5720 / 5721 DIGITAL POSITION CONTROLLER

APPLICATIONS MANUAL

HA058775

Issue 3

WARNING

NEVER WORK ON THE CONTROLLER
WITHOUT FIRST ISOLATING ALL
SUPPLIES TO THE SYSTEM.

CONTROLLER WARRANTY

For further details on Eurotherm Drives Controller Warranty and Repair refer to the Standard Conditions of Sale IA058393C

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5720 / 5721 DIGITAL POSITION CONTROLLER

APPLICATIONS MANUAL

The 5720 position controller and optional 5721 operator station may be used for a wide variety of motor control applications. The 5720 is capable of absolute accuracy in speed, position (phase) and absolute position (register) modes. Applications range from simple line shaft and gearbox replacements to complex applications such as print registration and constant speed cutters.

5720 quadraloc is compatible with all drives having analog set-points. These include d.c. thyristor drives, servo and brush-less servo drives. The 5720 requires minimal wiring, configuration being controlled by software. The means of monitoring and modifying parameters is by two EI compatible RS422 serial links. One serial link is dedicated to the 5721 operator station whilst the other is available for use by the customer. The user serial link is ASCII Bi-Sync and may be used with EI group supervisors such as PC3000 and Tactician, as well as other 'hosts'.

The 5721 can be used to monitor / modify parameters, displaying each with an English title. It can also be configured to provide a custom operator display enabling the operator to enter variables in engineering units. The operator display will limit what the machine operator may see and adjust to what you decide is safe. A typical display item will be two lines, the top line reads DRAW and the bottom 21.3 %. The display can also be configured to control switch parameters, giving them meaningful names such as PRINT REGISTER DISABLED.

The manual is divided into three applications, one each for speed, phase and register. It is useful to read all the examples even if yours is only simple. Certain features are demonstrated in each example, many of these being available in the other modes as well. For further detail please refer to the 5720 and 5721 manuals. (HA058183 and HA058017). Each example takes the form of a worked example and some commissioning notes to help you make your system work.

Some basic commissioning procedures should be followed. To commission the 5720 it is useful to follow a sequence of operations. Always start by commissioning the analog loop with no trim from the 5720. The less work the controller has to do the better the response. Then commission the speedloop followed by the phase and register loops. Never be tempted to skip a step because that is sure to be where the problem lies!

New 5721 operator stations must be configured to talk to either the 5720 or 570 series drive, to do this press [E] and type Ø on the numeric keypad, followed by [ENTER]. This will put you into the "Engineering Menu" use the arrow keys to find CONFIGURATION and press M until presented with the choice of 5720, 590 or 570. Use the arrow keys to select 5720 on the display and press [M]. Press [E] to exit.

To initialise the parameters before entering your own calculated values, use the arrow keys to find **PARAMETER SAVE** and push [M]. Use the arrow keys again to find **FACTORY DEFAULTS** and press [M]. The display will read **WORKING** and then return up one level to **PARAMETER SAVE**. The default values have now been loaded. These default values may be modified using the **SETUP PARAMETERS** menu level. (Further details of this menu structure is given in the 5720 manual appendix A and B).

If you have made any changes to the 5720 or 5721 parameters it is essential to save them once you are satisfied they are correct. If you do not save the data it will be lost when the power is removed from the unit. To initiate a save enter the **PARAMETER SAVE** menu item and push [M] twice. The display will prompt you to close the save switch on the 5720 PCB, a further push of [M] will perform the save. Both the 5720 and 5721 contain non-volatile EEPROM memory which is used to store the data. Both EEPROMS are exact copies of the other. Hence if either unit should become damaged, simply replace the damaged unit and up-load the data. This is simply done by using the **PARAMETER SAVE / QLOC TO OPSTN** or **OPSTN TO QLOC** save options. This can also be useful to set-up an number of near identical 5720's.

EXAMPLE 1: *SPEED LOCK* : DRAW APPLICATION

This application is a simple line shaft. The 5720 Quadraloc controller replacing a mechanical line shaft and gear box. In the mechanical system the gearbox ratio could be changed to affect the draw or extension of the product.

Consider first the simple line shaft replacement. The motor controlling the old line shaft section will serve as the master for the system, the new draw roll motor acting as the slave. As we can see from the diagram (HH058776 on page 4), the maximum line speed is 300 m/minute and the reference roll circumference is 471.23mm. From this we can calculate the reference frequency as;-

Reference frequency =
5 x (300/60) x (1/0.471) x 1024 = 54.324 kHz

It should be noted that the original 1024 pulse/rev encoder has been retained. To convert this encoder into the SSD fibre optic format for the 5720, a 5702/3 converter module has been used. This unit is supplied with 24V d.c. and may interface to encoders of 5V to 21.5V d.c. It will supply the encoder and use the A,B and zero index pulse (M) to generate the SSD fibre optic data.

The next step is to calculate the slave frequency, with no draw. The slave roller is 628.32mm in circumference, the gear box is 5 to 1 and at 300m/min the encoder will produce a frequency of;-

Slave frequency =
5 x (300/60) x (1/0.628) x 1000 = 39.78 kHz

These two frequencies are those appearing at D13 and D20 on the software block diagram (HH058185 in Appendix A). For the system to lock, the reference and slave frequencies must be equal at maximum line speed. (ie; D12 and D19 of the block diagram must be the same value). We can see that the reference frequency (D13) is higher than the slave frequency (D20). We must thus scale the reference frequency to reduce it to the same value as the slave frequency. This may be done using the reference software pre-scalar P25. (Indeed, we could also scale the slave frequency if that was necessary using P33). The value of P25 may be in the range 0 to 1.000000, and is the ratio of the frequencies given by:-

Reference scaling factor P25 =
39.78 / 54.32 = 0.732422

COMMISSIONING:

D12 and D19 will now have the same value at maximum line speed, enabling the system to lock correctly. It may be necessary to adjust the signs in order to obtain the correct rotational direction of the slave shaft. This is most simply performed by disconnecting the trim (terminal C5) and running the system in analog. If the slave shaft rotates in the wrong direction change the analog sign by changing parameter P58 (00H is non-inverting and any non-zero value inverts). Then re-connect the trim. If the values of D12 and D19 are of the same sign it will be necessary to change the sign of the feedback using parameter P34. Once the analog sign and feedback sign are correct, if the trim saturates change the error sign P36. (This will almost certainly be necessary if P58 has been modified).

Once the system is 'in lock' the loop tuning may be performed. The speed loop P and I values may be modified using P37 and P38. To do this it is suggested that a small square wave disturbance be applied to the slave drive and the P and I gains modified until the drive response looks like the square wave input. In many systems the mechanics will limit the response and this optimal position may not be attainable. If the system becomes unstable, back the gains off a little until a stable response is achieved. The trim (terminal C5) may also have a d.c. offset. If this is the case, remove this by modifying the drive speed calibration. Doing this will enable the trim to move over its entire ± 0.8V trim range, preventing saturation and temporary loss of lock.

The above is a description of a simple line shaft replacement. Once configured the system requires no input from the 5721 and the 5720 is used as a stand alone controller. In many systems some form of on-line modification is required, such as changes in draw between sections. If this is the case either a host system, such as PC3000 or Tactician, or the 5721 operator station will be required. These units allow the operator to enter data and modify parameters within the 5720 using an EI format serial link. In this system a 5721 operator station is used to set the required draw.

THE *5721* OPERATOR STATION

The 5721 has two modes of operation, *Engineering* and *Operator*. The operator station powers up in the operator mode. Entering the engineering menu is performed by pushing [E] and entering the password Ø followed by [ENTER]. The engineering menu allows access to all the parameter and diagnostic points shown in the block diagrams. (The menu structure and names for parameters are given with their P and D numbers in the appendix).

In the operator mode up to sixteen points from the block diagram may be displayed or modified by the operator. The engineering menu name is replaced by a name of up to sixteen characters defined by the user. Parameters with a numeric value may be assigned units such as mm or boxes/hr. The numeric value itself may be modified using a formula and have its entry value limited. One of three formulas may be chosen. (ax+b, {a/x}+b, and a/{x+b}). If the parameter is a switch type (on/off) the values of 0,1,2 and 3 may be assigned a text string of up to sixteen characters such as, **ENABLED**. (If the parameter has only two values, as most of them do, only text strings for the values 0 and 1 need be entered).

