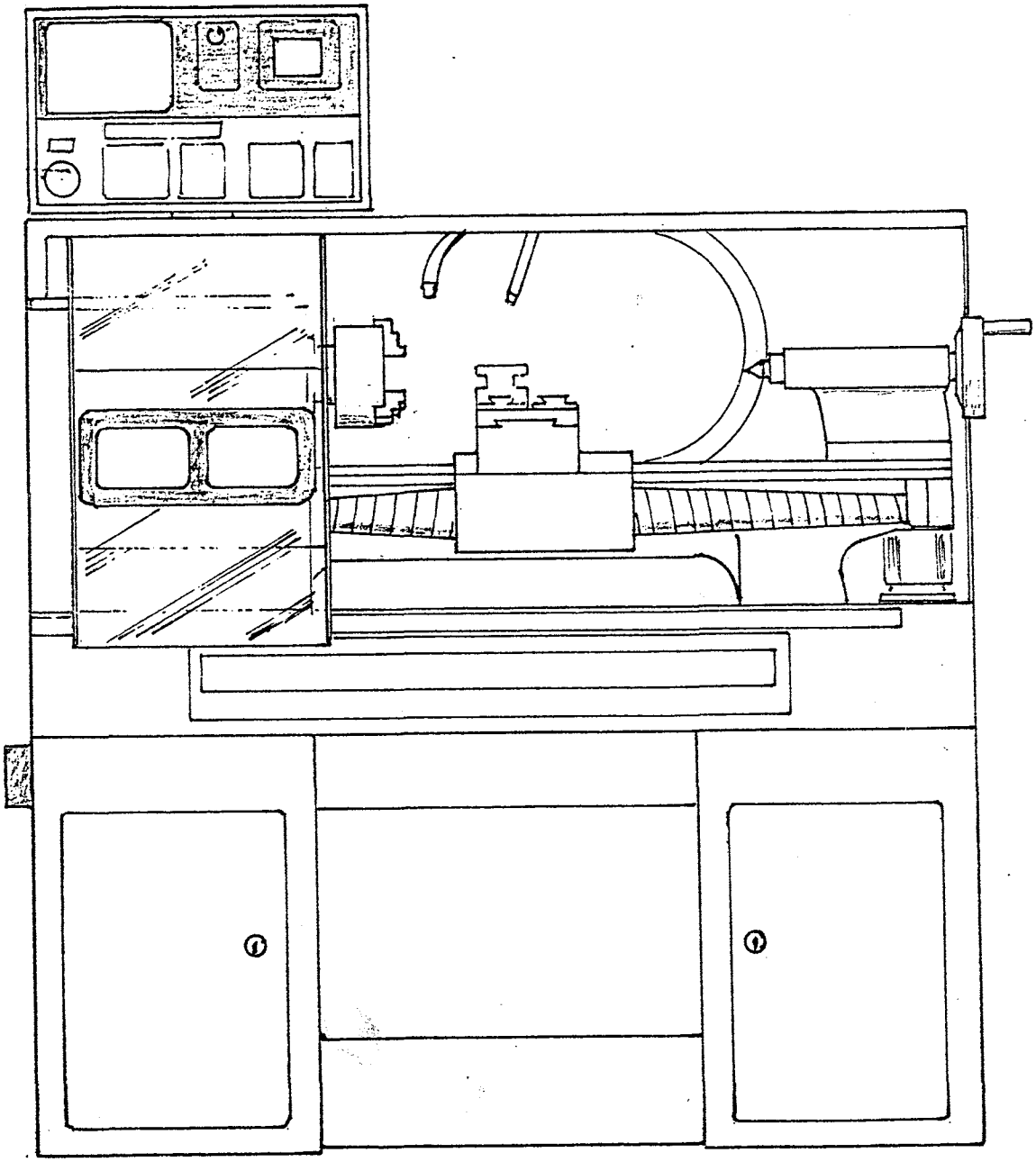
PASTURN S

INSTALLATION, PROGRAMMING AND MAINTENANCE MANUAL



BENFORD

SHUTTLE MACHINE

INDEX

INTRODUCTION

Easiturn utilizes the latest advances in microprocessor technology. These advances can be combined with a full backup facility, extra equipment, indexing tooling systems, and work holding accessories to provide a powerful and very versatile machine tool.

Other important features of Easiturn include computer software which enables the simulated running of programs for error detection, which can save valuable production time. Inputs and outputs can be monitored to enable Easiturn to work with robots in a flexible manufacturing system. The RS232 link allows DNC operation to be a standard feature of the machine, thus allowing direct programming from a host computer. CAD/CAM systems utilize this function to the full.

Easiturn is fitted with a parallel printer port, to offer the user full or part program hard copy printouts.

Easiturn's programming format is to the International Standard incorporating G and M codes. Alternatively function keys can be used in their place to ease programming. These functions keys offer a simple machine shop language so programming can be accomplished successfully by operators having no CNC experience of G or M code format.

Error messages are built into the system to help the operator to drastically reduce the amount of erroneous data being programmed.

As with any CNC machine tool, the programmer and operator should have a good knowledge of machine shop practice and be familiar with machine shop terminology. The quality of components produced is only a reflection on the programmer.

SECTION 1

THE CNC CONTROL UNIT

PNC 3 DESCRIPTION

The PNC 3 is an extremely versatile continuous path, computer based programmable numerical control unit designed to control up to 4 axis of movement where precise control and positioning is required. Related processes and functions can also be controlled by the PNC 3. The programming of stepper motor movements and the process control element is explained fully in this manual. The PNC 3 we are confident will be found to be very easy to operate.

From the front panel total control is obtained by the following features:

An easy to use keyboard for the input of data and commands by the a) ISO G and M code programming b) keyword system.

