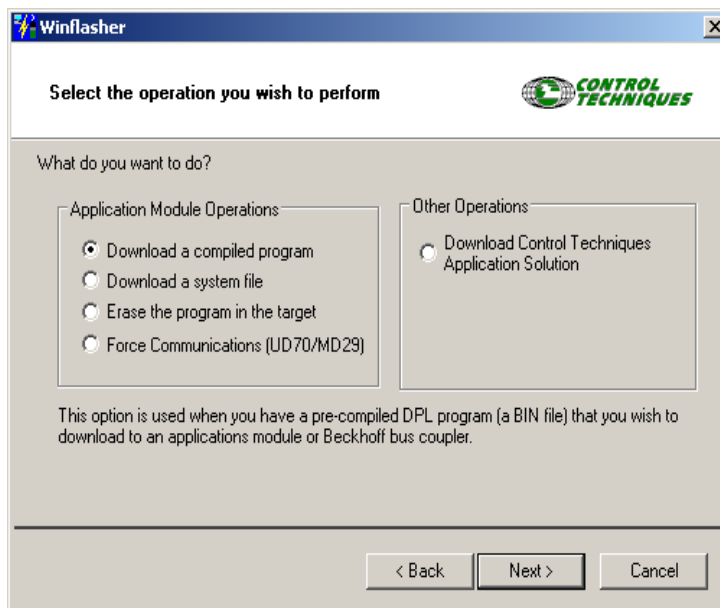
4 Software installation

Obtain the latest version of the Flying Shear Solution software, FlyingShear.bin, from your local drive center. The Flying Shear Solution software is downloaded using WinFlasher. An example showing how to download the Flying Shear Solution software file using WinFlasher is shown below:

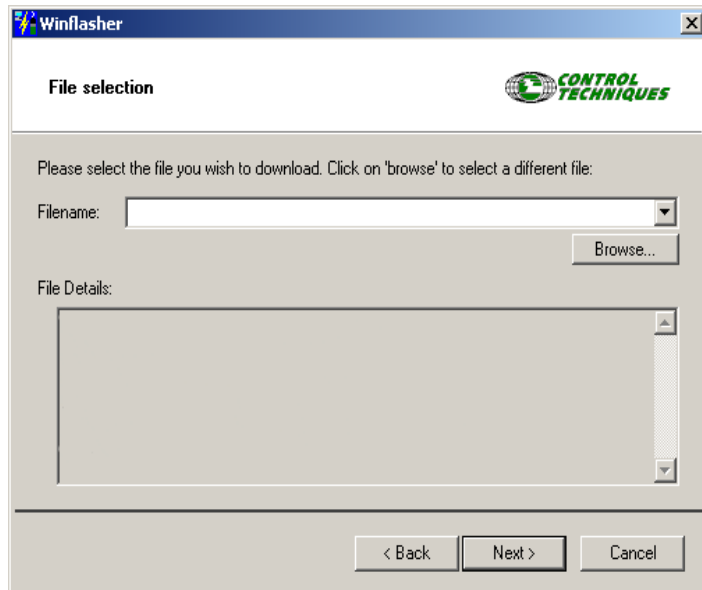
1. Start WinFlasher, then click Next>.



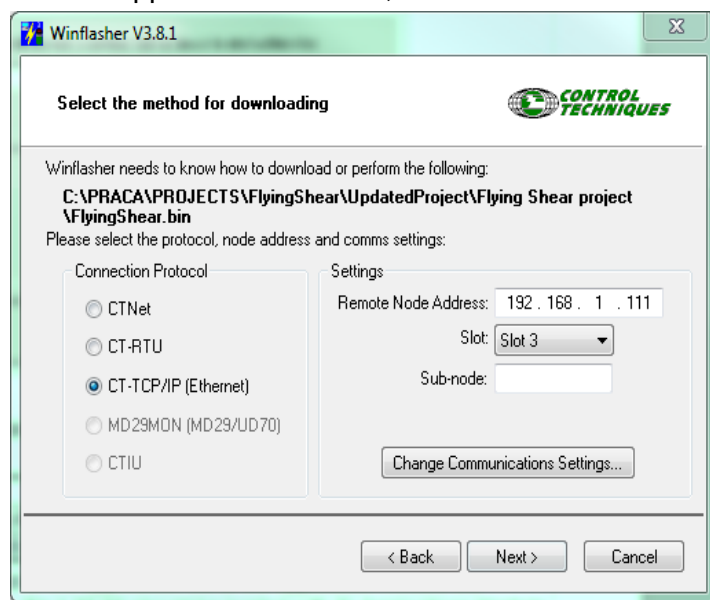
2. Select "Download a compiled program", then click Next>



3. Click the browse button, and locate the Flying Shear Software file (.bin extension) on the PC. When done click Next>.

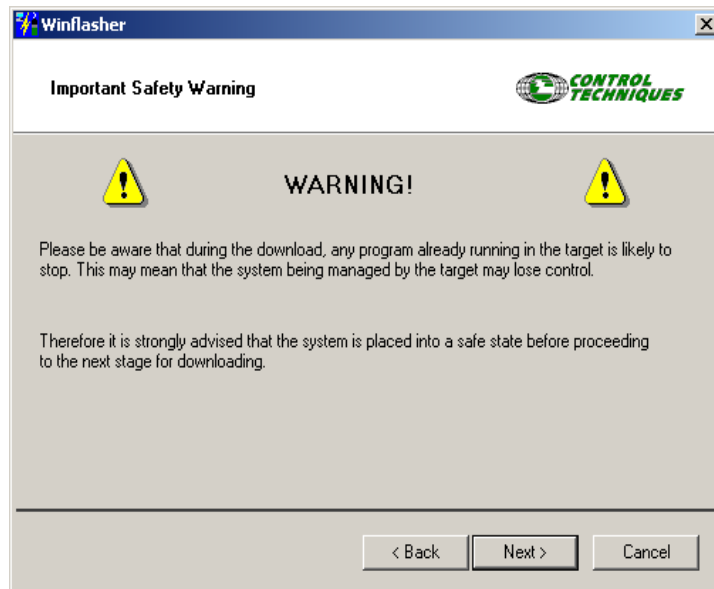


4. Select the “CT-TCP/IP (Ethernet)” option. Fill in the correct IP address of Unidrive M and select the SI-Application Plus Slot; this will be Slot 3

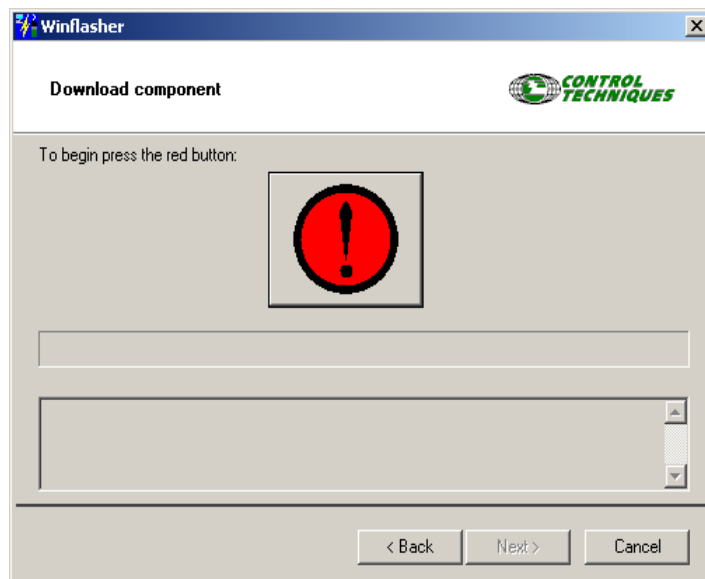


Check the communications settings are correct; if not click the “Change Communications Settings” button.

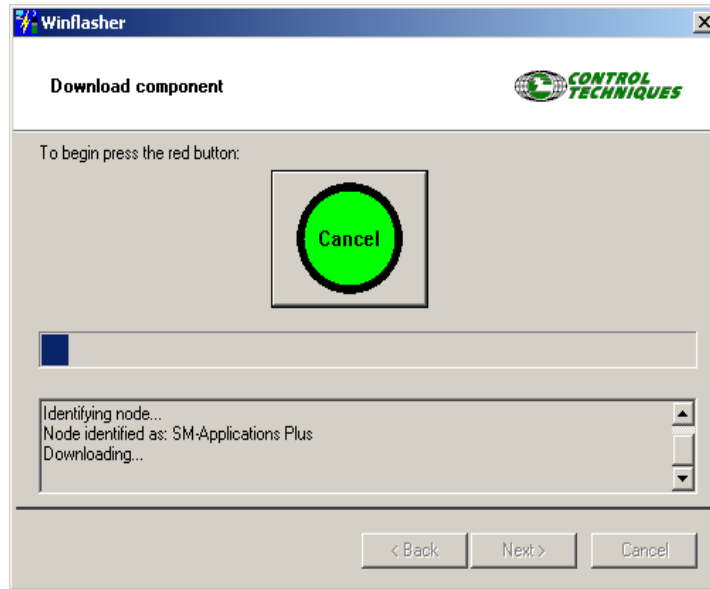
5. Make sure the drive is disabled, then click Next>.



6. Press the red button to start downloading. Click "Finish" when the file has loaded in



- When the program file starts to download the button will turn green.



- Click “Finish” when the file has loaded in to flash memory, to complete the process

Minimum acceptable software versions for the modules and drive:

Device	Software version number
Unidrive M	V01.13.01.00
SI-Applications Plus	V2.07.00
SI-Universal Encoder	V01.00.04.02

Hardware – Communications Connection

Communications between the PC and Unidrive-M drives can be either RS485 or CTNet (SI-Applications Plus only):

Unidrive-M RS485 Port

For this the CT RS232 to RS485 converter lead is required. The RS232 D-type connects to PC and the RJ45 connects the Unidrive-M RS485 port. The following parameters are to be set to ensure successful communications:

Parameter	Description	Value
Pr 11.023	Node address	11
Pr 11.024	Serial Mode	rtU
Pr 11.025	Baud Rate	Set to PC

CTNet

Refer to the SI-Application module manual for connection and Parameter details.

Software

To download the file Control Techniques Windows™ ‘WinFlasher’ software utility is required.

5 Getting started

5.1 Unidrive-M

It is recommended to commission the Unidrive-M in Closed loop mode before attempting to set up the Flying Shear Application. Consult the Unidrive-M *User Guide* for more details.

In practice, all or some of the related parameters that are listed in 7.1.1 Parameters set by software on power-up on page 80 may need to be configured.

Pr. **17.013** enables the Flying Shear software to auto-run on power up. If not set, perform the following procedure:

- Ensure that Pr. **17.013** is set to 1
- Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1000 in Pr **mm.000**) and press the reset button. This will save all current settings of parameters in menus 1 to 19 to non-volatile memory.
- Select 'Reset Modules' in Pr **mm.000** (alternatively enter a value of 1070 in Pr **mm.000**) and press the reset button. This will reboot the SI-Applications Plus module and run installed application software.

NOTE Pr **20.034** which selects the Line encoder location, and Pr **20.035** which selects the shear motor encoder location, must both be set correctly, where:

0 = P1 Drive Encoder

1 = P1 Slot 1

2 = P1 Slot 2

3 = P1 Slot 3

6 = P2 Drive

7 = P2 Slot 1

8 = P2 Slot 2

9 = P2 Slot 3

Failure to set these parameters will result in a Tr86 or Tr87 trip.

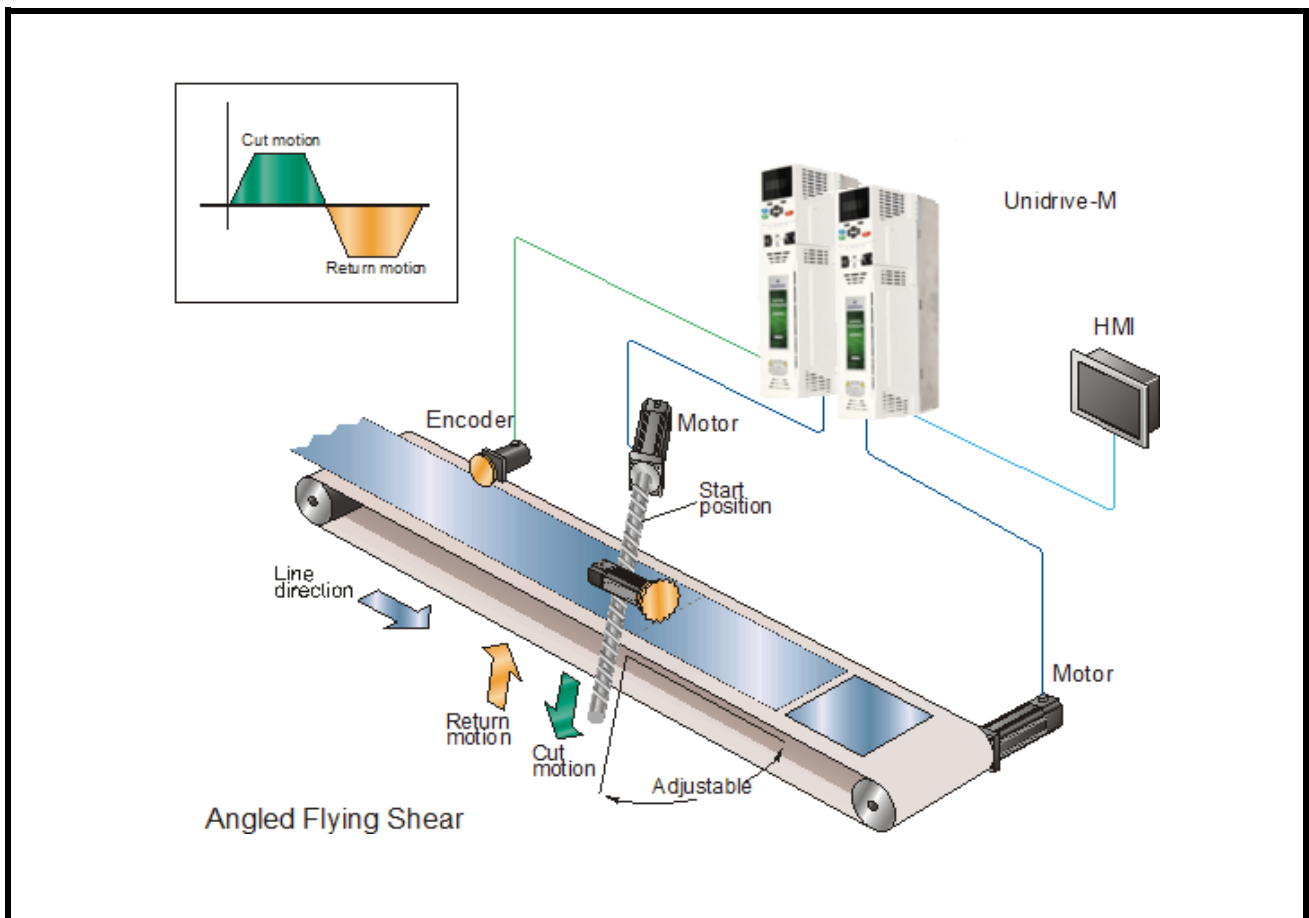
5.2 Operating modes

5.2.1 Parallel flying shear

With parallel flying shears, the carriage travels in the same direction as the material. In the example shown below a shear is used to cut through a material, while the carriage and the material are synchronized. The shear would then be raised and would return to the start position ready to repeat the Cycle. The parallel mode is best suited to applications where the tool operates instantaneously across the whole material width at the same time, such as a punch tool or a shear.

NOTE The shear profile is calculated based on the maximum line speed, and at lower line speeds than the maximum line velocity, the cut times Pr **20.009**, Pr **20.010** and Pr **20.011** increase inversely proportional to the line speed e.g. with a maximum line velocity (Pr **20.008**) of 100 units / second and a cut time (Pr **20.010**) of 100ms at a line speed of half the maximum set in Pr **20.008** the cut time will be 200ms or double. If your application requires that the cut time is constant regardless of the line speed (e.g. a bag sealing application), then Pr **18.050** can be set, which will keep the cut time Pr **20.010** in real time.

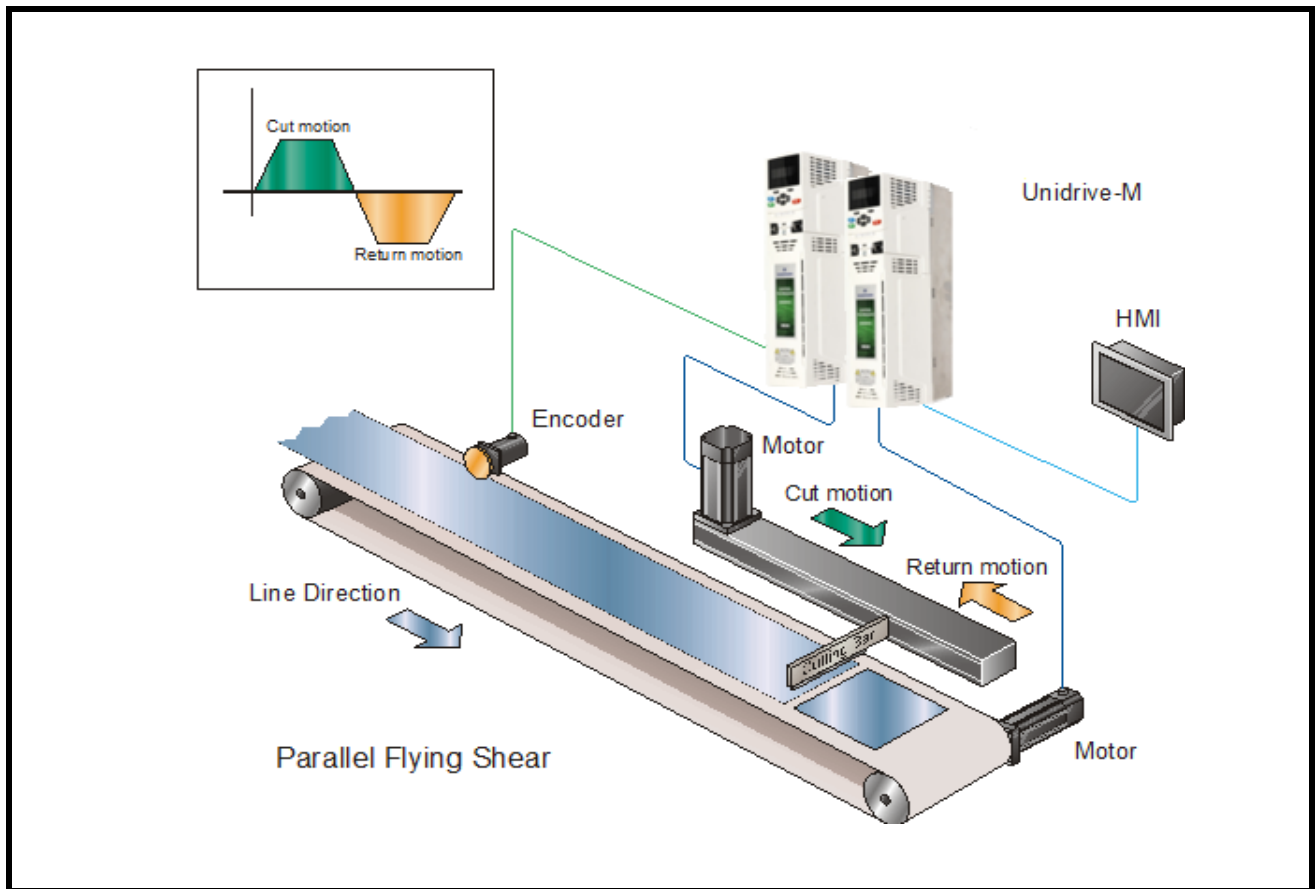
Figure 5-1 Parallel flying shear



5.2.2 Angled flying shear

With angled flying shears, the saw travels across the material at an angle to the product flow. The speed at which the saw carriage must travel, depends upon the angle between the shear and the material flow. This mode is especially useful in applications such as a saw or a plasma-cutting tool where the tool must travel across the product at 90° degrees to the flow.

Figure 5-2 Angled flying shear



NOTE The Angled cut axis speed can be calculated from:
Angled cut axis speed = Line Speed / Cos θ

5.3 Scaling

A suitable scale must be chosen, typically millimetres or inches. Any unit that represents distance may be used provided the Line encoder and shear encoder use the same units. The scaling is entered as encoder edges per unit as an integer numerator and denominator. Pr **20.030** and Pr **20.029** for the Line, and Pr **20.032** and Pr **20.031** for the shear, respectively.

The range of these parameters is $2^{31} - 1$

- | | |
|----------------------------|------------------------|
| Distance is entered as | units |
| Speed is entered as | units / s |
| Acceleration is entered as | units / s ² |
| 0 = Undefined User units | |
| 1 = mm x 100 | |
| 2 = mm x 10 | |
| 3 = mm | |
| 4 = mm / 10 | |
| 5 = mm / 100 | |
| 6 = inches x 10 | |
| 7 = inches | |
| 8 = inches / 10 | |
| 9 = inches / 100 | |

5.3.1 Selecting suitable units

The units selected affect the resolution and the maximum values of the parameters that are entered. For example if microns were used, then the longest cut length which could be set would be 32mm, and the resolution would be 0.001 microns. Alternatively, if metres were selected as the units, then the cut length could be up to 32000 metres.

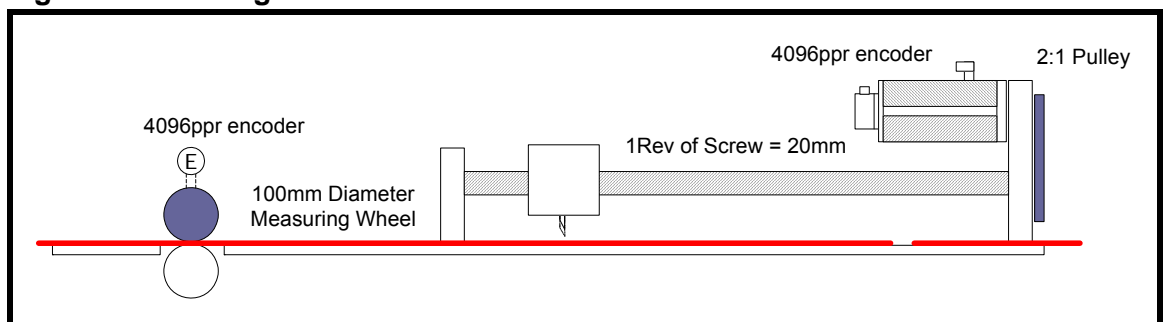
Table 5.1 Typical parameters examples

Parameter description	Resolution (units)	Maximum value (units)
Cut Length	0.001	32767
Length of the shear travel	1	2^{31}
Following error limit	0.001	32.767
Registration position	0.001	2^{31}
Fwd & Rev software limits	1	+/- 32767

5.3.2 Example scaling calculations

For this example we will select mm for the units.

Figure 5-3 Scaling calculation



Line (reference)

The quadrature encoder will give the following resolution

$$4 * 4096 = 16384 \text{ counts / rev}$$

Circumference of the measuring wheel is

$$\text{PI} * 100\text{mm} = 314.16 \text{ mm}$$

The encoder counts per mm = $16384 / 314.16 = 52.15$

The numerator and denominator could be entered as:

Numerator = 5215 - enter value into Pr **20.030**

Denominator = 100 - enter value into Pr **20.029**

To check the scaling is correct perform the following:

1. Cut the longest length required
2. Measure the length cut
3. If the cut length is not to the length set (+/- tolerance), then change the Line scaling parameter/s as follows:

$$\text{New scaling} = (\text{Pr } 20.030 / \text{Pr } 20.029) * ((\text{Pr } 20.005 + \text{Pr } 20.012) / \text{Actual measured length})$$

NOTE Only encoders that have a number of pulses per revolution that is a power of 2, may be used with the Flying Shear solution for Unidrive M e.g. 4096ppr is acceptable, but 5000ppr is not.

Shear (follower)

The encoder resolution is $4 * 4096 = 16384$ counts per revolution.
If the motor rotates 1 revolution then the screw will travel 0.5 revs
(2 :1 pulley) and the carriage will travel 10 mm.

Encoder counts per mm = $16384 / 10 = 1638.4$

The numerator and denominator could be entered as:

Numerator = 16384 - enter value into Pr **20.032**

Denominator = 10 - enter value into Pr **20.031**

If the value of the numerator is too large then the units must be changed, for example mm multiplied by 10 could be used.

NOTE

In this example the ratio between the Line and the shear resolution is approximately a factor of 31.4 ($1638.4 / 52.15$), this means that during the time that the shear is synchronized to the Line, when the Line moves 1 count then the shear must move 31.4 counts, this is like an amplifier with a very high gain, and can produce some problems with noisy operation and instability. To prevent these problems, it is recommended to increase the resolution of the Line so that it is similar to the resolution of the shear, this could be done by selecting a smaller measuring wheel diameter and / or increasing the encoder resolution or using SinCos encoder (see section 5.3.3. below).

Where it is not possible to fit a high resolution encoder, or if a system is retro-installed using an old encoder, Pr **18.035** has been introduced which enables a 40ms filter which will help reduce motor noise caused by low resolution encoders. When the filter is enabled there will be a small positional following error, when the Line accelerates or decelerates.

NOTE

Only encoders that have a number of pulses per revolution that is a power of 2, may be used with the Flying Shear solution for Unidrive M e.g. 4096ppr is acceptable, but 5000ppr is not.

5.3.3 Feedback application notes

Feedback types

The flying shear software can use any of the encoder types listed in the Unidrive M, SI-Universal Encoder, user guides, as position feedback for the Line and shear, with the exception of resolver feedback, which is not supported by the flying shear software.

NOTE

Only encoders that have a number of pulses per revolution that is a power of 2, may be used with the flying shear solution. For example, 4096ppr is acceptable, but 5000ppr is not.

SI-Applications Plus Line and shear Feedback Selection

Pr **20.034** and Pr **20.035** allow the user to select the feedback inputs for the Line and shear respectively.

Resolution

For Sin Cos, EnDat and SSI encoders (Types 6 – 10) 16 bit to 22 bit resolution is available (see Pr **19.028** and Pr **19.029** for further details), for both the Line and the shear. For Incremental Quadrature encoders (Types 0 and 3) only the resolution of the encoder is available (4*ppr) is available.

If you want to increase the resolution for a Sin Cos Encoder from 16 bit to 18 bit, for example, you would have to:

- Increase Pr **19.028** or Pr **19.029** to 2, which selects 18 bit resolution.
- Multiply Pr **20.030** or Pr **20.032** by $2^{\text{number of extra bits of resolution required}}$ to give the correct number of counts per unit with 18 bit resolution. In this example we would multiply by 2^2 .

NOTE Incremental encoders with frequency and direction (Fd), or forward and reverse (Fr) outputs (Types 1,2,4,5), or SSI encoders (Types 10 and 11) can not be used with the flying shear software.

Absolute Position

The Flying Shear software does not currently accommodate for the absolute position on power up, therefore a home routine is always required to be performed.

Freeze Input

If registration is required, then the sensor used has to be connected to the freeze input of either the SI-Universal Encoder or the Drive Input 5 (term.28) Both 24V and RS485 signal types are supported on the SI-Universal Encoder, but only 24V signals are supported on the Drive.

Registration input choice is dependent of hardware configuration has been used:

Table 5.2 Line source and freeze input dependency

Line Source	Resolution (units)	Maximum value (units)
Cut Length	0.001	32767
Length of the shear travel	1	2^{31}
Following error limit	0.001	32.767
Registration position	0.001	2^{31}
Fwd & Rev software limits	1	+/- 32767

Set up

NOTE It is important to set whether the freeze input is positive edge or negative edge triggered correctly. The result of not setting this correctly could mean that Registration Windowing will not function, and that the registration distance will be offset by the width of the registration mark. Triggering is controlled by x.041 for the SI-Universal Encoder, or x.043 for the SI-Applications Plus.

For more set up information on any of the encoder interfaces mentioned, refer to the Unidrive-M, SI-Universal Encoder *User Guide*.

5.4 Resolution and accuracy

Calculating the accuracy that is achievable with the flying shear depends upon many factors, and is difficult to calculate reliably.

If we assume that the mechanical system is well designed:

- The inertia mismatch between the load and motor is approximately 1:1.
- The couplings / gearing used are rigid and low backlash and not flexible rubber type couplings.
- The motor / drive combination is capable of producing sufficient torque to accelerate the load at the required rate.

Typically on a system with a 4096-ppr encoder, a steady state following error of between ± 10 to ± 50 counts per metre travelled can be achieved.

With reference to the example in section 5.3.2 Example scaling calculations we can calculate 50 counts of the shear axis equates to 0.03mm, therefore the likely achievable accuracy of the positioning system is worst case ± 0.03 mm. Other errors from mechanical tolerances will reduce the achievable accuracy of the machine.

If the resolution is increased, such as by fitting SinCos encoders then the accuracy can be improved, however it is not a linear relationship. If we double the encoder resolution then we cannot expect to half the error.

If the ratio between Line and shear is large, then slight movements on the Line axis cause large changes in required position in the shear. The net effect is a greater following error than if the gear ratio was nearer 1:1.