The best way of showing the operator menu is to give an example. In our current example, we may wish to modify the draw as a percentage. To modify draw we wish to change the speed of the slave shaft. Increasing speed gives positive draw, decreasing speed gives negative draw. To do this we can change the ratio value P27. Ratios greater than 1 give positive draw and ratios less than one give negative draw. A draw value of 0% gives a ratio value of 1. Let the formula for draw be;-

DRAW = (RATIO - 1) x 100

The ratio value is P27, serial link mnemonic 'sb'. Having entered the engineering menu find the **CONFIGURATION** menu item and select one of the R/W parameters (5 to 8). Push [M] twice and the prompt for a name will appear. Use the up and down arrow keys to cycle through the alphabet until the desired letter is reached and press [M]. (This key is also used to select spaces). Continue to enter the name one letter at a time and once complete press [ENTER]. You will then be prompted to enter the units, which in this case are **%**. This data is entered in the same way as the name. Remember to enter leading spaces using [M] so that the units will appear on the right hand side of the display.

You will then be prompted to enter the mnemonic for the parameter you wish to display. This data is shown in the appendix. The mnemonic for draw is 'sb' and is selected using the up and down arrow keys, only the relevant mnemonics being displayed. Once the correct mnemonic is being displayed press [M].

The next data to enter is the **DISPLAY FORMAT.** As we are entering **%** draw a maximum value of ± 100.00% is sufficient. Thus we select the display format as 3.2, ie; three places in front and two places behind the decimal point. The LCD will now show the format of the completed display. The data value may be moved left and right by the use of the up and down arrow keys.

The upper and lower limits must be configured. These limit the maximum and minimum values that the operator may enter. Let the range be ± 25%. The lower limit is set to -25.0 and the upper limit to 25.0. To do this go down one level from the **UPPER / LOWER LIMIT** menu items and enter 25 - and 25 using the numeric keypad followed by [ENTER]. (If this was a read only parameter it would not be necessary to enter these limits). It is necessary to ensure that the parameter to be displayed is within the legal limits by using the **PARAMETER SETUP** menu or the operator display will read **OUT OF RANGE** and not allow data entry.

The last data required is the formula and values of the coefficients A and B. Enter the **FORMULA** selection using the [M] and cycle around the choices using the arrow keys. Once the display reads **AX+B** press [M] to confirm the choice. Then enter the values of A and B using the numeric keypad and [ENTER]. In this case A is 100 and B is -100. The display point has now been set up and all that remains is to enable it. To do this enter **DISPLAY SEQUENCE.** It will prompt you for the number of parameters and in this case we have just one. Push the number [1] followed by [ENTER]. The display will then display all of the sixteen possible options using the up and down arrow keys to cycle around them. Once the correct one is displayed press [M]. In this case the configuration is now complete and you may exit to the operator menu by repeatedly pushing [E]. If there were more than one parameter displayed in the operator menu, you would be prompted to enter the second item and so forth. (The sixteen possible display items may be selected in any random order).

The operator menu is now configured and when powered up will read, **DRAW** on the top line and **0.00 %** on the bottom. This will be the only thing that the operator may observe or modify unless he has the password. Once all the parameters have been set and the operators menu configured, it is recommend that the changed data be saved. To do this enter the engineering menu by using the password. Find the **PARAMETER SAVE** menu entry and push [M]. The display will read **SAVE ALL.** Press [M] again and you will be told to close the parameter save switch on the 5720 control board. Press [M] again and the data will be saved. Once the save is complete press [E] a number of times to exit to the operator menu.

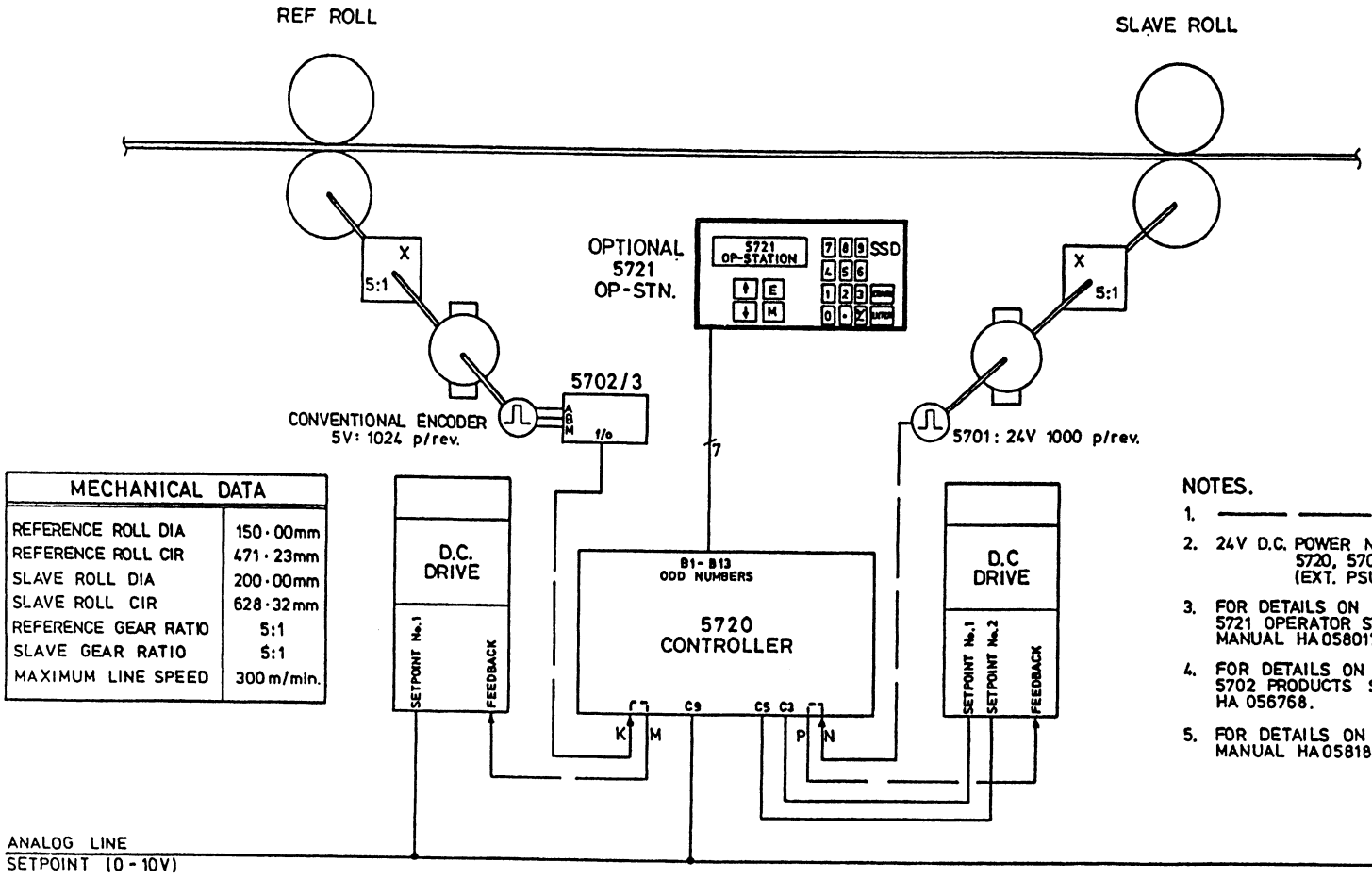
Further details on the operation of the 5721 operator station may be found in the op-stn manual (HA058017). The operator display configuration may be summarised as;-

DRAW CONTROL: Parameter 5

NAME	DRAW
UNITS	%
MNEMONIC	sb
DISPLAY FORMAT	3.2
LOWER LIMIT	-25.0
UPPER LIMIT	25.0
FORMULA	ax+b
a	100
b	-100

DO NOT SCALE	THIRD ANGLE PROJECTION	GENERAL DRAWING PRACTICE TO BS 308/ BS 3939

'S' S	DATE
A	20.9.90
1	3.12.90



MECHANICAL DATA	
REFERENCE ROLL DIA	150·00mm
REFERENCE ROLL CIR	471·23mm
SLAVE ROLL DIA	200·00mm
SLAVE ROLL CIR	628·32mm
REFERENCE GEAR RATIO	5:1
SLAVE GEAR RATIO	5:1
MAXIMUM LINE SPEED	300 m/min.