The 9" Display provides the user with:-

1. A display of the complete machine status
2. Prompts to assist the user in using the control system
3. Sections of the program during program loading, editing and execution
4. Machine, Control Unit and Program error information

Integral control unit memory stores typically 500 blocks.

Programming facilities include, repeat loops, threading, fixed/floating datums, dwells, program offsets, inch/metric and absolute/incremental programming with any mix.

The integral fast magnetic tape system provides unlimited program storage space, with each cassette side storing up to 3000 program blocks per side of tape.

Keyswitch to give manual programming/control, or single step program execution or automatic program operation. Program START and STOP switches.

Jog system giving manual control in all axes with plus and minus keys for feedrate override control.

Integral high power stepper motor drives.

CNC CONTROL SYSTEM SPECIFICATION

1. 490x290x335 mm Self Contained Console.
2. Green on Black 9" VDU with Anti-glare screen and outlet to external TV Monitor.
3. Alpha numeric keyboard allowing full manual Data Input.
4. Mini Magnetic Cassette Unit for Multi Program Storage.
5. MDI Single Step and Auto Selector for programs.
6. RS232C Interface 7 Din Pin connection to computers and paper tape punch units.
7. Parallel Printer Interface for obtaining hard copy of programs.
8. ISO Format - allowing 'G' and 'M' Code Programming from DIN 66025 extract.
9. Full 'G' and 'M' Code Listings on VDU when required to assist programming.
10. Single Mode Selection Keys.
11. Axis Jog on All Axes with variable feedrate and 0.01 mm step.
12. Feedrate override from 1 mm/min to 750 mm/min.
13. Programmable Spindle Speed 0-2000 RPM.
    Programmable Feedrate 0-1500 mm/min.
14. Linear Interpolation on 2 axes with vectorially correcting feedrates.
15. Circular Interpolation on X-Z Plane.
16. Absolute/Incremental, Inch/mm programming throughout program build-up.
17. Manual and Programmable Program Stops.
18. Repeat facility allowing build-up of canned cycles for screw cutting.
19. Floating Datum Facility.
20. 500 Block Memory (1000 blocks available).
21. Tool length Offsets for up to 16 tools.
22. Programmable Coolant.
23. Programmable Dwell from 0.1 to 9999.99 seconds.
24. Four Auxiliary Outputs.
25. Six Programmable Inputs.
26. Optional 3rd axis control.
27. System resolution 0.01 mm (0.0004").

SECTION 2

TECHNICAL SPECIFICATIONS

SWING OVER BED	280 MM
SWING OVER CROSS-SLIDE	170 MM
SPINDLE BAR CAPACITY	26 MM DIA
DISTANCE BETWEEN CENTRES	500 MM
LONGITUDINAL TRAVEL (Z)	480 MM
CROSS TRAVEL (X)	175 MM

SPINDLE SPEEDS - VARIABLE 0-2000 RPM

SPINDLE DRIVE

1.5 KW (2 HP) AC 1420 RPM 6.7 AMPS

AXES DRIVE MOTORS

HIGH POWER STEPPER MOTORS

X AXIS STEPPER MOTOR - 200 STEPS/REV
Z AXIS STEPPER MOTOR - 200 STEPS/REV

FEED RATES - RAPID TRAVERSE ON X AND Z AXES G00=1500 MM/MIN (60 INS/MIN) FEED RATES INFINATELY VARIABLE ON X AND Z AXES
0-1500 MM/MIN (0-60 IN/MIN)

MECHANICAL RESOLUTION - 0.01 MM (0.0004")

LINEAR INTERPOLATION - ON X AND Z AXIS WITH VECTORIALLY CORRECTED FEED RATES

CIRCULAR INTERPOLATION - ON X AND Z PLANES

FIXED ZERO REFERENCE POSITION

LOOKING AT THE FRONT OF THE MACHINE
Z=ZERO WHEN THE SADDLE IS UP TO THE CHUCK
X=ZERO WHEN THE SADDLE IS AT ITS MAXIMUM DISTANCE FROM THE FRONT OF THE MACHINE

MACHINE DIMENSIONS

LENGTH - 1370 MM (54")
WIDTH - 610 MM (24")
HEIGHT - 1680 MM (66")
WEIGHT - 600 KG (1320 LBS)

TOOL LENGTH OFFSETS - 16 TOOLS

TOOL SHANK - 16 MM SQ

STANDARD EQUIPMENT

5" 3 JAW CHUCK INT. 7 EXT. JAWS
MULTIFIX TOOLPOST
MULTIFIX TOOLHOLDER
GREASE GUN
HARD CENTRE NO. 3 M.T.
SOFT CENTRE NO. 4 M.T.
TOOLPOST KEY
2 - 1 AMP 20 MM FUSE
3 - 15 AMP 20 MM FUSE
CAMLOCK KEY

1 TOOL BOX
1 OIL CAN
2 SCREW DRIVERS
4 ALLEN KEYS 3, 4, 5 AND 6
4 SPANNERS, 12/13, 14/15, 16/17 AND 19 RING
1 MINI CASSETTE
1 POT OF PAINT

Flood Coolant System
Tool Kit
Halogen Lo Vo Light
Operation and Instruction Manual
Automatic Lubrication System

EXTRA EQUIPMENT

Spray Mist Coolant
Pneumatic Chuck
Eight Station Indexing Tool Post
Printer
CAD/CAM Systems
BBC Apple and IBM Software for Off Line Programming
Desk Top Programmer
Robot