5.5 Commissioning / start up sequence

Figure 5-4 Start up overview

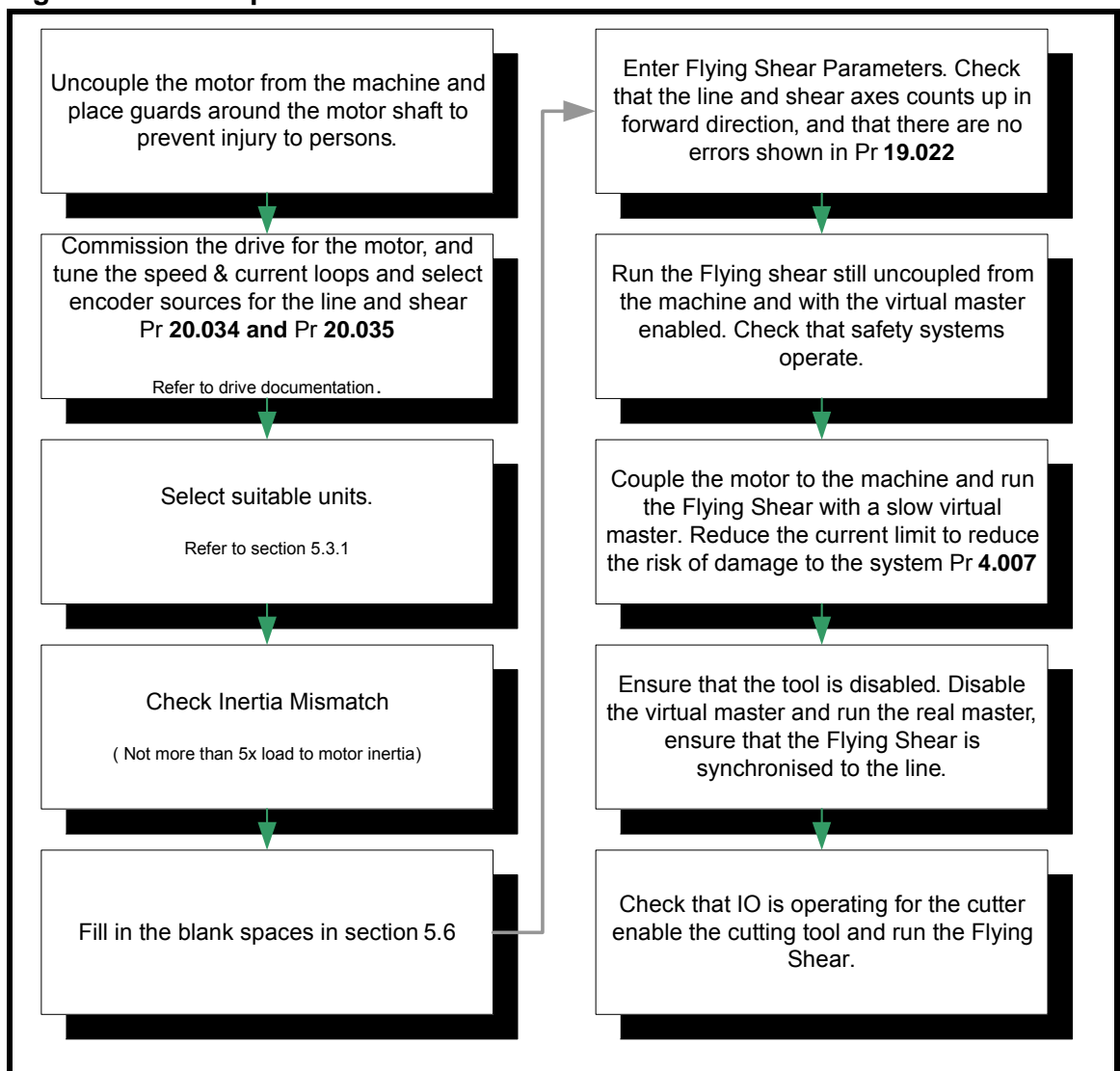


Figure 5-5 Commissioning / start up sequence start

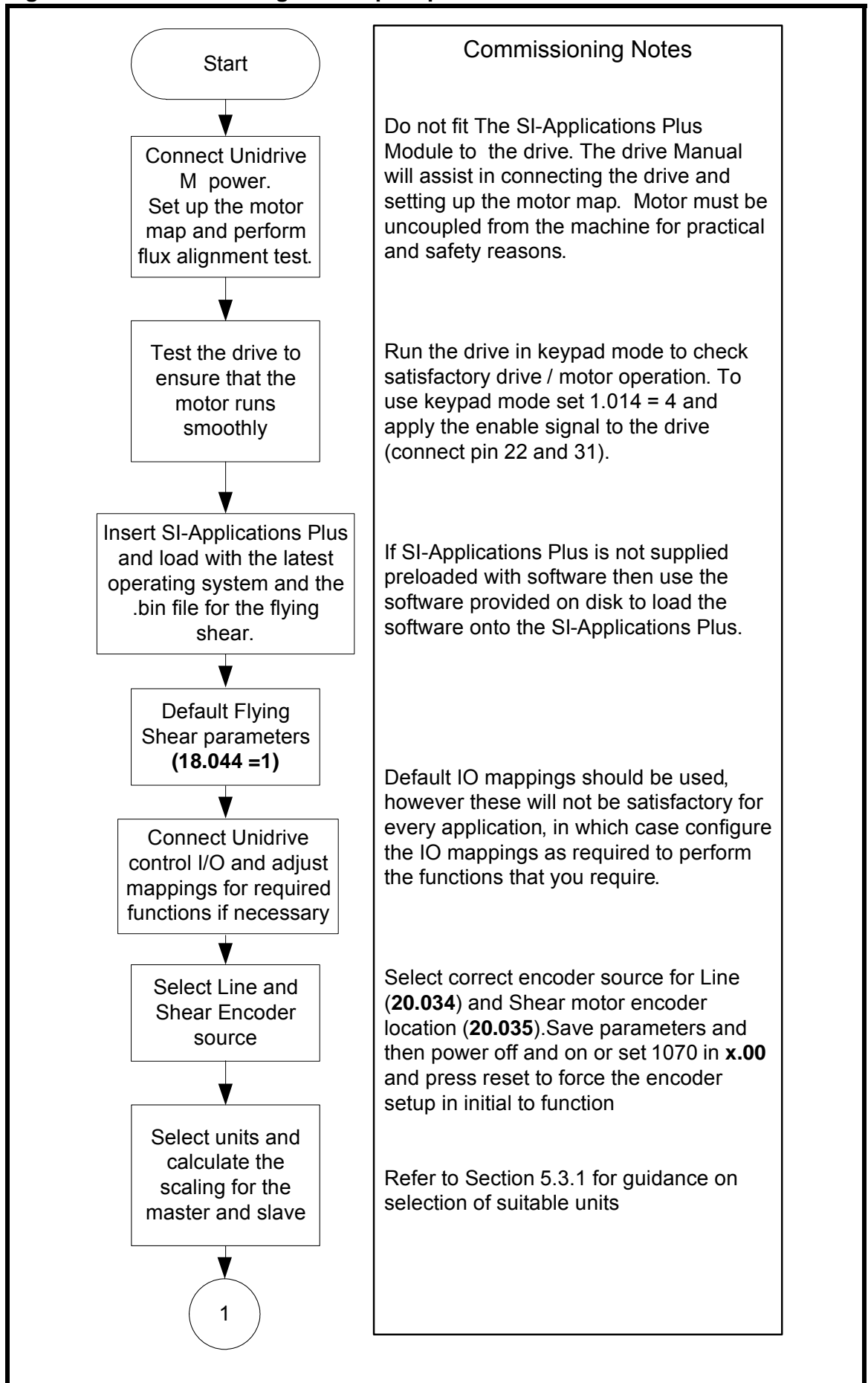


Figure 5-6 Commissioning / start up sequence 1

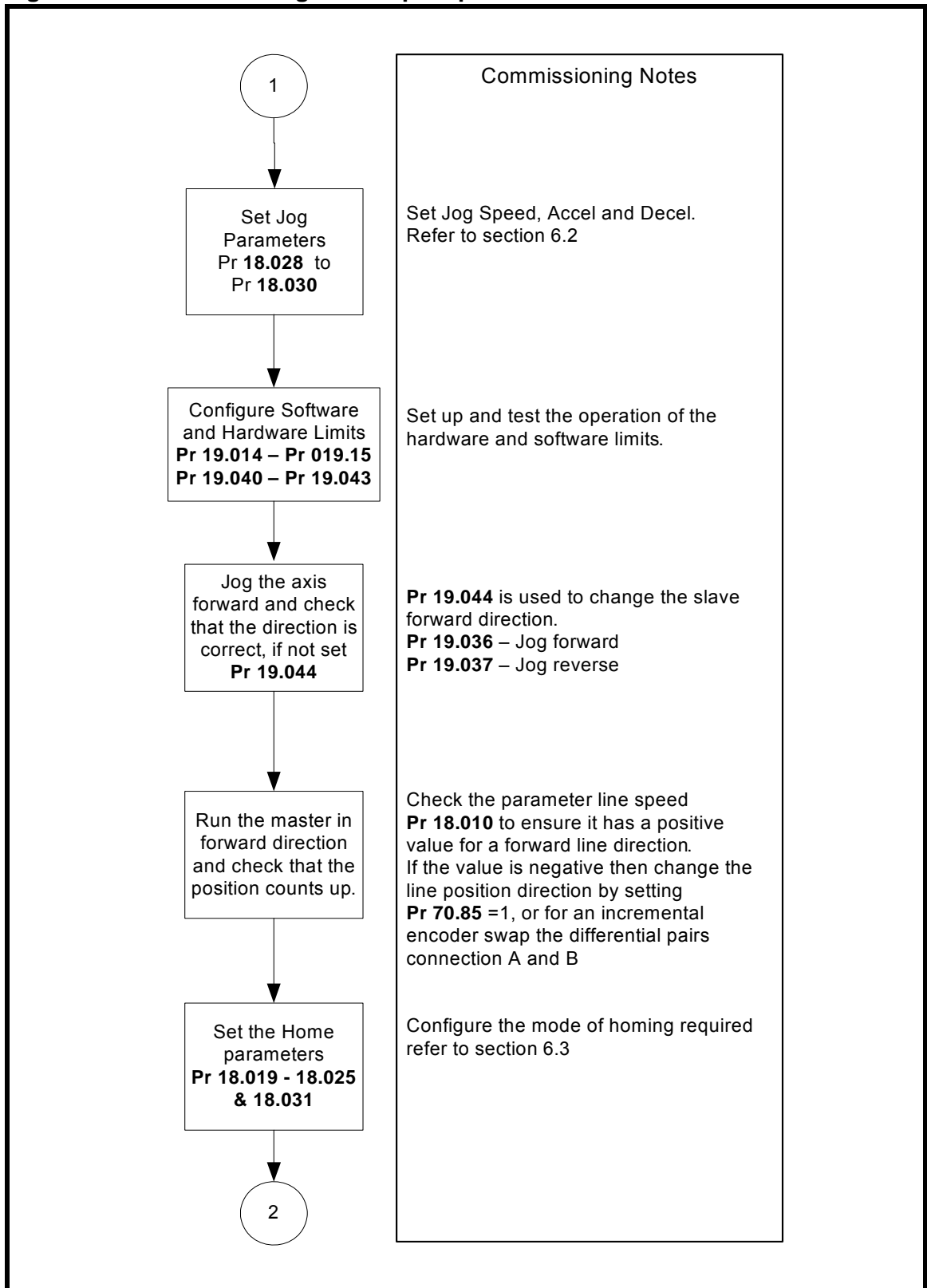
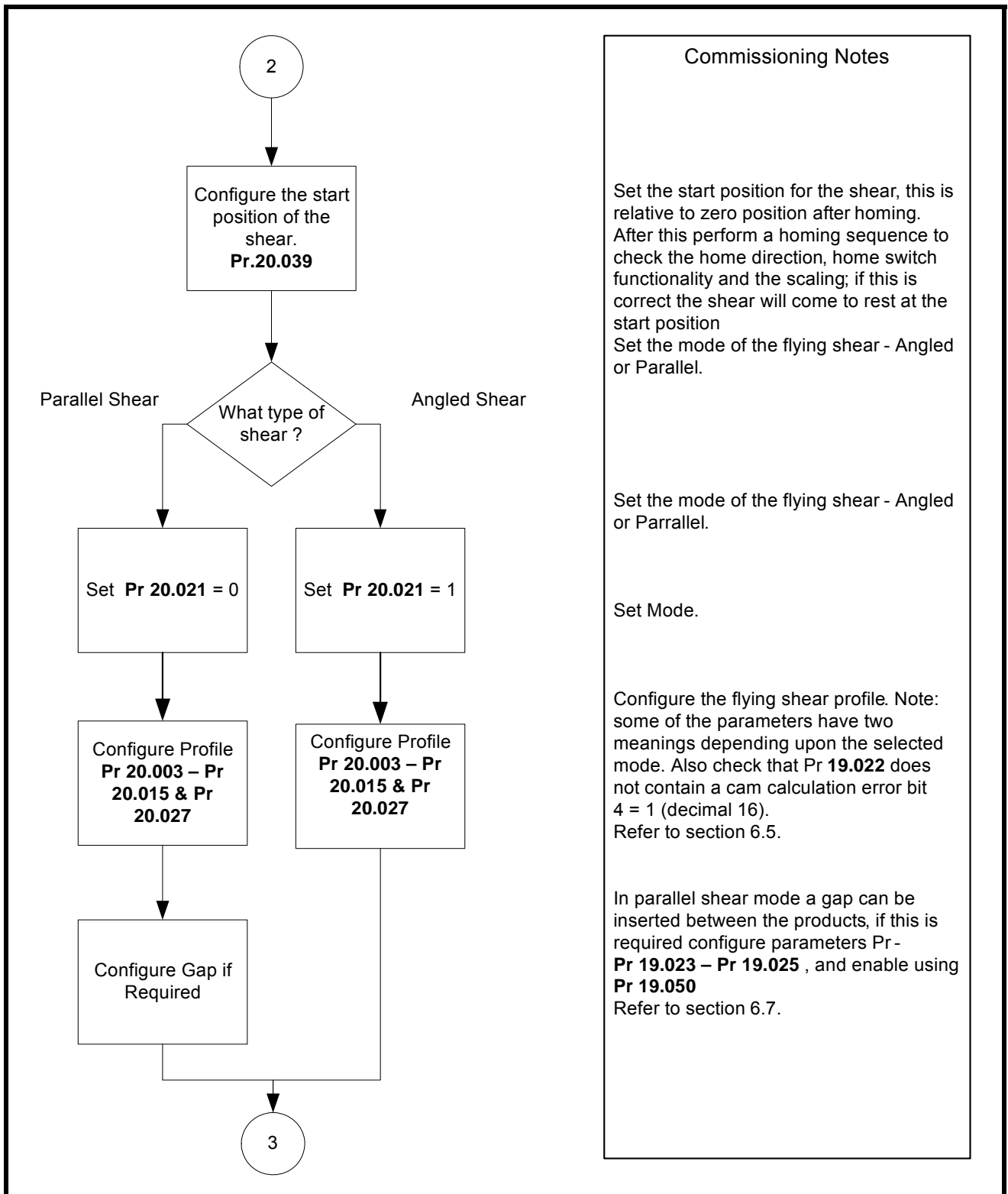


Figure 5-7 Commissioning / start up sequence 2



Commissioning Notes

Set the start position for the shear, this is relative to zero position after homing. After this perform a homing sequence to check the home direction, home switch functionality and the scaling; if this is correct the shear will come to rest at the start position
Set the mode of the flying shear - Angled or Parallel.

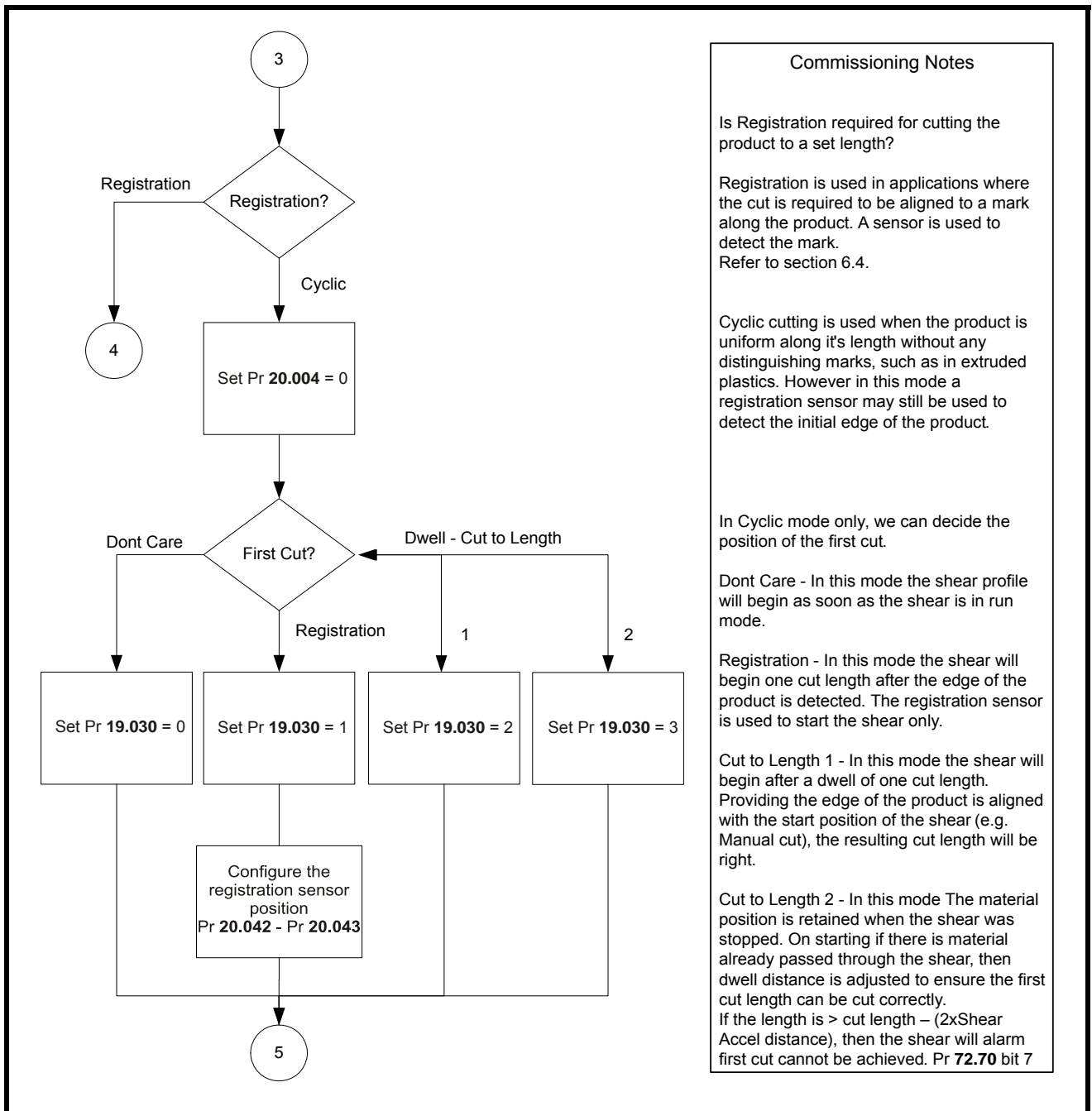
Set the mode of the flying shear - Angled or Parallel.

Set Mode.

Configure the flying shear profile. Note: some of the parameters have two meanings depending upon the selected mode. Also check that Pr 19.022 does not contain a cam calculation error bit 4 = 1 (decimal 16). Refer to section 6.5.

In parallel shear mode a gap can be inserted between the products, if this is required configure parameters Pr - Pr 19.023 – Pr 19.025 , and enable using Pr 19.050 Refer to section 6.7.

Figure 5-8 Commissioning / start up sequence 3



Commissioning Notes

Is Registration required for cutting the product to a set length?

Registration is used in applications where the cut is required to be aligned to a mark along the product. A sensor is used to detect the mark. Refer to section 6.4.

Cyclic cutting is used when the product is uniform along its length without any distinguishing marks, such as in extruded plastics. However in this mode a registration sensor may still be used to detect the initial edge of the product.

In Cyclic mode only, we can decide the position of the first cut.

Dont Care - In this mode the shear profile will begin as soon as the shear is in run mode.

Registration - In this mode the shear will begin one cut length after the edge of the product is detected. The registration sensor is used to start the shear only.

Cut to Length 1 - In this mode the shear will begin after a dwell of one cut length. Providing the edge of the product is aligned with the start position of the shear (e.g. Manual cut), the resulting cut length will be right.

Cut to Length 2 - In this mode The material position is retained when the shear was stopped. On starting if there is material already passed through the shear, then dwell distance is adjusted to ensure the first cut length can be cut correctly. If the length is > cut length - (2xShear Accel distance), then the shear will alarm first cut cannot be achieved. Pr 72.70 bit 7

Figure 5-9 Commissioning / start up sequence 4

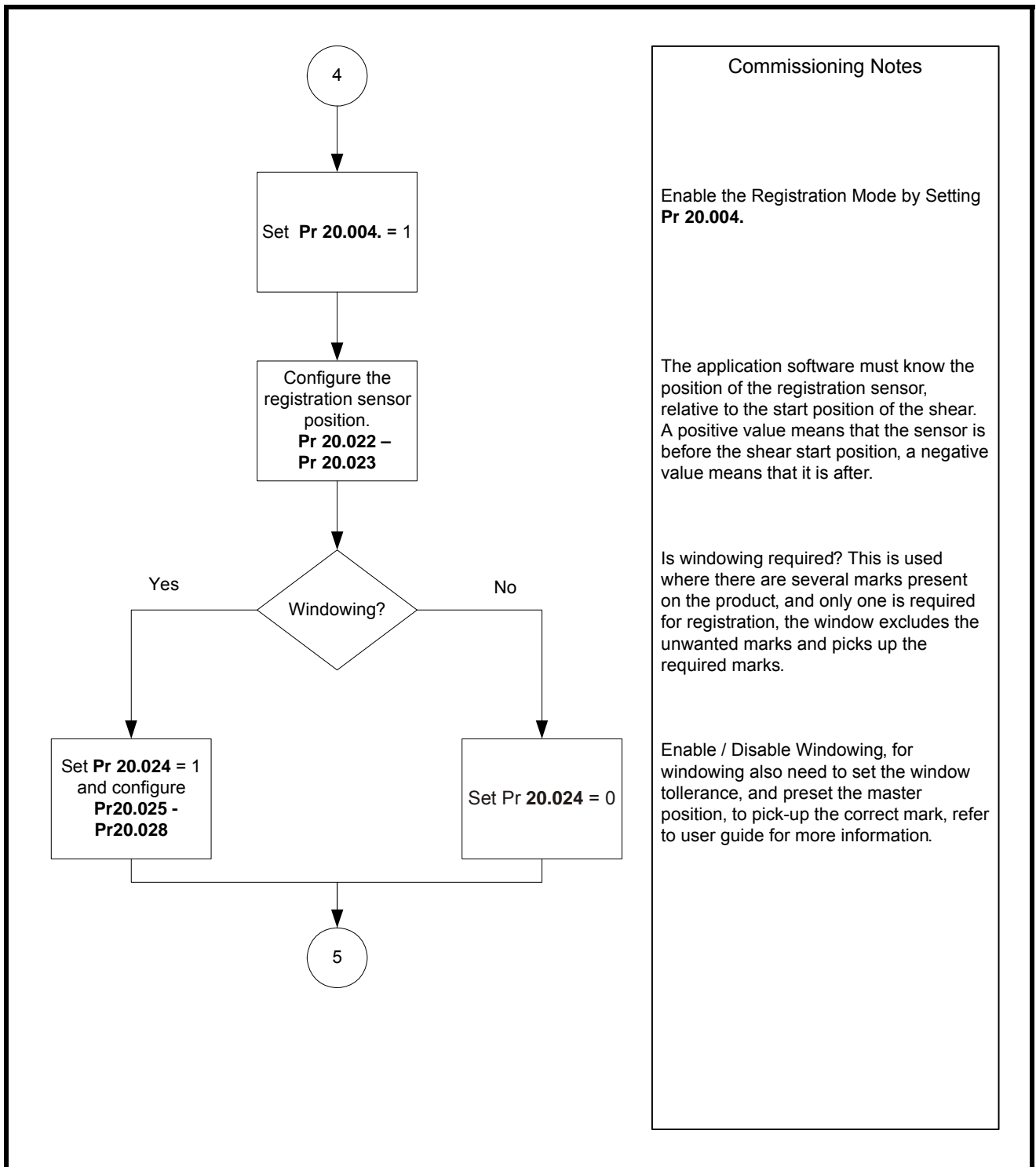


Figure 5-10 Commissioning / start up sequence 5

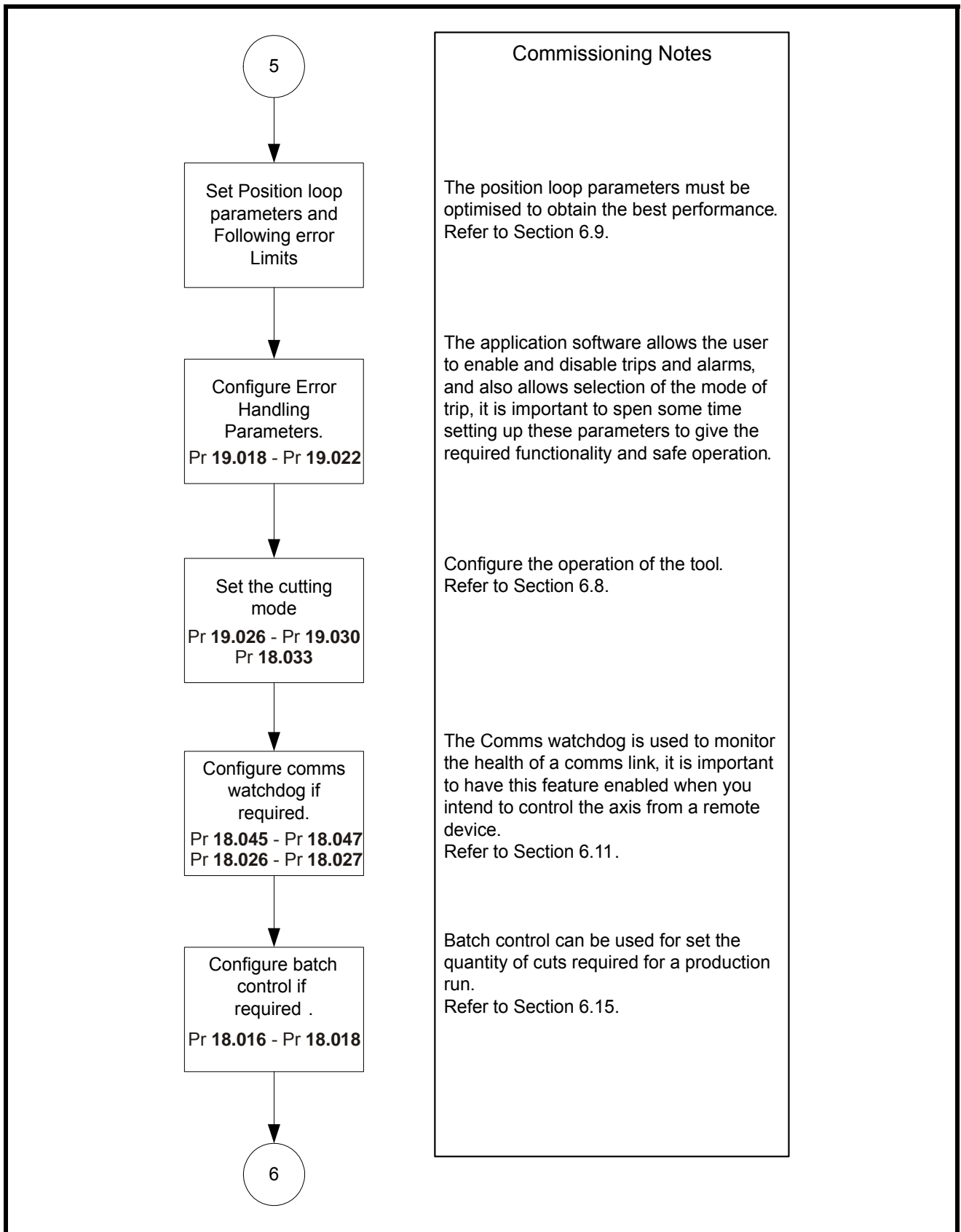
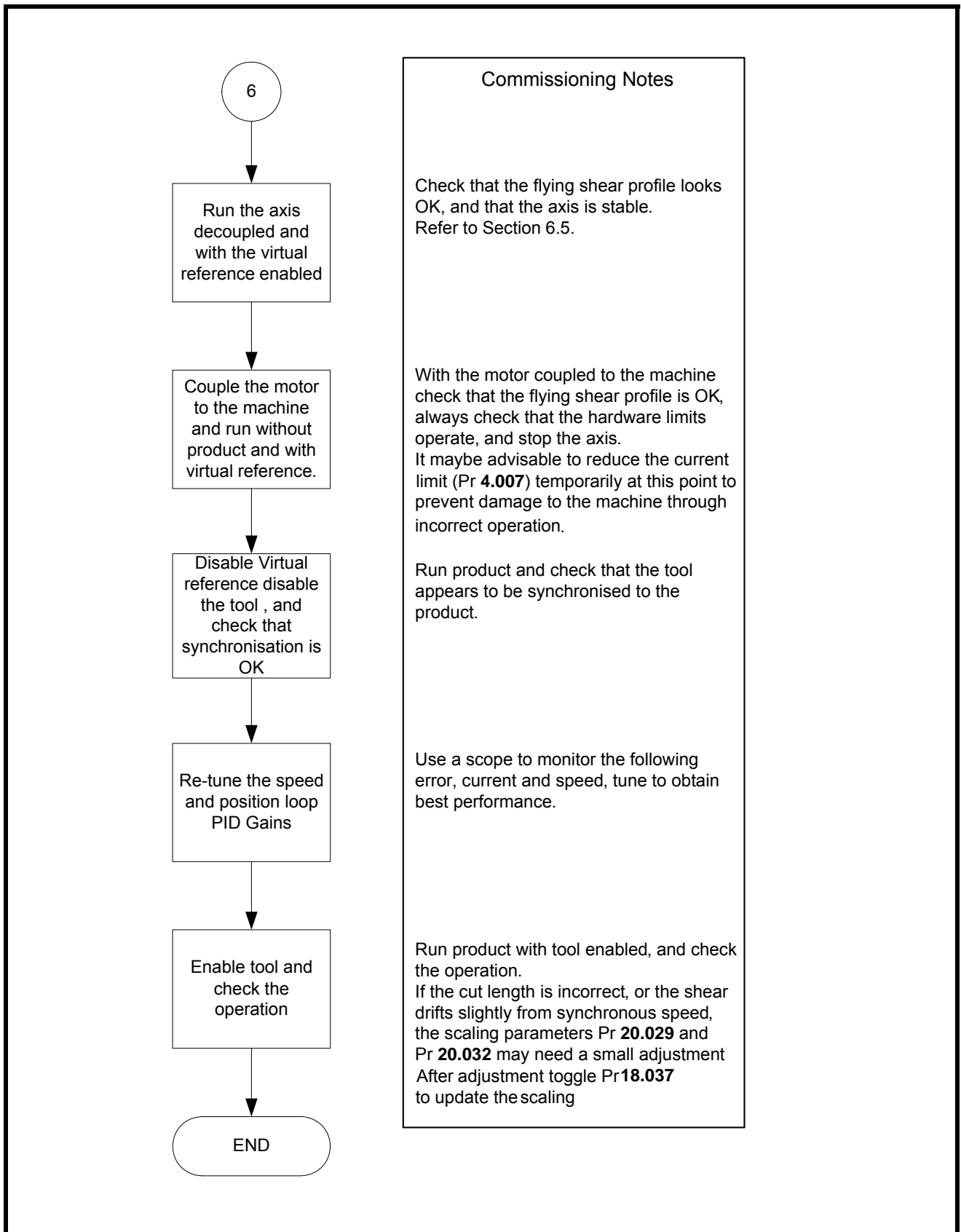


Figure 5-11 Commissioning / start up sequence 6



5.6 Application set-up parameters

1 Scaling			
See also section 5.3 Scaling or section 7.2 Application parameters			
NOTE Scaling is only updated on power-up, or by setting update scaling (Pr 18.037). Only encoders with a resolution of a power of 2 may be used e.g. 4096ppr.	Line numerator	Pr 20.030	
	Line enominator	Pr 20.029	
	Shear numerator	Pr 20.032	
	Shear denominator	Pr 20.031	
2 Jogging			
See also section 6.2 Jogging / positioning or section 7.2 Application parameters			
What speed do you want to Jog	Units / s	Pr 18.028	
Set the Jog Acceleration Rate	Units/s/s	Pr 18.029	
Set the Jog Deceleration Rate	Units/s/s	Pr 18.030	
3 Homing			
See also section 6.3 Homing or section 7.2 Application parameters			
Is the home switch in the forward or reverse direction?			
NOTE Forward direction is when the flying shear travels in the same direction as the normal flow of the product.	1 = Forwards 0 = Reverse	Pr 18.022	
Which Home mode is required?	0 = Search for leading edge of home switch. 1 = Search for leading edge of Home switch and then datum on the next motor encoder marker pulse.	Pr 18.020	
Which speed do you want to search for the home?	Home Search Speed Units/s	Pr 18.019	
Which speed do you want to back-off the home switch?	Home Back-off Speed % of 18.19	Pr 18.021	
Which Acceleration / Deceleration rates do you want to use for homing?	Homing Accel / Decel Units/s/s	Pr 18.023	
The homing sequence can fail if the time it takes exceeds a preset time. How long do you wish to make the time-out?	Homing Time-out Time is ms	Pr 18.024	
The position that you want to pre-set the position loop to at the home position.	Zero Position Units	Pr 18.025	
What is the polarity of the home switch	1 = Normally Closed 0 = Normally Open	Pr 18.031	
4 Registration			
See also section 6.4 Registration or section 7.2 Application parameters			
How far is the registration input located from the flying shear start position?	Registration Sensor Position. Units	Pr 20.023	
Do you want to add a fine trim to the registration sensor position?	Registration Sensor Position fine offset. Units/1000	Pr 20.022	
Do you want to use windowing so that the registration sensor excludes marks outside the window?	Enable Windowing. 1 = Enable 0 = Disable	Pr 20.024	
The position will roll over to zero when the cut length is reached, the window will be open before and after the rollover within a tolerance.	What Tolerance do you want to apply to the window? Units	Pr 20.025	
The Line position may be preset to the value of Pr 20.047 when a transition from 0 – 1 occurs in Pr 20.046 .	Line position preset.	Pr 20.028	

5 Flying Shear Profile (Parallel)

See section 6.5 Flying Shear profile calculation , section 6.10 Hardware and software limits / positions and section 7.2 Application parameters

Do you want the flying shear to synchronize to a mark on the product, or do you want the flying shear to run cyclically?	1 = Cut on Mark 0 = Run Cyclically	Pr20.004	
If cyclic mode is selected you can select when the first cut is executed.	0 = Cut immediately 1 = Cut using the registration sensor. 2 = Cut after one cut length 3 = Measure material distance travelled and cut correct length	Pr19.030	
If cyclic mode is selected you can choose the mode of optimization for the return section of the profile. If fast is selected then the shear will return at the maximum speed and dwell before the next cycle. If slow is selected the shear will return with enough pace to achieve the next cut without any need to dwell.	0 = Slow 1 = Fast	Pr20.020	
What is the start position for the flying shear?	Units	Pr20.019	
What cut length do you want to achieve?	Enter cut length in units	Pr20.005	
Do you want to add a fine adjustment to the cut length?	Enter a fine offset to the cut length. Units / 1000	Pr20.012	
What is the travel available for the shear? This is taken as the distance from the start position of the flying shear to the hardware / software forward limits.	Units	Pr20.027	
What is the accel / decel rate for the shear during the fly (forward) part of the profile.	Units/s/s	Pr20.006	
What is the accel / decel rate for the shear during the return (reverse) part of the profile.	Units/s/s	Pr20.007	
What is the Maximum Speed of the Line axis during this profile?	Units/s	Pr20.008	
The synchronous part of the flying shear profile, is split into three areas, settling time,	Settling time milliseconds	Pr20.009	
the cut time and the tool rise time. If the cut time needs to be in real	Tool down/cut time milliseconds	Pr20.010	
Time at all speeds, set 18.50 to 1 (Refer to section 6.8.2 Real time cut).	Tool up time milliseconds	Pr20.011	
The flying shear will only attempt to activate the cut output if the following error (FE) is within the FE cut limit.	FE cut limit encoder counts	Pr20.013	
How do you want the flying shear to accelerate, Linear or S-Ramped? NOTE The S-ramp profile should not be used in conjunction with fieldbus options, as it may cause the drive to spuriously trip.	1 = S-ramp 0 = linear	Pr20.015	
At what rate would you like the flying shear to decelerate if a limit switch is hit.	Set Fast Decel Rate Units/s/s	Pr20.014	

6 Flying Shear Profile (Angled)			
See also section 6.5 Flying Shear profile calculation or section 7.2 Application parameters			
Enable angled shear	= Parallel 1 = Angled	Pr20.021	
Do you want the flying shear to synchronize to a mark on the product, or do you want the flying shear to run cyclically?	1 = Cut on Mark 0 = Run Cyclically	Pr20.004	
If cyclic mode is selected you can select when the first cut is executed.	0 = Cut Immediately 1 = Cut Using the registration sensor to detect the edge of the material. 2 = Cut after one cut length 3 = Measure material distance travelled and cut correct length	Pr19.030	
You can choose the mode of optimization for the return section of the profile. If fast is selected then the shear will return at the maximum speed and dwell before the next cycle. If slow is selected the shear will return with enough pace to achieve the next cut without any need to dwell.	0 = Slow 1 = Fast	Pr20.020	
What is the start position for the flying shear?	Units	Pr20.019	
What cut length do you want to achieve?	Enter Cut Length In Units	Pr20.005	
Do you want to add a fine adjustment to the cut length?	Enter a fine offset to the cut length. Units / 1000	Pr20.012	
What is the angle between the shear and the material conveyor?	0.001 degrees	Pr20.027	
What length is the start distance? (not less than 20.29)	Units	Pr20.006	
What is the accel / decel rate for the shear during the return (reverse) part of the profile.	Units/s/s	Pr20.007	
What is the Maximum Speed of the Line axis during this profile?	Units/s	Pr20.008	
What distance is the shear to be accelerated over?	Units	Pr20.009	
What distance do you want the shear to be synchronized for?	Units	Pr20.010	
What distance do you want to decelerate the shear in?	Units	Pr20.011	
The flying shear will only attempt to activate the cut output if the following error (FE) is within the FE cut limit.	FE cut limit encoder counts	Pr20.013	
How do you want the flying shear to accelerate, Linear or Sinusoidal Ramped? NOTE The S-ramp profile should not be used in conjunction with fieldbus options, as it may cause the drive to spuriously trip.	1 = Sinusoidal ramp 0 = Linear	Pr20.015	
At what rate would you like the flying shear to decelerate if a limit switch is hit	Set fast decel rate Units/s/s	Pr20.014	
7 Virtual line			
See also section 6.6 Cam control and virtual reference control or section 7.2 Application parameters			
Enable virtual reference	1 = Enabled 0 = Disabled	Pr20.017	
Virtual reference speed	Virtual reference speed units/s	Pr20.018	

8 Tool Control			
See also section 6.8 Tool control or section 7.2 Application parameters			
Enable the tool cut output when synchronized.	1 = Enable 0 = Disabled	Pr19.049	
Tool manual cut.	1 = Cut 0 = No Cut	Pr19.031	
After the tool has synchronized then the tool up input (parameter 19.46) is checked to ensure that the flying shear is able to decelerate, if the tool is not raised then we can handle the fault in one of two ways:	1 = extend the synchronization to the line speed, and stop the line. 0 = Decelerate as normal.	Pr18.033	
Cutter mode. Only modes 0 and 1 are available in angled shear mode.	0 = Set output during the cut part of the cycle, ignore tool up/down signals 1 = Use tool up signal 2 = Use tool down signal 3 = use tool up and down signals	Pr19.026	
Cut at start	0 = don't cut on start 1 = cut on start	Pr19.027	
9 Line and Shear Encoder Reference			
See section 5.3.3 Feedback application notes or section 7.2 Application parameters			
Select the encoder sources for the Line and shear encoder positions	0 = Drive 1 = Slot 1 2 = Slot 2 3 = Slot 3	Pr20.034 Pr20.035	
10 Position Loop			
Refer to section 6.9 or 7.2			
Position loop velocity feed forward gain. Do not change from 1000.	Set to 1000	Pr19.012	1000
Position loop proportional gain	Proportional Gain Val / 1000	Pr19.013	
Position loop proportional term limit	Set as a percentage of the drive maximum speed.	Pr19.016	
FE Limit, following error maximum value before an error condition will occur	FE Limit Encoder Counts	Pr19.011	
At position tolerance, this is the tolerance for the at position flag	Units/1000	Pr19.017	
Change forward direction of the axis	0 = Normal 1 = Reverse	Pr19.044	
Change forward direction of the shear	0 = Normal 1 = Reverse	Pr19.044	
Change direction of the Line position	0 = Normal 1 - Reverse	Pr70.085	
11 Hardware and Software Limits			
See also section 6.10 Hardware and software limits / positions or section 7.2 Application parameters			
At what positions do you want to put the software limits?	Forward Limit Units	Pr19.014	
	Reverse Limit Units	Pr19.015	
What is the polarity of the Hardware Limits	1 = Normally Closed 0 = Normally Open	Pr19.042	
Do you want to disable the limit switches during homing; this will be needed if you use the limit switch as a homing switch, or if the homing switch is outside the limit switch.	Enable Limits during homing. 1 = Disable Limits 0 = Enable Limits	Pr19.043	
How quickly do you want the shear to stop?	0 = Instantly 1 = Using the ramp rate set by 20.014	Pr18.048	

12 Watchdog			
Refer to section 6.11 Communications watchdog			
Watchdog Enable	1 = Enable 0 = Disable	Pr18.045	
Watchdog In Error Delay, if the watchdog clock from the remote device does not change state within the time allowed then an error state would result.	Watchdog Error Delay. Milliseconds	Pr18.026	
Watchdog Out Time Period, This sets frequency that the clock will change state.	Watchdog time period. Milliseconds	Pr18.027	
13 Batch Control			
Refer to section 6.15 Batch and line control			
Enable Batch Control	1 = Enable 0 = Disable	Pr18.016	
Batch Quantity		Pr18.017	
Batch Reset	1 = Reset	Pr18.038	

5.7 Command parameters

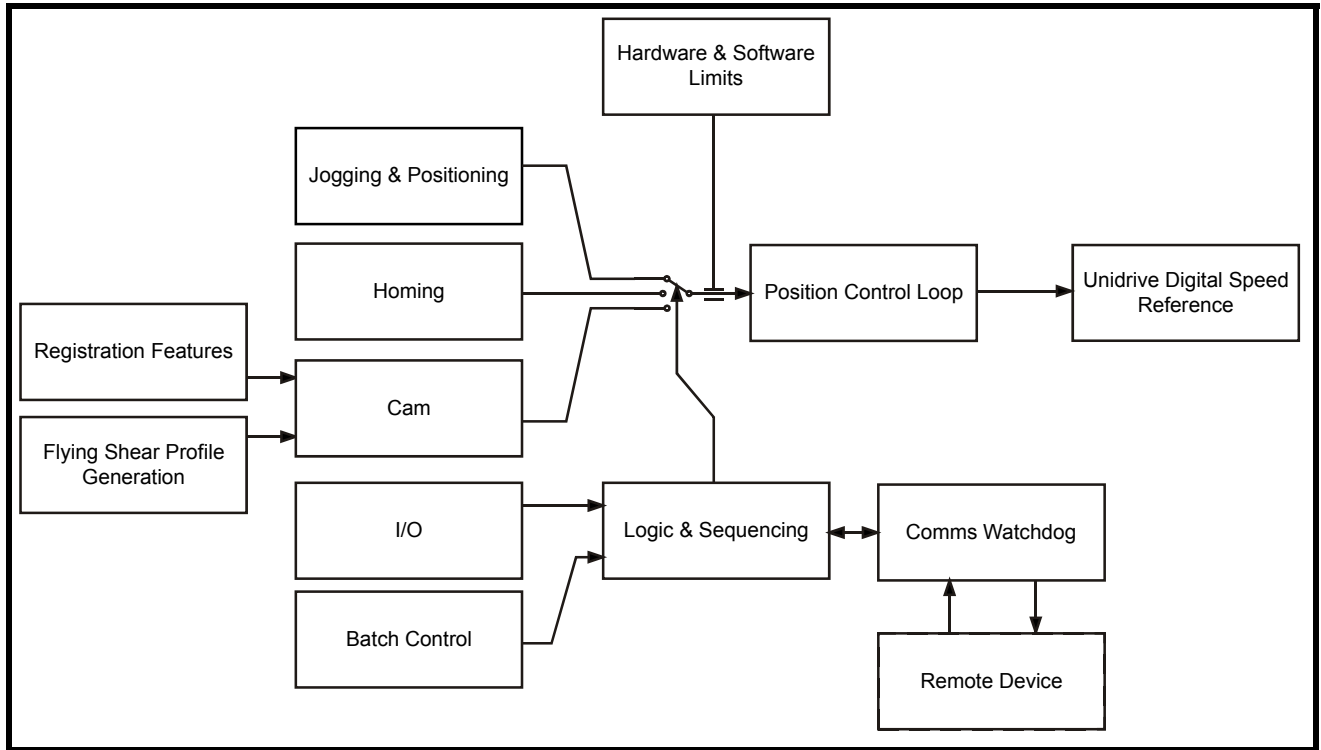
Update Scaling & Direction	0 – 1 Transition = Update	Pr 18.037	Not Mapped
Manual Tool Cut Command	0 – 1 Transition = Cut	Pr 19.026	Not Mapped
Drive / Software Reset	1 = Reset	Pr 19.032	Not Mapped
Shear Run Command	1 = Run 0 = Stop	Pr 19.033	Mapped to F3
Go to Start Position	1 = Go to Start	Pr 19.034	Not Mapped
Local / Remote Control	1 = Remote	Pr 19.035	Controlled by fieldbus control word
Jog Forward	1 = Jog	Pr 19.036	Not Mapped
Jog Reverse	1 = Jog	Pr 19.037	Not Mapped
Home / Datum Command	0 - 1 Transition = Home	Pr 19.038	Mapped after default to either Ain 2, through thresholds or T25 / F2
Abort Motion	1 = Abort	Pr 19.039	Not Mapped
Enable Tool	1 = Enabled	Pr 19.049	Not Mapped
Preset Line Position	1 = Preset	Pr 20.046	Not Mapped

6 Functional description

6.1 Overview

The diagram below illustrates the software architecture.