NOTES.

1. ——— ——— FIBRE OPTIC CABLE.
2. 24V D.C. POWER NOT SHOWN:- 5720, 5702/3 & 5721 (EXT. PSU, NOT DRIVE 24V)
3. FOR DETAILS ON CONNECTION OF 5721 OPERATOR STATION SEE MANUAL HA 058017.
4. FOR DETAILS ON CONNECTION OF 5702 PRODUCTS SEE MANUAL HA 056768.
5. FOR DETAILS ON 5720 SEE MANUAL HA 058183.

DRAWN D.E.B / P.B.	MATERIAL	DIMS. IN M.M. APPLY OVER FINISH (EXCEPT FOR PAINT AND LACQUER)	ASSEMBLED ON	SCALE
CHECKED		GENERAL TOLERANCE X = ± 0·4, X.X = ± 0·2, X.XX = ± 0·1; HOLES <Ø7 mm -0.02 +0.07	SSD LITTLEHAMPTON, ENGLAND. TELEX 87142	TITLE: 5720 SPEEDLOCK DRAW APPLICATION
DESIGN APPROVAL	FINISH			DRAWING NUMBER: HH 058776 D
MANF. APPROVAL				SHT. 1 OF 1

SRS LTD 19375/A/86 A3 (3/41)

EXAMPLE 2: *PHASE LOCK* : WRAPPING APPLICATION

This is an interesting example. The wrapping or armouring machine rotates around the cable which passes through it. As the machine rotates it lays the wrapping material on to the cable. The lay length is the distance between consecutive wraps. Obviously, the lay length is a function of the relative speed of cable through the machine and the rotational speed of the machine. Two 5270's are required, one to lock the first wrapper to the cable speed and one to lock the second wrapper to the first. We will only consider the second 5720.

The two wrapping machines may be used in a number of modes. Firstly, only the first wrapper may be required, the second being parked. A second mode allows both wrappers to work independently of each other, each machine laying directly on to the cable. The last mode allows the first machine to feed its wrapping through the second, the second laying on both of the wrappings. It is this mode that we will examine.

The use of multiple modes is becoming more common. The 5720 fully supports different modes, in this application by the use of a host supervisory computer. The host computer can down-load new parameter set-up's using its RS422 serial link. For the given example, the first mode may be enabled by either quenching the 5720 or setting the ratio to zero. This will prevent the 5720 generating either a set-point or trim value for the second wrapper. The second mode is no different to mode 3. We could use speed-lock for mode 2 but phase lock must be used for mode 3. If speed-lock were used for mode 3 there would be a possibility of a twist developing between the two wrappers which may be unacceptable.

The other unusual thing about this machine is that the 5720 is used to generate the analog line set-point. The **SOFTWARE ANALOG LOOP** parameter **ANALOG REFERENCE** (P55) is used to perform this task. In general, P55 is 1000 / 1v of output on terminal C7. Thus, if we set the selector switch P54 to be non-zero the parameter P55 will be selected as the input to the S/W analog loop. By varying this parameter between 0 and 10000 the voltage appearing on terminal C7 will vary between 0 and 10 volts. (This assumes that the ratio is 1). The line speed may be changed by writing new values to P55 or by setting P55 to 10000 and changing the ratio. To change the ratio, parameter P61 is made non-zero so that the **ANALOG RATIO** is selected in place of the **DIGITAL RATIO**. The analog ratio is varied between 0 and 1.000000 by writing to parameter P60. If we require the direction of the line to change this may be done by changing parameter P56.

As the two wrapping machines have the same gear boxes and mechanics and must follow one another, all the digital scaling factors and digital ratio are 1.000000. The lay length is modified by changing the ratio between the line speed and the rotational speed of the first wrapper. (Using the first 5720). The 'twist' between the two wrapping machines may be controlled by using the INCH facility. The digital inputs may be used to inch the second wrapper around forwards or backwards, or serial link control may be used. If parameter P52 is made non-zero, the value stored in **INCH GAIN** (P50) will be added to the error whilst P52 is true. The inch may be reversed by changing the **INCH SIGN** (P51). This has the same effect as using the digital inputs. We can also rotate the machine by a known angle. To do this parameter P74 (position offset control) is made non-zero. Any value entered into parameter P75 (**POSITION OFFSET**) will be added once to the summing juction, note:-

Rotational resolution =
4 x 1000 x (2/1) = 8000 counts / rev

Thus 1 degree = 8000 / 360 = 22.222 counts

This would probably be done using the host computer, the 5721 operator station being used only for diagnostics and monitoring. However for this example we will assume that the operator station is used to set the line set-point and inch the second wrapper. As we have said, the line set-point is modified by changing the analog ratio P60. The inch facility will be controlled by the serial link inch control parameter P52. The operator station configurations for these two operations would be;

LINE SET-POINT: Parameter 6

NAME	LINE SPEED
UNITS	M/MIN
MNEMONIC	ra
DISPLAY FORMAT	3.0
LOWER LIMIT	0
UPPER LIMIT	150
FORMULA	ax+b
A	66.666666
B	0.000000

DISPLAY:	LINE SPEED
	125 M/MIN

INCH CONTROL: Parameter 13

NAME	SECOND WRAP INCH
MNEMONIC	wk
MAXIMUM VALUE	1
TEXT FOR VALUE 0	DISABLED
TEXT FOR VALUE 1	ENABLED

DISPLAY:	SECOND WRAP INCH
	DISABLED

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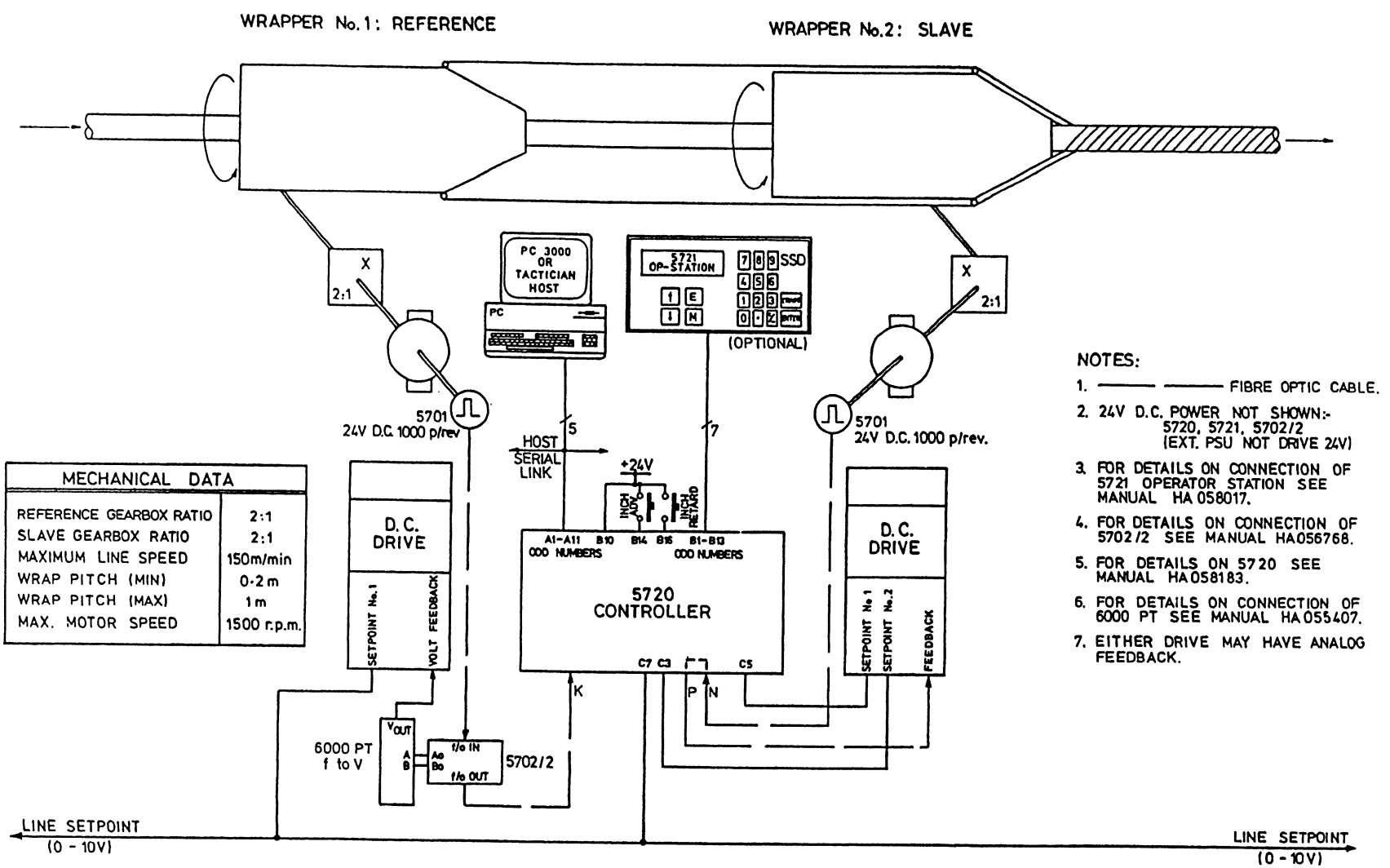
The first thing to remember is that a phase lock application is simply a speed lock system with an extra PI control term. The system may be commissioned by firstly carrying out all the commissioning procedures detailed in the speed lock application. (To do this convert the controller to a speedloop by removing the loop type control input from terminal B10). Once the system is commissioned as a speedloop, re-connect the wire on terminal B10 and tune the phaseloop P and I gains as was done for the speedloop. The phase P and I gains are P44 and P45.