SAFETY FEATURES

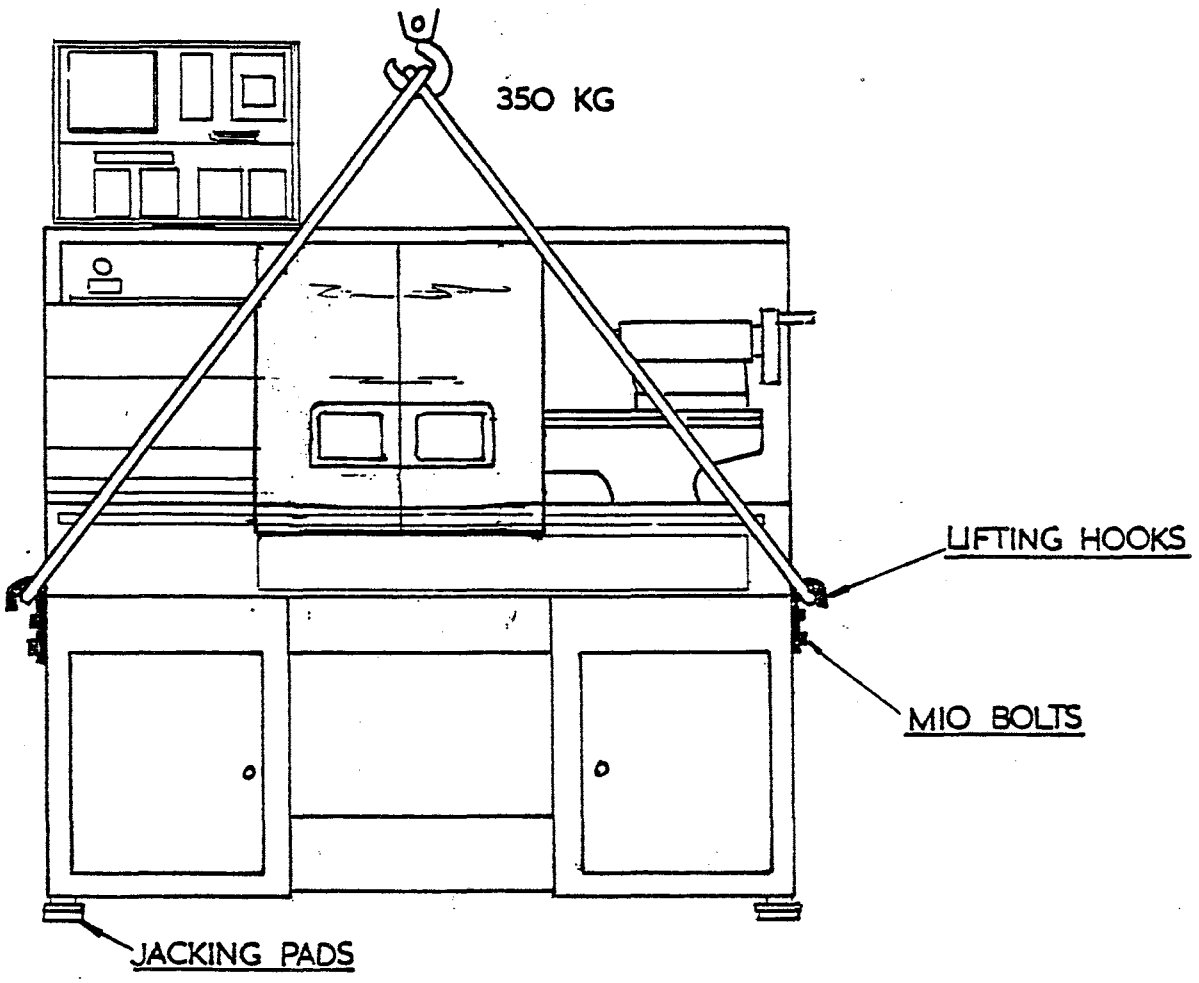
Axis Limit Switches
Diagnostic Fault Finder
Key Operated Program Control
Interlocking Chuck Guards

SECTION 3

INSTALLATION

LIFTING MACHINE

The lathe will be supplied with four lifting hooks (BVS.160/80). To fit the lifting hooks to corner of the cabinet, first remove the eight plugs, two at each corner. The hooks are secured by M10 bolts - 30 long. Bolts and washers provided.

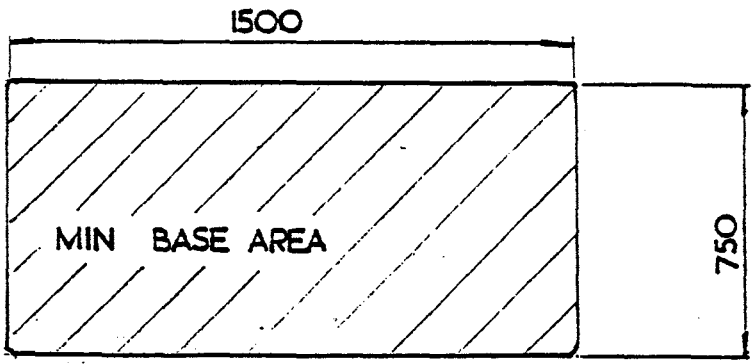


Check to ensure that the lifting sling is of correct capacity to lift the weight of the machine and that the sling is in good condition.

It is advisable at this stage to fit the jacking pads - see section on levelling.

FOUNDATION

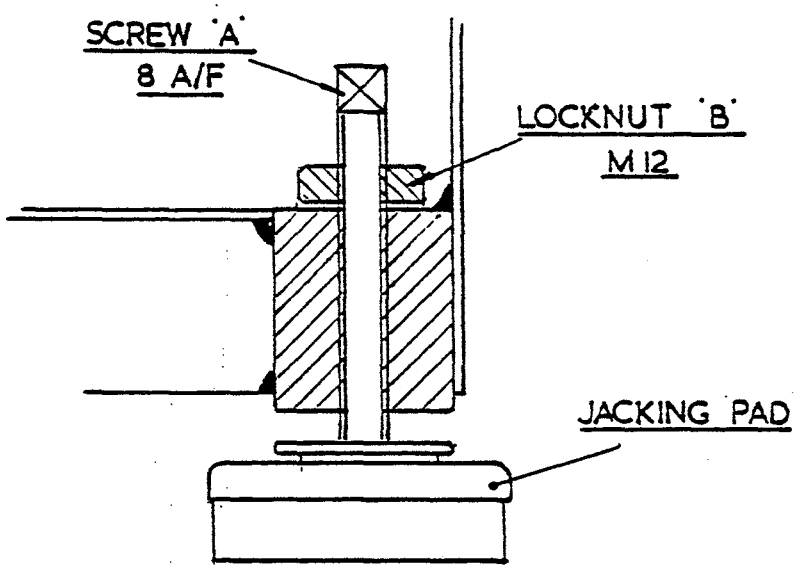
The lathe should be positioned on a firm level base, preferably concrete.