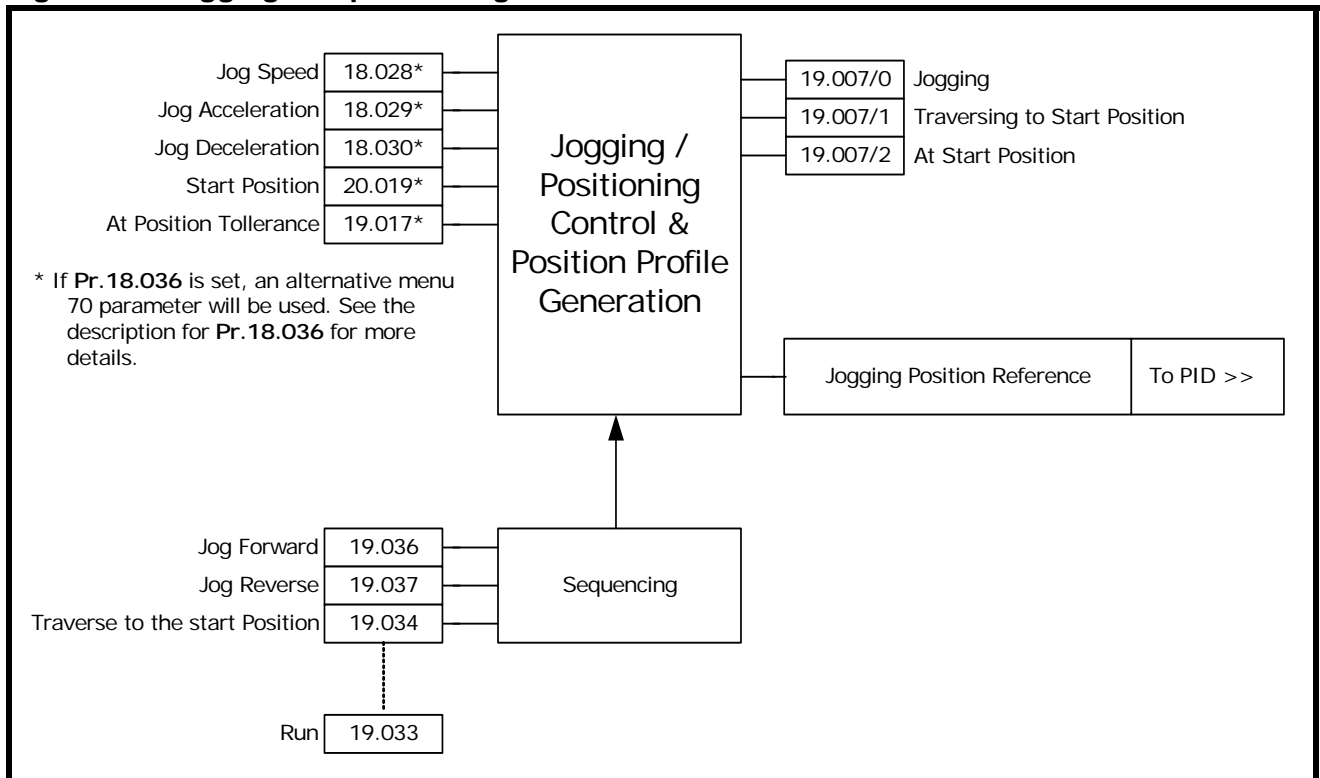
Figure 6-1 Software architecture



6.2 Jogging / positioning

Jogging can be done at any time provided the flying shear axis is idle and the tool is in the up position. Provided that the system is homed, after jogging the axis can be sent back to the start position ready for a flying shear profile, by toggling Pr **19.034**, or by running the Shear (Pr **19.033**=1). Hardware limits are always active when jogging; the software limits are also active providing the system has been homed.

Figure 6-2 Jogging and positioning function



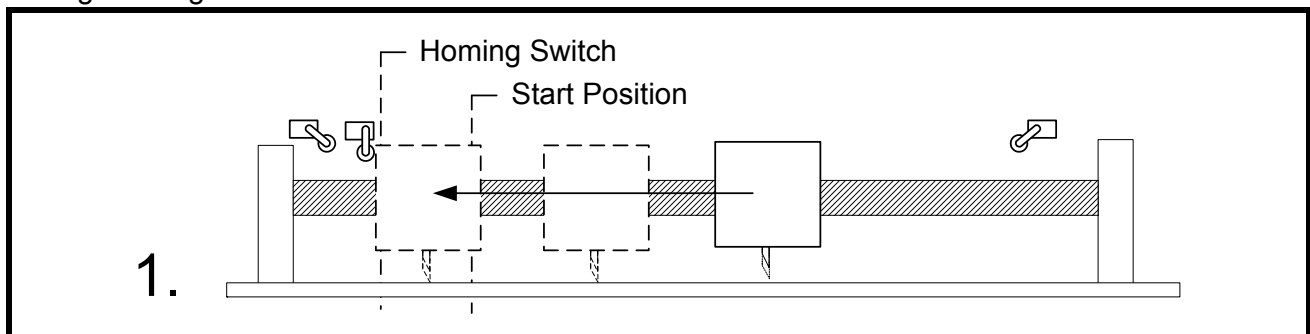
NOTE The Jog command is triggered by a rising edge. If Jog forward and Jog reverse are selected at the same time, the first one detected takes priority.

6.3 Homing

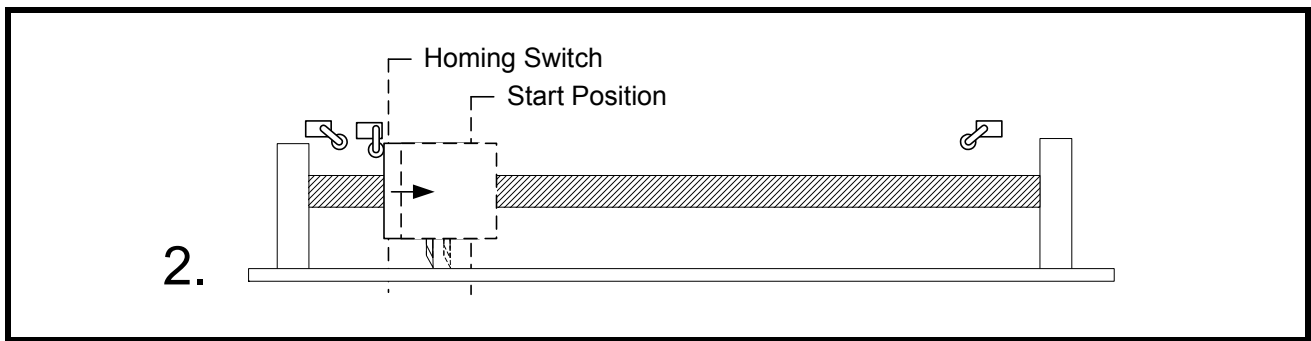
To home the shear:

- Another mode must not be active e.g. Jogging, cutting.
- The drive must be OK and enabled
- The Tool must be in the up position
- Sequence Abort must not be active (Pr 19.039)

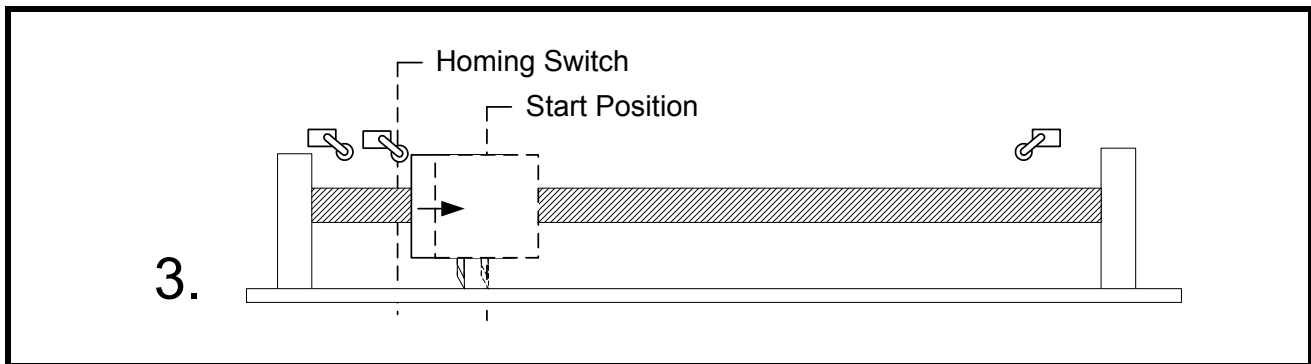
During Homing:



The flying shear carriage travels at home speed to find the home switch.



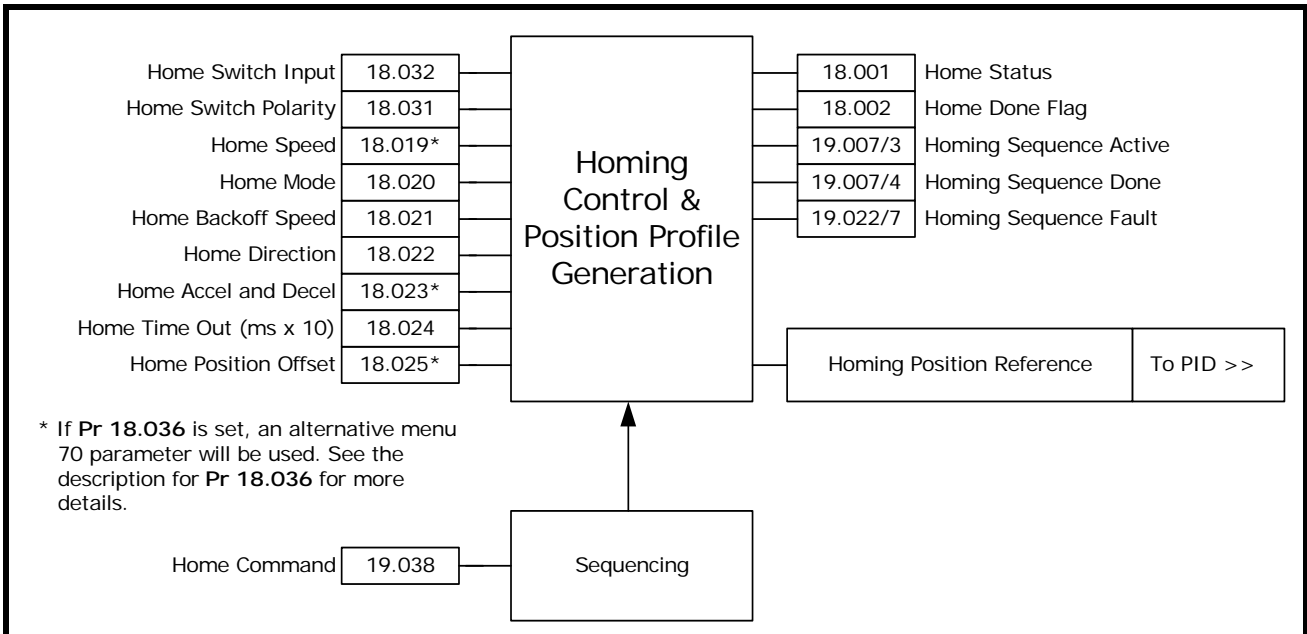
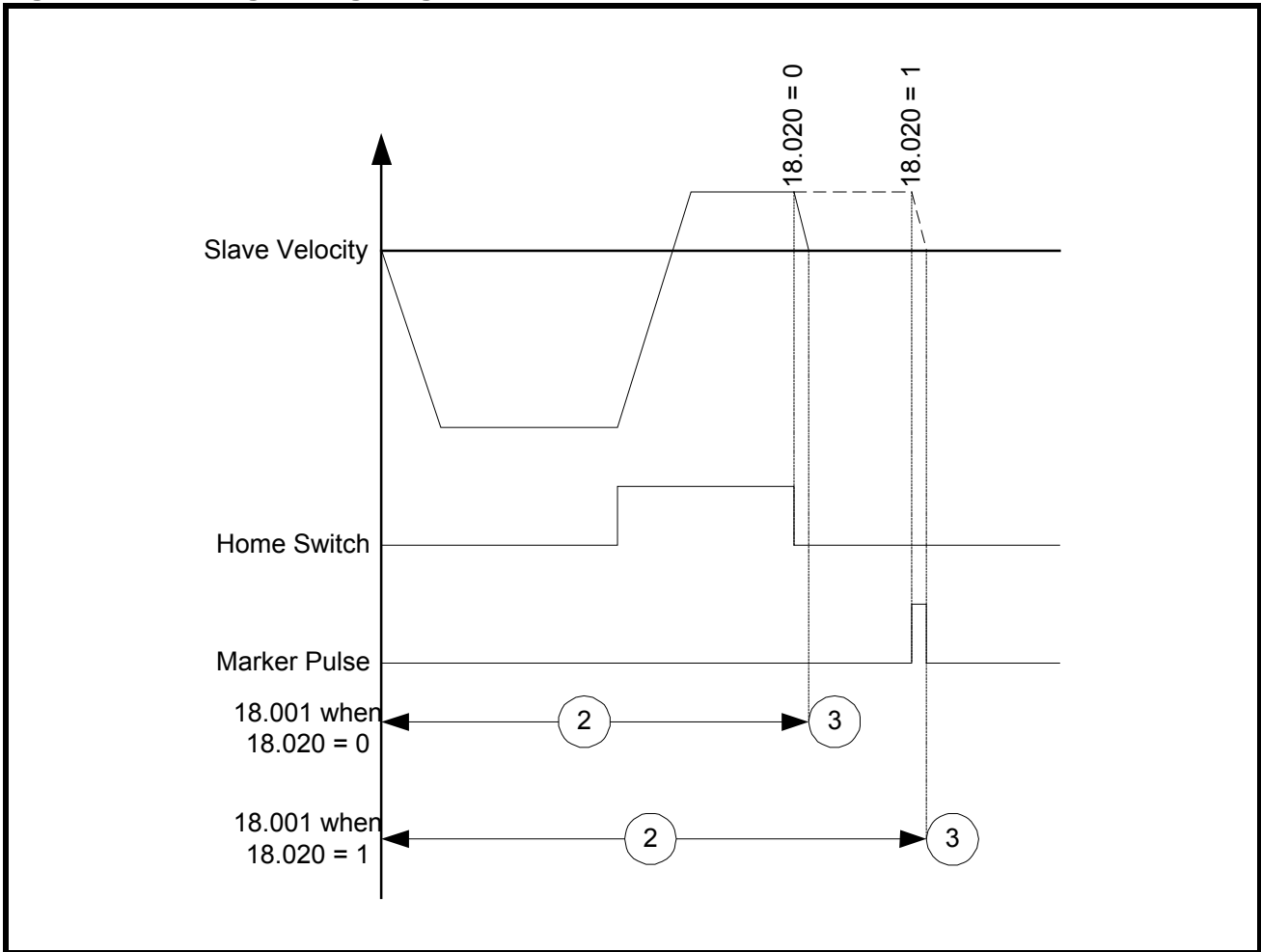
The flying shear reverses at back-off speed, a percentage of the home speed (Pr **18.019**), until the home switch is reset, or finds the next marker pulse; the position is then pre-set to the zero position preset (Pr **18.025**).



The carriage travels to the start position using the jog speed reference (Pr **18.028**), ready to run.

NOTE If you select a low home acceleration / deceleration rate (Pr **18.023**), with a high home speed (Pr **18.019**), during homing the shear may overshoot the home switch and crash the carriage. This is most likely to cause damage if the limit switches are disabled (Pr **19.043**=1), while a home sequence is completed.

Figure 6-3 Homing Timing Diagram



6.4 Registration

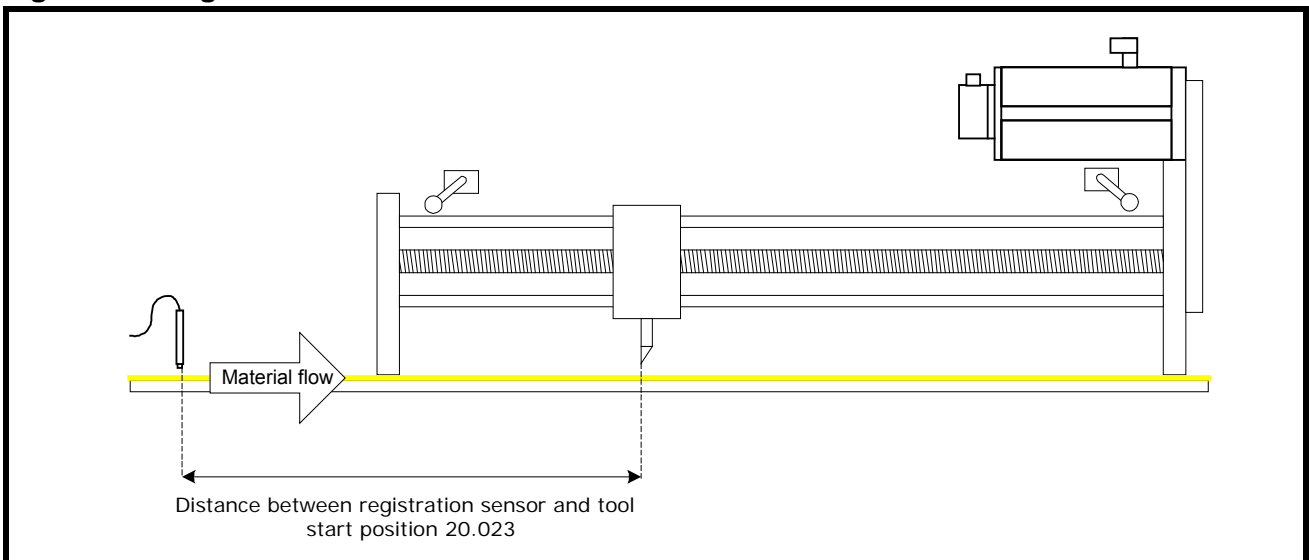
The registration sensor can have different functions depending upon the mode of the flying shear, cyclic or Registration.

In cyclic mode the flying shear can be used to detect the initial product edge and allow the first cut to be as accurate as the following cuts, setting the first cut mode to 1 (Pr **19.030**) enables this function.

In Registration mode the registration sensor is used to set the position where the flying shear will synchronize with the line. The sensor could be used to detect the position of a mark on a printed product, or alternatively to detect individual products that are randomly spaced out.

The position of the registration sensor is important. Once a registration event has occurred there must be enough space for the shear to accelerate, and synchronize, but if the sensor is located some distance from the shear some loss of accuracy may result.

Figure 6-4 Registration function



The registration offset between the registration sensor and the knife start position are entered into the registration offset (Pr **20.023**) and fine offset (Pr **20.022**) which allows a resolution of up to 0.001 units. If this is entered accurately, then the flying shear will synchronize with the position where the registration sensor detected the registration event.

However, the requirement may be to synchronize a fixed distance from that position, as opposed to detecting a mark. This can be achieved simply by adding or subtracting from the distance between the sensor and the knife start position. Ensure that there is sufficient distance for the flying shear to accelerate and synchronize with the new position.

Freeze configuration for registration functionality.

Freeze system setup depends on the hardware configuration that is used in the application. After defaulting/choosing the line encoder source (Pr **20.034**). The freeze system is configure as shown in following tables:

Table 6.1 Parameter settings for configuration 1 (SI-Applications Plus Module only)

Parameter	Setting
03.105 (F2 Freeze trigger source)	1 (Digital Input 5)
03.106 (F2 Freeze mode)	0 (Rising first)
03.107 (F2 Freeze Position Source)	1 (P2)
03.110 (Common freeze Source 1)	4 (Disabled)
03.111 (Common Freeze Source 2)	4 (Disabled)

Table 6.2 Parameter settings for configuration 2 (SI-Applications Plus and SI-Universal Encoder modules)

SI-Encoder Slot number	Line Encoder Location (Pr 20.034)	Parameter	Setting
1	1	15.102 (F1 Freeze Position Source)	0 (P1)
	7	15.107 (F2 Freeze Position Source)	1 (P2)
2	2	16.102 (F1 Freeze Position Source)	0 (P1)
	8	16.107 (F2 Freeze Position Source)	1 (P2)

This configuration is made automatically for the user when they correctly setup the encoder source, save parameters, and power off on or reset the SI-Applications Plus module (Pr **x.00** = 1070,press reset and save).

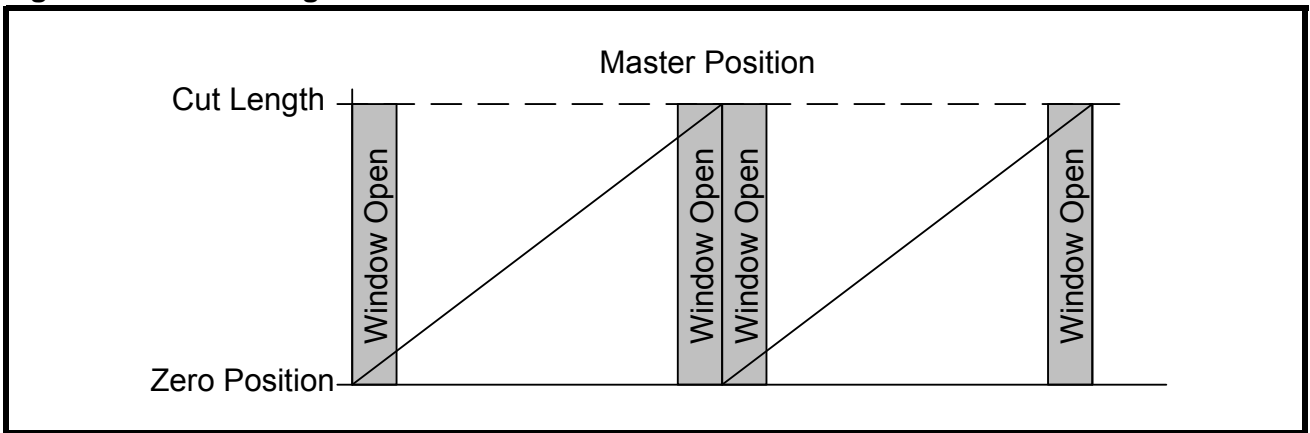
Windowing

The registration sensor may detect several marks during each cycle. It is common that only one of the marks is relevant for registration purposes, in this case we can enable windowing, which will reject marks that are detected outside a small position window.

The cut length (Pr **20.005**) is used to set the rollover distance relative to the line position count. The window tolerance (Pr **20.025**) is then used to set how wide the band is where the line will accept a registration mark.

As shown in the Figure 6-5 below, the window is always located about the rollover position. When a valid registration mark is detected, the position of the line is then automatically reset to zero, so that any drift in position is compensated.

Figure 6-5 Windowing



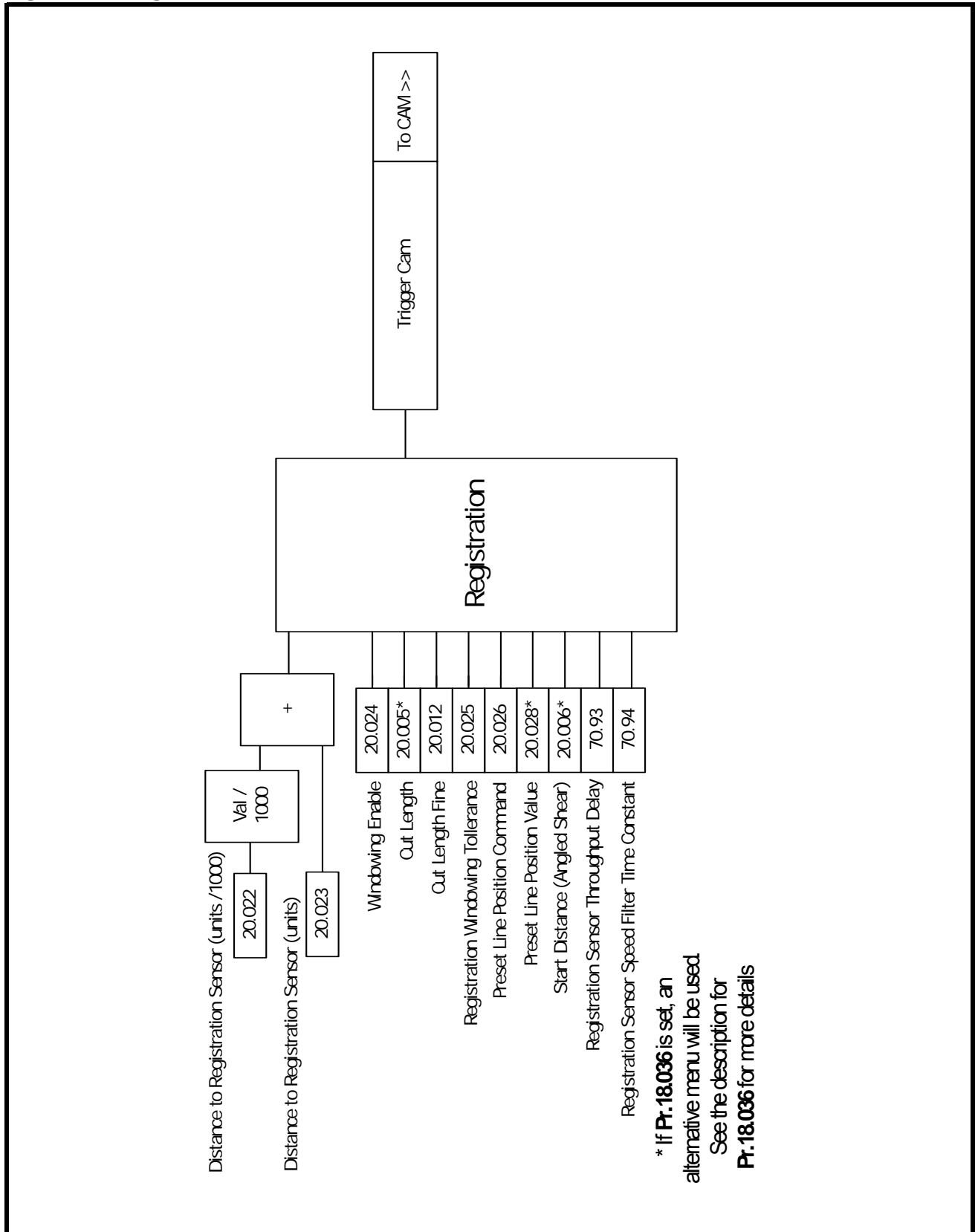
To start the flying shear using the correct mark, the line should be jogged so that the mark is aligned with the registration sensor (it can be just before or on the registration mark), and the line position is then reset to zero by toggling Pr **20.026**.

When the flying shear is started it will cut in the correct position. If it is necessary to configure the window while running, Pr **20.026** should be toggled before the required mark and not on it, as you may create a scrap cut.

If the sensor is located further from the start position than one cut length, there will be several registration positions that need to be recorded. Up to 25 registration events can be buffered at any one time.

If a mark is not seen within the window, then bit 9 of the Status Word 1 Pr **72.70** will be set. This status will be reset when the window is re-opened.

Figure 6-6 Registration function



6.5 Flying Shear profile calculation

The profile is calculated automatically from parameter data that is entered in real engineering units. The profile is checked to ensure that it can be achieved without exceeding any of the entered parameters, such as shear length. If there is a problem with the entered profile, a cam calculation error will be flagged in the raw alarm word (Pr **19.022**) bit 4, and the cam status word (Pr **20.003**) will show the type of error.

From the data a CAM profile is generated with 10 points, as shown below. Not all of the points are always used, such as, we are able to use either a triangular or trapezoidal return profile, whichever is the most efficient, and so while the standard profile has a segment 8, this may or may not be required.

The cam can be recalculated while the flying shear is running. The new cam will be calculated, and will take effect on the following flying shear cycle, providing the cut-length and / or profile information is loaded before point 9 of the current profile. The current cam / profile point, is displayed by the cam pointer (Pr **20.016**).

If the new calculated cam has an error, then the cam will not be accepted, and will generate a fault in the fault word (Pr **19.022**). This can be used to generate an alarm or a trip as required.

The maximum speed for the return profile is determined by Pr **20.036** which is limited to 99% of the drive speed (Pr **1.006**) x 0.99.

Normally there is no need adjust any of the profile parameters while the shear is running, however if parameters are changed incrementally via the drive keypad while the shear is running, it will take two profile cycles before the new values are accepted.

For example, If the current cut length is 1500mm and you decrement the value in steps of 100 to a new cut length of 1000mm using the keypad, the next cut length will be 1400mm as the cam recalculation instantly grabs the first value it sees, after which it will use 1000mm.

If any of the profile parameters are changed via the serial comms while the shear is running, the new values will take effect once the current profile has completed, provided the new values are entered before the cam pointer reaches 9, (Pr **20.016**).

If a new cam profile was entered while the shear was running causes a cam error, then if the cam trip is enabled, the current cut profile will finish and the shear software will trip. If the cam trip is not enabled then, the shear will continue to use the last valid set of profile parameters.

NOTE If there is a cam calculation error the first time the flying shear is run, you will not be able to start the shear. Ensure that Pr **19.022** and Pr **19.018** bits 4 are set to 1, and then modify the profile parameters to rectify the fault and reset the shear (Toggle Pr **19.032**).

NOTE If a small cut length can not be achieved because the required cut length (Pr **20.005**) is smaller than the minimum cut length (Pr **20.002**), try making the maximum line velocity (Pr **20.008**) as close as possible to the actual line velocity. If this does not reduce (Pr **20.002**) sufficiently for a parallel shear, increase the fly acceleration / deceleration rate (Pr **20.006**), for both parallel and angled, and increase the return acceleration / deceleration rate (Pr **20.007**). The acceleration and deceleration rates should only be increased within the limits of the machine, drive and motor.

In the majority of Flying Shear applications, the profile information like the max speed, acceleration rates and cut times, have been fixed for the worst case line speed.

Therefore the cut length could be changed on the fly with no issues, provided the new cut length is changed before CAM point 9 begins to act on the next cut.

This is acceptable in cases where the user wishes to cut lengths equal or greater to the minimum cut length that can be achieved for the give profile data, however in some cases the customer wishes to cut shorter lengths, which means that the line speed would have to be reduced to achieve the new length. If the user is in control of the line speed, then the line speed can be clamped from a simple approximation based on the following equation.

$$\text{Line Speed} = (\text{Max Line Speed} * \text{Required Cut Length} / \text{Min Cut Length at Max Line speed})$$

This equation would be limited to the maximum line speed incase the required cut length is greater than the minimum cut length at maximum speed.

When changing profile data on the fly, it is important to make sure that the correct sequence of events is used when changing the cut length, maximum profile speed and the actual line speed.