Any additional features may now be exercised. In this case, we should check correct operation of the inch facility, both over the serial link and by the external push-buttons. Having checked correct operation of the host link, run the system over its entire speed range confirming all is well.

It should be noted that the drives should be matched as closely as possible in analog before closing any additional loops. This should always be done, but is especially important when an f to v (6000PT) unit is used to supply the feedback to a drive. Performing this simple step can save a lot of problems later.

DO NOT SCALE | THIRD ANGLE PROJECTION | GENERAL DRAWING PRACTICE TO BS 308/ BS 3939

I/S	DATE
A	20.9.90
1	3.12.90



MECHANICAL DATA	
REFERENCE GEARBOX RATIO	2:1
SLAVE GEARBOX RATIO	2:1
MAXIMUM LINE SPEED	150m/min
WRAP PITCH (MIN)	0·2 m
WRAP PITCH (MAX)	1 m
MAX. MOTOR SPEED	1500 r.p.m.

NOTES:

1. ——— ——— FIBRE OPTIC CABLE.
2. 24V D.C. POWER NOT SHOWN:- 5720, 5721, 5702/2 (EXT. PSU NOT DRIVE 24V)
3. FOR DETAILS ON CONNECTION OF 5721 OPERATOR STATION SEE MANUAL HA 058017.
4. FOR DETAILS ON CONNECTION OF 5702/2 SEE MANUAL HA056768.
5. FOR DETAILS ON 5720 SEE MANUAL HA058183.
6. FOR DETAILS ON CONNECTION OF 6000 PT SEE MANUAL HA055407.
7. EITHER DRIVE MAY HAVE ANALOG FEEDBACK.

DRAWN D.E.B. / P.B	MATERIAL	DIMS. IN M.M. APPLY OVER FINISH (EXCEPT FOR PAINT AND LACQUER)	ASSEMBLED ON	SCALE
CHECKED		GENERAL TOLERANCE X = ± 0·4, X.X = ± 0·2, X.XX = ± 0·1; HOLES <Ø7 mm −0.02 +0.07	SSD LITTLEHAMPTON, ENGLAND. TELEX 87142	
DESIGN APPROVAL	FINISH			

TITLE: 5720 PHASELOCK ARMOURING WRAPPING APPLICATION

DRAWING NUMBER: HH 058777 D

SHT. 1 OF 1

SRS LTD 19275/A/86 A3 (3/41)

EXAMPLE 3: *REGISTER LOCK* : PRINTING APPLICATION

This application is shown in drawing HH058778 on page 9 and is a downstream printing unit locked to another unit up-stream. The up-stream unit prints a simple dark mark on the paper, this mark being detected by an electric photo-eye. The reference point, having been established by the eye-mark, is locked to the print mark which is derived from an encoder on the end of the print roll. Using this system, no setting up is required, the print roll automatically positioning itself to line up with the reference eye-mark. Because it is difficult for the printer to align his plate accurately on the roll, a delay facility is provided to change the lock point to any point in the repeat.

Between marks the phaseloop controls the position of the print roll. In this case the reference encoder is not mounted on a motor but on its own line driven roll. This configuration gives the optimal performance as we are measuring the line speed as closely as possible to the point of action and the line speed is not isolated by other factors such as tension isolation rolls. Again, the drive in this system uses analog feedback provided by the 5702/2 and 6000PT units.

As has been discussed, the basic loop is a phaseloop with a register loop imposed upon it. The first thing to do is to calculate the parameters concerned with the phaseloop. Let us consider the reference frequency at maximum line speed. The reference roll is 471mm in circumference, the maximum line speed is 300m/min and the encoder is 5000 pulses per rev. The reference frequency is given by;-

Reference frequency (D13) =
(300/60) x (1/0.471) x 5000 = 53.05 kHz

The repeat length is 750mm and at 300m/min the slave encoder will produce a frequency of:-

Slave frequency (D20) =
(300/60) x (1/0.75) x 5000 = 33.33 kHz

Thus for the system to 'lock' the reference frequency must be scaled to equal the slave frequency. The value of the reference scaling factor is given by;-

Reference scaling factor (P25) =
33.33 / 53.05 = 0.628319

The only other requirement for the phase loop is the generation of a set-point for the slave drive. In this system there is no analog line set-point and the slave drive set-point must be derived from the reference encoder. This may be done automatically within the 5720 controller. As was demonstrated in the phase-lock example, the value of P55 may be varied between 0 and 10000 to produce a set-point of 0 to 10 volts on terminal C7. If instead of using P55 as the set-point to the S/W analog loop we use D38 to obtain the same result. D38 is derived from the reference encoder value D13. D13 is not actually 53 kHz but is in fact that frequency multiplied by the loop-time in seconds. (ie; it is a count value). Thus, given a 10mS loop-time, the value of D13 is 530.5 at maximum line speed. (Refer to the 5720 manual for the loop-time for the software issue you are using). Thus to convert this to 10000 (10V) the scaling factor must be;-

Tacho scaling factor (P53) =
10000 / 530.516 = 18.849556

Thus, with the line running at full speed the voltage on terminal C7 should be 10 volts. The first stage of commissioning, as always, is to run the system in analog with the trim wire on terminal C5 removed. If the slave drive runs backwards, reverse the sign of the analog using P56. Once the analog speeds have been matched, the speedloop and phaseloop commissioning should be carried out as before. The system may be run as a speedloop by removing the wire on terminal B12. To run the system as a phaseloop connect the wire that was on B12 to B10.

Once the phaseloop commissioning is completed check the accuracy of the phase-lock. This is particularly important. Whilst running as a phaseloop align the reference (eye) and slave (print roll) marks with the advance / retard push-buttons and observe them for a few moments. It is quite likely that one will drift with reference to the other. This is not due to any inaccuracy the 5720 but due to small variations in roll diameters from those quoted by the manufacturer. This drift is simply eliminated by tuning the ratio value (P27) until the drift stops. Run the machine over its entire speed range to confirm correct operation of the phaseloop.

We can now consider the register loop. We must first calculate the values of the various parameters associated with this loop. In our example we will delay the slave (print roll) mark to vary the registration point. We will not be using the window facility but will use missing mark. Whatever features are being used, there are two parameters which must be set-up. P13 is the normalisation factor and P62 the zero speed threshold. P13 is simply the value of D13 at maximum line speed and we have already calculated this to be 531. P62 the zero speed threshold is the speed at which the register loop starts to work and may be between 1 and P13. For our purposes we wish the register loop to work down to low speed so P62 = 1. (The phase loop will continue to work below this speed).

The next thing to consider is the parameters for the slave delay block. These parameters are the slave resolution (P10) and the slave delay (P9). P10 is simply calculated as the circumference of the print roll is 750mm and the encoder has 5000 pulses/rev. (And four times this number of counts / rev as we count A and B rising and falling edges).