See installation DRG. 'SK.726.A'.

LEVELLING

Four jacking pads must be fitted at each corner of the cabinet. Bosses are welded into the cabinet base for this purpose.



Thoroughly clean the bedways and, using a precision machine level at both ends of the bed, level the machine using the jacking pads thus:-

With locknut 'B' slack, rotate screw 'A' until the bedway is level. Tighten locknuts 'B'.

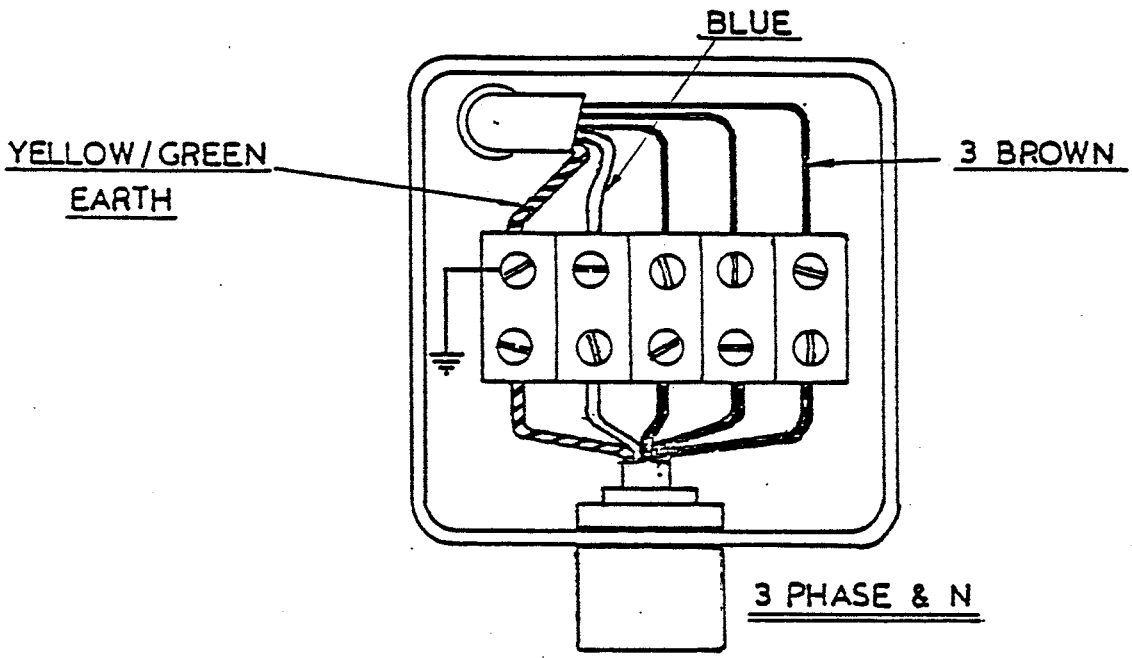
CLEANING

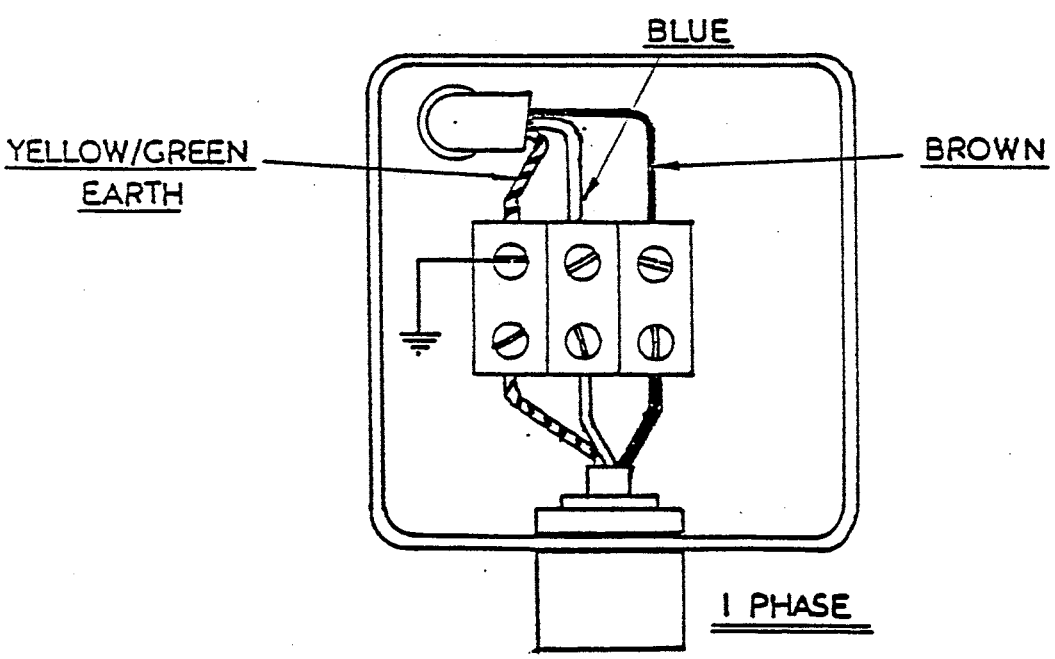
On delivery the machine will have the bright surfaces coated with a protective solution. This must be removed using a kerosene base solvent before any attempt is made to move the slides or operate the machine.