As explained previously if the minimum cut length was determined by the best case profile for acceleration, motor max speed and tool time at the maximum line speed, then the line speed can be reduced proportionally with cut lengths less the Minimum Cut length in a second SI-Applications Plus module as follows:-

$$\text{Line Speed or Cut Profile Speed} = \text{MIN}((\text{Max Line Speed} * (\text{New Cut Length} / \text{Min Cut Length at Max Line speed})), \text{Max Line Speed})$$

When changing profile data on the fly, these three cases may be considered:

1 Longer cut length, above minimum cut length at maximum line speed

This is the simplest case; all that is required is that the new length has to be entered before CAM point 9 on the last cut of the current batch. It will run at the same line speed, and a new dwell distance will be calculated.

2 Shorter cut length, below minimum cut length at maximum line speed

The following sequence is required: -

a) Reduce the actual line speed to the required set point for the reduced cut length. If possible set the deceleration for the line so it can reach 0 with in one cut cycle of the shear at maximum line speed using the following formula:

$$(\text{Min cut} - \text{Acceleration Distance} - \text{Settling Distance})$$

e.g. If the Min cut was 3m, Acceleration and Settling Distance 0.5m, and the max line speed was 45m/min, then the deceleration time should be set to less than $(2.5 * 60/45) = 3.3\text{sec}$. The lower the decel time is set then better, but care must be taken that it does not cause any slippage or mechanical issues on the line.

b) Once at the new line speed, set the maximum profile speed with the current cut length, before CAM point 9. This will ensure that the next new cut, which can be less than the current cut length), can be achieved successfully.

c) Set the new cut length before CAM point 9.

To successfully achieve this sequence, it may take three CAM cycles or three cut lengths depending on the deceleration time of the line. Of course point (a) has taken the worst case deceleration time, but in reality it will be less as the line will not be ramped to zero. So from this it may take 2 cycles to complete. Therefore on the current cut batch, this sequence will have to take effect 2 or 3 cuts before the last current cut batch is complete. If the batch contains one cut length, then the above will not work, so it is advisable to look ahead, and run the next cut at a lower speed.

3 Longer cut length above current cut length

The following sequence is required: -

- a. On the last cut of the current profile change Max profile speed and cut length together before CAM point 9.
- b. On acknowledgement the new CAM has been calculated increase the line speed to the new cut length speed.

In the majority of applications with batch control, sequence 2 is most commonly used for stacking/handling purposes. Longest cut lengths on the bottom and the shortest on the top.

To ensure the profile data is acquired at the same time before the next cut, a profile parameter acquire bit can be used. When not using this feature the software looked at change of a parameter only, which means that it could not be guaranteed that if two or more profile parameters were changed that they would be both acquired for the next cut. The Acquire bit can be used directly using parameters or using the serial comms control word. The acquire function can be enabled by means of Pr **18.039**.

Figure 6-7 Parallel Shear profile

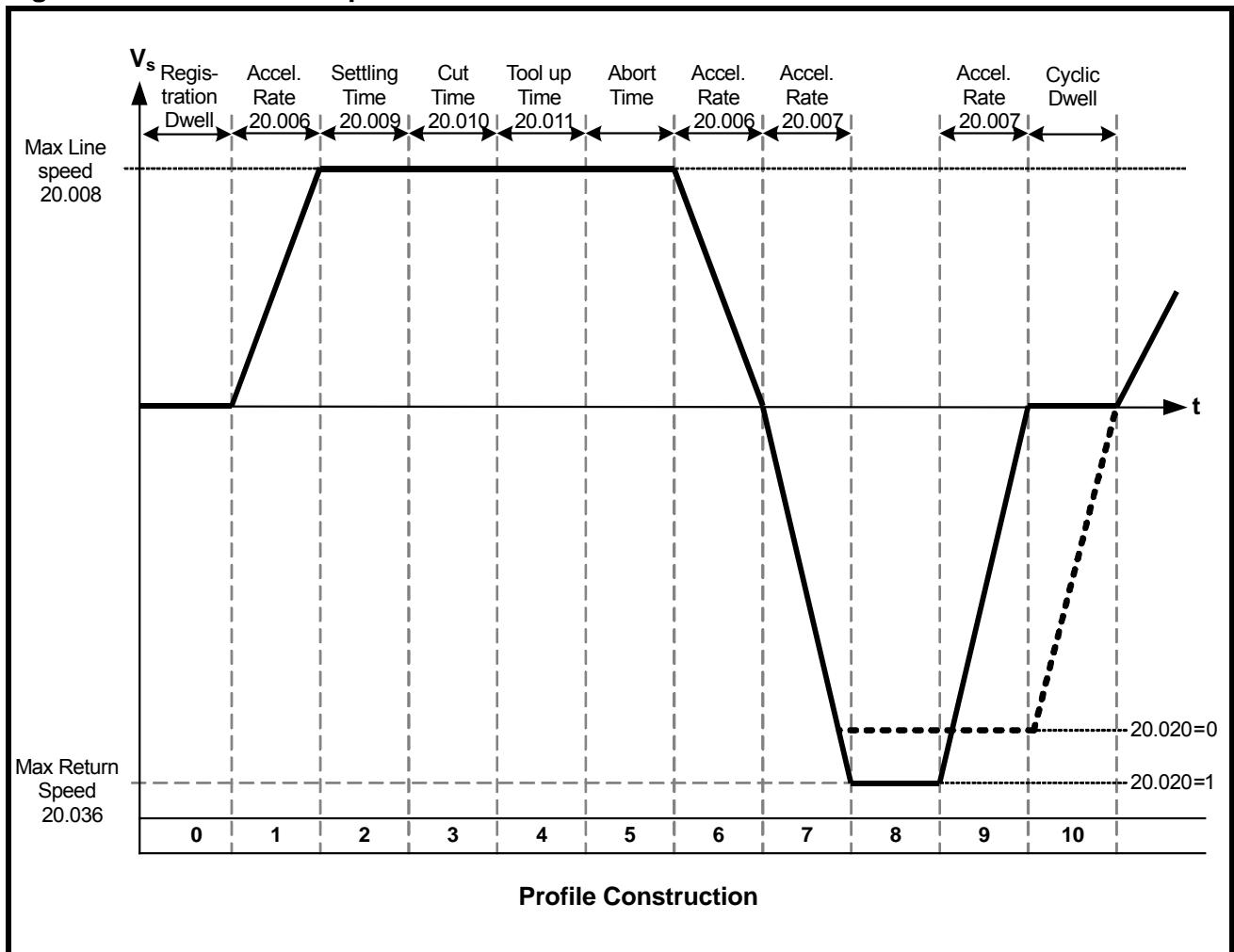


Figure 6-8 Profile without / with extended sync distance

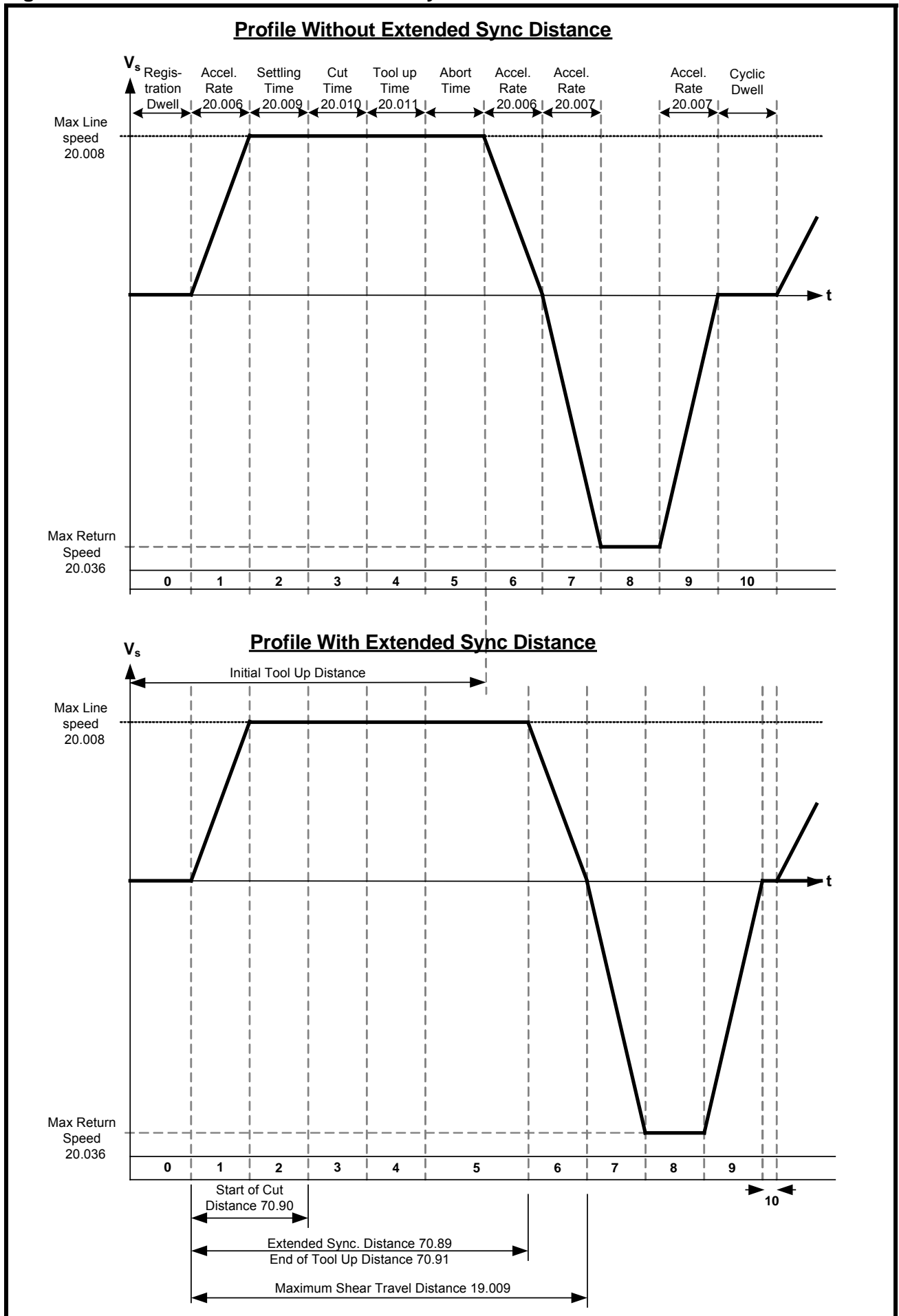


Figure 6-9 Angled Shear Profile

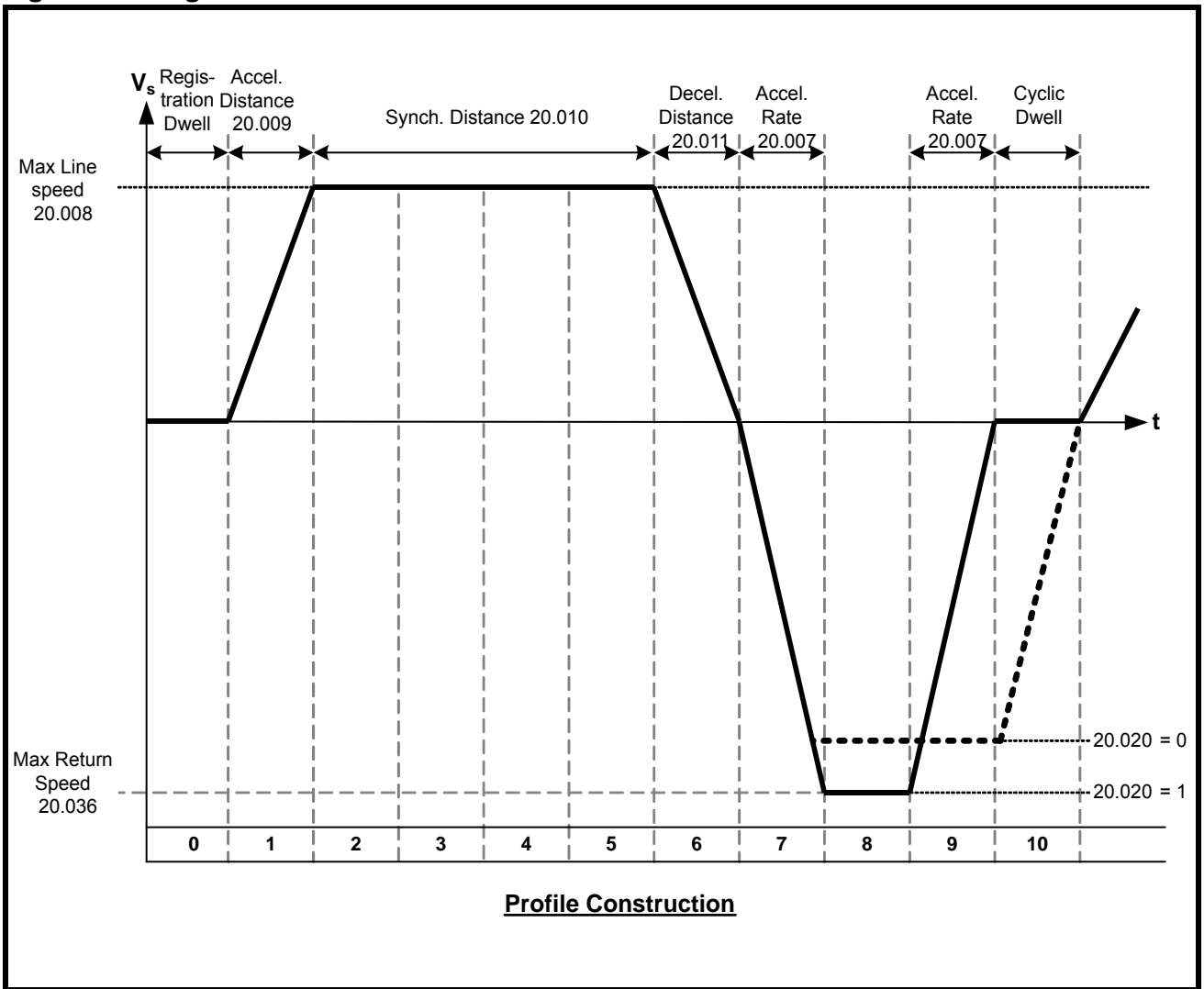
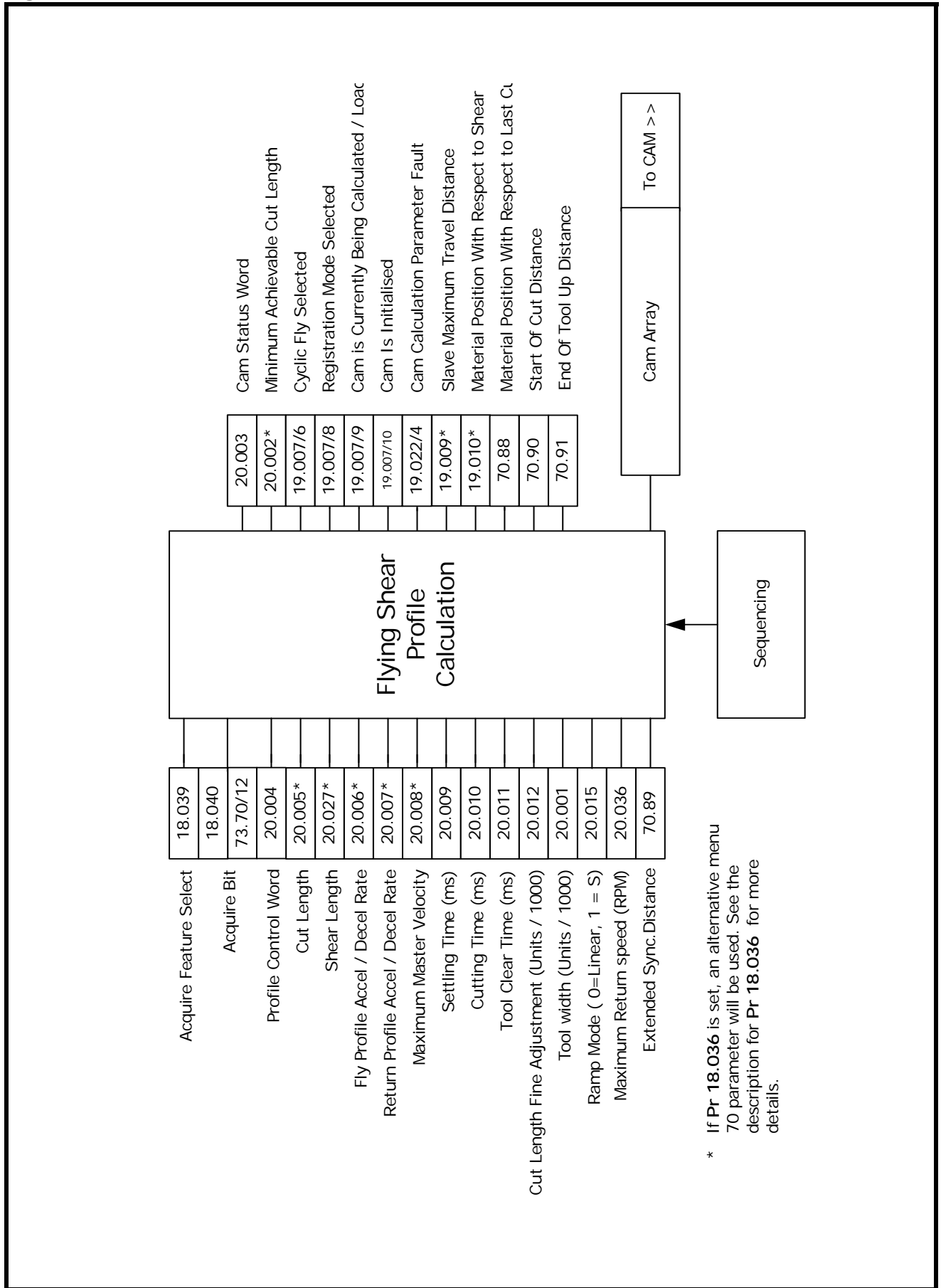


Figure 6-10 Profile calculation function



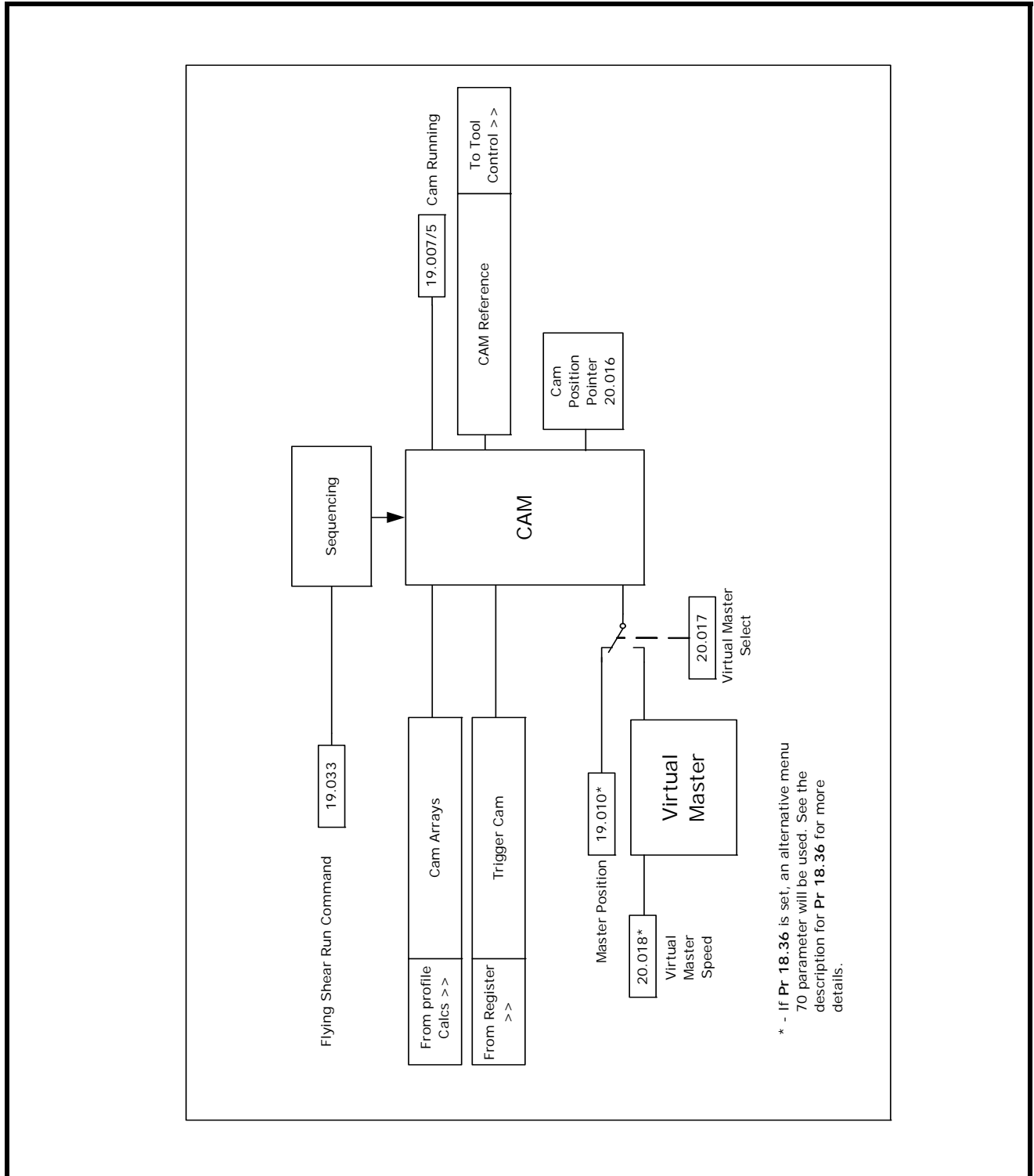
6.6 Cam control and virtual reference control

The Cam accepts inputs from the registration block and the profile calculator, and executes the cam with reference to the line position.

For commissioning / start up purposes, a virtual reference may be used to check the system without the need to waste product, the virtual line does not have a ramp, and so the speed should not be changed by large increments while the profile is in operation.

Comparing the performance of the virtual reference to the actual line position, will highlight if there are any issues with line encoder noise, resolution, or velocity stability

Figure 6-11 Virtual reference function



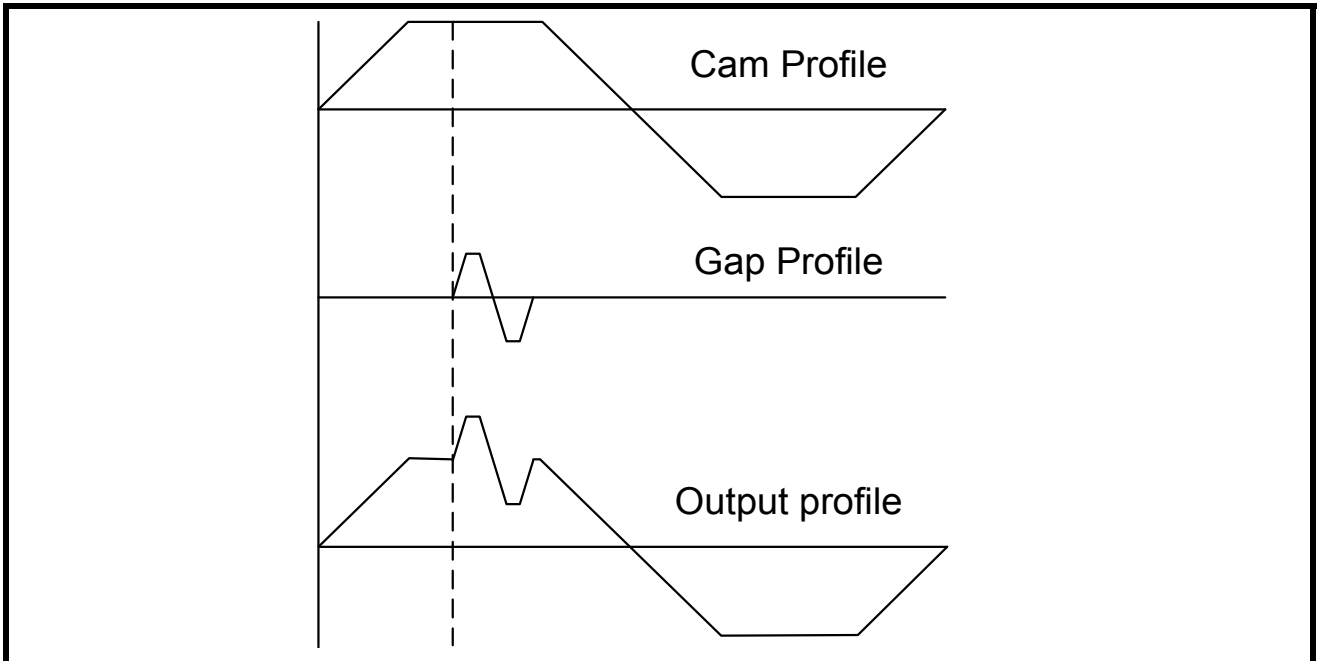
6.7 Gap profile generator

Some applications require a gap to be inserted between products by accelerating above synchronization speed once the cut has been done, using the tool to push the cut material forward (Parallel shear only). This is also useful where the product is viscous, and so requires the product to be completely severed during the cut.

The gap is achieved using a trapezoidal profile generator which is added on to the main position reference to produce the gap, it is important to note that the gap profile is triggered by the tool down signal, or in applications where tool down is not used then it is triggered when the Cam is in tool-up part of the cycle (Cam point 4). The Gap profile is not synchronized to the line like a cam, and so once triggered will continue even if the line is stationary.

NOTE If the shear is in Tool Cut mode 1 (Pr 19.026 =1), and Tool Up Time (Pr 20.011) is set to low, the gap profile may not have enough time to execute. Consequently the Tool Up time must be increased. Pr 70.84 indicates the actual gap distance achieved, therefore if the gap distance was successful, the value in this parameter should be equal to the gap distance set.

Figure 6-12 Gap profile generator



NOTE The overall speed of the Profile and Gap must not exceed the shear motor linear speed detailed below:

$$\text{Max Slave Linear Speed} = \frac{\text{Pr } 1.006 \times 0.99 \times \text{Pr } 3.034 \times 4 \times \text{Pr } 20.031}{\text{Pr } 20.032 \times 60} \text{Units/s}$$

In some applications, it may be required for the Gap Control to operate so that part, or all the gap distance is completed during the shear return part of the profile. This prevents the shear cutting tool being struck by the advancing material.

Figure 6-13 Gap control

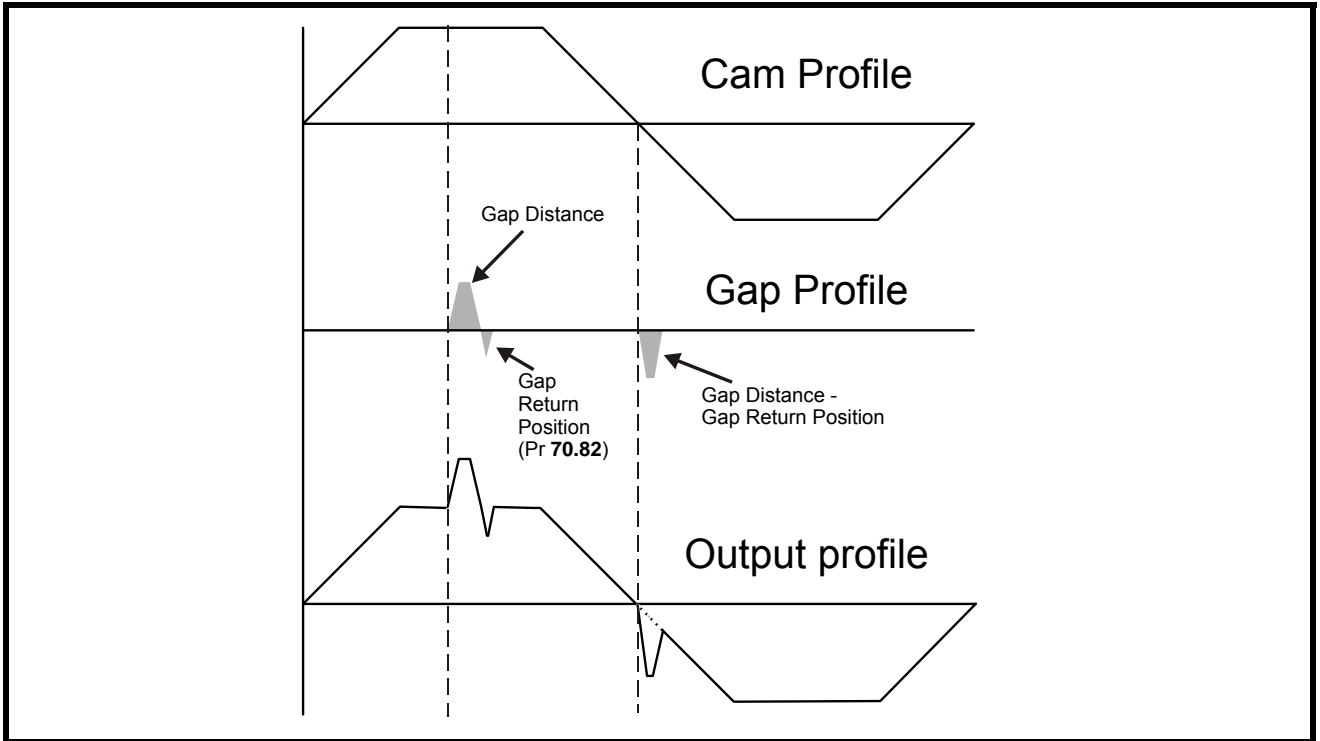
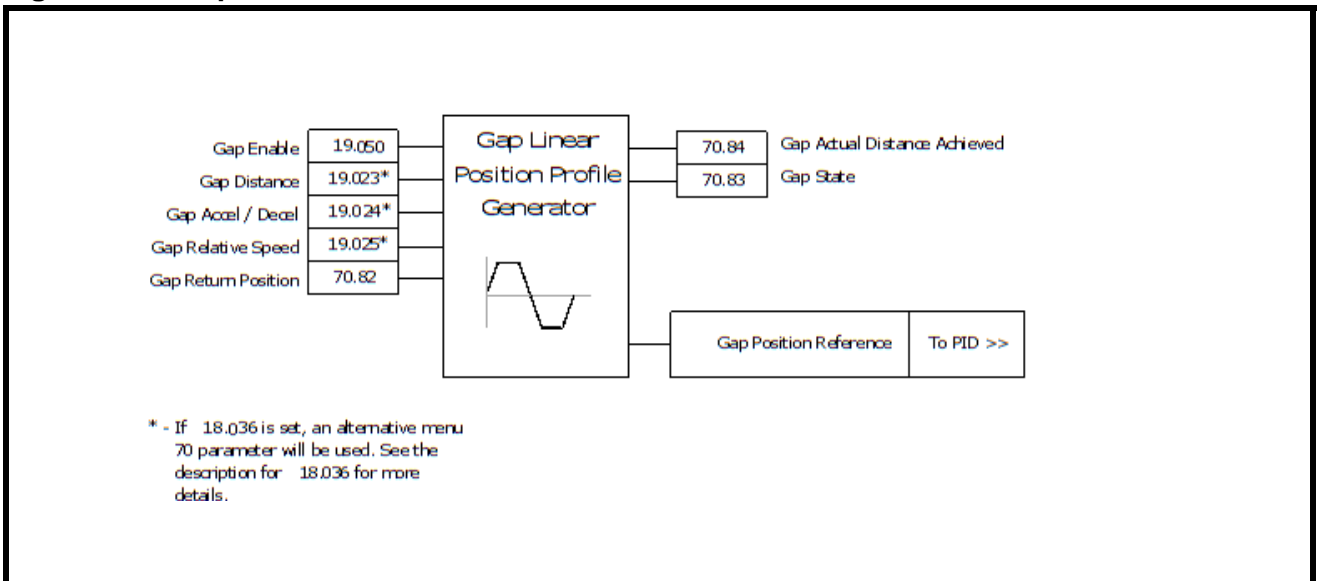


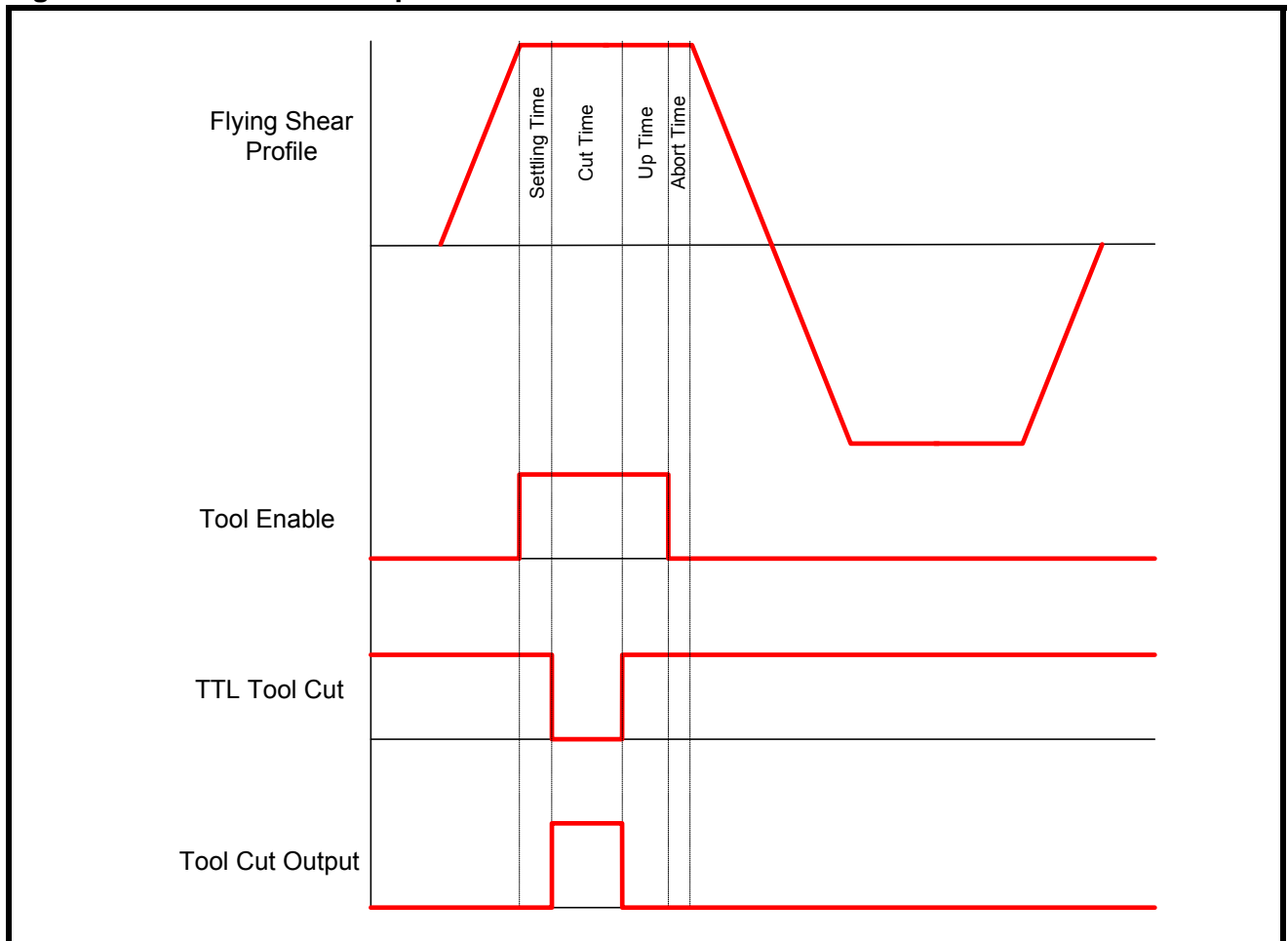
Figure 6-14 Gap control function



6.8 Tool control

For many applications the tool requires very accurate control to ensure that the flying shear profile is optimized to achieve the smallest cut length at the highest line speed. By setting the time required for performing the cut and using a high-speed output direct from the SI-Applications Plus to activate the cut mechanism we can optimize the performance of the shear.