Slave resolution (P10) =
4 x 5000 = 20 000 counts/repeat

Or 26 667 counts / meter

Or 0.0375 mm / count.

The reference resolution is slightly higher at 31831 counts / repeat. Which is 0.0236 mm / count. Normally we would say the accuracy of registration is 10 to 15 times the measurement resolution, giving an accuracy of ± 0.5mm. This figure is however an approximation and does depend greatly upon the mechanics of the machine and the quality of the web transport.

If P9 were set to 20000 the delay would obviously be one revolution. To make data entry easy, three menu items will be set up for the operator. The operator may enter the repeat length in mm, the delay in mm and turn the register control on and off. The repeat length parameter will drive P10, the delay parameter will drive P9 and the register enable parameter will drive P64 (**REGISTER ENABLE**). The operator configurations will be;-

REGISTER ENABLE: Parameter 7

NAME	REGISTER MODE
MNEMONIC	wl
MAX VALUE	1
TEXT FOR VALUE 0	ENABLED
TEXT FOR VALUE 1	DISABLED

REPEAT LENGTH: Parameter 8

NAME	REPEAT LENGTH
UNITS	MM
MNEMONIC	m9
DISPLAY FORMAT	3.0
LOWER LIMIT	750
UPPER LIMIT	750
FORMULA	ax+b
A	0.037500
B	0

DELAY VALUE: Parameter 14

NAME	PRINT DELAY
UNITS	MM
MNEMONIC	m5
DISPLAY FORMAT	3.1
LOWER LIMIT	0
UPPER LIMIT	750
FORMULA	ax+b
A	0.037500
B	0

In our example we only have one repeat length so P10 could be fixed. In general we would wish to change repeat length and to do this we would allow the upper and lower limits of REPEAT LENGTH to be the repeat length range. Typically the repeat range may be 500 to 3000mm. If we wish to change the repeat length we would also need to change the ratio in the phaseloop (P27) for each repeat. This could also be set using the 5721 operator station menu.

COMMISSIONING:

Once all the parameters have been set into the 5720 and the phaseloop has been commissioned we may proceed to the register loop. Ensure that terminal B12 is pulled to 24V so that the 5720 is programmed as a register loop and that the trim is connected to terminal C5. Simplify the register loop as much as possible. Disable the missing mark correction and reference and slave windows. (P15, P65 and P66 are 00H). Either select the non-delayed external marker, using the operator station and jumpers (issue 2 and U005 boards only) or set the delay value to 1. Run the system with **REGISTER ENABLED** and confirm that the system aligns the two marker pulses. Operate the machine over its entire speed range to confirm correct operation. If one mark steps out with speed this will be due to a constant time delay in the system, usually caused by a filter. If either marker is filtered, both must be filtered by the same amount.

If correct operation has been confirmed proceed by adding the various features required. Firstly select the delayed marker, in our case the slave, and use the push-buttons to change the register point. You should see the operator display for **REGISTER DELAY** change as you use the push-buttons. Align the ink marks from the up-stream and down-stream print units and operate over the whole speed range. It should be noted that lock accuracy during acceleration and declaration will be worse than at steady state speed. Typically the figure is four times, this may be reduced by changing speed slowly.

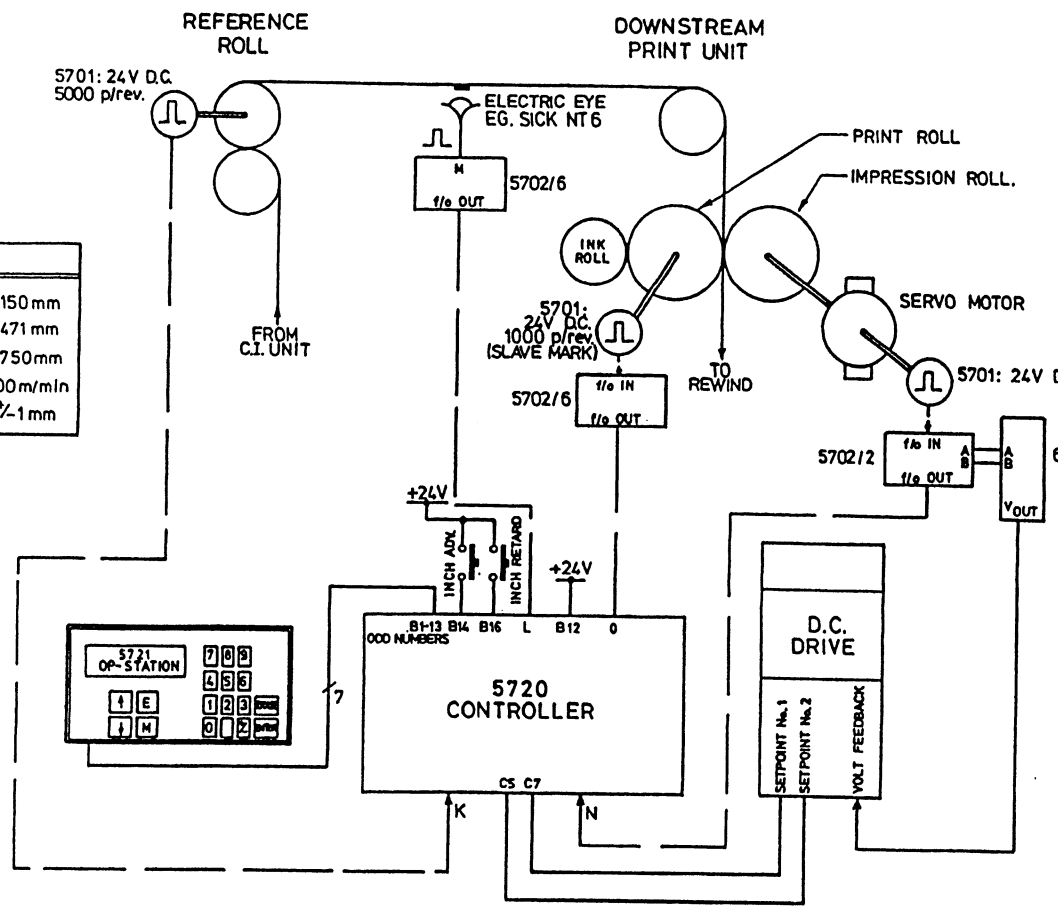
If lock is occasionally lost completely check the pick-up of the markers. Electric eyes are especially prone to mis-triggering due to dirt on the web or web movement. (The best place for the eye is on a roller just before the down-stream unit). Windows may be used to prevent noise pick-up. If we use windows we must delay the print roll (FB) and window the eye (REF) as windows and delay are incompatible.

Next enable the windows and / or missing mark. In our system we will use missing mark only as the feedback mark should be noise free, being derived from a 5701 fibre optic micro-tach. The selection of window size is quite straightforward. If the accuracy is ± 1mm we will set the missing mark window to approximately 4mm so that it is not triggered by acceleration. Now 4mm is 0.005333 of one repeat (750mm). So P14 is set to 0.005333. We can watch the out of sync output by observing D1 or by making P67 = 1 and observing OOS on digital output 1 (terminal B4). The missing mark window (P14) may be tuned so that it is as fine as possible without constant triggering.

Once all the features have been selected and their operation confirmed, run over the speed range of the machine to confirm all is well. If there is a problem always go back to basics, do not try to guess what may be wrong.

DO NOT SCALE | THIRD ANGLE PROJECTION | GENERAL DRAWING PRACTICE TO BS 308/ BS 3939

S	DAT
A	20.9.
B	19.11
1	8.12.



MECHANICAL DATA	
REFERENCE ROLL DIA	150 mm
REFERENCE ROLL CIR.	471 mm
REPEAT LENGTH	750 mm
MAXIMUM LINE SPEED	300 m/min
REQUIRED ACCURACY	+/-1 mm

NOTES

1. 24V D.C. POWER NOT SHOWN :- 5720, 5721, 5702 (EXT PSU NOT DRIVE 24V)
2. FOR DETAILS ON CONNECTION OF 5702 PRODUCTS SEE MANUAL HA 056768.
3. FOR DETAILS ON CONNECTION OF 5721 OPERATOR STATION SEE MANUAL HA 058017.
4. FOR DETAILS ON 5720 SEE MANUAL HA 058183.
5. FOR DETAILS ON CONNECTION OF 6000 PT SEE MANUAL HA 055407.