ELECTRICAL SUPPLY CONNECTION

The regular electrical mains power supply to the machine is 3 phase + N 380/440V 50HZ or 1 phase 220/240V, 50HZ.

Connect the mains supply to the isolator box located at the rear left of the machine.





N.B.

Only a competent electrical engineer should commission the machine.

LUBRICATION

Lubrication to the bedways, saddle, cross slide and ball screw is supplied by the automatic lubrication system.

Ensure that the reservoir on the system is full.

LUBRICATION		
	SHELL	CASTROL
	VITREA 68	PERFECTO NN
	VITREA 68	PERFECTO NN
	ALVANIA Nº 3	SPHEEROL AP3

All slideways should be lightly oiled before movement of the saddle and tailstock.

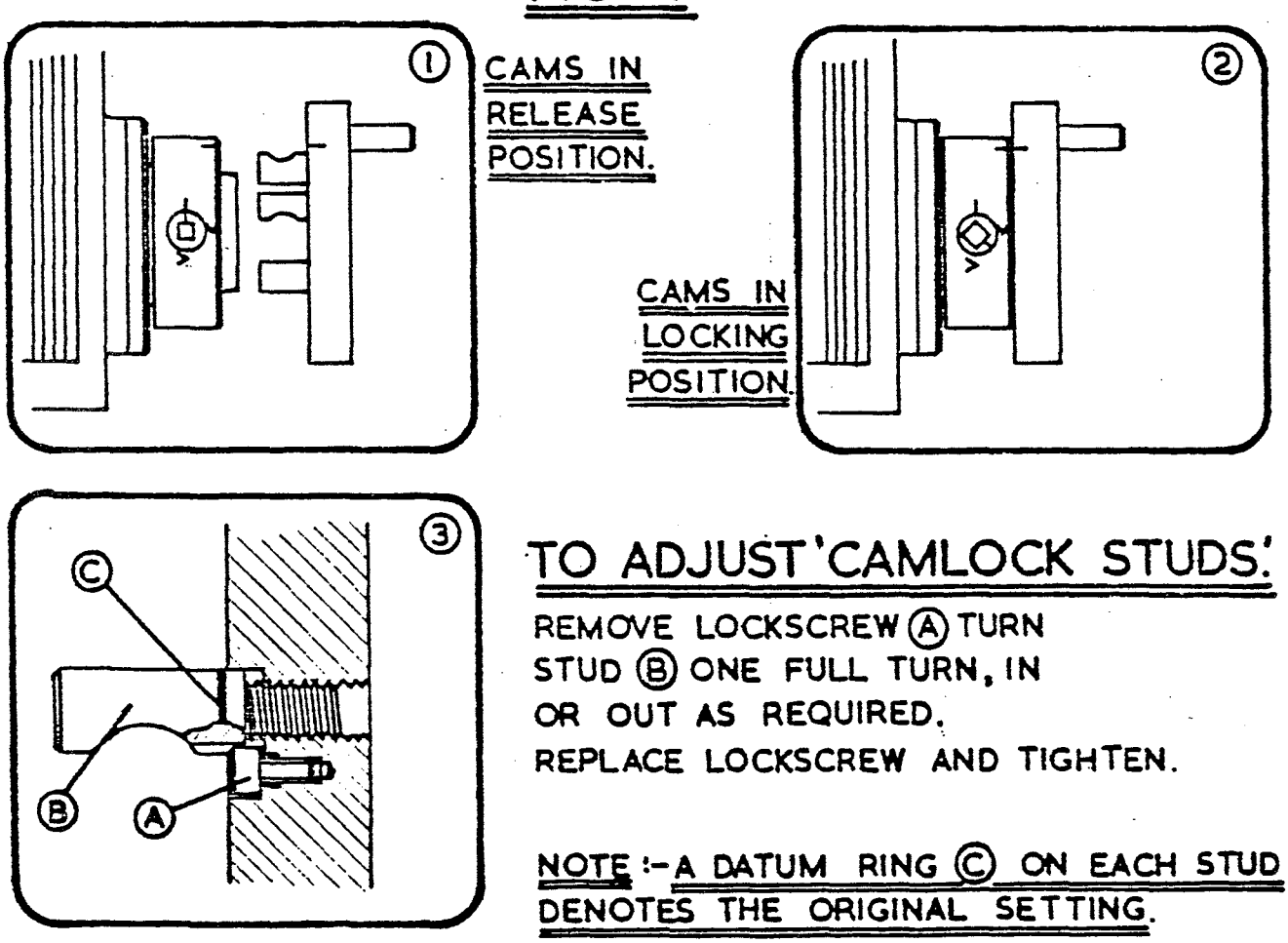
CHUCK AND FACEPLATE MOUNTING

Before mounting chuck or faceplate first ensure that the spindle taper and the internal taper of the chuck or faceplate is clean and free from dirt or protective covering.

The line on the camlock cams in the spindle should be in line with the mark on the spindle o/d when the chuck is loaded to the spindle. Load the chuck and turn the cams with the key provided in a clockwise direction to tighten and lock the chuck to the spindle nose. The correct position of the cams in the lock position is shown in diagram 2 - Fig.4.

It may be necessary on chucks supplied without the camlock studs fitted, to adjust the studs so that the required cam action is obtained. This can best be set by screwing the studs to the bottom thread and then removing one complete turn. Adjustment for locking should then be carried out.

FIG 4.