Figure 6-15 Tool control sequence



NOTE The enable signal is generated through software and therefore cannot be relied upon to prevent injury to persons working on or around the machine. It is mandatory for a hardware safety circuit to be implemented to electrically isolate the moving parts to provide a safe working environment.

6.8.1 Cutter modes

The cut mode (Pr 19.026) allows the user to select one of four cutter modes:

Mode 0

The cut output is switched on during the cut segment of the flying shear, and off at all other times. The tool up / down inputs are not used, and so the system will not detect that the tool is jammed in the product.

Mode 1

The cut output is switched on during the cut segment of the flying shear, and off at all other times. The tool up signal is used to detect that the tool is up at the end of the synchronized period, this can be used to synchronize the shear with the line for an extended period, and initiate a line stop, or

alternatively can be used to flag an error or trip the drive (see Tool Sync Enable (Pr **18.033**) in section 10.1. In this mode if the Tool Up signal is not present before shear run is enabled (Pr **19.033** = 1), then the shear will not run.

Mode 2

The cut output is switched on at the start of the cut segment of the flying shear, and off as soon as the tool down signal is received. If by the end of the flying shear cut segment, the tool down signal has not been received, then the tool output is switched off anyway and an error condition is set, which can be used to alarm or trip the drive. If the Tool down signal is still on at profile segment 5, then the drive will behave the same as if a tool up signal is not received, i.e. depending on how Tool Sync Enable is set. This mode is not available when the Angled Shear is selected.

Mode 3

This is the same as Modes 1 and mode 2 together. This mode is not available when the Angled Shear is selected. In this mode if the Tool Up signal is not present before the shear is started, Pr **19.033** = 1, then the shear will not run.

6.8.2 Real time cut

When real time cut is enabled (Pr **18.050**=1), the tool cut time (Pr **20.010**) is set in real time, in milliseconds, and is not influenced by the line speed. The tool is fired at the beginning of profile point 3 section To ensure the profile data is acquired at the same time before the next cut, a profile parameter acquire bit can be used. When not using this feature the software looked at change of a parameter only, which means that it could not be guaranteed that if two or more profile parameters were changed that they would be both acquired for the next cut. The Acquire bit can be used directly using parameters or using the serial comms control word. The acquire function can be enabled by means of Pr **18.039**.

When real time cut is disabled (Pr **18.050**=0), the tool cut time (Pr **20.010**) is only applicable when the line is running at the maximum line velocity (Pr **20.008**). The cut time will increase inversely proportional with line speed e.g. If the maximum line velocity (Pr **20.008**) = 100 Units / s and the cut time (Pr **20.010**) = 100ms, at maximum line speed the cut time is 100ms, and at half maximum line speed the cut time is 200ms.

6.8.3 Start cut mode

If start cut is set (Pr **19.027**=1), then the flying shear will always perform an initial cut when shear run is enabled (Pr **19.033** = 1), this is so that any scrap can be removed, and can be used to ensure that the first cut is of the correct length.

6.8.4 Manual cut / scrap cut

To perform a manual / scrap cut, set Pr **19.031** or control word bit 13 (Pr **73.70**). When the line is at standstill setting the manual cut bit will immediately fire the tool, however, if the line is moving and the shear is in cyclic mode, the shear will synchronize to the material, and then perform the scrap cut. Scrap cutting with a moving line can only be performed in cyclic mode.

6.8.5 Firing the tool at a specific position

To make the tool fire at a specific position along the shear travel, the following method may be used:

1. Measure the distance from the knife starting position, to the point on the shear travel where the tool must be fired, in units.
2. Select fast optimization, Pr **20.040** = 1.
3. Calculate the distance used with the current acceleration rates to get up to the maximum line velocity using the following formula:

$$\text{Acceleration Distance (units)} = (\text{Pr } 20.008^2) / (2 * \text{Pr } 20.006)$$

The calculated acceleration distance must be equal to or less than the distance measured in step 1; if the distance calculated is longer, increase Pr **20.006**.

4. Calculate the settling time using the following formula:

$$\text{Settling Time (Pr } 20.029) = (\text{Distance step 1} - \text{Distance step 3}) / \text{Pr } 20.008$$

Enter the new settling time value in to Pr **20.009**

Pr **70.90** indicates the Start Of Cut Absolute Position from Start Distance. This is based on the acceleration rate (Pr **20.006**), Maxline Velocity (Pr **20.008**) and settling time (Pr **20.009**) entered.

6.8.6 Test cut length mode

This enables a test cut length to be done on the fly which is a different to the cut length to that is set in Pr **20.006**. The Test Cut Length is set in Pr **70.92** and enabled by Pr **18.046** or Bit 14 of the control word Pr **73.70**.

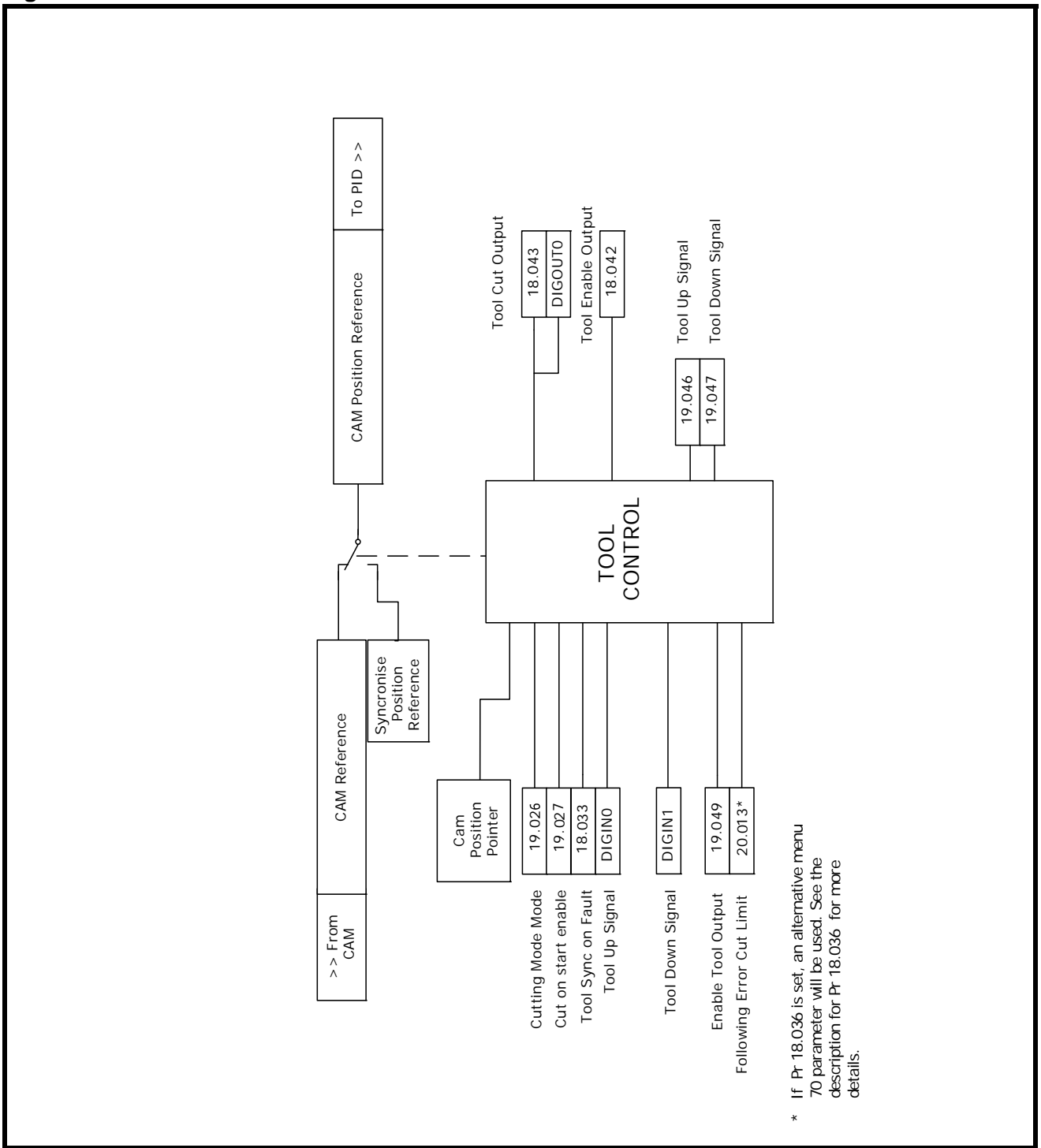
The first cut length test cut length will be cut if the bit remains set prior to a shear start in cut modes 2 or 3.

When the shear is running, the test cut is enabled by a rising edge of the Test Cut bit. This will cause the next cut length to be the test cut length, provided the bit is set before CAM point 9.

If the Test Length is required to be repeated then test bit enable will need to remain set.

The batch counter will disable the when a test length is being cut.

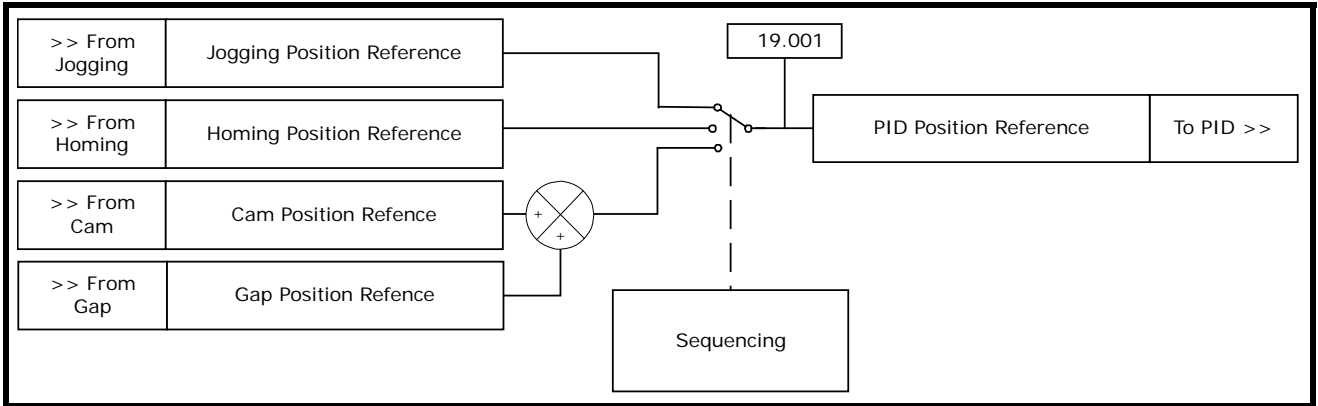
Figure 6-16 Tool control function



The reference is selected automatically by the sequencing.

6.9 Reference selection and PID

Figure 6-17 Reference selection and PID



The position loop encompasses a Proportional (P) and Velocity Feed Forward (VFF) terms, in dynamic position loops such as flying shears integral and differential gains do not offer any benefits. The VFF gain is calculated so that it will produce the correct values if the gain is set to 1000, any other value will give a steady state error. The proportional gain will require tuning to achieve the best response for the mechanical system.

6.9.1 Tuning procedure

1. Tune the speed and current loop gains to the required profile acceleration rates and cycles. Use the profile for the shortest cut at the maximum allowable line speed.

Current Loop Parameters: Proportional Gain Pr **4.013**

Integral Gain Pr **4.014**

Speed Loop Parameters: Proportional Gain Pr **3.010**

Integral Gain Pr **3.011**

Differential Gain Pr **3.012**

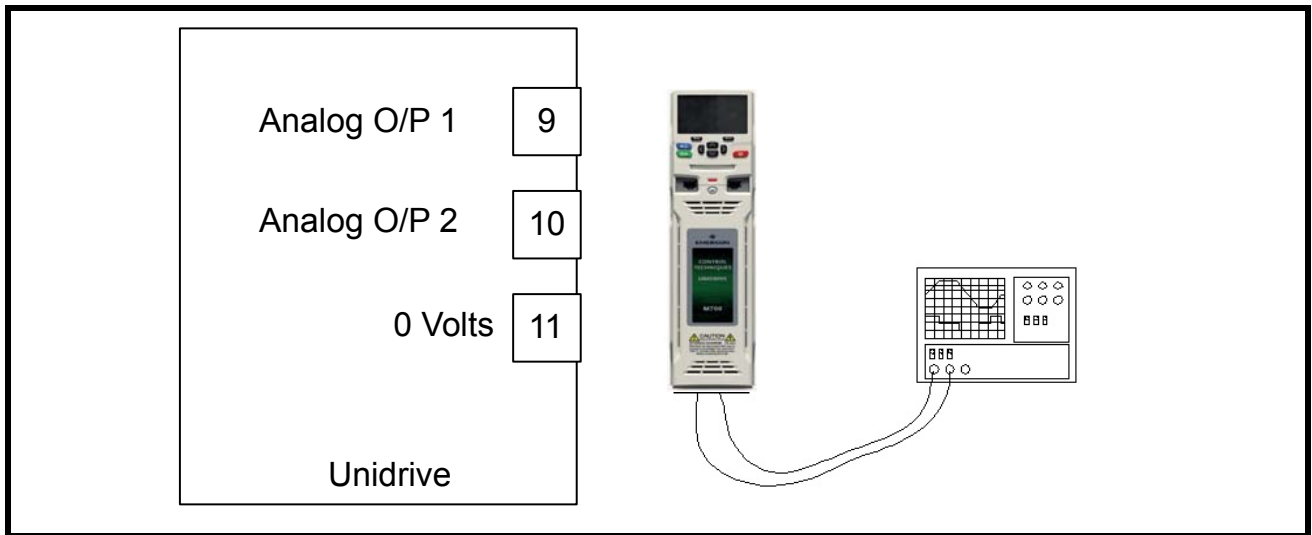
Refer to the Unidrive-M *User Guides* for more information.

2. Tune the position Loop.
 - a. Velocity feed-forward gain (Pr **19.012**), this derives the rate of change of position reference. This is set in fixed-point integer where 1000 = 1.000. This must always be set to 1000. With the proportional gain set to 0 and the velocity feed-forward gain set correct, this can be used to tune the speed loop gains as it provides the required speed profile reference generated from the CAM, with no positional correction from the proportional term.

NOTE Without a Proportional term, an accumulative position error will occur, so care must be taken if this method of tuning of the speed loops is used as the end limits may be exceeded.

- b. Proportional gain - this provides the amount of position correction from the position error. This is set in fixed-point integer where 1000 = 1.000. For an error of 1 encoder count and a proportional gain of 1000, there will be an output of 1 count per second.
- c. Proportional Output Limit - the proportional output is summed with the velocity feed-forward output, the amount of proportional output correction applied to the velocity feed-forward is limited by Pr **19.016**, nominally this set between 1 and 20%, dependant on the application. If set too low a following error will accumulate and will effect the deceleration or end of the profile, and may also trip the drive on Tr71.

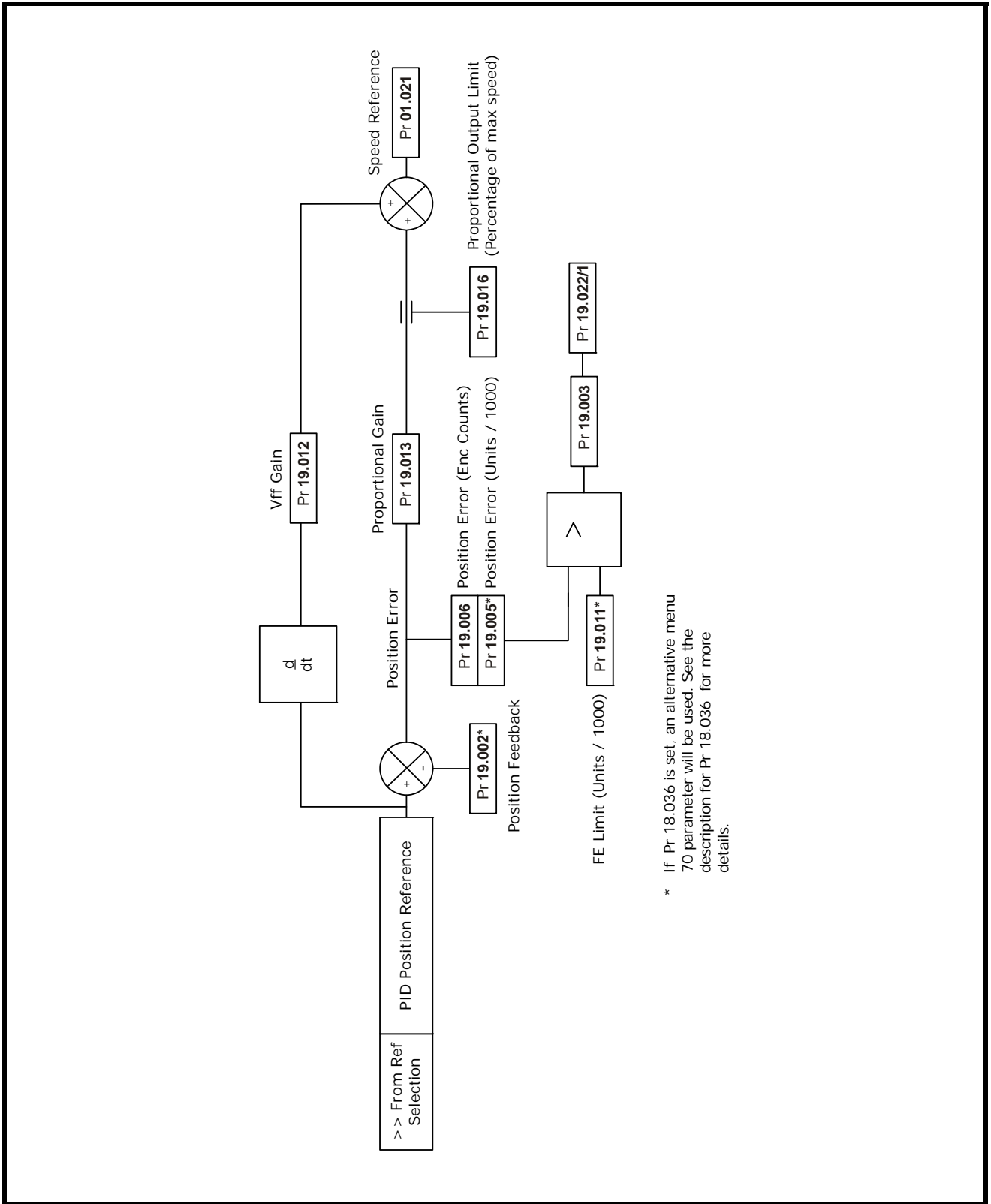
To help tune the system a scope should be used connected to analog outputs 1 & 2.



Analog output 1 can be set to give following error and analog output 2 set to give the speed profile of the flying shear.

The speed (Pr **3.002**) and current (Pr **4.002**) can be sourced to the analog outputs on a fast update. Set analog output 1 source (Pr **7.019**) to Pr **3.002**, and analog output 2 source (Pr **7.022**) to Pr **3.02**. To monitor the following error, one analog output will have to be changed to the following error in encoder counts (Pr **19.006**). The following error analog update will be slower (max 4ms).

Figure 6-18 Position loop function



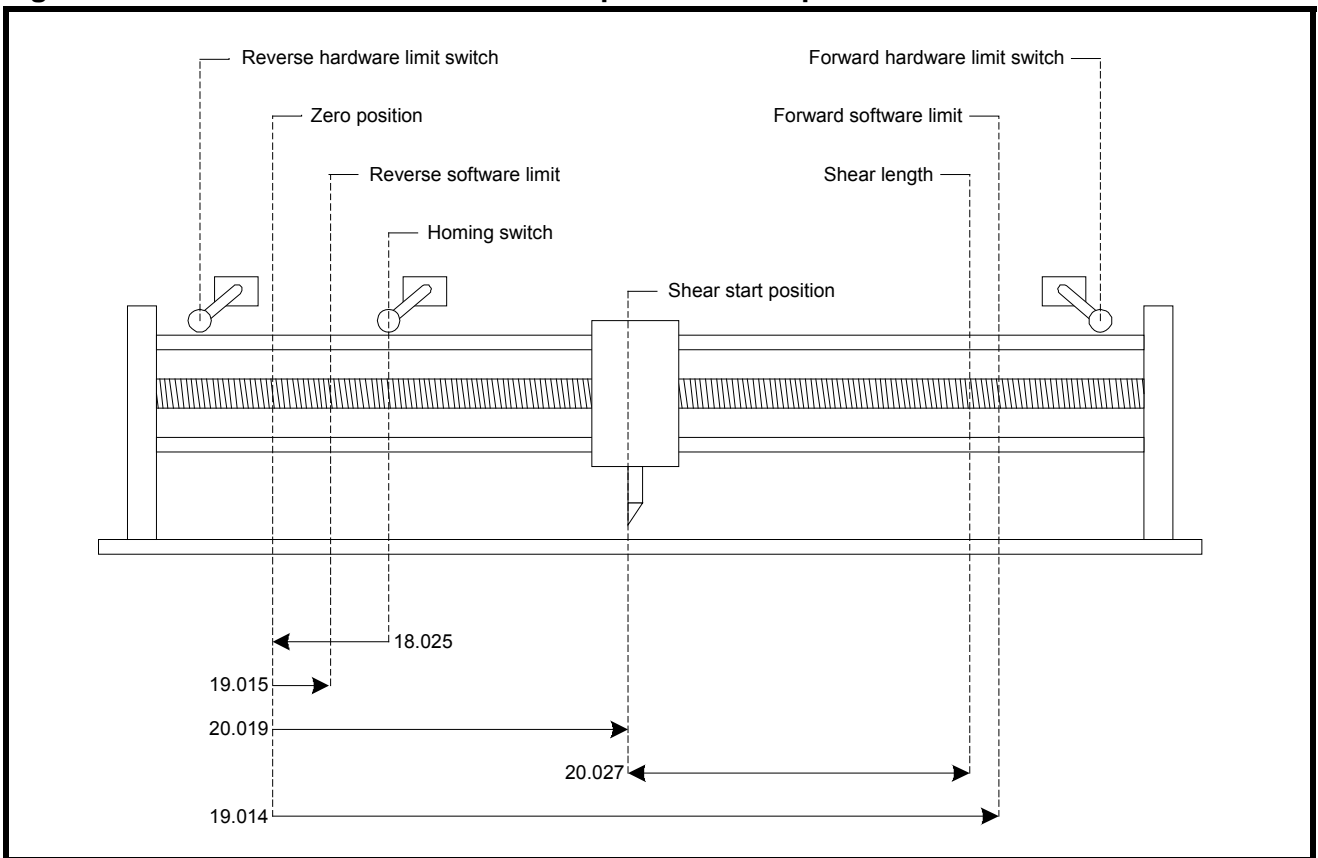
* If Pr 18.036 is set, an alternative menu 70 parameter will be used. See the description for Pr 18.036 for more details.

6.10 Hardware and software limits / positions

NOTE A risk assessment should be carried out to determine the potential risk of injury to persons caused by the flying shear drive losing control, if any risk exists then the standard hardware and software limits are not suitable. An external safety circuit should be used that utilises built-in redundancy to detect a potential hazard and automatically (mechanically) brake the flying shear safely.

The Hardware and software limits will override any other flying shear functions, and will initiate a flying shear deceleration. This is controlled by fast ramp enable (Pr 18.048); if Pr 18.048 = 0 then the shear will stop instantaneously / Shear pin, if Pr 18.048 = 1 then the shear will stop at the fast decel rate (Pr 20.014). It will also cause an alarm in parameter Pr 19.022, this may be used to trip the drive, or cause an alarm.

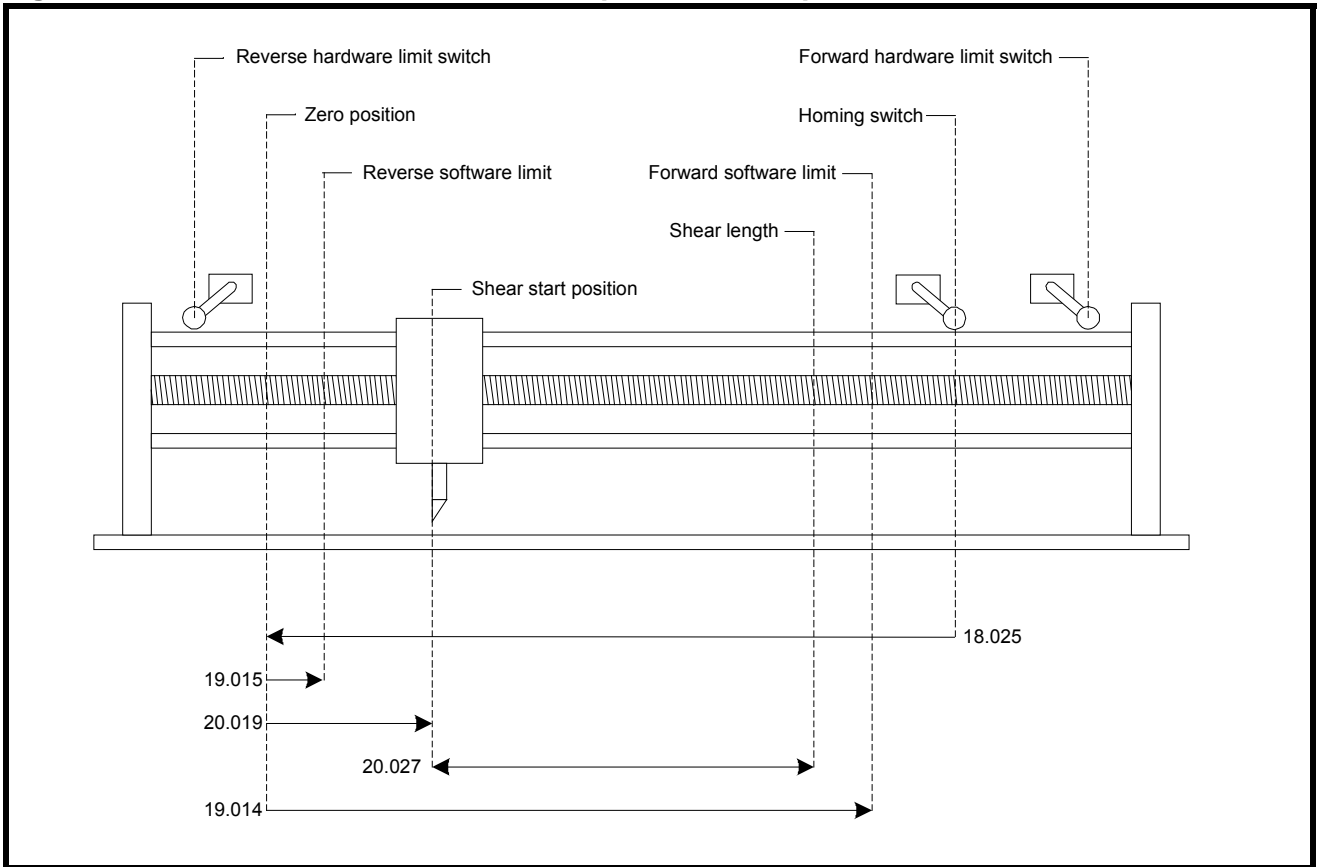
Figure 6-19 Hardware and software limits position example 1



6.10.1 Example setup 1:

- Pr 18.025 = 200 Units
- Pr 19.015 = 100 Units
- Pr 20.019 = 500 Units
- Pr 20.027 = 500 Units
- Pr 19.014 = 1050 Units

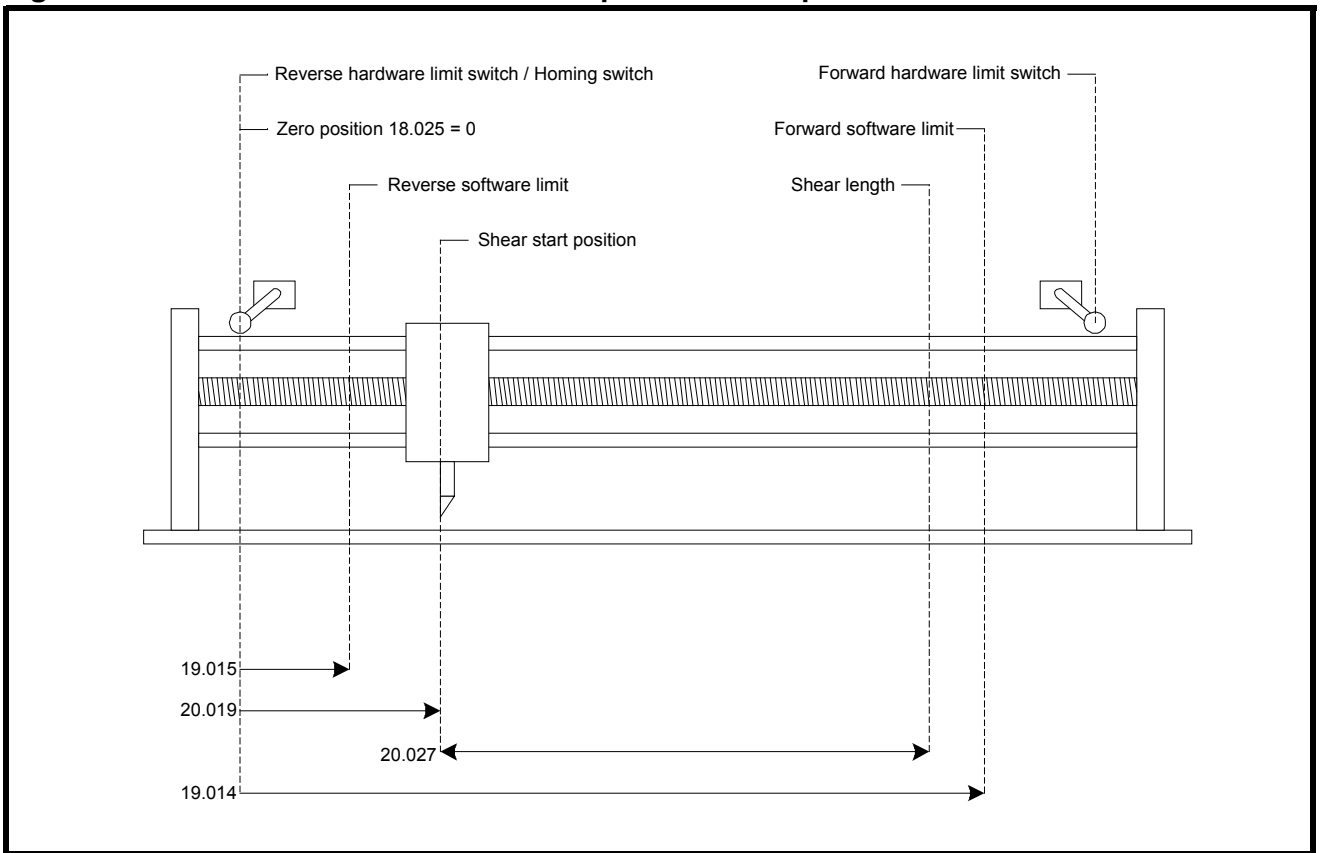
Figure 6-20 Hardware and software limits position example 2



6.10.2 Example setup 2:

- Pr **18.025** = 1000 Units
- Pr **19.015** = 100 Units
- Pr **20.019** = 300 Units
- Pr **20.027** = 500 Units
- Pr **19.014** = 900 Units

Figure 6-21 Hardware and software limits position example 3



6.10.3 Example setup 3:

Pr 18.025 = 0 Units

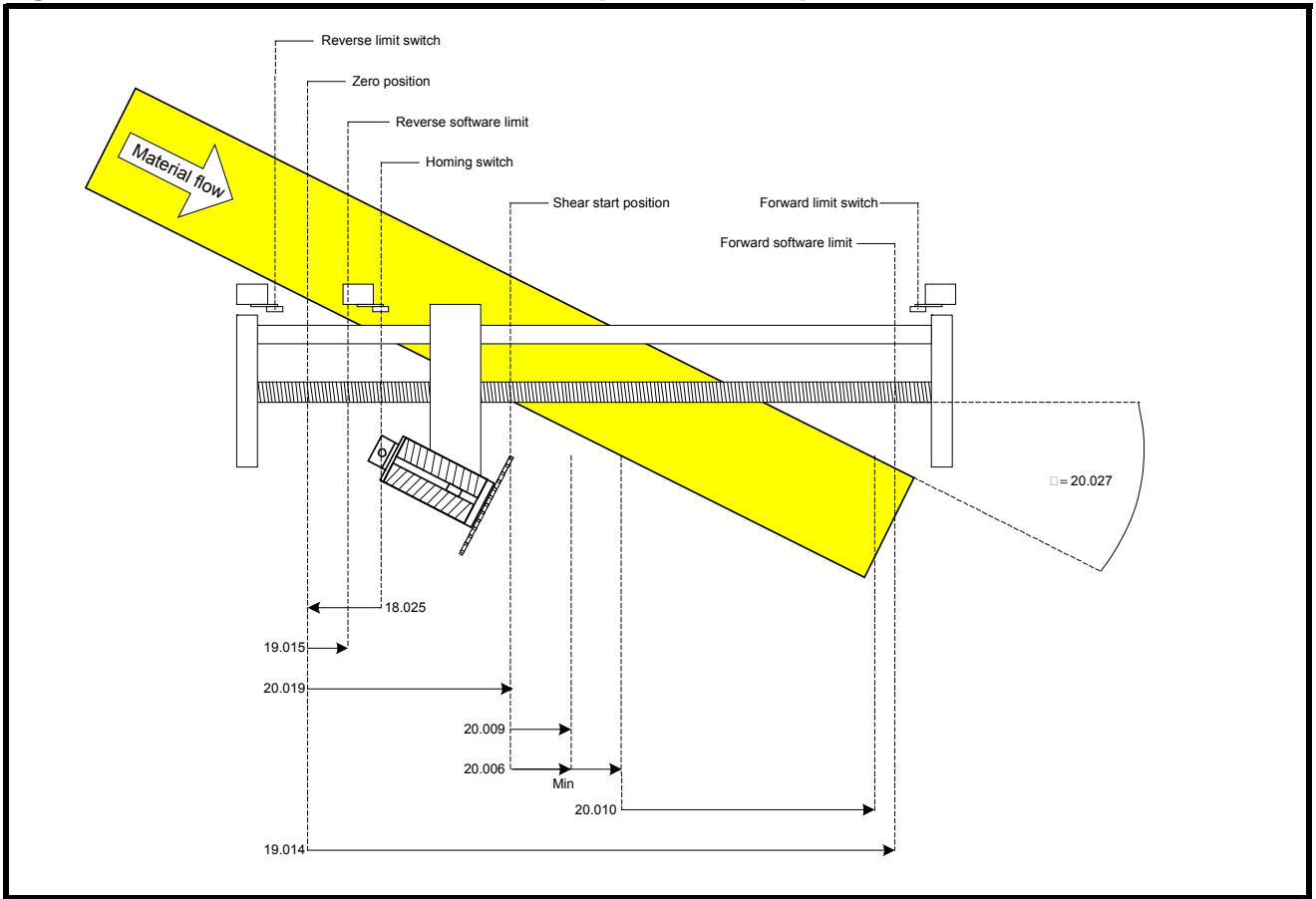
Pr 19.015 = 200 Units

Pr 20.019 = 400 Units

Pr 20.027 = 600 Units

Pr 19.014 = 1050 Units

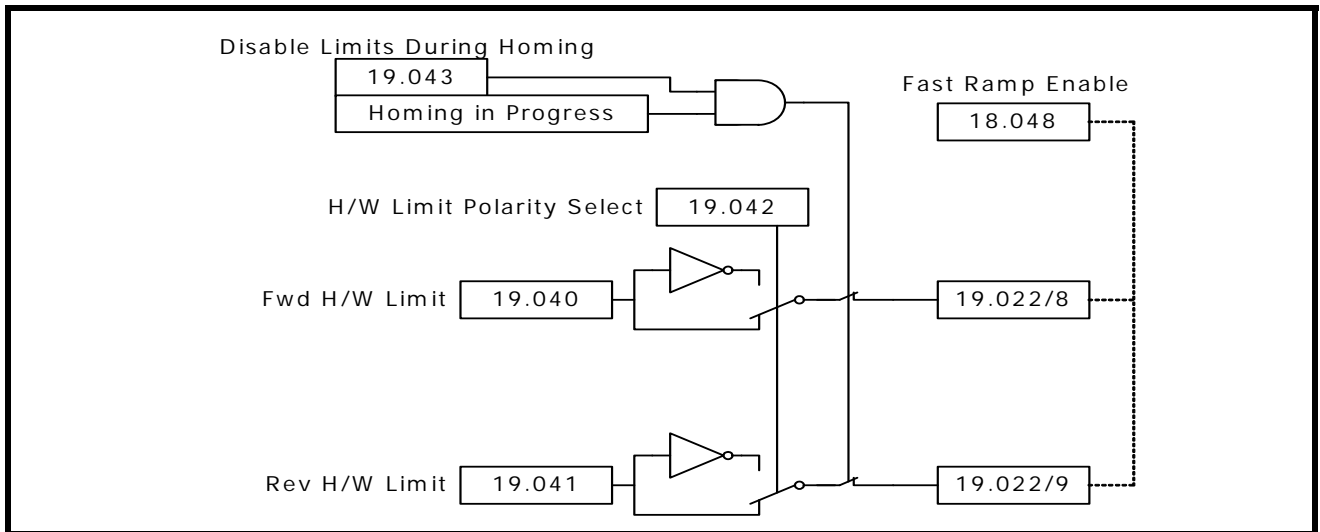
Figure 6-22 Hardware and software limits position example 4