DRAWN D.E.B. / P.B.
CHECKED
MATERIAL
FINISH

DIMS. IN M.M. APPLY OVER FINISH
(EXCEPT FOR PAINT AND LACQUER)

GENERAL TOLERANCE			
	X	- ± 0·4	HOLES <Ø7 mm
	Y	± 0·2	-0.02 +0.07
	)	± 0·1	

ASSEMBLED ON | SCALE

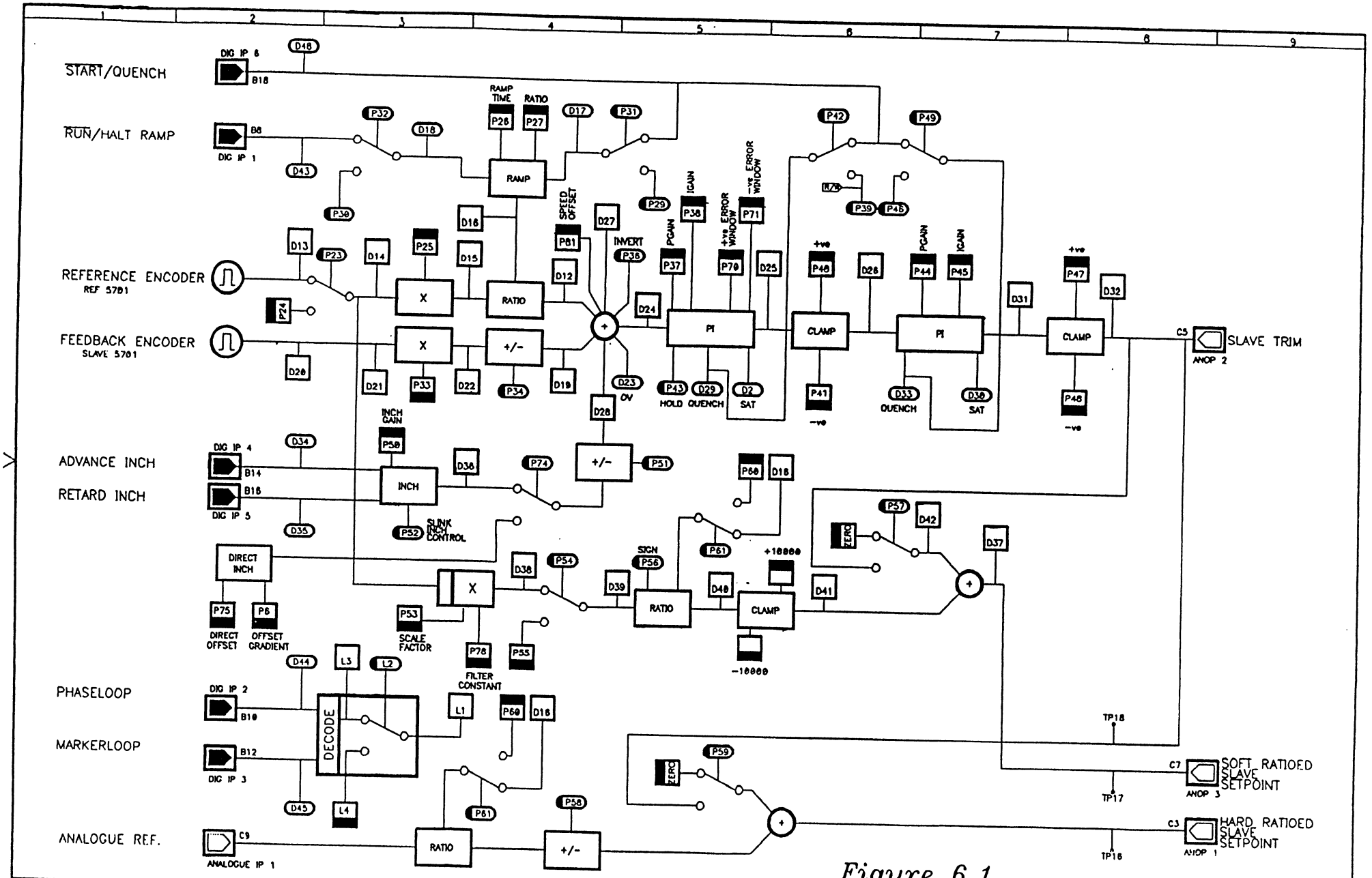
SSD LITTLEHAMPTON, ENGLAND. TEI EX 87142

TITLE
5720 REGISTER LOCK
DOWNSTREAM PRINTING UNIT

DRAWING NU 056 D | SHT. 1 OF

APPENDIX A

Block Diagrams



DRAWN	CHECKED	DATE	ISS	TITLE	USED ON
DEB		28/3/90	A	BLOCK DIAGRAM FOR PHASE LOOP (Version 2.3)	5720
TRACED	DESIGN APP.	11/4/90	B		DRAWING NUMBER
MLE	DEB	18/10/90	C		HH 058185
		03/12/90	1		SHT 1 OF
		13/02/91	2		
		15/10/92	3		