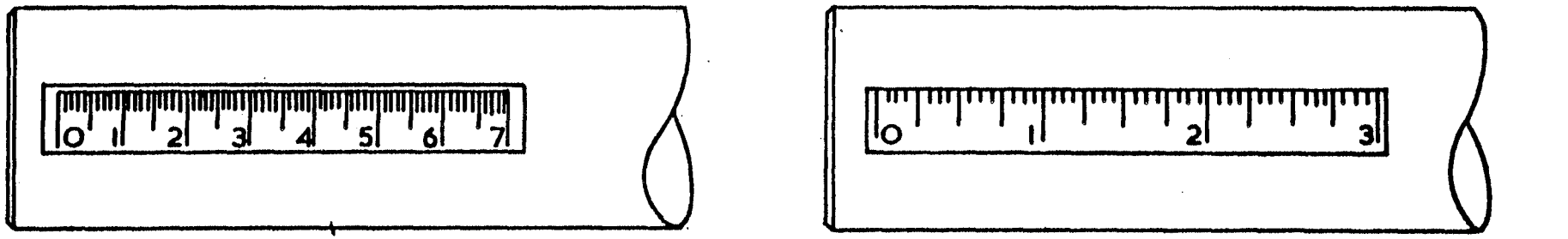


SECTION 4

THE QUICK CHANGE TOOLPOST

To change tools in the toolpost either pull or push the clamping lever to the central position and lift out the tool holder. Insert the new tool holder ensuring the height adjusting screw is firmly down on the base body, and clamp the holder by either pulling or pushing the clamping lever to the locked position.

To set the centre height of the lathe tool slacken off the clamping handle, and loosen the locking nut - then either screw the height adjusting screw clockwise to raise the tool holder or vise-versa. The manufacturers repeatable accuracy on clamping is 0.01 mm.



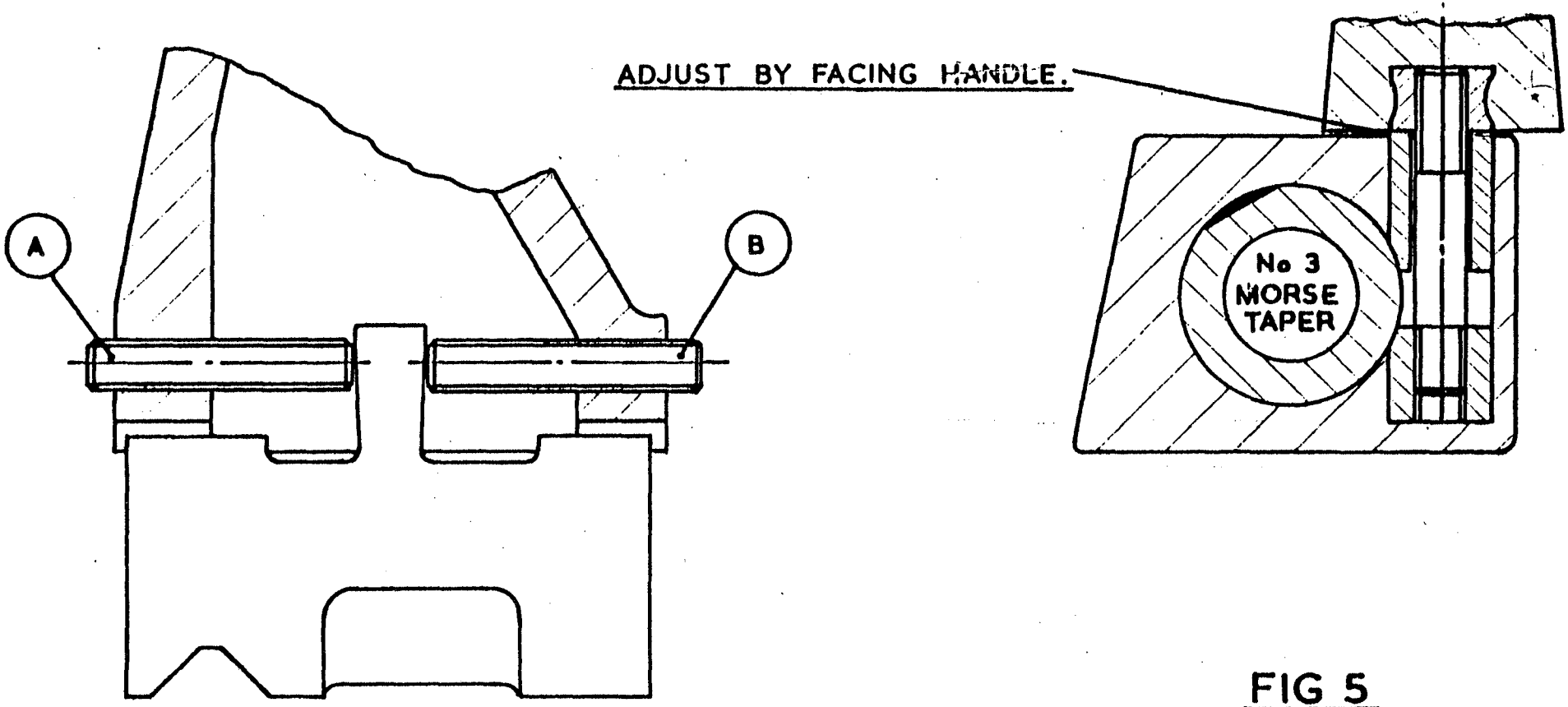


FIG 5

TAILSTOCK ADJUSTMENT.

TAILSTOCK

The tailstock is of solid cast iron construction mounted on a cast iron shoe for adjustment and the turning of shallow tapers.

The tailstock quill is self ejecting and is graduated for direct reading for drill depths etc. The quill has a 3MT bore and may be locked in position by the locking handle as shown in Fig.5.

LOCKING

The tailstock is locked to the bed by means of a bed clamp operated by lever (B) Fig.8. The quill is locked by moving lever (A) away from the headstock in a clockwise direction.

ADJUSTMENT

The tailstock is set to turn parallel to the bed. Should any adjustment be required i.e. taper turning - adjustment is made by the two grub screws at the front and back of the tailstock. To adjust, loosen off one of the grub screws A and B and tighten the other until the desired taper is achieved. Fig.5.