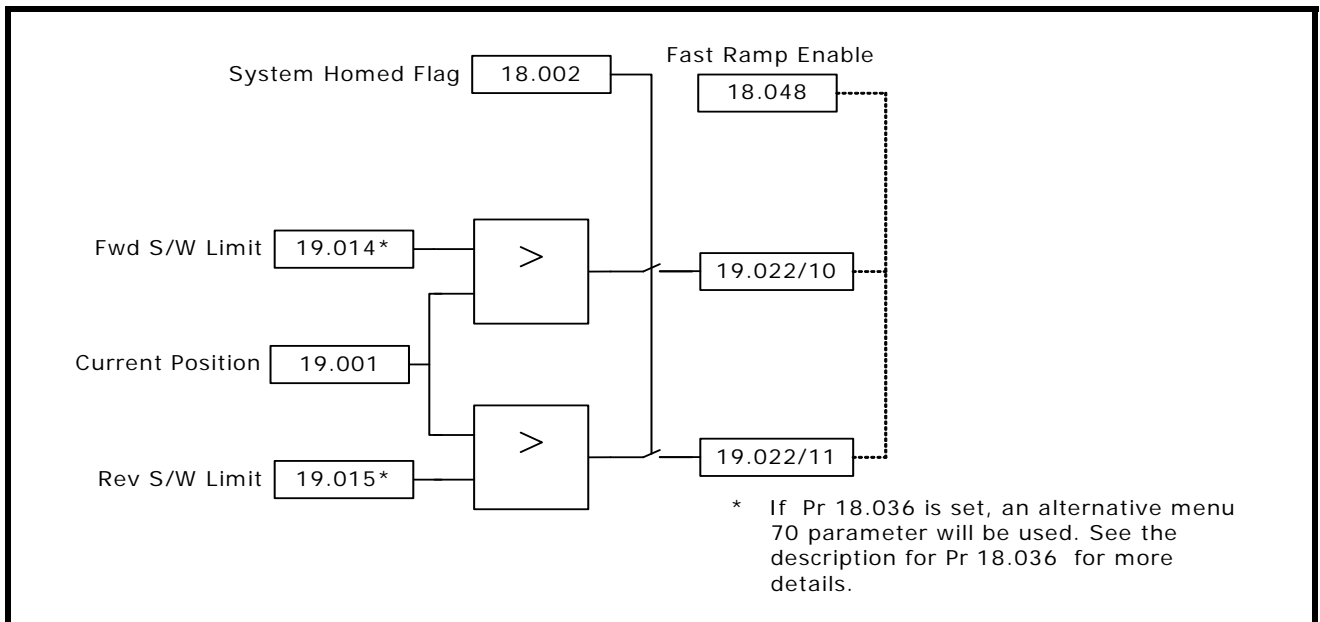
6.10.4 Example setup 4:

- Pr 18.025 = 170 Units
- Pr 19.015 = 90 Units
- Pr 20.019 = 400 Units
- Pr 20.027 = 3000 = 30.00 Degrees
- Pr 20.009 = 110 Units
- Pr 20.006 = 200 Units
- Pr 20.010 = 500 Units
- Pr 19.014 = 1150 Units

6.10.5 Hardware limits



6.10.6 Software limits

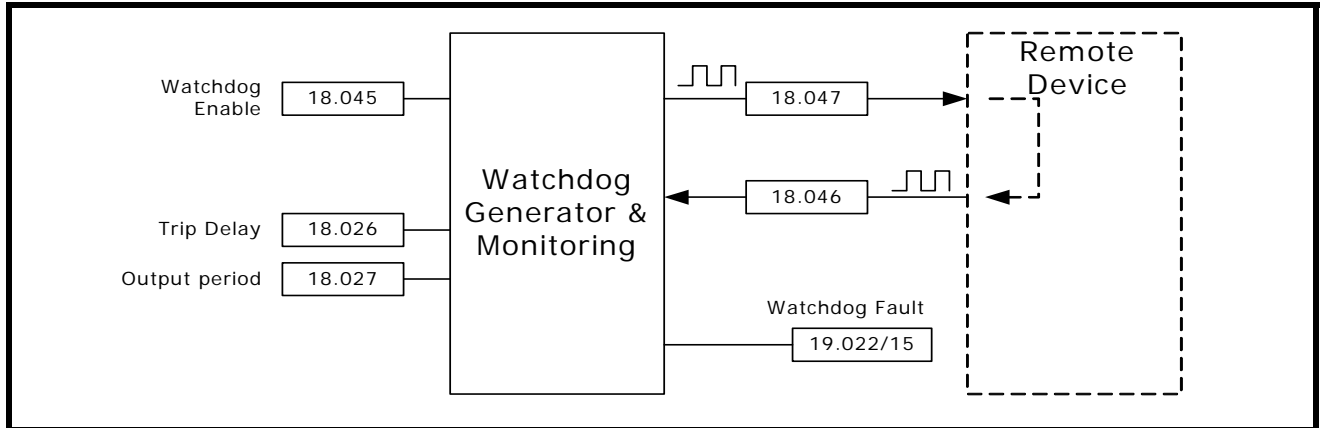


NOTE The software limits are only active after the homing sequence has been completed.

6.11 Communications watchdog

The Watchdog is used to provide a mechanism to ensure safe operation when movement is being controlled from a remote device. The watchdog checks that the remote device is online and capable of both sending and receiving data. This is done by sending a clock signal to the remote device, which responds by resending the same clock signal back, the returned signal is then monitored to make sure that the received data is of similar clock period to the sent data.

Figure 6-23 Communications watchdog



6.12 Fault handling

The Flying Shear fault handling scheme, may be monitored and adjusted with the following parameters:

Pr **19.018** is the Alarm word. This is a 14 bit word which indicates the status of the alarms; a bit at 1 indicates an alarm is active e.g. if bit 4 is 1 then there is a cam calculation alarm. See list below for individual bit functions.

Pr **19.019** is the Alarm / Trip mask word. This is a 14 bit word which selects whether an alarm should trip the drive; a bit at 1 indicates that particular alarm is active, and will trip the drive e.g. if bit 4 is 1 then if there is a cam calculation alarm the drive will trip. See list below for individual bit functions.

Pr **19.020** is the Trip conditional select word. This is a 14 bit word which selects when the drive should trip under fault conditions; a bit at 1 indicates that a trip will occur immediately, a bit at 0 indicates that the drive will trip on that particular fault at the end of the current profile cycle e.g. if bit 4 is 1 then the drive will trip immediately if a cam calculation fault occurs. See list below for individual bit functions.

Pr **19.021** is the Alarm / Trip Enable mask. This is a 14 bit word which enables whether a fault should trigger an alarm or drive trip. A bit at 1 indicates an Alarm / Trip is active, a bit at 0 indicates an Alarm / Trip is inactive e.g. if bit 4 is 1 then a cam calculation fault is enabled to trigger an Alarm or Trip. See list below for individual bit functions.

Pr **19.022** is the Raw Alarm Word. This is a 14 bit word which is used to generate the above parameters; a bit at 1 indicates a fault is active e.g. if bit 4 is 1 then there is a cam calculation fault. See list below for individual bit functions.

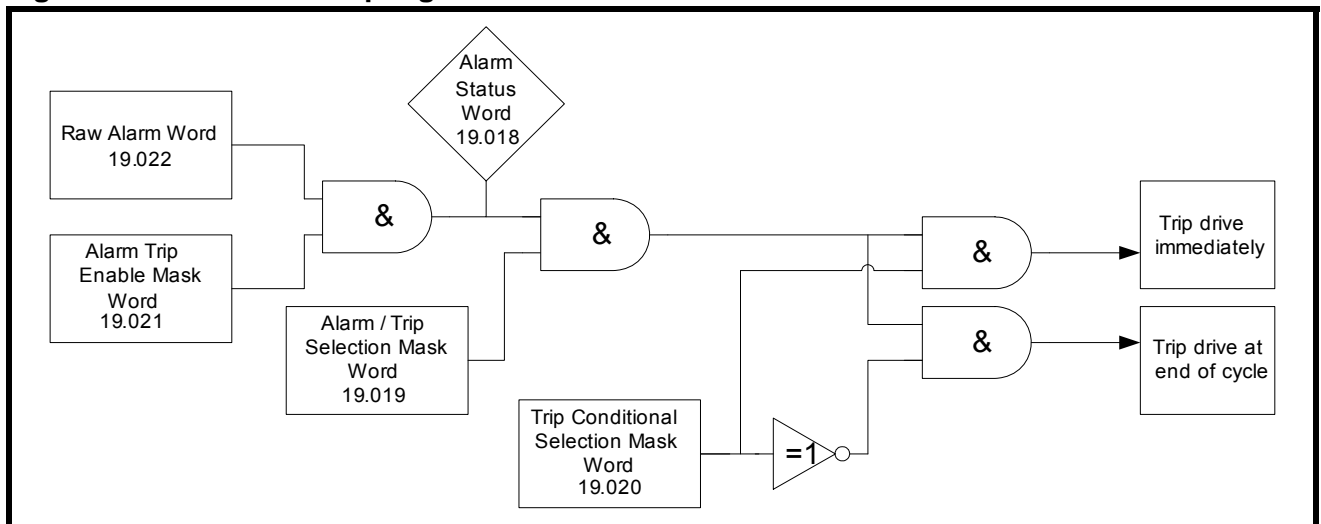
Bit functions

- Bit 0 - Tool did not rise at the end of the cycle – alarm only
- Bit 1 - Following Error Outside Limit
- Bit 2 - Other tool error
- Bit 3 - Start-up cut not done as master not stationary
- Bit 4 - Cam calculation parameter fault
- Bit 5 - Line Speed too fast
- Bit 6 - Sequence abort parameter fault
- Bit 7 - Homing Fault
- Bit 8 - Fwd H/W Lim
- Bit 9 - Rev H/W Lim
- Bit 10 - Fwd S/W Lim
- Bit 11 - Rev S/W Lim
- Bit 12 - Remote Fieldbus Trip
- Bit 13 - Watchdog fault error

When parameters Pr **19.018** to Pr **19.022** are viewed from the drive's display, the decimal equivalent will be shown e.g. bit 4 will be shown as 16 (2^4).

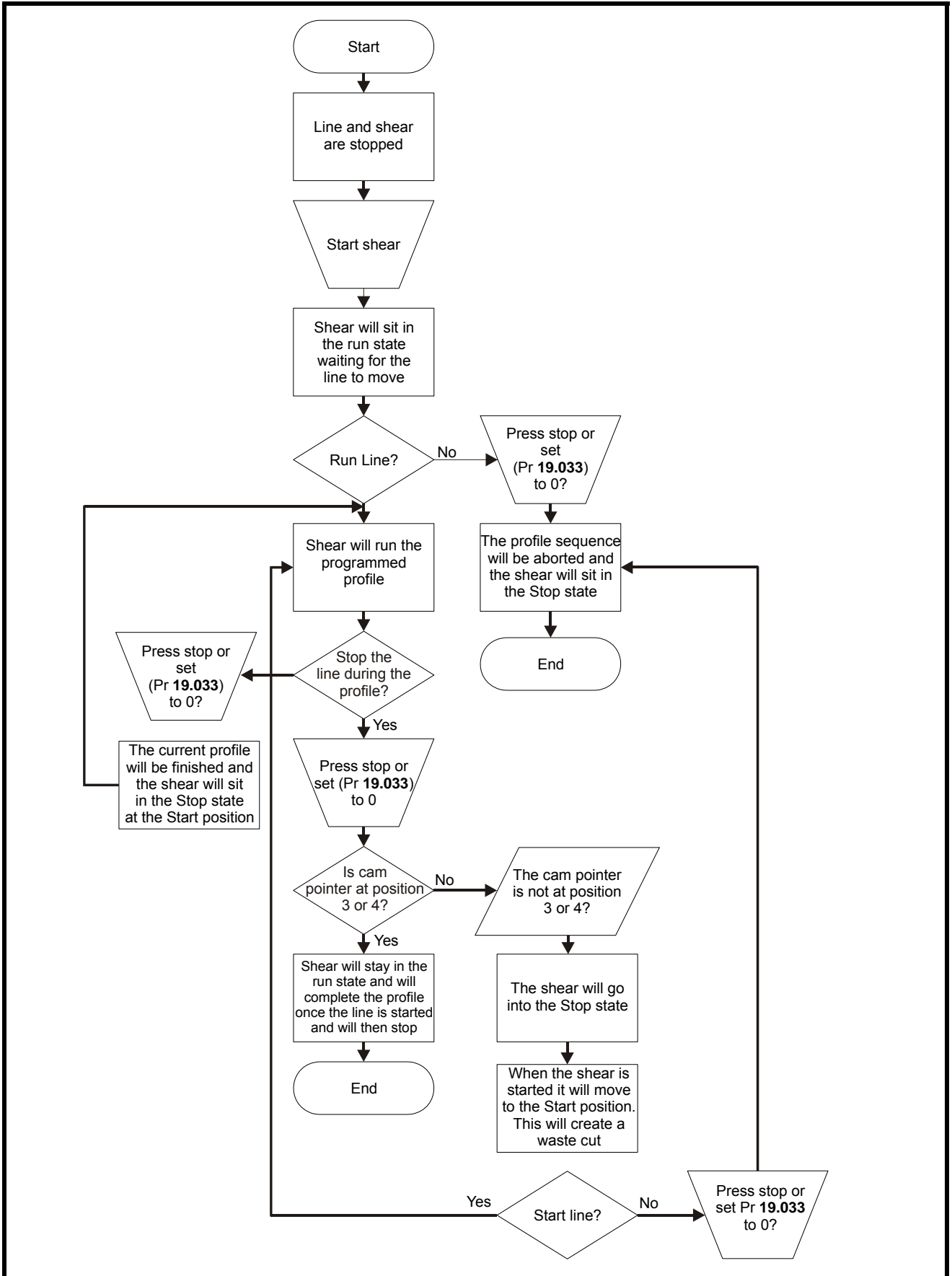
To reset an Alarm / Trip, first remove the cause of the trip, then toggle Pr **19.032** (0 – 1 – 0). Pr **19.032** performs an application reset together with a drive reset.

Figure 6-24 Alarm and trip logic



6.13 Start / stop logic

Figure 6-25 Start / Stop logic flow diagram



6.14 Interlocks

The flying shear software contains several interlocks to prevent damage occurring to the tool. If you are trying to perform a Jog, Home, Go To Start or Run, and you cannot, the following lists detail the interlocks which need to be true before the action can be performed.

Jog Interlocks

- Drive must be enabled and healthy (Pr **18.049** = 1)
- A flying shear profile must not be running (Pr **19.033** = 0)
- The shear must not be homing (Pr **19.038** = 0)
- A Go To Start must not be in progress (Pr **19.034** = 0)
- A Sequence Abort must not be selected (Pr **19.034** = 0)
- A manual cut must not be selected (Pr **19.031** = 0)
- If tool control mode Pr **19.026** is at 1 or 3 then the tool must be up

Home Interlocks

- Drive must be enabled and healthy (Pr **18.049** = 1)
- A flying shear profile must not be running (Pr **19.033** = 0)
- The shear must not be Jogging (Pr **19.036** = 0 and Pr **19.037** = 0)
- A Go To Start must not be in progress (Pr **19.034** = 0)
- A Sequence Abort must not be selected (Pr **19.034** = 0)
- A manual cut must not be selected (Pr **19.031** = 0)
- If tool control mode Pr **19.026** is at 1 or 3 then the tool must be up
- There must not be a homing fault (Pr **18.001** = a negative value)

Go To Start Position Interlocks

- Drive must be enabled and healthy (Pr **18.049** = 1)
- A flying shear profile must not be running (Pr **19.033** = 0)
- The shear must not be Jogging (Pr **19.036** = 0 and Pr **19.037** = 0)
- The shear must not be on a software / hardware limit (check Pr **19.022**)
- A Sequence Abort must not be selected (Pr **19.034** = 0)
- A manual cut must not be selected (Pr **19.031** = 0)
- If tool control mode Pr **19.026** is at 1 or 3 then the tool must be up
- The shear must be homed

Run Interlocks

- Drive must be enabled and healthy (Pr **18.049** = 1)
- The shear must not be Jogging (Pr **19.036** = 0 and **19.037** = 0)
- The shear must not be on a software / hardware limit (check Pr **19.022**)
- A Sequence Abort must not be selected (Pr **19.034** = 0)
- A manual cut must not be selected (Pr **19.031** = 0)
- If tool control mode Pr **19.026** is at 1 or 3 then the tool must be up
- A Go To Start must not be in progress (Pr **19.034** = 0)
- The shear must be homed

6.15 Batch and line control

6.15.1 Batch control

The flying shear software incorporates a batch counter, with the following functions:

Batch Enable (Pr 18.016):

This enables batch control when set to 1

Batch Quantity (Pr 18.017):

This sets the number of cuts in a batch, from 1 to 32767.

Batch Reset (Pr 18.038):

This resets the batch counters, both up (Pr 18.004) and down (Pr 18.005), and also resets the Batch flags, Last Cut (Pr 18.041) and Batch done (Pr 18.006). Batch reset must be toggled (Pr 18.038 = 0 – 1 – 0) to fully reset, and re-enable the batch counter; if the batch reset is just set from 0 to 1 the flags and counters will all be reset, but the batch counter will not function until batch reset is set back to 0. After a batch has been completed, the shear will stop at the start position; toggling the run command (Pr 19.033 = 1 – 0 – 1), will reset the batch counters and flags.

Batch Count Up (Pr 18.004) and Down (Pr 18.005):

These count the number of cuts performed. The count is triggered by the Tool Cut Output. If Tool Enable (Pr 19.049) is not enabled (Pr 19.049=1), then the Tool Cut Output will not be triggered, and therefore the batch counter will not function.

Disable Batch Reset On Start Up (Pr 70.81):

When set to 0, the batch counter will be reset to 0 if the drive is powered down, or the SI-Applications module is reset.

When set to 1, the batch counter will be reset to the last count value reached before power down or a SI-Applications module reset.

6.15.2 Line control

The flying shear drive is able to interlock with the line drive, and provide control signals. Three control signals are given: System Healthy, Run Command and Last Cut:

System Healthy

If the system healthy is false then there is a serious problem, the line drive should decelerate at the maximum safe rate to ensure a minimum of damage.

Connecting this interlock is highly recommended.

Run

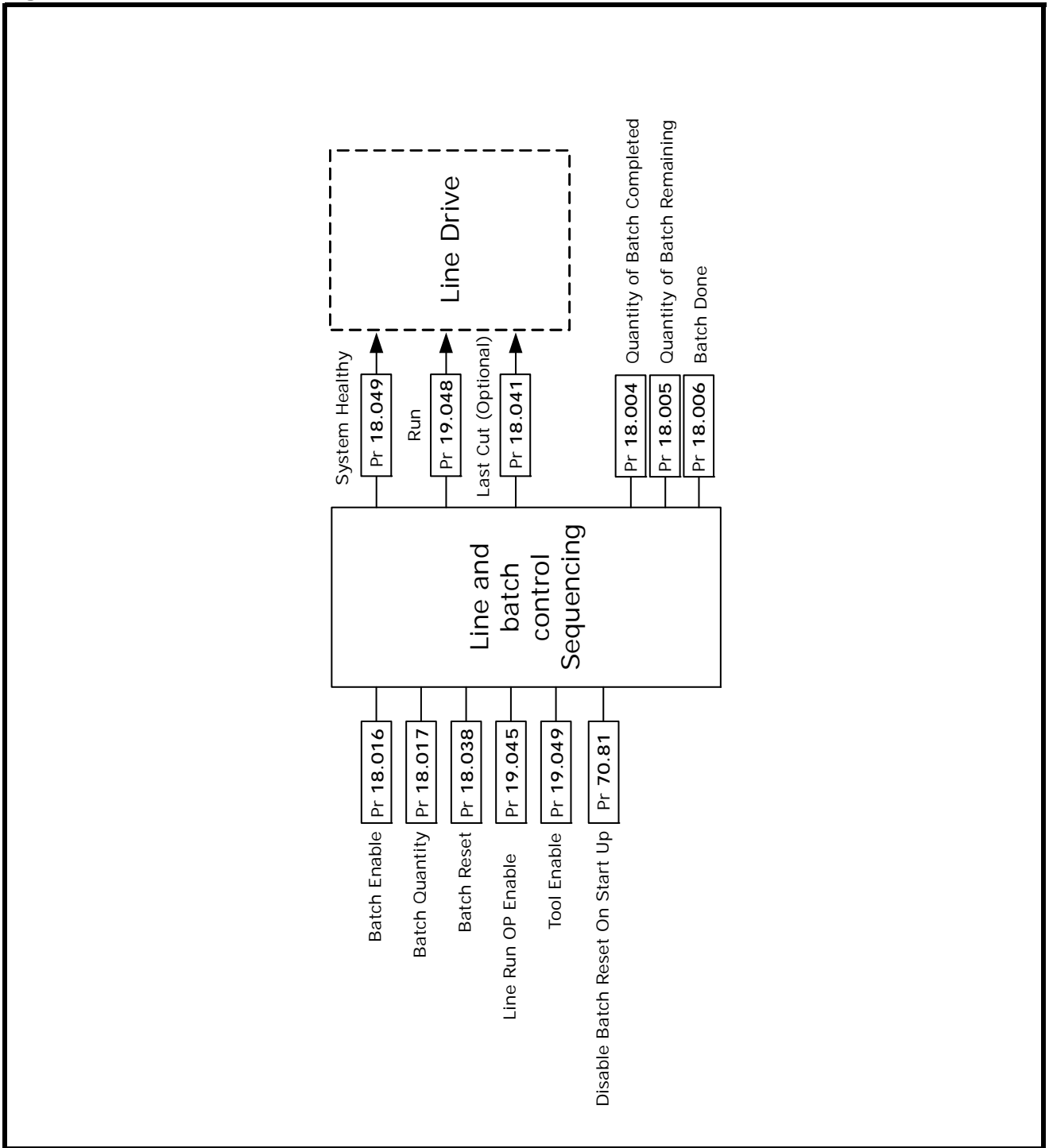
The Run signal may be used to command the line drive to run and stop, or may be used as a flying shear ready interlock. This signal is optional.

Last Cut

The last cut signal is used to indicate that the current cut will be the last, this can be used to reduce the speed of the line to a crawl until the run signal is removed, this will result in a minimum of waste production. Last cut stays on until it is reset (Pr 18.038=1), or until a new batch is started. This signal is optional.

NOTE The batch counter is disabled during test if parameter Pr 19.030=0 or a Test Cut Length is being performed.

Figure 6-26 Line batch control



NOTE Pr 19.049 tool control enable must be set to 1 for the batch counter to function.

7 Parameter descriptions

7.1 Relevant Unidrive M parameters

7.1.1 Parameters set by software on power-up

6.040	Enable sequencer latching
Application Setting	0 – No latching
17.007	RS485 Comms baud rate
Application Setting	5 – 9600 Baud Rate
17.011	Clock task scheduling
Application Setting	4 – 4ms
17.012	Pos task scheduling
Application Setting	4 – 2ms
17.013	Application auto run
Application Setting	1 – Auto Run
17.014	Enable global trips
Application Setting	1 – Global trips enabled
17.016	Encoder data update rate (Only on >= V01.03.00)
Application Setting	1 – Update every Pos task
17.017	Enable parameter over range trip
Application Setting	0 – Disabled
17.020	Auto save on power down
Application Setting	1 – Auto save
17.021	Enable Menu 20 save
Application Setting	1 – Saving menu 20 in SI-Apps enabled
20.039	Application software version
Application Setting	Software Dependant
91.01	Shortcut enable
Application Setting	1 – Speed reference fast write from 91.02

7.1.2 Parameters set by software permanently

1.010	Bipolar reference enable
Application Setting	1 – Bipolar reference selected
1.014	Reference selector
Application Setting	3 – Preset references selected
1.015	Preset speed selector
Application Setting	1 – Preset Speed 1 Selected
1.055	Linear Speed Select
Application Setting	0 – the units for speed parameters are RPM
2.002	Ramp enable
Application Setting	0 – Ramps Disabled
2.004	Ramp mode select*
Application Setting	0 – Fast
6.001	Stop mode
Application Setting	2 – No Ramps
6.015	Drive enable
Application Setting	Software dependant
6.030	Sequencing bit: run forward
Application Setting	Software dependant
91.05	Full scale speed (rpm)
Application Setting	Parameter 01.006 Max Speed

7.1.3 Drive parameters set after a default (18.044 = 1)

8.21	T24 Digital I/O 1 source / destination
Application Setting	19.040 Forward Hardware Limit
8.022	T25 Digital I/O 2 source / destination
Application Setting	19.038 – Home Enable
8.023	T26 Digital I/O 3 source / destination
Application Setting	19.033 – Flying Shear Run Input
8.024	T27 Digital I/O 4 source / destination
Application Setting	18.032 – Home Switch Input
8.025	T28 Digital I/O 5 source / destination
Application Setting	Registration Sensor Input / Not Configured
8.026	T29 Digital I/O 6 source / destination
Application Setting	19.041 – Reverse Hardware limit
8.027	T1&2 Relay source
Application Setting	18.049 – Flying Shear OK
8.029	Positive logic select
Application Setting	1 – Positive Logic
8.031	T24 Digital I/O 1 output select
Application Setting	1 – Input
8.032	T25 Digital I/O 2 output select
Application Setting	0 – Input
8.033	T26 Digital I/O 3 output select
Application Setting	0 – Input
8.039	T28 & T29 Digital Input auto selection disable*
Application Setting	1 - Disabled

7.2 Application parameters

7.2.1 Menu 18

18.001	Home state
Coding	RO, Bi
Range:	-3 to 5
Units:	List

This indicates the condition of the Home sequence

- 0 = STOP state.
- 1 = Initialise.
- 2 = Search for Home state.
- 3 = Home detection state.
- 4 = Position Offset state.
- 5 = Preset final home position/Completion state.

ERROR States less than 0.

- 1 = Home disabled during home sequence.
- 2 = Home time exceeded timeout.
- 3 = Drive not enabled.

18.002	Home Complete
Coding	RO, Bit

If set, this parameter indicates that the home sequence has been completed successfully.

18.003	Scan Time
Coding	RO, Uni
Range:	1 to 500
Units:	ms

Indicates the scan time of the Background task in ms.

18.004	Batch Counter (Count UP)
Coding	RO, Uni
Range:	0 to 18.17
Units:	Qty

Batch Counter, indicates the number of cut cycles completed.

18.005	Batch Counter (Count DOWN)
Coding	RO, Uni
Range:	18.17 to 0
Units:	Qty

Indicates the quantity remaining in the batch.

18.006	Batch Done
Coding	RO, Bit

Indicates that the current batch is completed.

18.007	Minimum Registration Distance
Coding	RO, Uni
Units	Units

Indicates the minimum distance the registration sensor can be away from the tool / material edge. Add 10% to this distance to make sure the profile can be met. Pr **20.023** is limited to a minimum of this value.

18.008	Length of Last Cut 1
Coding	RO, Uni
Range:	0 to 32767
Units:	Units

Indicates the length of the last cut. This function will not work unless Pr **19.049** tool enable is set to 1 or ON.

18.009 Length of cut before last cut	
Coding	RO, Uni
Range:	0 to 32767
Units:	Units

Indicates the length of the cut before the last cut Pr **18.008**. This function will not work unless Pr **19.049** tool enable is set to 1 or ON.

18.010 Line speed indication	
Coding	RO, Uni
Range:	0 to 32767
Units:	Units/(min*18.18)

This parameter indicates the line speed in selected units per min. The units can be scaled with the line speed scalar parameter Pr **18.018**.

Pr **18.010** = Selected Units (Pr **18.011** and Pr **20.029**) / Pr **18.018**

Example:

- a. To display metres/min when the selected units are in millimetre set parameter Pr **18.018** = 1000.
- b. To display feet/min when the selected units are in 0.1 inches set Pr **18.018** = 20.

NOTE This parameter is filtered to produce a steady indication of speed.

18.011 Units	
Coding	RW, Uni
Range:	0 to 9
Default settings:	0
Units:	List

This parameter does not make any difference to the operation of the flying shear, and is simply used as a non-volatile memory for the display.

- 0 = Undefined user units
- 1 = mm x 100
- 2 = mm x 10
- 3 = mm
- 4 = mm / 10
- 5 = mm / 100
- 6 = inches x 10
- 7 = inches
- 8 = inches / 10
- 9 = inches / 100

18.016 Enable batch control	
Coding	RW, Bit
Default settings:	0

Set to enable batch control to be used.

18.017 Batch quantity	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	10
Units:	Qty

Quantity in a batch.

18.018 Line speed scalar	
Coding	RW, Uni
Range:	1 to 32767
Default settings:	1000
Units:	Scale

Refer to Pr **18.010**

18.019 Home speed	
Coding	RW, Uni
Range:	0 to * see parameter description below
Default settings:	5
Units:	Units / s

This parameter sets the speed that the home sequence will search for the home switch, and the speed used to travel to the start position set by Pr **20.019**.

* This parameter is limited by the max. speed of the drive which is converted to Units/sec, and it is derived as follows:

$$\text{Max Speed Limit (Units/s)} = (01.006 * 03.034 * 4 * 20.031 * 0.99) / (60 * 20.032).$$

The Max speed limit is 99% of the drive max speed, to allow some small margin for positional correction, if required.

18.020 Home mode	
Coding	RW, bit
Default settings:	0

This parameter determines the homing mode as follows:

- 0 – Home to the leading edge of home/limit switch
- 1 – Search for the leading edge of home/limit switch and home on next encoder marker pulse.

NOTE Mode 1 is not possible with SinCos or Resolver feedbacks.

18.021 Home back-off speed	
Coding	RW, U
Range:	0 to * see description in Pr 18.019
Default settings:	1
Units:	Percentage of Pr 18.019

This parameter set the speed that the axis will back-off the Home / Datum switch.

18.022 Home search direction	
Coding	RW, Bit
Default settings:	0

This set the initial direction for searching for the home.

1 = Forwards

0 = Reverse

18.023 Home acceleration / deceleration	
Coding	RW, U
Range:	0 to 32767
Default settings:	50
Units:	Units / s ²

This parameter defines the acceleration and deceleration ramps for the homing sequence.

18.024 Home time	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	1000
Units:	0.01 Seconds

This parameter defines the time allowed for the homing sequence to complete.

18.025 Zero position preset	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	0
Units:	Units

This parameter sets the zero position for this axis. This distance is added in a negative direction to the Home / Datum position.

18.026 Watchdog trip delay	
Coding	RW, Uni
Range:	0 to 32000
Default settings:	2200
Units:	ms

18.027 Watchdog out time period	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	700
Units:	ms

The Watchdog is used for monitoring the state of a communications link.

The drive generates a clock signal with an on / off time set by Pr **18.027**. The clock signal is read by the remote device, which then sends the clock signal back to the drive. If the received clock from the remote device does not change state within the time set by Pr **18.026** then a fault condition occurs. This checks the communication link is able to read and write to/from the drive.

18.028 Jog speed	
Coding	RW, Uni
Range:	0 to * see description in Pr 18.019
Default settings:	5
Units:	Units / s

Set the jog speeds for both forward and reverse. This also defines the speed used to travel to the start position (Pr **20.019**) after homing.

18.029 Jog acceleration rate	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	100
Units:	Units / s ²

Sets the acceleration rate for the flying shear axis jog. This also defines the acceleration rate used when traveling to the start position (Pr **20.019**) after homing.

18.030 Jog deceleration rate	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	100
Units:	Units / s ²

Sets the deceleration rate for the flying shear axis jog. This also defines the deceleration rate used when traveling to the start position (Pr **20.019**) after homing.

18.031 Home switch polarity	
Coding	RW, Bit
Default settings:	1

Sets the polarity of the home switch input.

1 = Normally Closed

0 = Normally Open

For safety reasons a fail-safe normally closed switch is recommended.

18.032 Home switch input	
Coding	RW, Bit
Default settings:	0

This parameter is used as the home switch input, if a digital input is used, then it should be written to this parameter. This parameter is controlled by Digital Input F4 from default.

18.033 Tool sync enable	
Coding	RW, Bit
Default settings:	0

This parameter sets the failure mode of the flying shear when the tool raised signal is not received, or a tool down signal remains on at the end of the normal synchronized period. There are two options:

Decelerate the flying shear, or we can stay synchronized to the line and stop the line, the choice will depend upon the risk of damage to the tool, and the ability to stop the production line within the available travel of the flying shear.

0 = Decelerate as normal (at the fast decel rate Pr **20.014**)

1 = Synchronize to the line

NOTE In angled shear mode (Pr **20.021** = 1) option 1 is not available, and has no effect.

18.034 Flying Shear ready	
Coding	RO, Bit
Default settings:	0

If this parameter is set to one then the flying shear will attempt to start when parameter 19.033 is set to one.

18.035 Enable feed forward term filter	
Coding	RW, Bit
Default settings:	0

When enabled, a 40ms filter is introduced in to the speed feed forward term, which is derived from the line encoder speed feedback. This will help to reduce motor noise in the shear when a low resolution line encoder has been installed, or where there is a low number counts per base unit for the line compared with the shear.

NOTE Enabling Pr **18.035** will cause a small positional following error, when the line accelerates or decelerates.