ELECTRICAL SYMBOLS GENERALLY TO BS 3939

SSD LITTLEHAMPTON ENGLAND TELEX 87142

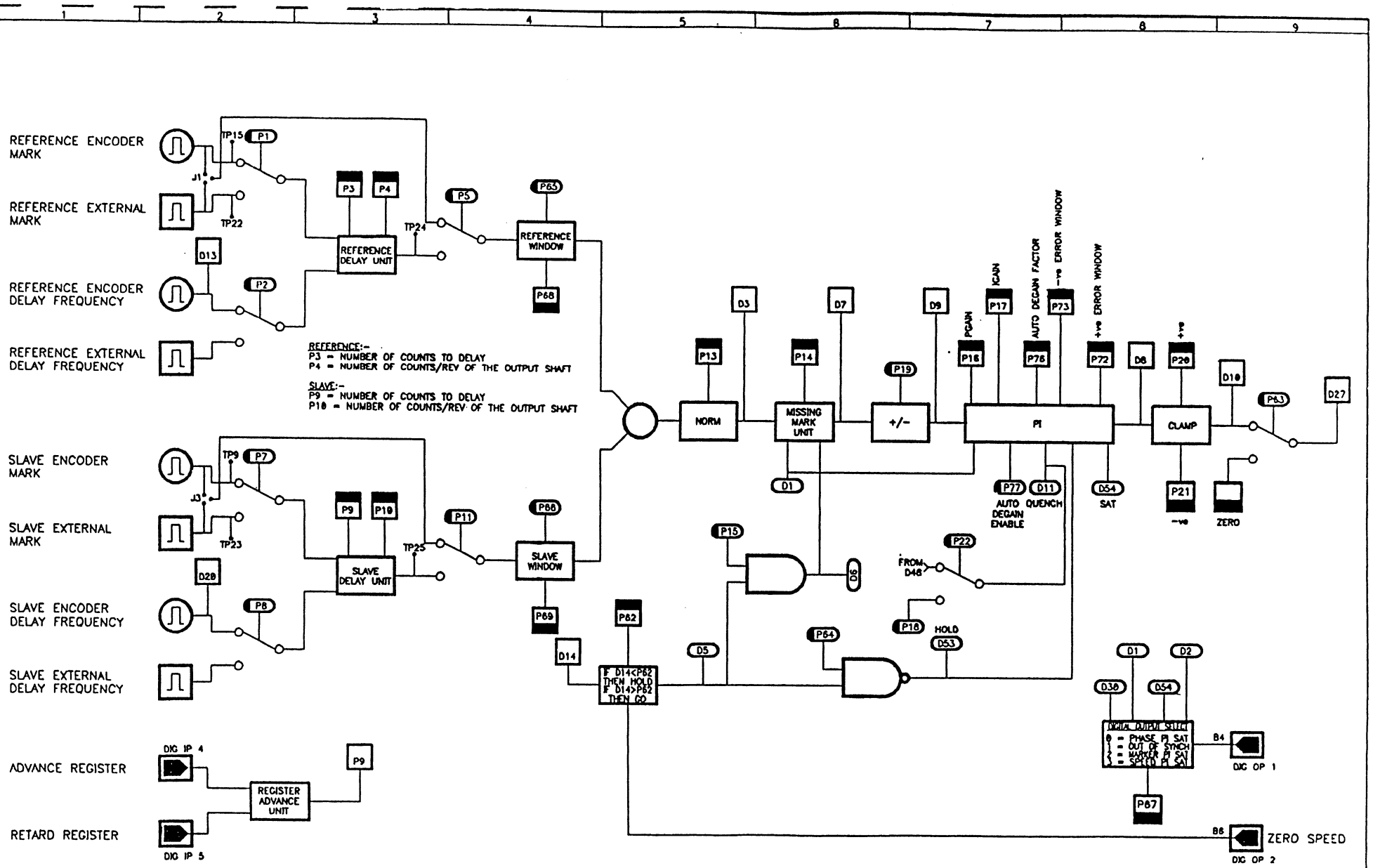


Figure 6.7

DRAWN DEB	CHECKED GDL	ISS	DATE					ELECTRICAL SYMBOLS GENERALLY TO BS 3939	TITLE BLOCK DIAGRAM FOR REGISTER LOOP (Version 2.3)	USED ON 5720	
TRACED MLL	DESIGN APP. DEB	A	20/3/90	1	12/3/90			SSD LITTLEHAMPTON ENGLAND TELEX 87142		DRAWING NUMBER HH 058184	D
		B	10/4/90	2	13/02/91						
		C	10/10/90	3	15/10/92						

APPENDIX B

DIAGNOSTIC POINTS FOR USE WITH QUADRALOC

SUB-MENU NAME	DISPLAY TITLE	VALUE	MNEMONIC	REF	TYPE[1]
MARKER INPUT	OUT OF SYNC	FALSE/ TRUE	f1	D1	1
	NORMALIZED O/P	xxxxx.xxxxxx	m3	D3	4
	ZERO SPEED	TRUE/ FALSE	fc	D5	1
	ENABLE CORRECT'N	NO CORRECTION/ CORRECTION	fa	D6	1
	MISSING MARK O/P	xxxxx.xxxxxx	m7	D7	4
	M LOOP PI INPUT	xxxxx.xxxxxx	m2	D9	4
	M LOOP PI OUTPUT	xxxxx.xxxxxx	m1	D8	4
	MARKER TRIM	xxxxx.xxxxxx	mt	D10	4
	PI QUENCH	UNQUENCHED/ QUENCHED	f5	D11	1
	PI HOLD	OFF/ON	fb	D53	1
	M LOOP PI SAT	UNSATURATED/ SATURATED	fe	D54	1
REF INPUT	RATIOED REF	xxxx	sr	D12	4
	MASTER SPEED	xxxxx	s1	D13	2
	UNSCALED REF IP	xxxxx	s2	D14	2
	NORMALIZED REF	xxxx	sn	D15	4^2
	RAMPED RATIO	x.xxxxxx	sg	D16	4
	RAMP QUENCH	UNQUENCHED/ QUENCHED	f6	D17	1
	RAMP HALT	RUN/HALT	f7	D18	1
FEEDBACK INPUT	SIGNED FEEDBACK	xxxx	ss	D19	4^2
	SLAVE SPEED	xxxxx	s3	D20	2
	UNSCALED FB IP	xxxxx	s4	D21	2
	NORMALIZED FB	xxxx	sf	D22	4^2
SPEED LOOP P.I.	SUMMING JCT OV	NO OVERFLOW/ OVERFLOW	f3	D23	1
	SPEED LOOP ERROR	xxxxxxxx.xxxxxx	se	D24	4
	S LOOP PI OUTPUT	xxxxxxxx.xxxxxx	so	D25	4
	SPEED LOOP TRIM	xxxxx	st	D26	2
	SPEED TRIM 1	xxxxx.xxxxxx	t1	D27	4
	SPEED TRIM 2	xxxxx.xxxxxx	t2	D28	4
	PI QUENCH	UNQUENCHED/ QUENCHED	f8	D29	1
	S LOOP PI SAT	UNSATURATED/ SATURATED	fd	D2	1

PHASE P.I.	P LOOP PI SAT	UNSATURATED/ SATURATED	f4	D30	1
	P LOOP PI OUTPUT	xxxxx	po	D31	2
	PHASE LOOP TRIM	xxxxx	pt	D32	2
	PI QUENCH	QUENCHED/ UNQUENCHED	f9	D33	1
INCH	INCH ADVANCE	FALSE/ TRUE	ia	D34	1
	INCH RETARD	FALSE/ TRUE	ir	D35	1
	INCH TRIM	xxxxx	it	D36	4^2
SW ANALOG LOOP	ANALOG OUTPUT	xxxxx	ao	D37	2
	SUMMED REFERENCE	xxxxx	m6	D4	3
	SCALED INPUT	xxxxx	ay	D38	2
	MASTER SETPOINT	xxxxx	as	D39	2
	RATIOED REF	xxxxx	ar	D40	2
	CLAMP OUTPUT	xxxxx	ac	D41	2
	LOOP TRIM	xxxxx	at	D42	2
DIGITAL INPUTS	INPUT 1 TBB8	OFF/ ON	d1	D43	1
	INPUT 2 TBB10	OFF/ ON	d2	D44	1
	INPUT 3 TBB12	OFF/ ON	d3	D45	1
	INPUT 4 TBB14	OFF/ ON	d4	D46	1
	INPUT 5 TBB16	OFF/ ON	d5	D47	1
	INPUT 6 TBB18	OFF/ ON	d6	D48	1
ANALOG I/O	INPUT 1 TBC9	xx.xx VOLTS	a1	D49	2
	INPUT 2 TBC11	xx.xx VOLTS	a2	D50	2
	OUTPUT 2 TBC5	xx.xx VOLTS	o1	D51	2
	OUTPUT 3 TBC7	xx.xx VOLTS	o2	D52	2
SYSTEM VALUES	HEALTH WORD	xxxx	he	D55	1
	HEALTH STORE	xxxx	hs	D56	1
	CYCLE TIME	5 - 21.7ms	ct	D57	2

PARAMETRIC POINTS FOR USE WITH QUADRALOC

SUB-MENU NAME	DISPLAY TITLE	VALUE	RANGE	MNEMONIC	REF	TYPE[1]
MARKER LOOP:						
REFERENCE INPUT	SELECT REF INPUT	ENCODER/ EXTERNAL		x6	P1	1
	SELECT REF CLOCK	ENCODER/ EXTERNAL		x7	P2	1
	REFERENCE DELAY	xxxxxxx	0 to 1048575	m4	P3	4^2
	REF RESOLUTION	xxxxxxx	1 to 1048575	m8	P4	4^2
	REF MARK SELECT	REFERENCE MARKER/ DELAYED REF MARK		xa	P5	1
	REF WINDOW	DISABLE/ ENABLE		xg	P65	1
	REF MARK WINDOW	x.xxxxxx	0 to 1	mu	P68	4
FEEDBACK INPUT	SELECT FB INPUT	ENCODER/ EXTERNAL		x8	P7	1
	SELECT FB CLOCK	ENCODER/ EXTERNAL		x9	P8	1
	FEEDBACK DELAY	xxxxxxx	0 to 1048575	m5	P9	4^2
	FB RESOLUTION	xxxxxxx	1 to 1048575	m9	P10	4^2
	FB MARK SELECT	FEEDBACK MARKER/ DELAYED FB MARK		xb	P11	1
	FEEDBACK WINDOW	DISABLE/ ENABLE		xh	P66	1
	FB MARK WINDOW	x.xxxxxx	0 to 1	mv	P69	4
P.I.	MAX SPEED	xxxx	1 to 4095	mb	P13	3
	CORRECTION RATIO	x.xxxxxx	0 to 1.5	mc	P14	4
	ENABLE CORRECT'N	NO CORRECTION/ CORRECTION		w3	P15	1
	M LOOP PROP GAIN	xxxxxxxx.xxxxxx	0 to 10000	mp	P16	4
	M LOOP INT GAIN	xxxxxxxx.xxxxxx	0 to 10000	mi	P17	4
	M LOOP PI QUENCH	UNQUENCHED/ QUENCHED		w4	P18	1
	M LOOP SIGN	NORMAL/ INVERT		wc	P19	1