NB. Ensure that the two screws are tight before reclamping the tailstock to the bed. The amount of set over required for a given taper may be calculated as follows:-

$$\text{Set over required (mm)} = \frac{\text{Length (mm) x taper (mm)}}{2}$$

$$\text{Set over required (inches)} = \frac{\text{Taper per foot on dia. x length (ins)}}{24}$$

SECTION 6

MAINTENANCE

Routine inspection and maintenance of the machine should be carried out to the following schedule:-

PERIOD	MAINTENANCE REQUIRED
DAILY	Check oil level in reservoir. Clean out swarf.
WEEKLY	Clean machine thoroughly. Check coolant tank.
SIX MONTHLY	Check adjustment of saddle strips. Check adjustment of cross slide strip. Grease headstock bearings. Lubricate tailstock barrel.
ANNUALLY	Check machine alignments and accuracy. Check headstock bearing adjustment. Check spindle drive belt.

HEADSTOCK BEARING ADJUSTMENT

Remove the green rubber mat above the headstock, then the inspection cover which lies beneath.

Slacken the locking grub screw, adjust the pre-load on the bearings with the locknut.
Note the thread is left hand.
After tightening of the locknut check that the pre-load is not excessive.

The machine should run at top speed and the bearings should not exceed 65° (150°F).

NOTE: A certain amount of temperature rise must be expected when running the lathe at high speed but it should be possible to place the hand on the spindle nose after an hour's running without discomfort.

Check that locknut is tight up against bearings after adjustment, and re-tighten the grub screw.

SECTION 7

MACHINE AXIS FORMAT

Fig.5 illustrates the plan view. The Z axis runs along the length of the bed and the X axis along the cross slide at 90° to the bed. The plus and minus signs indicate the direction of the tool.

Fig.5A ABSOLUTE

(Z axis) To the left hand side of Z0 towards the chuck is negative.
To the right hand side of Z0 away from the chuck is positive.

(X axis) X0 is on the centre line of the spindle. Away from X0 towards the splash guard the movement is negative and towards the operator from X0 is positive.

Fig.5B INCREMENTAL

(Z axis) Towards the chuck is negative.
Away from the chuck is positive.

(X axis) Away from the operator is negative.
Towards the operator is positive.