18.036 Enable high resolution alternative parameters	
Coding	RW, Bit
Default settings:	0

When set to 1, alternative menu 70 (_Px%) parameters become enabled for all distance, speed and acceleration related functions. This parameter can only be changed when the drive not running i.e. when it is in the “stop” or “ready” state. The following table details the alternative parameters selected when Pr **18.036** = 1:

Function	Pr 18.031 = 0	Pr 18.031 = 1
Home Speed	Pr 18.019	Pr 70.00
Home Accel / Decel	Pr 18.023	Pr 70.01
Zero Position Preset	Pr 18.025	Pr 70.02
Jog Speed	Pr 18.028	Pr 70.03
Jog Acceleration	Pr 18.029	Pr 70.04
Jog Deceleration	Pr 18.030	Pr 70.05
Following Error Limit	Pr 19.011	Pr 70.06
Forward Software Limit	Pr 19.014	Pr 70.07
Reverse Software Limit	Pr 19.015	Pr 70.08
At Position Tolerance	Pr 19.017	Pr 70.09
Gap Length	Pr 19.023	Pr 70.10
Gap Acceleration	Pr 19.024	Pr 70.11
Gap Relative Speed	Pr 19.025	Pr 70.12
Cut Length	Pr 20.005	Pr 70.13
line Velocity	Pr 20.008	Pr 70.14
Shear Travel Length	Pr 20.027	Pr 70.15
Profile Fly Accel / Decel Rate	Pr 20.006	Pr 70.16
Profile Return Accel / Decel Rate	Pr 20.007	Pr 70.17
Cut Following Error Limit	Pr 20.013	Pr 70.18
Fast Deceleration Rate	Pr 20.014	Pr 70.19
Virtual line Speed	Pr 20.018	Pr 70.20
Start Position	Pr 20.019	Pr 70.21
Registration Distance	Pr 20.023	Pr 70.22
Preset line Distance	Pr 20.028	Pr 70.23
Minimum Cut Length	Pr 20.002	Pr 70.50
Length Of Last Cut	Pr 18.008	Pr 70.51
Length Of Cut Before Last Cut	Pr 18.009	Pr 70.52
Actual Cut Length Position	Pr 19.010	Pr 70.53
Following Error	Pr 19.005	Pr 70.54
Max. Recorded Cut Following Error	Pr 19.008	Pr 70.55
Shear Travel Distance For Profile	Pr 19.009	Pr 70.56
Shear Actual Position Reference	Pr 19.001	Pr 70.57
Shear Actual Position Feedback	Pr 19.002	Pr 70.58
Minimum Registration Distance	Pr 18.007	Pr 70.59
Line Registration Window Position	Pr 19.004	Pr 70.60

18.037	Update scaling
Coding	RW, Bit
Default settings:	0

This parameter is set to one to update the scaling of the line and shear axis, it will return to zero automatically when completed. This can only be performed when the shear is stopped. If Pr **18.037** is set to 1 while the shear is running, the update will only be actioned when the shear is next stopped.

18.038	Batch count reset
Coding	RW, Bit
Default settings:	0

Resets the batch counters.

18.039	Acquire feature select
Coding	RW, Bit

This bit enables the Acquire feature. When Pr **18.039** = 1, the Flying Shear system will only update the CAM motion profile when Pr **18.040** transitions 0 - 1. This prevents the the CAM motion profile parameters from being updated over several cycles of the flying shear, and instead, makes sure all of the changes happen at the same time.

18.040	Acquire bit
Coding	RW, Bit

When Pr **18.039** = 1, and upon a 0 - 1 transition of Pr **18.040**, all of the motion profile parameters e.g. Cut Length, maximum line velocity etc, will be used to re-calculate the Flying Shear CAM profile. Bit 12 of the Control Word `_S70%` performs the same function.

18.041	Last cut
Coding	RO, Bit

Indicates that the last cut in the batch is in progress, this can be used to slow the line down, to reduce the waste product produced.

18.043	Tool cut output
Coding	RW, Bit
Default settings:	0

Can be used as a source for a digital output to trigger the tool to cut the product. See the *3.5.4 Digital I/O allocation* on page 18 for the default terminal allocation.

18.044 Default parameters	
Coding	RW, Bit
Default settings:	0

Set to 1 to set the parameters to default.

18.045 Watchdog enable	
Coding	RO, Bit
Default settings:	0

A Communications watchdog can be used to monitor the health of a communications link, the watchdog simply sends a clocked (0,1,0,1) signal to the remote device, and expects to get a similar signal returned. This parameter enables the watchdog monitoring.

18.046 Test cut length enable	
Coding	RW, Bit

When set will set the cut length to TEST CUT LENGTH. See Pr **70.92** for more details. This parameter is ORed with bit 14 of the control word (Pr **73.70**)

18.047 (Not used)	
Coding	

18.048 Fast ramp enable	
Coding	RW, Bit
Default settings:	0

This parameter determines what happens when a software or hardware limit is hit or reached.

- 0 = Shear pin stop, this will stop the shear instantaneously (no ramp) when a limit is hit.
- 1 = Fast stop, this will ramp the shear to a stop when a limit is hit. The fast deceleration rate is determined by Pr **20.014**

18.049 System Healthy	
Coding	RW, Bit
Default settings:	0

This Parameter should be used as an interlock to stop the line, if this parameter = 0 then the flying shear is in a fault condition and the line should stop as quickly as possible. See section 3.7.4 *Digital I/O allocation* on page 18 for the default terminal allocation.

18.050	Real time cut enable
Coding	RW, Bit
Default settings:	0

When this parameter is set at 1, the tool cut time, Pr **20.010**, is set in real time, in milliseconds and is not influenced by the line speed. The tool is fired at the beginning of profile point 3 section 6.5 *Flying Shear profile calculation* on page 53.

When this is set to 0 Pr **20.010** is only applicable at maximum speed. The time increase is inversely proportional to the line speed e.g. If Pr **20.008** = 100 Units / s and Pr **20.010** = 100ms, at maximum line speed the cut time is 100ms, and at half maximum line speed the cut time is 200ms.

NOTE This only applies to the parallel shear mode not angled mode.

7.2.2 Menu 19

19.001	Shear position reference
Coding	RO, Bi
Range:	± 32767
Units:	Units

This parameter indicates the demand position of the flying shear axis.

19.002	Shear actual position
Coding	RO, Bi
Range:	±32767
Units:	Units

This parameter returns the actual position of the flying shear axis.

19.003	FE active
Coding	RO, Bit

If Set to 1, this parameter indicates that the following error is outside the following error limit, set by parameter Pr **19.011**

19.004	Line registration windowing position
Coding	RO, Bi
Range:	±32767
Units:	Units x 1000

This parameter indicates the line position in user units, with respect to the registration windowing. Alternative register Pr **70.60**, for extended range of value.

19.005 Following error (units*1000)	
Coding	RO, Bi
Range:	±32767
Units:	Units x 1000

This parameter returns the following error of the flying shear axis.

19.006 Following error (encoder counts)	
Coding	RO, Uni
Range:	±32767
Units:	Encoder Counts

This parameter returns the following error, based on the number of encoder counts error for maximum resolution.

19.007 Flying Shear status word	
Coding	RO, Uni

This Parameter returns the current activity of the flying shear; it is coded in a bit-wise form.

Bit	Description	Decimal Value
0	Jogging	1
1	Travelling To Start Position	2
2	At Start Position	4
3	Homing Sequence In Progress	8
4	System Homed	16
5	Flying Shear Cycle Running	32
6	Cyclic Mode Selected	64
7	0 = Local 1 = Remote	128
8	Registration Mode Selected	256
9	New Cam Is Being Calculated	512
10	Cam Is Ready	1024
11	On Last Cut In batch	2048
12	Batch Done	4096
13	Shear Is Ready To Run	8192
14	Alarm Active	16384

NOTE When this parameter is viewed from the drives display, the decimal equivalent will be shown; e.g. bit 4 will be shown as 16 (2⁴).

19.008	Max cut fe detected
Coding	RO, Uni
Range:	0 to 32767
Units:	0.001 Units

This parameter shows the maximum peak cut following error detected in the previous cut cycle. The maximum value is displayed at the end of profile segment 3 as shown in section 6.5, and reset during segments 1 & 2. This parameter should be used to set up Pr **20.013**; an upper value should be determined from several samples in Pr **19.008**, then a reasonable margin added to give headroom before entering a value in Pr **20.013**.

19.009	Shear maximum travel distance
Coding	RO, Bi
Range:	0-32767
Units:	Units

This indicates how far in user units the shear axis will travel during the fly part of the cutting profile.

19.010	Material position with respect to shear
Coding	RO, Bi
Range:	±32767
Units:	Units

This parameter returns the actual position of the line axis, relative to the last cut point on the material., and the Shear position, see also Pr **70.88**.

19.011	FE limit
Coding	RW, Uni
Range:	1 to 32767
Default settings:	100
Units:	0.001 units

This parameter sets the allowable flowing error, before a fault condition is reported.

19.012	Velocity feed forward gain
Coding	RW, Uni
Range:	0 to 32767
Default settings:	1000
Units:	0.001Kd/sec

The feedback for the flying shear is generated from the feedback device mounted on the back of the motor, this parameter should always be set to 1000; any other value will produce a steady state following error.

19.013 Proportional gain	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	1600
Units:	0.01Kp

This parameter is the proportional gain for the position loop.

19.014 Forward software limit position	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	10
Units:	Units

Forward Software limit for the flying shear.

19.015 Reverse software limit position	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	0
Units:	Units

Reverse Software limit for the flying shear axis

19.016 Proportional gain output limit	
Coding	RW, Uni
Range:	0 to 100
Default settings:	10
Units:	% of max speed (01.006)

In the position loop the feed-forward gain will give the drive approximately the correct speed reference, the proportional gain is then added to the feed-forward as a small trim to keep the axis at the correct position, The proportional gain should not need to generate any more that a fraction of the full speed of the axis, a typical value for this parameter should be between 10 – 25% of motor maximum speed set in Pr **1.006**.

19.017 At position tolerance	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	1000
Units:	Units / 1000

This defines the allowable error when the axis is in a set position e.g when the shear is at the start position.

19.018	Alarm Word
Coding	RO, Uni
19.019	Alarm / trip selection mask word
Coding	RW, Uni
Range:	0 to 16383
Default settings:	16383
19.020	Trip conditional select mask word
Coding	RW, Uni
Range:	0 to 16383
Default settings:	8064
19.021	Alarm / trip enable mask
Coding	RW, Uni
Range:	0 to 16383
Default settings:	16383
19.022	Raw Alarm / trip data
Coding	RO, Uni

The Pr **19.018** – Pr **19.021** are arranged with the following bit functions:

Bit	Function	Decimal value
0	Tool did not rise at the end of the cycle – alarm only	1
1	Following Error Outside Limit*	2
2	Other tool error**	4
3	Start-up cut not done as line not stationary	8
4	Cam calculation parameter fault	16
5	Line Speed too fast	32
6	Sequence abort parameter fault	64
7	Homing Fault	128
8	Fwd H/W Lim	256
9	Rev H/W Lim	512
10	Fwd S/W Lim	1024
11	Rev S/W Lim	2048
12	Remote Fieldbus Trip	4096
13	Watchdog fault error	8192

*This can be FE Limit (Pr **19.011**) or Cut FE Limit (Pr **20.013**)

**This can be: tool did not fire, tool is still in the product when shear is moved,
or FE Cut Limit is exceeded

Pr **19.018** is the alarm word, and gives the status of all the current alarms immediately that the alarms occur.

Pr **19.019** selects whether the alarm should also trip the drive, set to 1 to trip the drive and alarm, set to zero for alarm only.

Pr **19.020** allows you to select when you want the trip to occur. If set to 1 then the trip will occur at the same time as the alarm, if set to 0 then the trip will occur at the end of the current flying shear cycle.

Pr **19.021** allows you to enable / disable alarms and trips, set to 1 to enable alarm and/ or trip.

NOTE The alarms for the hardware and software limits cannot be disabled.

Pr **19.022** contains the raw fault data that is used to generate the above parameters. When these parameters are viewed from the drives display, the decimal equivalent will be shown e.g. bit 4 will be shown as 16 (2^4).

A Reset (Pr **19.032** = 1) must be performed after altering any of these parameters, or after a trip has occurred. See "Fault handling" on page 74 for more information.

19.023 Gap distance	
Range:	0 to 32767
Coding	RW, Uni
Default settings:	0
Units:	Units

If Gap mode is enabled (Pr **19.050**) then this parameter is used to set the length of the gap. A Gap is produced between cuts, by adding a trapezoidal profile on to the cam. The gap is added when the tool is down or in cam point 3. Length, acceleration rate and speed are required to determine the required profile. See also Gap Return Position parameter Pr **70.82**.

19.024 Gap accel	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	0
Units:	Units/s ²

This parameter is used to set the acceleration and deceleration rate for the gap producing profile.

19.025 Gap relative speed	
Coding	RW, Uni
Range:	0 to 32767
Default settings:	0
Units:	Units/s

This parameter is used to set the relative speed for the gap producing profile.

19.026	Cut mode
Coding	RW, Uni
Range:	0 to 3
Default settings:	0

The cut mode determines how the up and down inputs are used:

- 0 = Does not use tool up/down inputs for feedback
- 1 = Use cutter up input only to check that the tool is clear prior to decelerating
- 2 = Use cutter down input only to give the shear the signal when to remove the tool cut signal. If the tool down signal is not present at the end of the cut period then the tool will rise and a fault condition will be set.
- 3 = Use both up and down.

See also section 6.8 *Tool control*

NOTE In Angled Shear only modes 0 and 1 are available. If a tool up error is detected, at the end of a cut, the shear will stop before the return part of the cycle (Cam point 6) can happen. For this reason it is important to leave extra cut length to make sure the tool is clear of the material when a fault is detected, otherwise the tool may be damaged.

19.027	Cut on start of shear cycle
Coding	RW, Bit
Default settings:	0

If this input is set to one then the shear will always perform an initial cut prior to going into run mode, this is so that the first cut can be of the correct length. This function is not available in Angled Shear mode (Pr **20.021** = 1).

19.028	Line position resolution selector
Coding	RW, Bi
Range:	0 to 6
Default settings:	0

This parameter selects how many bits of resolution the line encoder has when a SinCos, SSI or EndAt encoder is installed. With this parameter set at 0, the resolution is set at 16 bit or 65536 (2^{16}) counts/ rev, and for every unit Pr **19.028** is raised by, the line resolution is raised e.g. if Pr **19.028** = 2 then the line resolution will be set at 18 bit.

NOTE This is not applicable to incremental type encoders; where the resolution is equal to 4 * Encoder PPR.

19.029 Shear resolution selector	
Coding	RW, Bi
Range:	0 to 6
Default settings:	0

This parameter selects how many bits of resolution the shear encoder has when a SinCos, SSI or EndAt encoder is installed. With this parameter set at 0, the resolution is set at 16 bit or 65536 (2^{16}) counts/ rev, and for every unit Pr **19.029** is raised by, the shear resolution is raised e.g. if Pr **19.029** = 3 then the shear resolution will be set at 19 bit.

NOTE This is not applicable to incremental type encoders; where the resolution is equal to 4 * Encoder PPR.

19.030 First cut mode	
Coding	RW, Uni
Range:	0 to 3
Default settings:	0

This parameter is used to define how the first cut is performed when the flying shear is operating in cyclic mode. This may be used to ensure that the first cut is of the correct length, and therefore eliminate any waste caused by the first cut.

0 = Cut Immediately (don't worry about waste).

1 = Use registration once only to detect product edge, and cut one length later.

2 = Cut after a dwell of one cut length, this is used when the product starts off aligned to the cutting tool.

3 = Cut first length correctly if the material has already past the shear and is not less than 2 x the Shear Accel distance. If cut cannot be achieved the first cut alarm bit (Pr **72.71**, bit 7) will be set. If the Shear is started with this bit set the shear will ramp up and sync and cut immediately.

19.031 Manual tool cut command	
Coding	RW, Bit
Default settings:	0

Perform a manual cut when the Line axis is stationary, or perform a scrap cut when the shear is running. If the Line is stopped, the tool will be fired immediately, however if the line is moving and cyclic mode is selected, the shear will start immediately synchronize to the line, and then perform a cut.

A scrap cut can only be done with a moving Line, when the shear is set to cyclic mode and the fast optimization mode is set (Pr **20.040**).

Ensure that interlocks are present to prevent injury to persons.

19.032 Drive / fault reset	
Coding	RO, Bit
Default settings:	0

This parameter is the global reset, and will perform the same function as the drive reset button, and it resets flying shear software alarms and trips.

19.033 Shear run command	
Coding	RW, Bit
Default settings:	0

If this parameter is set to one, on the rising edge, provided all of the interlocks are made the flying shear will start to run, and will continue to run unless a fault condition develops or the run command is removed. See also section 6.14 *Interlocks* .

When the axis starts it will:

- Go to the start position (Pr **20.019**), if the shear is not already at the start position.
- If Cut on start (Pr **19.027**) is set, then it will perform an initial cut cycle.
- Pr **19.048** will be set to 1, this may be used as an interlock for the line to start. The flying shear is then ready to run.

Refer to section 6.14 *Interlocks* , if the shear will not Run. See also section 3.7.4 *Digital I/O allocation* .

19.034 Go to start position	
Coding	RW, Bit
Default settings:	0

This parameter is used to send the flying shear axis to the start position that is defined by parameter Pr **20.019**. This parameter requires a rising edge to initiate the move. The Shear will move at the Jog speed and acceleration rate.

19.035 Local / remote control select	
Coding	RW, Bit
Default settings:	0

This parameter defines where the command signals are generated, they may be generated from a control word from a fieldbus using parameter `_Sxx%`, `_Rxx%`

NOTE

The watchdog must be enabled to allow the Local / Remote mode to be set to remote, this is done to prevent the flying shear from running / jogging or homing unexpectedly.

19.036 Jog forward command	
Coding	RW, Bit
Default settings:	0

Set to 1 to jog the flying shear axis forward. Requires a rising edge to initiate the motion, and will continue while the signal is present. Refer to section 6.14 *Interlocks* if the shear will not jog.

19.037 Jog reverse command	
Coding	RW, Bit
Default settings:	0

Set to 1 to jog the flying shear axis Reverse. Requires a rising edge to initiate the motion, and will continue while the signal is present. Refer to section 6.14 *Interlocks* if the shear will not jog.

19.038 Home / datum command	
Coding	RW, Bit

Set to 1 to home the flying shear axis. Requires a rising edge, the signal does not need to be maintained. This is controlled from default by analog input 2 via Drive Menu 12. Refer to section 6.14 *Interlocks* if the shear will not home. See also section 3.7.4 *Digital I/O allocation* for the default terminal allocation.

19.039 Abort motion command	
Coding	RW, Bit

Set to 1 to stop all motion and trip the drive.

19.040 Forward hardware limit input	
Coding	RW, Bit

This parameter is used as the source for the forward hardware limit. The digital input used for this limit switch input should be set with the destination set to this parameter. This parameter has to be mapped to manually from either a digital input, or from a remote device via comms (see parameter Pr **20.033** and `_S71%`).

19.041 Reverse hardware limit input	
Coding	RW, Bit

This parameter is used as the source for the Reverse hardware limit. The digital input used for this limit switch input should be set with the destination set to this parameter. This parameter has to be mapped to manually from either a digital input, or from a remote device via comms (see Pr **20.033** and `_S71%`).

19.042 Hardware limit polarity

Coding	RW, Bit
--------	---------

Sets the polarity of the Limit switch inputs.

1 = Normally Closed

0 = Normally Open

For safety reasons a fail-safe normally closed switch is recommended.

19.043 Disable limit switches during homing

Coding	RW, Bit
--------	---------

Default settings:	0
-------------------	---

This parameter allows the user to disable the limit switches while the axis is homing, this may be needed because the same switch is used for the limit switch and the home switch, or because the limit switch is located inside the home switch. Care must be taken if this feature is used to ensure that it cannot cause injury to persons or damage to the machine if the home or datum switch fails to operate.

19.044 Change forward direction of shear

Coding	RW, Bit
--------	---------

Default settings:	0
-------------------	---

This parameter may be used to change the forward direction of the axis, however the speed will indicate a negative speed when travelling forward. This is only read on power-up, or when the SI-Applications Plus is reset, by setting Pr **x.000** to 1070, then press the red reset button on the drives display.

19.046 Tool raised input

Coding	RO, Bit
--------	---------

This Parameter indicates that the tool is raised, and therefore that the flying shear is decelerated. Tool up is controlled either by digital input (on UT70 or drive depending on the Applications module used), or from a remote device via comms (see Pr **20.033** and **_S71%**).

19.047 Tool down input

Coding	RO, B
--------	-------

This Parameter should be used to indicate that the tool is fully down and is ready to rise. Tool down is controlled either by the digital input (on SI-Applications Plus or the drive depending on the Applications module used) or from a remote device via comms (see Pr **20.033** and **_S71%**).

19.048 Flying Shear running

Coding	RO, B
--------	-------

Default settings:	0
-------------------	---

This parameter indicates that the Flying Shear is running and the cam is enabled, this parameter should be used as a ready interlock, or a start signal to the line.

19.049 Tool enable	
Coding	RW, B
Default settings:	0

This parameter is used to enable the tool output to operate, however, it should not be used as a safety feature, and an external fail-safe device that is able to inhibit the tool from operating should be used to protect persons from injury or damage to the machine. If this parameter is not set to 1, the batch control will not function.

19.050 Gap enable	
Coding	RW, B
Default settings:	0

This parameter is used to enable a trapezoidal profile to be added to the cam profile to produce a gap between flying shear cycles, it can only be used in the parallel shear mode. See also parameters Pr **19.023** to Pr **19.025** and Pr **70.82** to Pr **70.84**.

NOTE This feature is not available in Angled Shear mode (Pr **20.021** = 1).

7.2.3 Menu 20

20.001 Tool width compensation	
Coding	RO, Uni
Range:	0 to 32. 767
Units:	Units / 1000

This parameter allows for the tool width to be added to the required cut length. This compensation is useful where a saw is used as a cutting tool.

20.002 Minimum cut length	
Coding	RO, Uni
Range:	0 – 32767
Units:	Units

This parameter reports the minimum cut length that can be achieved with the current parameters.

20.003 Cam status word	
Coding	RO, Uni
Range:	0 to 5

This parameter returns the status of the flying shear profile calculation, based on the given profile information cut length, line speed, profile acceleration and cut time.

0 = Cam Calculated OK

Faults

Bit 0 = Insufficient travel available for the flying shear to perform flying shear profile

Bit 1 = Cut length is not achievable with flying shear profile parameter.

Bit 2 = line is too fast, shear is unable to synchronize

20.004 Flying Shear profile control mode	
Coding	RW, Bit
Range:	0 to 1
Default:	0

This parameter is used to specify the operation of the flying shear.

0 = Cyclic cut without registration

1 = Cut on registration mark

20.005 Cut length	
Coding	RW, Uni
Range:	0 to 32767
Default	500
Units:	Units

This parameter has different functions depending upon Pr **20.004**.

If parameter Pr **20.004** is set for cyclic cut, this parameter is used to set the cut length.

If Pr **20.004** is set for Registration, then this parameter is used to set the windowing distance.

20.006 Fly acceleration / deceleration rate / start distance	
Coding	RW, Uni
Range:	0 to 32767
Default:	50
Units:	Units / s ² / Units

This parameter defines the acceleration and deceleration rate for the fly part of the profile in Parallel Shear mode.

In Angled Shear mode, this parameter sets the Start Distance. The start distance is equal to Pr **20.009** plus an offset to make sure the tool is up to speed before cutting the material. This value can never be smaller than Pr **20.009**. See section 6.10 for more information.

20.007 Return acceleration / deceleration rate	
Coding	RW, Uni
Range:	1 to 32767
Default:	50
Units:	Units / s ²

This parameter defines the maximum acceleration and deceleration rate when the axis is returning to the start position, following the fly profile.

20.008 Maximum line velocity	
Coding	RW, Uni
Range:	1 to 32767
Default:	48
Units:	Units / s

This parameter defines the maximum velocity that the line is expected to travel, it is used for calculating the profile, the actual line must not exceed this speed.

20.009 Settling time / accel distance	
Coding	RW, Uni
Range:	0 to 32767
Default:	50
Units:	ms / Units

The function of this parameter depends upon the operating Mode:

Parallel Shear

The synchronized part of the fly profile is broken down into three areas, settling time, tool down time, and tool up time.

The settling time defines the number of ms that are required to recover following error following the acceleration of the flying shear.

Angled Shear

This parameter defines the distance over which the shear can be accelerated to sync speed.

20.010 Cut time / sync distance	
Coding	RW, U
Range:	0 to 32767
Default:	50
Units:	ms / units

This parameter depending upon the application / the operating Mode changes definition:

Parallel Shear

The cutting time is used to specify the number of ms that the tool cut output needs to be on to perform the cut; e.g. Tool down time.

Angled Shear

This parameter defines the distance (units) over which the shear must be synchronized with the product. This must include enough distance to make sure the tool has come out of the material after the cut. See section 6.10 *Hardware and software limits / positions*

20.011 Tool up time / decel distance	
Coding	RW, Uni

Range:	0 to 32767
Default:	50
Units:	ms/units

This parameter depending upon the application / the operating Mode changes definition:

Parallel Shear

The Tool up time is used to specify the number of ms required for the tool up input to be received after the tool cut signal is removed.

At the end of this time the tool up input is interrogated and action is taken according to the setting of Pr **18.033**. See also Pr **70.92**.

Angled Shear

This parameter defines the distance over which the shear can be decelerated from sync speed to a stop.

20.012	Cut length fine adjustment
Coding	RO, Uni
Range:	0 to 32767
Default:	0
Units:	Units / 1000

This parameter is used to provide a fine adjustment to the required cut length.

20.013	FE cut limit
Coding	RW, Uni
Range:	1 to 32767
Units:	0.001 units

This parameter is used to specify the acceptable following error during the cut part of the profile. When the shear is at the cut point in the profile, if the actual value for the following error is outside of the limit set by Pr **20.013**, the tool will not fire.

NOTE

If Pr **20.013** is set too close to the actual value of the following error, the tool may randomly not fire during normal operation. Make sure Pr **20.013** is a reasonable margin above Pr **19.008** the maximum cut following error detected.

20.014	Fast decel rate
Coding	RW, U
Range:	1 to 32767
Units:	Units/s/s

This parameter is used to specify the rate at which the flying shear will decelerate if a software or hardware limit is hit.

20.015 Ramp mode	
Coding	RW, Bit
Range:	0 to 1
Default:	0

If this parameter is set to 1 then s-ramps will be used for the flying shear profile.

NOTE Using this mode takes additional processor resources and in some cases especially where fieldbus options are used may cause intermittent nuisance trips.

20.016 Cam pointer	
Coding	RO, Uni
Range:	0 to 10

This parameter returns the position of the cam pointer.

20.017 Enable virtual line reference	
Coding	RW, Bit
Default settings:	0

A virtual line may be used for commissioning / start up of the application, so that the profiles can be seen without any risk of damage to the machine.

Set to 1 to enable the virtual line.

NOTE The virtual line can not be used to test registration mode.

20.018 Virtual line speed	
Coding	RW, Uni
Range:	1 to [max line speed - 20.08]
Default:	50
Units:	Units / s

Set the speed at which you want the virtual line to run.

NOTE The virtual line has no ramps.

20.019 Flying Shear start position	
Coding	RW, Bi
Range:	±32767
Default:	5
Units:	Units

This sets Flying Shear start position from Zero position (Pr **18.025**). The speed used to travel to the start position is defined by the Jog Speed (Pr **18.028**).

20.020 Shear optimization mode	
Coding	RW, Bit
Default:	

This parameter is used to select the mode of optimization for the return part of the shear profile when in cyclic mode.

0 = Slow

1 = Fast

In slow mode the shear will return to the start position at the minimum speed, but with enough pace to immediately start the next cut without the need to stop.

In fast mode the shear will return at the maximum acceleration, deceleration and speed, and will then dwell at the start position before beginning the next cycle. Refer to parameter Pr **19.031** manual cut for scrap cuts setup.

20.021 Angled shear enable	
Coding	RW, Bit
Range:	0 – 1

The software is able to handle both parallel flying shears and Angled flying shears, where the shear is positioned at an angle to the production flow.

20.022 Registration fine offset	
Coding	RW, Uni
Range:	+/- 5000
Default:	0
Units:	Units / 1000

The distance between a Registration sensor and the start position of the knife is set by Pr **20.023**, This parameter gives a fine offset to allow higher accuracy.

20.023 Registration offset	
Coding	RW, Uni
Range:	+/- 2 ³¹
Default:	0
Units:	Units

Distance between the registration sensor and the flying shear start position. this can not be set to a value less than Pr **18.007**.

20.024 Registration window enable	
Coding	RW, Bit
Default:	0

Set to 1 to enable registration windowing.

20.025 Registration window tolerance	
Coding	RW, Uni
Range:	0 to 2^{31}
Units:	Units
Default:	0

This parameter is used to set the open and close position for the window and any marks detected outside the tolerance will be rejected.

Pr **20.005** is used to set the distance for the centre position of the window.

20.026 Preset line position command	
Coding	RW, Bit
Default:	0

On the rising edge, this parameter is used to preset the line / material position to the value in Pr **20.028** so that the windowing function can be used.

20.027 Shear length / shear angle	
Coding	RW, Uni
Range:	1 to 2^{31} / 60.000
Default:	1000
Units:	Units / 0.001degrees

This parameter depending upon the application / the operating Mode changes definition:

Parallel Shear

The shear length is used to ensure that the flying shear profile does not attempt to exceed the available travel. This parameter should be entered as the amount of travel available from the start position of the flying shear to just before the forward software limit.

Angled Shear

This parameter defines the angle between the flow of the product and the shear carriage in units of 0.001 degrees

20.028 Line position preset value	
Coding	RW, Bi
Range:	+/- 2^{31}
Units:	Units
Default:	0

This value is used to preset the line / material position on the rising edge of Pr **20.026**.

20.029 Line scaling denominator	
Coding	RW, Uni
Range:	1 to 2 ³¹
Default settings:	1
Units:	Units

Line encoder feedback scaling denominator.

NOTE This parameter is only read on power up and when update scaling (Pr **18.037**) is set to 1.

NOTE Only encoders that have a number of pulses per revolution that is a power of ², may be used with the Flying Shear solution e.g. 4096ppr is acceptable, but 5000ppr is not.

20.030 Line scaling numerator	
Coding	RW, Uni
Range:	1 to 2 ³¹
Default settings:	16384
Units:	Counts

Line encoder feedback scaling numerator.

NOTE This parameter is only read on power up and when update scaling (Pr **18.037**) is set to 1.

NOTE Only encoders that have a number of pulses per revolution that is a power of ², may be used with the Flying Shear solution for e.g. 4096ppr is acceptable, but 5000ppr is not.

20.031 Shear scaling denominator	
Coding	RW, Uni
Range:	1 to 2 ³¹
Default settings:	1
Units:	Units

Shear encoder feedback scaling denominator.

NOTE This parameter is only read on power up and when update scaling (Pr **18.037**) is set to 1.

NOTE Only encoders that have a number of pulses per revolution that is a power of ², may be used with the Flying Shear solution for e.g. 4096ppr is acceptable, but 5000ppr is not.

20.032 Shear scaling numerator	
Coding	RW, Uni
Range:	1 to 2 ³¹
Default settings:	16384
Units:	Counts

Shear encoder feedback scaling numerator.

NOTE This parameter is only read on power up and when update scaling (Pr **18.037**) is set to 1.

NOTE Only encoders that have a number of pulses per revolution that is a power of 2, may be used with the Flying Shear solution for e.g. 4096ppr is acceptable, but 5000ppr is not.

20.033 Remote I/O select word	
Coding	RW, Uni
Range:	0 to 32000
Default settings:	0

This word selects the source for tool up, tool down, home, and the hardware limits. If a bit is set in Pr **20.033**, control of the corresponding function is taken from control word `_S71%` (Pr **73.70**) i.e. if Bit 0 is set in Pr **20.033** the home switch input is only accepted from control word `_S71%` (Pr **73.70**) Bit 0.

Pr **20.033** and `_S71%` (Pr **73.70**), have the following bit functions:

Bit	Function	Decimal Value
0	Home	1
1	Tool Up	2
2	Tool Down	4
3	Reverse Limit	8
4	Forward limit	16

NOTE On the drives display, Pr **20.033** shows the decimal equivalent of the set bits, i.e. if bit 4 is set this will appear as 16 (2⁴).

20.034 Line / Master encoder source	
Coding	RW, Uni
Range:	0 to 9
Default settings:	0

This parameter selects the location of the line encoder information, where:

0 = P1 Drive Encoder

1 = P1 Slot 1

2 = P1 Slot 2

3 = P1 Slot 3

- 6 = P2 Drive
- 7 = P2 Slot 1
- 8 = P2 Slot 2
- 9 = P2 Slot 3

Failure to set this parameter will result in a Tr87 trip. Once the selection is made save parameters and power down or reset the module to apply the setup.

NOTE Only encoders that have a number of pulses per revolution that is a power of 2, may be used with the Flying Shear solution for e.g. 4096ppr is acceptable, but 5000ppr is not.

20.035 Shear / Slave encoder source	
Coding	RW, Uni
Range:	0 to 9
Default settings:	0

This parameter selects the location of the Shear encoder information, where:

- 0 = P1 Drive Encoder
- 1 = P1 Slot 1
- 2 = P1 Slot 2
- 3 = P1 Slot 3
- 6 = P2 Drive
- 7 = P2 Slot 1
- 8 = P2 Slot 2
- 9 = P2 Slot 3

Failure to set this parameter will result in a Tr86 trip. Once the selection is made save parameters and power down or reset the module to apply the setup.

NOTE Only encoders that have a number of pulses per revolution that is a power of 2, may be used with the Flying Shear solution e.g. 4096ppr is acceptable, but 5000ppr is not.

20.036 Maximum return profile speed	
Coding	RW, Uni
Range:	0 to 99% of Pr 1.006
Default settings:	99% of Pr 1.006 (2700rpm with drive defaults)

This parameter sets the maximum profile speed for the return part of the shear profile. This can be used to ensure that the return profile is always trapezoidal, for applications where a triangular return profile is too aggressive for the mechanics. This can be achieved by selecting fast shear optimization (Pr **20.020** = 1), which forces the system to use the return accel/decel rate (Pr **20.007**), and thereby allow the user to fully customize the return profile.

20.039	Application software version
Coding	RW, U

7.2.4 PLC registers

Pr **70.00** to Pr **70.60** are assigned as high resolution alternatives for the profile / motion setup. See Pr **18.36** for more details.

70.81	Disable batch reset on start up
Coding	RW, Bit
Range:	0 or 1
Default settings:	0

When set to 0, the batch counter will be reset to 0 if the drive is powered down, or the SI-Applications Plus module is reset.

When set to 1, the batch counter will be reset to the last count value reached before power down or a SI-Applications Plus module reset.

70.82	Gap return position
Coding	RW, Uni
Range:	0 to Pr 19.023
Default settings:	0
Units:	Units

When the Gap Function is enabled (Pr **19.050**) and the Gap parameters are set, this parameter defines the GAP return position of the shear when the Gap Position (Pr **19.023**) has been reached. The GAP will return to zero on the return part of the shear profile (e.g. CAM pointer =>7). This prevents the shear cutting tool from potentially being damaged from the oncoming material.

With the Return Gap Position set to zero the GAP profile will return back to 0 immediately after the Gap position (Pr **19.023**) has been reached.

Refer to Gap Profile Generation Functional description for more detail (6.7**).

70.83	Gap state indication
Coding	RW, Uni
Range:	0 to 3
Default settings:	-
Units:	-

This parameter indicates the Gap States

0 - Load Gap distance when tool down.

1 - If gap distance is reached (Pr **19.023**), return gap to return distance.

2 - Return Distance position reached

3 - Profile complete with tool up time. If State 3 was not indicated the final gap distance was not achieved within the time. Refer to the Pr **70.84**.

The state is reset to 0, if Gap distance was not achieved or if state 3 was achieved and the shear is in the return profile >7.