	+ve M LOOP CLAMP	xxxxx	1 to 10000	m+	P20	4^2
	-ve M LOOP CLAMP	xxxxx	-1 to -10000	m-	P21	4^2
	QUENCH CONTROL	DIGITAL INPUT/ SERIAL INPUT		x1	P22	1
	ZERO SPD THRESH	xxxx	1 to 4096	ma	P62	3
	REGISTER ENABLE	DISABLED/ ENABLED		wl	P64	1
	DISCONNECT TRIM	CONNECTED/ DISCONNECTED		xf	P63	1
	M LOOP +ve ERROR	xxxxxxx.xxxxxx	0 to 1048576	mw	P72	4
	M LOOP -ve ERROR	xxxxxxx.xxxxx	0 to -1048576	mx	P73	4
	AUTO DE-GAIN	ENABLED/ DISABLED		my	P77	1
	DE-GAIN FACTOR	xxxx	1 to 1000	w1	P76	3
REF INPUT	RATIO	x.xxxxxx	0 to ±1.999999	sb	P27	4
	SELECT REF INPUT	MASTER SPEED/ SPEED REFERENCE		xc	P23	1
	SPEED REFERENCE	xxxxx	0 to 10000	s5	P24	3
	REF SCALE FACTOR	x.xxxxxx	0 to 1.000000	sm	P25	4
	RAMP GRADIENT	x.xxxxxx	0 to 1.999999	sa	P26	4
	RAMP QUENCH	UNQUENCHED/ QUENCHED		wg	P29	1
	RAMP HALT	RUN/ HALT		wh	P30	1
	RAMP QUENCH CNTL	DIGITAL INPUTS/ SERIAL INPUTS		x2	P31	1
	RAMP HALT CNTL	DIGITAL INPUTS/ SERIAL INPUTS		x3	P32	1
FEEDBACK INPUT	FB SCALE FACTOR	x.xxxxxx	0 to 1.000000	sc	P33	4
	FEEDBACK SIGN	NORMAL/ INVERT		w6	P34	1
SPEED LOOP P.I.	ERROR SIGN	NORMAL/ INVERT		w7	P36	1
	S LOOP PROP GAIN	xxxxxxxx.xxxxxx	0 to 32767	sp	P37	4
	S LOOP INT GAIN	xxxxxxxx.xxxxxx	0 to 50	si	P38	4
	S LOOP PI QUENCH	UNQUENCHED/ QUENCHED		w8	P39	1
	+ve S LOOP CLAMP	xxxxx	0 to 32767	s+	P40	3
	-ve S LOOP CLAMP	xxxxx	0 to -32767	s-	P41	3^3
	QUENCH CONTROL	DIGITAL INPUTS/ SERIAL INPUTS		x4	P42	1

	PI HOLD	RUN/HOLD		wj	P43	1
	S LOOP +ve ERROR	xxxxxx.xxxxxx	0 to 1048576	su	P70	4
	S LOOP -ve ERROR	xxxxxx.xxxxxx	0 to -1048576	sv	P71	4
	SPEED OFFSET	xxxx.xxxxxx	0 ± 1000	sz	P81	4
PHASE P.I.	P LOOP PROP GAIN	xxxxx	0 to 10000	pp	P44	3
	P LOOP INT GAIN	xxxxx	0 to 10000	pi	P45	3
	P LOOP PI QUENCH	UNQUENCHED/ QUENCHED		w9	P46	1
	+ve P LOOP CLAMP	xxxxx	0 to 8191	p+	P47	2
	-ve P LOOP CLAMP	xxxxx	0 to -8191	p-	P48	2
	QUENCH CONTROL	DIGITAL INPUTS/ SERIAL INPUTS		x5	P49	1
INCH	INCH GAIN	xxxxx	0 to 2048	ii	P50	3
	INCH SIGN	NORMAL/ INVERT		wf	P51	1
	SERIAL LINK CNTL	NO INCH/ INCH		wk	P52	1
	POS OFFSET CNTL	INCH/DIRECT		xi	P74	1
	POS OFF R GRAD	xxxx	0 to 2048	ig	P6	3
	POSITION OFFSET	xxxxxx	0 to 204800	io	P75	4
SW ANALOG LOOP	TACHO SCALER	xxxxx.xxxxxx	0 to 10000	am	P53	4
	SELECT REF INPUT	MASTER SPEED/ SPEED REFERENCE		xc	P54	1
	ANALOG REFERENCE	xxxxx	-10000 to 10000	ax	P55	2
	ANALOG SIGN	NORMAL/ INVERT		wb	P56	1
	ADD TRIM	OFF/ ON		xd	P57	1
	RATIO SELECT	DIGITAL RATIO/ ANALOG RATIO		rs	P61	1
	ANALOG RATIO	x.xxxxxx	0 to ±1.999999	ra	P60	4
	FILTER CONSTANT	xxxxx	1 to 10000	cf	P78	3
HW ANALOG LOOP	ANALOG SIGN	NORMAL/ INVERT		wb	P58	1
	ADD TRIM	OFF/ON		xe	P59	1
	RATIO SELECT	DIGITAL RATIO/ ANALOG RATIO		hr	P79	1
	ANALOG RATIO	x.xxxxxx	0 to ±1.999999	rb	P80	4
DIG OP 1 SELECT	DIG OP 1 SELECT	PHASE PI SAT/ OUT OF SYNC/ MARKER PI SAT/ SPEED PI SAT		d9	P67	6

LOOP TYPE CONTROLS FOR USE WITH QUADRALOC

SUB-MENU NAME	DISPLAY TITLE	VALUE	MNEMONIC	REF	TYPE[1]
LOOP TYPE	ACTUAL	SPEED LOOP/ PHASE LOOP/ MARKER LOOP	lt	L1	5
	CONTROL SOURCE	DIGITAL INPUTS/ SERIAL INPUTS	wi	L2	1
	DIGITAL INPUTS	SPEED LOOP/ PHASE LOOP/ MARKER LOOP	ld	L3	5
	SERIAL INPUTS	SPEED LOOP/ PHASE LOOP/ MARKER LOOP	ls	L4	5

Note 1

The type column indicates the data type of the variable. All serial link messages conform to the Eurotherm ASCII Bisynch protocol, format 23 (variable length hexadecimal). The type column indicates the number of data bytes in the data field from the following table.

Type 1 — Two value (binary) type. The data field consists of a ASCII single character, with value 0 or 1. In this appendix, the MMI display for the zero value is shown first.

Type 2 — Signed word type. The data field consists of four characters, each an ASCII coded hexadecimal digit. They form a 2's complement word; the highest order nibble is transmitted first.

Type 3 — Unsigned word type. The data field consists of four characters, each an ASCII coded hexadecimal digit. They form an unsigned 16 bit word; the highest order nibble is transmitted first.

Type 4 — Long type. The data field consists of 16 characters, each an ASCII coded hexadecimal number. The first 8 characters form the 4 byte magnitude plus sign integer part of the number. The sign is the most significant bit of the most significant of the 4 bytes. The last 8 characters form an 4 byte decimal part. The decimal part can take the value 00000000_{16} to $000F423F_{16}$, representing 0.000000_{10} to 0.999999_{10}.

Type 5 — Three state type. It is used for loop type variables. The data field consists of two characters. The first ASCII character is 0; the second character may take the following values:

Value	Loop type
0	Speed loop
1	Phase loop
2	Marker loop

Type 6 — Four state type. It is used to define the signal source for digital output 1. The data field consists of two characters. The first character is 0; the second character may take the following values:

Value	Source
0	PHASE PI SAT
1	OUT OF SYNC
2	MARKER PI SAT
3	SPEED PI SAT

Note 2

Only the integer part of the value is significant. The decimal part should be ignored when reading the parameter, and set to 0 when writing to it.

Note 3

This is an unsigned number; the 5720 converts to negative internally.

ISS.	MODIFICATION	CP.NO.	DATE	APPROVAL
1	Initial Issue	6070	9.10.90	DEB
2	Replacing Block Diagrams Issue 1 with Issue 2	6553	05.06.91	DEB
3	Replacing Block Diagrams Issue 2 with Issue 3. Various up-dates, corrections and modifications.	7972	09.11.92	

FIRST USED ON	MODIFICATION RECORD 5720 / 5721 Digital Position Controller Applications Manual	
EUROTHERM DRIVES	DRAWING NUMBER ZZ058775C	SHT. 1 of 1 SHTS

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