70.84 Gap actual position achieved	
Coding	RW, Uni
Range:	0 to Pr 19.023
Default settings:	-
Units:	Units

This parameter indicates the gap position achieved during the tool down segment. If the gap profile (speed, acceleration, position) is set correctly then this parameter should equal Pr **70.82**.

This can be used to determine the max Gap distance that can be achieved with the Gap profile settings and tool down time.

70.85 Line encoder direction select	
Coding	RW, Bit
Range:	0 - 1
Default settings:	0
Units:	-

Setting this parameter will invert the current direction of the Line encoder position.

70.86 Line speed filter tc	
Coding	RW, Uni
Range:	0 – (2 ³² -1)
Default settings:	10
Units:	-

This sets the Line speed filter time.

70.87 Line zero speed threshold detection	
Coding	RW, Uni
Range:	0 – Max Line Velocity (Pr 20.008)
Default settings:	1
Units:	Units/s

This sets the Line speed Zero Speed Threshold to indicate the line has stopped. If set too low then spurious line stops maybe experienced therefore functions like manual cut may not be able to be performed.

70.88 Material position	
Coding	RO, Uni
Range:	0 – (2 ³² -1)
Default settings:	1
Units:	Units

This indicate the material actual position between cuts. This is unlike Pr **19.010**, (or Pr **70.53**) as the position indicated is not with respect to the Shear position.

70.89 Extended sync distance	
Coding	RW, Uni
Range:	0 – Travel Length (Pr 20.027)
Default settings:	0
Units:	Units

This extends the synchronous distance by increasing the Tool Up distance and is the absolute distance from the start position (Pr **20.019**). This is useful for applications where the shear has to carry the cut material to the take off conveyor to prevent it from falling through the machine.

Applying this distance will affect the resultant performance as the minimum cut length (Pr **20.002**), will increase proportionally with the increase distance beyond the initial tool up distance with the given line speed and profile data (Pr **20.003**).

Where the Extended Sync Distance is less than the end of the tool up distance then it will be ignored.

70.90 Start of cut distance	
Coding	RO, Uni
Range:	-
Default settings:	-
Units:	Units

This is the absolute distance from start position (Pr **20.019**), to the start of Cut Segment. This is useful to find out where the cut happens along the shear travel.

70.91 End of tool up distance	
Coding	RO, Uni
Range:	-
Default settings:	-
Units:	Units

This is Absolute distance from start position to end of Tool Up Segment. This will assist with determining the extended sync distance (Pr **70.89**).

70.92 Test cut length	
Coding	RW, Uni
Range:	0 - ($2^{32}-1$)
Default settings:	1000
Units:	Units

This is sets the test cut length and is enabled by the Test Cut bit Pr **18.046** or Bit 14 of the control word Pr **73.70**. When enable allows this test cut length to be done on the fly, which is of different length to that is set by Pr **20.006**.

The first cut length test cut length will be cut if the bit remains set prior to a shear start in cut modes 2 or 3 (Pr **19.030**).

When the shear is running, the test cut is enabled by a rising edge of the Test Cut bit. This will cause the next cut length to be the test cut length, provided the bit is set before CAM point 9.

If the Test Length is required to be repeated then test bit enable will need to remain set. The batch counter will disable the when a test length is being cut.

Application PLC register Pr **70.93**, is reserved for internal use and should not be used or written to via serial communications.

The following Application PLC registers are used for serial communications control and status word:

Pr **72.69** – Fault word

Pr **72.70** – Status Word 1

Pr **72.71** – Status word 2

Pr **73.70** – Control word

Pr **73.71** – Remote I/O Control Word

Refer to section 9.1 for more details.

70.93 Registration sensor throughput delay	
Coding	RW, Uni
Range:	0 to 20000
Default settings:	0
Units:	Microseconds

This is the time in microsecond from when the registration sensor optics see the mark to when it outputs an electrical signal. This is normally quoted in the sensor data sheet as throughput delay or prorogation delay. This allows the flying shear software to compensate the registered position for this delay.

70.94 Registration sensor speed filter time constant	
Coding	RW, Uni
Range:	0 to $2^{31} - 1$
Default settings:	32
Units:	Time Constant

This is the filter time constant for the speed sampling used to compensate for registration sensor throughput delay.

75.00 to 75.10 Master CAM Segment 0 to 10	
Coding	RW, Uni
Range:	0 to $2^{31} - 1$
Default settings:	-
Units:	Counts

These are the master CAM coordinates for the flying shear profile, where Pr **75.00** is master CAM segment 0, Pr **75.01** is master CAM segment 1 and so on. This is provided

for diagnostic purposes only.

75.11 Master CAM segment 0 + 1 + 2 converted to distance units	
Coding	RO Uni
Range:	0 to $2^{31} - 1$
Default settings:	-
Units:	Units

These is the sum of master CAM coordinates 0, 1 and 2 converted from counts to units. This is provided for diagnostic purposes only.

75.20 to 75.30 Slave CAM segment 0 to 10	
Coding	RO, Bi
Range:	0 to $2^{31} - 1$
Default settings:	-
Units:	Counts

These are the slave CAM coordinates for the flying shear profile, where Pr **75.00** is slave CAM segment 0, Pr **75.01** is slave CAM segment 1 and so on. This is provided for diagnostic purposes only.

8 Error handling / trouble shooting

8.1 Application error handling

As the system is designed to be as flexible as possible, some trips may or may not be required, depending upon the individual application. Customers therefore may wish to conduct a risk analysis in order to decide how the errors should be handled.

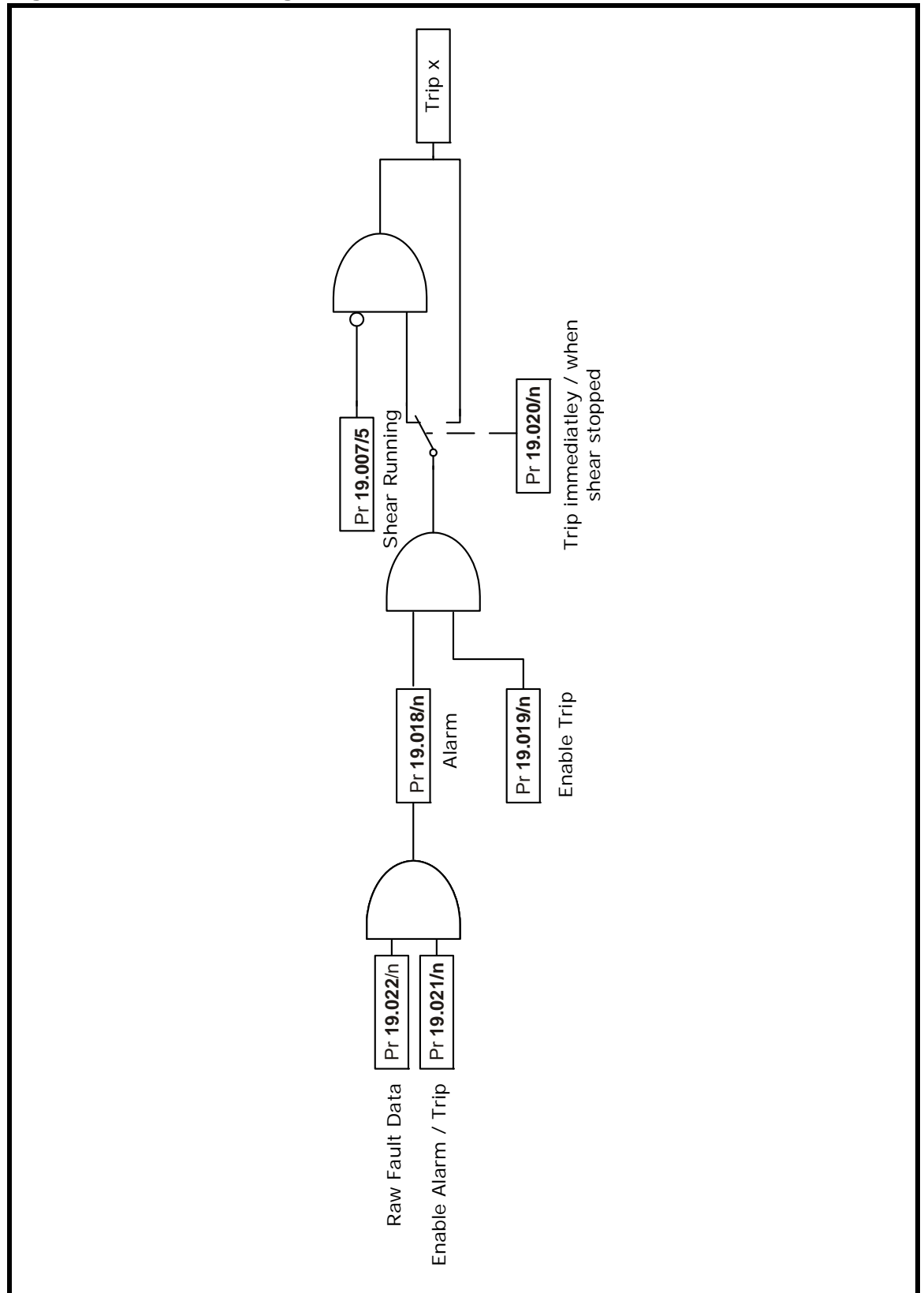
Options available:

- No alarm, no trip
- Alarm & no trip
- Alarm & trip Drive Immediately
- Alarm & trip drive if idle or otherwise after current flying shear cycle

These are set using three registers that contain an individual bit for each of the error states:

Bit	Description	Decimal Value
0	Tool did not rise at the end of the cycle – Alarm only	1
1	Following error outside limit	2
2	Other tool error	4
3	Start Cut Error, line not stationary	8
4	Cam calculation parameter fault	16
5	line Speed too fast	32
6	Sequence abort parameter fault	64
7	Homing fault	128
8	Fwd H/W Lim	256
9	Rev H/W Lim	512
10	Fwd S/W Lim	1024
11	Rev S/W Lim	2048
12	Remote fieldbus trip	4096
13	Watchdog fault error	8192

Figure 8-1 Error handling



8.1.1 Trip codes

Trips 70 to 84 – Application specific trips

Trips 85 to 89 – Application standard trips

Trip Number	Description
Tr70	Tool Did not rise at the end of the cycle
Tr71	FE limit error
Tr72	Other tool error
Tr73	Start cut error, line not stationary
Tr74	Profile calculated incorrectly
Tr75	Line over speed error
Tr76	Sequence abort Pr 19.039
Tr77	Homing Error, refer to Pr 18.001 for details
Tr78	Forward hardware limit error
Tr79	Reverse hardware limit error
Tr80	Forward software limit error
Tr81	Reverse software limit error
Tr86	20.035 for the shear encoder location is not set
Tr87	17.16 for the SI-Applications Plus is not set
Tr87	20.034 for the line encoder location is not set
Tr88	Remote fieldbus trip
Tr89	Communications watchdog error

Trip 70

This alarm / trip is set when the tool is not up at the end of the flying shear cycle, it is only used only if Tool Sync (Pr **18.033**) is set to 1, the trip will only occur when the axis is stationary, and so trip immediately is disabled

Trip 71

This trip can be caused by either a general following error trip, which is set when the following error exceeds the value set by Pr **19.011** or when the following error is exceeds the FE Cut Limit (Pr **20.013**) during a cut cycle, in the later case the following error is only checked before the tool is fired.

Trip 72

This trip can occur for a number of reasons, refer to Pr **19.026** for modes:

Tool not up at the start of the cut cycle

Tool not up at the end of the sync period

The tool down signal is not set at the end of the cut period

The following error is exceeded, and cut is aborted

Trip 73

This trip will occur only if cut on start (Pr **19.027**) is set to 1, and occurs when the line axis is not stationary to allow the cut to take place.

Trip 74

The flying shear profile cannot be achieved. This should not cause a dangerous condition, as the old profile will continue to be used until a suitable cam is calculated. The cause for the calculation error is given by Cam Status (Pr **20.003**).

Trip 75

Line speed exceeds the value set by the maximum line velocity (Pr **20.008**) by more than 10%.

Trip 76

Sequence abort (Pr **19.039**) is set to 1.

Trip 77

A homing fault has occurred, such as the home sequence has taken too long and has timed out. Refer to the home state (Pr **18.001**) for more detail on the specific fault.

Trip 78 – 81

Hardware and Software Limits.

Trip 86

Pr **20.35** for the shear encoder location is not set.

Trip 87

Pr **20.34** for the line encoder location is not set.

Trip 88

Set by the remote control word, parameter `_S70%` bit 7.

Trip 89

This trip occurs if the watchdog is enabled (Pr **18.045**=1), and is caused by a communication loss between a remote device and the SI-Applications Plus.

8.1.2 Drive trip recovery

When the drive trips the application programme will be reset when the drive is reset. However, the cause of the trip may still be present, such as a hardware limit may be active, the application software will prevent the drive from tripping again so that the cause of the problem can be fixed, but will prevent the system from restarting until the trip condition is reset.

To perform a system reset, the reset parameter (Pr **19.032**) must be toggled. If for example the forward hardware limit is hit and this trips the drive, after a drive reset, the only operation that the drive will be able to perform will be jog reverse, to move the axis off the limit switch.

Following a drive trip a homing sequence (Pr **19.038**=1) must be performed.

9 Advanced features

9.1 Serial communications / fieldbus control

9.1.1 Control word `_S70%` (Pr 73.70)

Introduction

The fieldbus control word is an efficient way of remotely controlling the motion of a Drive. Due to the restriction of most fieldbus word length the control word length will be no more than 16bits, SI-Applications Plus PLC register `_S70%` will be used to ensure full resolution is maintained (e.g. drive parameter limited to 32767 or 1000).

Each bit in the fieldbus control word has a particular function, and provides a method of controlling the output functions of the Drive (RUN, JOG, TRIP, etc.) with a single data word, (16Bits).

To use the fieldbus control word, the ENABLE terminal on the drive must be closed, and the MASK bit must be set to 1. The 0-1 transition of the MASK bit will cause the digital I/O control to be switched from local terminal mode to fieldbus control.

When the MASK bit is reset to 0, the Digital I/O control is switched terminal control mode.

A selector switch can also be used to select between local (terminal) and remote (fieldbus) control of the Drive. If a digital input is configured to directly control mode parameter assigned (**MM.PP**), the value written by the Main Title interface will be immediately overwritten by the digital input.

NOTE

If you use the SYPT watch window or similar monitoring tool for the purpose of commissioning / start up, you must have the Watchdog enabled (Pr **18.045** = 1), and the Watchdog trip disabled (Pr **19.021** bit 13 = 1).

Bit	Function	Description
0	ENABLE	Must be set to 1 to put the Unidrive M in READY mode. Resetting to 0 will immediately disable the Drive, and the motor will coast to stop.
1	Run	A 0-1 transition of this bit will run the flying shear cycle, when reset to zero the flying shear will stop at the end of the current cycle.
2	Jog FWD	A 0-1 transition of this bit will run the motor in the forward direction. When reset to 0, the motor will stop.
3	Jog REV	A 0-1 transition of this bit will run the motor in the Reverse direction. When reset to 0, the motor will stop.
4	MASK	A 0-1 transition of this bit will set MM.PP to 1 to enable fieldbus control of the Drive. Pr 19.035 can subsequently be over-written by a digital input if a terminal or fieldbus control selector switch is required. (A 1-0 transition will reset Pr 19.035 to 0.)
5	Reserved	
6	RESET	A 0-1 transition will reset the drive from any trip condition. If the cause of the trip has not been cleared, the Drive will not trip again immediately.
7	TRIP	A 0-1 transition will force a “tr98” trip on the Drive. If the RESET and TRIP bits change from 0 to 1 on the same cycle, the TRIP bit will take priority.
8	Home	A 0-1 transition will initiate a homing sequence.
9	Tool Enable	If set to 1 then the cutting tool is enabled.
10	Start Pos	A 0-1 transition will command the drive to travel to the start position.
11	Save Pars	A 1-0 transition will perform a Save of parameters.
12	Acquire	A 0-1 transition will allow the motion profile parameters in menu 20 to be acquired and to re-calculate the CAM profile using the new profile data together, when Pr 18.039 = 1
13	Manual Cut	A 0-1 transition will cause a manual cut. See Pr 19.031 for more details.
14	Test Cut Length Enable	If set to 1 the test cut length will be set
15	WDIn	Watchdog In - Comms clock from remote device.

The recommended control method for the PLC program is to reset the fieldbus control word to a safe state, e.g. Drive disabled. When a fault is detected with either the application software or communication link, the drive control word is reset to 0 automatically when the Drive trip is reset.

When the Serial Communication link is OK again, the appropriate fieldbus control word can be set, the Drive control word will in turn be updated and the Drive will restart. Some example fieldbus control word values to control the Drive are given in the table below.

Wdin is the communication watchdog bit transmitted from remote intelligent device, (PLC, keypad, HMI etc).

9.1.2 Remote I/O control word _S71% (Parameter #73.71)

Bit	Description	Decimal Value
0	Home sensor input	1
1	Tool up	2
2	Tool down	4
3	Reverse limit	8
4	Forward limit	16

If any of these control bits are used, then the corresponding drive I/O will no longer be used for that function and is free to be used for other purposes (This depends on which modules are installed in the shear drive see section 3.5.2 and also the description for the Remote I/O select word (Pr 20.033).

9.1.3 Fault word _R69% (Pr 72.69)

The Fault word returns the current fault status of the drive.

Bit	Description	Decimal Value
0	Tool not raised at end of cut period	1
1	Following Error Outside Limit	2
2	Tool did not rise at end of the cut sequence	4
3	Cut at start not completed (line moving)	8
4	Cam calculation parameter fault	16
5	Line speed is too fast	32
6	Sequence abort parameter fault	64
7	Homing fault	128
8	Fwd H/W lim	256
9	Rev H/W lim	512
10	Fwd S/W lim (only active after homing)	1024
11	Rev S/W lim (only active after homing)	2048
12	Remote field bus trip	4096
13	Watchdog error	8192

9.1.4 Status word 1 _R70% (Pr 72.70)

Bit	Parameter	Description	Decimal Value
0	10.01	Drive OK	1
1	10.02	Drive output stage active	2
2	10.03	Zero speed	4
3	8.07 & 06.15	Drive enabled (ready)	8
4	01.11	Reference ON	16
5	-	Line speed is at zero	32
6	-	Batch counter enabled	64
7	-	First cut alarm (Pr 19.030 = 3)	128
8	-	Registration window open	256
9	-	Registration missed mark	512

9.1.5 Status word 2 _R71% (Pr 72.71)

Bit	Description	Decimal Value
0	Jogging	1
1	Travelling to start position	2
2	At Start position	4
3	Homing sequence in progress	8
4	Homing completed	16
5	Flying Shear cycle running	32
6	Cyclic mode selected	64
7	0 = Local 1= Remote	128
8	Registration mode selected	256
9	New cam is being calculated	512
10	Cam is ready	1024
11	On last cut in batch	2048
12	Batch done	4096
13	Shear is ready to run	8192
14	Alarm active	16384
15	Watchdog out	32768

NOTE The watchdog must be enabled to allow the Local / Remote mode to be set to remote, this is done to prevent the flying shear from running / Jogging and Homing unexpectedly. The Flying Shear Status (Pr **19.007**) contains the same information as _R71%.

10 Quick reference

10.1 Application parameters - Menu 18, 19, 20, 70 and 75

10.1.1 Menu 18

No.	Description	Typ	Units	Range	Default	Setting
18.001	Home state	RO	List	-3 – +5	-	
18.002	Home complete flag	RO	Bit	-	-	
18.003	Background scan time	RO	Ms	0 – 32767	-	
18.004	Batch counter (count up)	RO	Qty	0 – 32767	-	
18.005	Batch counter (count down)	RO	Qty	0 – 32767	-	
18.006	Batch done flag	RO	Bit	-	-	
18.007	Minimum registration distance	RO	Units	-	-	
18.008	Length of last cut	RO	Units	32767	-	
18.009	Length of cut before last cut	RO	Units	32767	-	
18.010	Line speed indication	RO	Units/min*18.018	32767	-	
18.011	Units	RW	List	0 – 9	0	
18.016	Enable batch control	RW	Bit	-	0	
18.017	Batch quantity	RW	Qty	0 – 32767	10	
18.018	Line speed scalar	RW	-	1-32767	1000	
18.019	Home speed	RW	Units/s	0 – *	5	
18.020	Home mode	RW	Bit	0-1	0	
18.021	Home back-off speed	RW	% of 18.019	1 – 100	1	
18.022	Home search direction	RW	Bit	-	0	
18.023	Home accel / decel	RW	Units/s ²	0 – 32767	50	
18.024	Home time-out	RW	0.01sec	0 – 32767	1000	
18.025	Home position preset	RW	Units	0 – 32767	0	
18.026	Watchdog trip delay	RW	ms	0 – 32767	2200	
18.027	Watchdog output time period	RW	ms	0 – 32767	700	
18.028	Jog speed	RW	Units/s	0 – *	5	
18.029	Jog acceleration rate	RW	Units/s ²	0 – 32767	100	
18.030	Jog deceleration rate	RW	Units/s ²	0 – 32767	100	
18.031	Home switch polarity	RW	Bit	-	1	
18.032	Home switch input	RW	Bit	-	-	
18.033	Tool sync enable	RW	Bit	-	0	
18.034	Flying Shear ready	RO	Bit	-	-	
18.035	Enable feed forward term filter	RW	Bit	-	-	
18.036	Enable high resolution alternative parameters	RW	Bit	-	-	
18.037	Update scaling	RW	Bit	-	0	
18.038	Batch reset	RW	Bit	-	0	
18.039	Acquire feature select	RW	Bit	-		
18.040	Acquire bit	RW	Bit	-		
18.041	Last cut flag	RO	Bit	-	-	
18.043	Tool cut output	RO	Bit	-	-	
18.044	Default parameters	RW	Bit	-	0	
18.045	Watchdog enable	RW	Bit	-	0	
18.046	Test cut length enable	RW	Bit	-	0	
18.047	Not used	-	-	-	-	
18.048	Fast ramp enable	RW	Bit	-	0	
18.049	System ok output	RO	Bit	-	-	
18.050	Real time cut enable	RW	Bit	-	0	

10.1.2 Menu 19

No.	Description	Typ	Units	Range	Default	Setting
19.001	Shear position reference	RO	Units	+/-32767	-	
19.002	Shear actual position	RO	Units	+/-32767	-	
19.003	FE active	RO	Bit	-	-	
19.004	Line registration windowing position	RO	Units	0 - 32767	-	
19.005	Following error (units)	RO	0.001 Units	+/-32767	-	
19.006	Following error (enc counts)	RO	Counts	+/-32767	-	
19.007	Flying Shear status word	RO	-	-	-	
19.008	Max cut fe detected	RO	0.001 Units	0 - 32767	-	
19.009	Shear maximum travel distance	RO	Units	+/- 32768	-	
19.010	Material position with respect to shear	RO	Units	+/-32767	-	
19.011	FE limit	RW	0.001 Units	1 – 32767	100	
19.012	Position loop velocity feed forward gain	RW	0.001Kd/s	0 – 32767	1000	
19.013	Position loop proportional gain	RW	0.01Kp	0 – 32767	1600	
19.014	Forward software limit	RW	Units	0 – 32767	5	
19.015	Reverse software limit	RW	Units	0 – 32767	0	
19.016	Proportional gain output limit	RW	Percent of 01.006	0 – 100%	10	
19.017	At position tolerance	RW	0.001 Units	0 – 32767	1000	
19.018	Alarm word	RO	-	-	-	
19.019	Alarm / trip select word	RW	-	0 – 16383	16383	
19.020	Trip conditional select word	RW	-	0 – 16383	8064	
19.021	Alarm / trip enable word	RW	-	0 – 16383	16383	
19.022	Raw alarm / trip data	RO	-	-	-	
19.023	Gap distance	RW	Units	0 – 32767	0	
19.024	Gap accel / decel rate	RW	Units/s ²	0 – 32767	0	
19.025	Gap relative speed	RW	Units/s	0 – 32767	0	
19.026	Cutter IO Mode	RW	Bit	0 – 3	0	
19.027	Cut before start	RW	-	-	0	
19.028	Line resolution selector	RW	-	0 - 6		
19.029	Shear resolution selector	RW	-	0 - 6		
19.030	First cut mode	RW	-	0 – 3	0	
19.031	Manual cut command	RW	Bit	-	0	
19.032	Drive / fault reset	RW	Bit	-	0	
19.033	Shear run command	RW	Bit	-	0	
19.034	Go to start position	RW	Bit	-	0	
19.035	Local / remote select	RW	Bit	-	0	
19.036	Jog forward	RW	Bit	-	0	
19.037	Jog reverse	RW	Bit	-	0	
19.038	Home command	RW	Bit	-	0	
19.039	Abort motion command	RW	Bit	-	0	
19.040	Forward hardware limit input	RW	Bit	-	0	
19.041	Reverse hardware limit input	RW	Bit	-	0	
19.042	Hardware limit input polarity	RW	Bit	-	0	
19.043	Disable limits during homing	RW	Bit	-	0	
19.044	Change forward direction	RW	Bit	-	0	
19.046	Tool up input	RW	Bit	-	0	
19.047	Tool down input	RO	Bit	-	0	
19.048	Flying Shear running	RO	Bit	-	0	
19.049	Tool enable	RO	Bit	-	0	
19.050	Gap enable	RW	Bit	-	0	

10.1.3 Menu 20

No.	Description	Typ	Units	Range	Default	Setting
20.001	Tool width compensation	RW	Units	0 – 32.767	0	
20.002	Minimum cut length	RO	Units	-	-	
20.003	Cam status word	RO	-	-	-	
20.004	Flying Shear profile mode	RW	Bit	-	-	
20.005	Cut length	RW	Units	1 – 32767	500	
20.006	Fly accel / decel rate / start distance	RW	Units/s ²	1 – 32767	50	
20.007	Return accel / decel rate	RW	Units/s ²	1 – 32767	50	
20.008	Maximum line velocity	RW	Units/s	1 – 32767	48	
20.009	Settling time / accel. distance	RW	ms / units	0 – 32767	50	
20.010	Cut time / sync distance	RW	ms/units	0 – 32767	50	
20.011	Tool up time / decel. distance	RW	ms / units	0 – 32767	50	
20.012	Cut length fine adjustment	RW	0.001 Units	0 – 32767	0	
20.013	FE cut limit	RW	Counts	1 – 32767	500	
20.014	Fast deceleration rate	RW	Units/s ²	1 – 32767	0	
20.015	Ramp mode	RW	Bit	-	0	
20.016	Cam pointer position	RO	-	0 – 10	-	
20.017	Enable virtual reference	RW	Bit	-	0	
20.018	Virtual reference speed	RW	Units/s	0 – [20.008]	10	
20.019	Flying Shear start position	RW	Units	+/- 32767	5	
20.020	Shear optimization mode	RW	Bit	-	0	
20.021	Flying Shear type parallel / angled	RW	Bit	-	0	
20.022	Registration fine offset	RW	0.001 Units	+/- 5000	0	
20.023	Registration offset	RW	Units	+/- 2 ³¹	0	
20.024	Registration window enable	RW	Bit	-	0	
20.025	Registration window tolerance	RW	Units	0 – 2 ³¹	20	
20.026	Preset line position command	RW	Bit	-	0	
20.027	Shear length / shear angle	RW	Units/0.001°	1 – 2 ³¹ /60.000	50	
20.028	Line preset position value	RW	Units	+/- 2 ³¹	0	
20.029	Line scaling (denominator)	RW	Units	1 – 2 ³¹	1	
20.030	Line scaling (numerator)	RW	Counts	1 – 2 ³¹	16384	
20.031	Shear scaling (denominator)	RW	Units	1 – 2 ³¹	1	
20.032	Shear scaling (numerator)	RW	Counts	1 – 2 ³¹	16384	
20.033	Remote I/O select word	RW	-	-	0	
20.034	line / Master encoder location	RW	-	0 - 9	0	
20.035	Shear / Slave encoder location	RW	-	0 - 9	0	
20.036	Maximum return profile speed	RW	rpm	0 to 99% of 1.006	2700	
20.039	Application software version	RW	-	-	-	

10.1.4 Menu 70

Table 10-1 Menu 70 Alternative high resolution parameters

No.	No.	Description	Typ	Units	Range	Default	Setting
70.00	18.019	Home speed	RW	Units/s	0 – *	5	
70.01	18.023	Home accel / decel	RW	Units/s ²	0 – 2 ³¹	50	
70.02	18.025	Zero position preset	RW	Units	0 – 2 ³¹	0	
70.03	18.028	Jog speed	RW	Units/s	0 – *	5	
70.04	18.029	Jog acceleration rate	RW	Units/s ²	0 – 2 ³¹	100	
70.05	18.030	Jog deceleration rate	RW	Units/s ²	0 – 2 ³¹	100	
70.06	19.011	FE limit	RW	0.001 Units	1 – 2 ³¹	100	
70.07	19.014	Forward software limit	RW	Units	0 – 2 ³¹	0	
70.08	19.015	Reverse software limit	RW	Units	0 – 2 ³¹	0	
70.09	19.017	At position tolerance	RW	0.001 Units	0 – 2 ³¹	1000	
70.10	19.023	Gap length	RW	Units	0 – 2 ³¹	0	
70.11	19.024	Gap accel / decel rate	RW	Units/s ²	0 – 2 ³¹	0	
70.12	19.025	Gap relative speed	RW	Units/s	0 – 2 ³¹	0	
70.13	20.005	Cut length	RW	Units	1 – 2 ³¹	500	
70.14	20.008	Maximum master velocity	RW	Units/s	1 – 2 ³¹	48	
70.15	20.027	Shear length / shear angle	RW	Units / 0.001×	1 – 2 ³¹ / 60.000	50	
70.16	20.006	Fly accel / decel rate / start distance	RW	Units/s ²	1 – 2 ³¹	50	
70.17	20.007	Return accel / decel rate	RW	Units/s ²	1 – 2 ³¹	50	
70.18	20.013	FE cut limit	RW	Counts	1 – 2 ³¹	500	
70.19	20.014	Fast deceleration rate	RW	Units/s ²	1 – 2 ³¹	0	
70.20	20.018	Virtual master speed	RW	Units/s	0 – [20.008]	10	
70.21	20.019	Flying Shear start position	RW	Units	+/- 2 ³¹	0	
70.22	20.023	Registration offset	RW	Units	+/- 2 ³¹	0	
70.23	20.028	Master preset position value	RW	Units	+/- 2 ³¹	0	
70.50	20.002	Minimum cut length	RO	Units	-	-	
70.51	18.008	Length of last cut	RO	Units	2 ³¹	-	
70.52	18.009	Length of cut before last cut	RO	Units	2 ³¹	-	
70.53	19.010	Master position	RO	Units	+/- 2 ³¹	-	
70.54	19.005	Following error (units)	RO	0.001 Units	+/- 2 ³¹	-	
70.55	19.008	Max cut fe detected	RO	0.001 Units	0 - 2 ³¹	-	
70.56	19.009	Shear calculate travel distance	RO	Units	0 - 2 ³¹	-	
70.57	19.001	Position reference	RO	Units	+/- 2 ³¹	-	
70.58	19.002	Actual position	RO	Units	+/- 2 ³¹	-	
70.59	18.007	Minimum registration distance	RO	Units	-	-	
70.60	19.004	Line Registration Window Position	RO	Units	0 - 2 ³¹	-	
70.82		Gap Return Position	RW, Uni	Units	0 to 19.023	0	
70.83		Gap State Indication	RW, Uni	-	0 to 3	-	
70.84		Gap Actual Position Achieved	RW, Uni	Units	0 to 19.023	-	
70.85		Line Encoder Direction Select	RW, Bit	-	0 to 1	0	

No.	No.	Description	Typ	Units	Range	Default	Setting
70.86		Line Speed Filter TC	RW, Uni	-	0 - ($2^{32}-1$)	10	
70.87		Line Zero Speed Threshold Detection	RW, Uni	Units/s	0 - Max Line Velocity (20.008)	1	
70.88		Material Position	RO, Uni	Units	0 - ($2^{32}-1$)	1	
70.89		Extended Sync Distance	RW, Uni	Units	0 - Travel Length (20.027)	0	
70.90		Start of Cut Distance	RO, Uni	Units	-	-	
70.91		End of Tool Up Distance	RO, Uni	Units	-	-	
70.92		Test Cut Length	RW, Uni	Units	0 - ($2^{32}-1$)	1000	
70.93		Registration Sensor Throughput Delay	RW, Uni	Micro-seconds	20000	0	
70.94		Registration Sensor Speed Filter Time Constant	RW, Uni	Units	0 - ($2^{32}-1$)	32	

10.1.5 Menu 75

Table 10-2 Menu 75 high resolution parameters

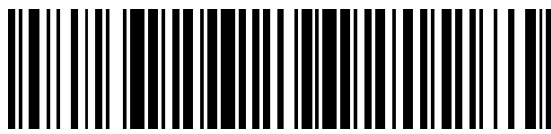
No.	No.	Description	Typ	Units	Range	Default	Setting
75.00		Master CAM Segmet 0	RO, Uni	Counts	0 - 2^{31}		
75.01		Master CAM Segmet 1	RO, Uni	Counts	0 - 2^{31}		
75.02		Master CAM Segmet 2	RO, Uni	Counts	0 - 2^{31}		
75.03		Master CAM Segmet 3	RO, Uni	Counts	0 - 2^{31}		
75.04		Master CAM Segmet 4	RO, Uni	Counts	0 - 2^{31}		
75.05		Master CAM Segmet 5	RO, Uni	Counts	0 - 2^{31}		
75.06		Master CAM Segmet 6	RO, Uni	Counts	0 - 2^{31}		
75.07		Master CAM Segmet 7	RO, Uni	Counts	0 - 2^{31}		
75.08		Master CAM Segmet 8	RO, Uni	Counts	0 - 2^{31}		
75.09		Master CAM Segmet 9	RO, Uni	Counts	0 - 2^{31}		
75.10		Master CAM Segmet 10	RO, Uni	Counts	0 - 2^{31}		
75.11		Master CAM Segmet 0 + 1 + 2 Converted To Distance Units	RO, Uni	Units	0 - 2^{31}		
75.12		Registration Sensor Delay Position	RO, Bi	Counts	+/- 2^{31}		
75.20		Slave CAM Segmet 0	RO, Bi	Counts	+/- 2^{31}		
75.21		Slave CAM Segmet 1	RO, Bi	Counts	+/- 2^{31}		
75.22		Slave CAM Segmet 2	RO, Bi	Counts	+/- 2^{31}		
75.23		Slave CAM Segmet 3	RO, Bi	Counts	+/- 2^{31}		
75.24		Slave CAM Segmet 4	RO, Bi	Counts	+/- 2^{31}		
75.25		Slave CAM Segmet 5	RO, Bi	Counts	+/- 2^{31}		
75.26		Slave CAM Segmet 6	RO, Bi	Counts	+/- 2^{31}		
75.27		Slave CAM Segmet 7	RO, Bi	Counts	+/- 2^{31}		
75.28		Slave CAM Segmet 8	RO, Bi	Counts	+/- 2^{31}		
75.29		Slave CAM Segmet 9	RO, Bi	Counts	+/- 2^{31}		
75.30		Slave CAM Segmet 10	RO, Bi	Counts	+/- 2^{31}		

11 Documentation reference

11.1 Documentation location

- User Guide
- Advanced User Guide
- SI-Applications Plus
- SI-Universal Encoder
- SI-IO Plus
- SI-PROFIBUS
- SI-DeviceNet
- SI-CANopen
- SI-Ethernet
- SI-EtherCAT

These manuals are available from the Control Techniques website www.controltechniques.com.



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