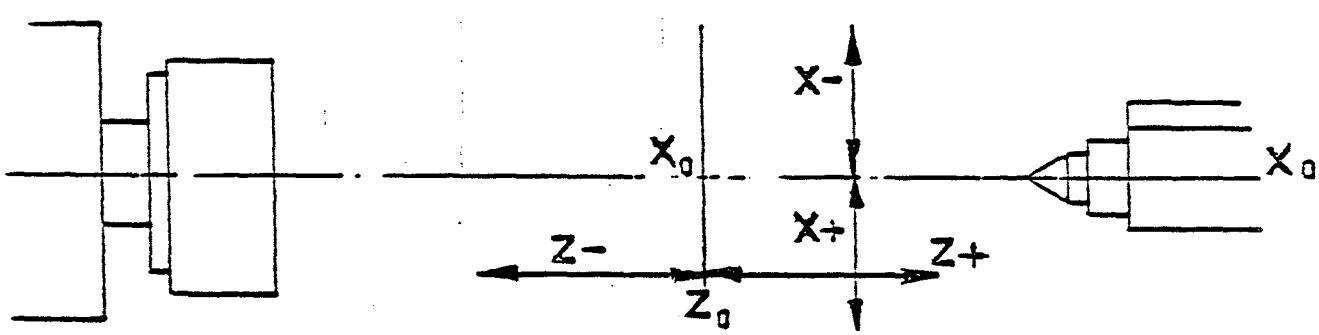


FIG.5A

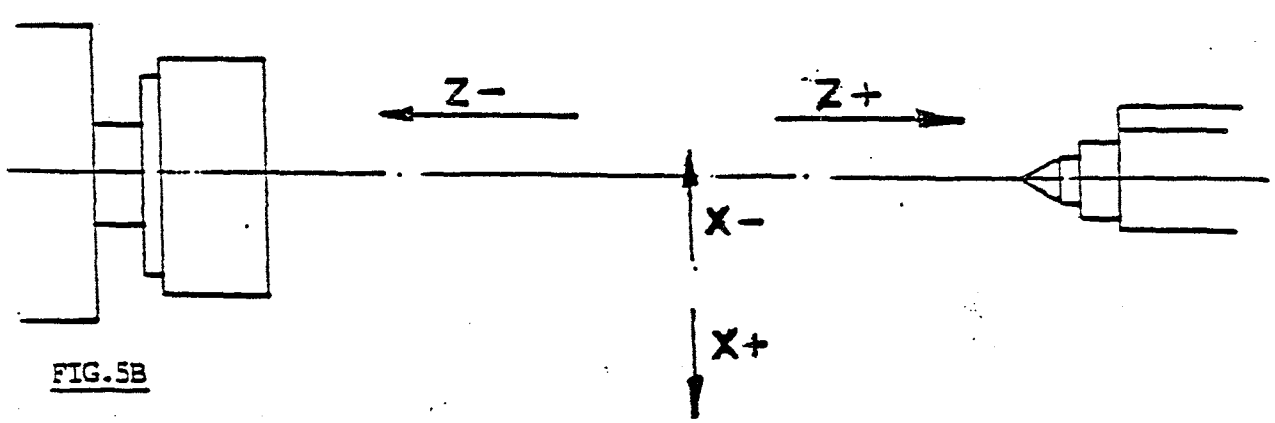


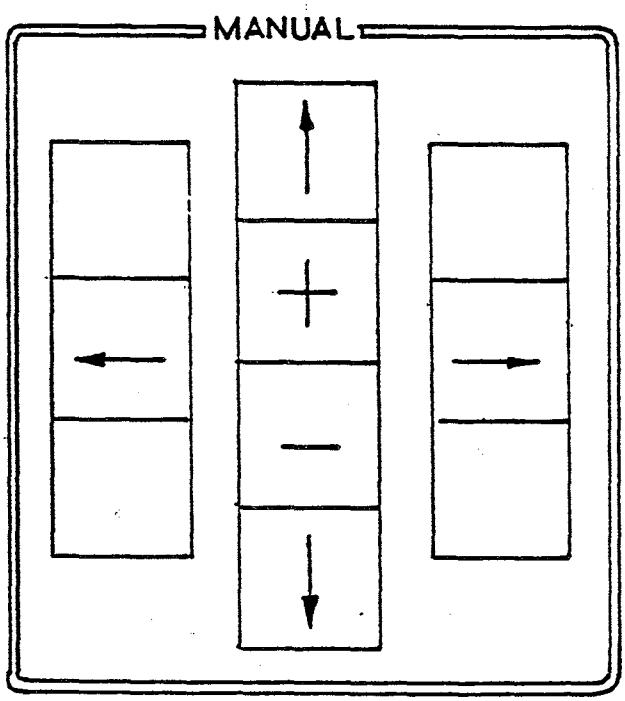
FIG.5B

MANUAL JOG MODES

For operating Easiturn in the manual mode, that is without the use of programming, first set the key to "MAN" position. The machine can be jogged into positon by depressing the directional arrow keys in the jog button cluster. One press represents 0.005 mm or 0.0002" jog. If a jog key is held depressed, continuous movement is maintained. Depress the appropriate arrowed key first which will select the slowest jog speed and then at the same time depress the + key which will accelerate the jog speed. Continually holding down the + key will accelerate the jog speed up to its maximum value 239 mm/min. the - key allows the jog speed to be decreased.

Movement will only occur as long as the appropriate arrowed key is depressed.

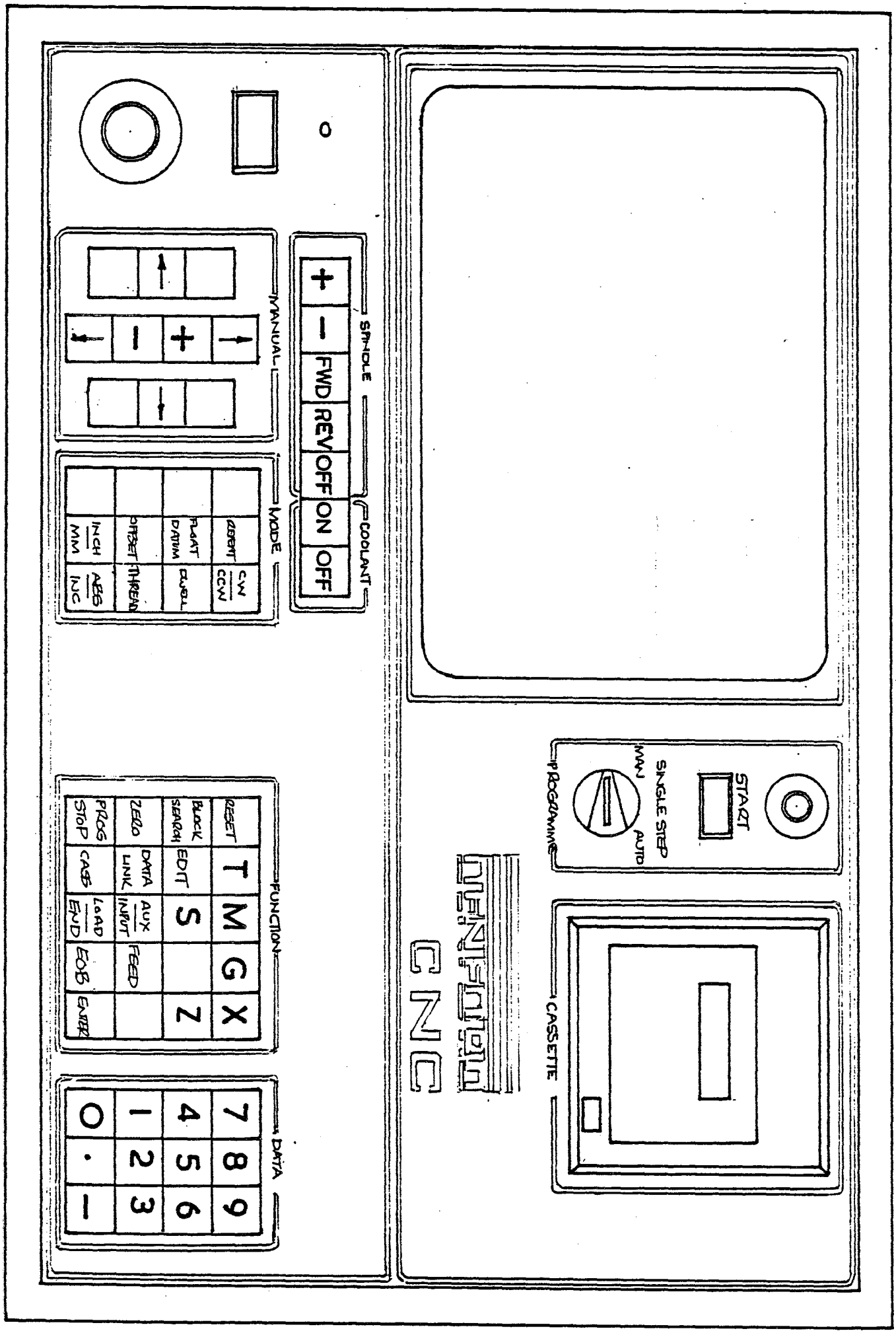
Caution should be taken when approaching an obstruction, such as the chuck or the workpiece. Because the machine needs a short distance to decelerate.



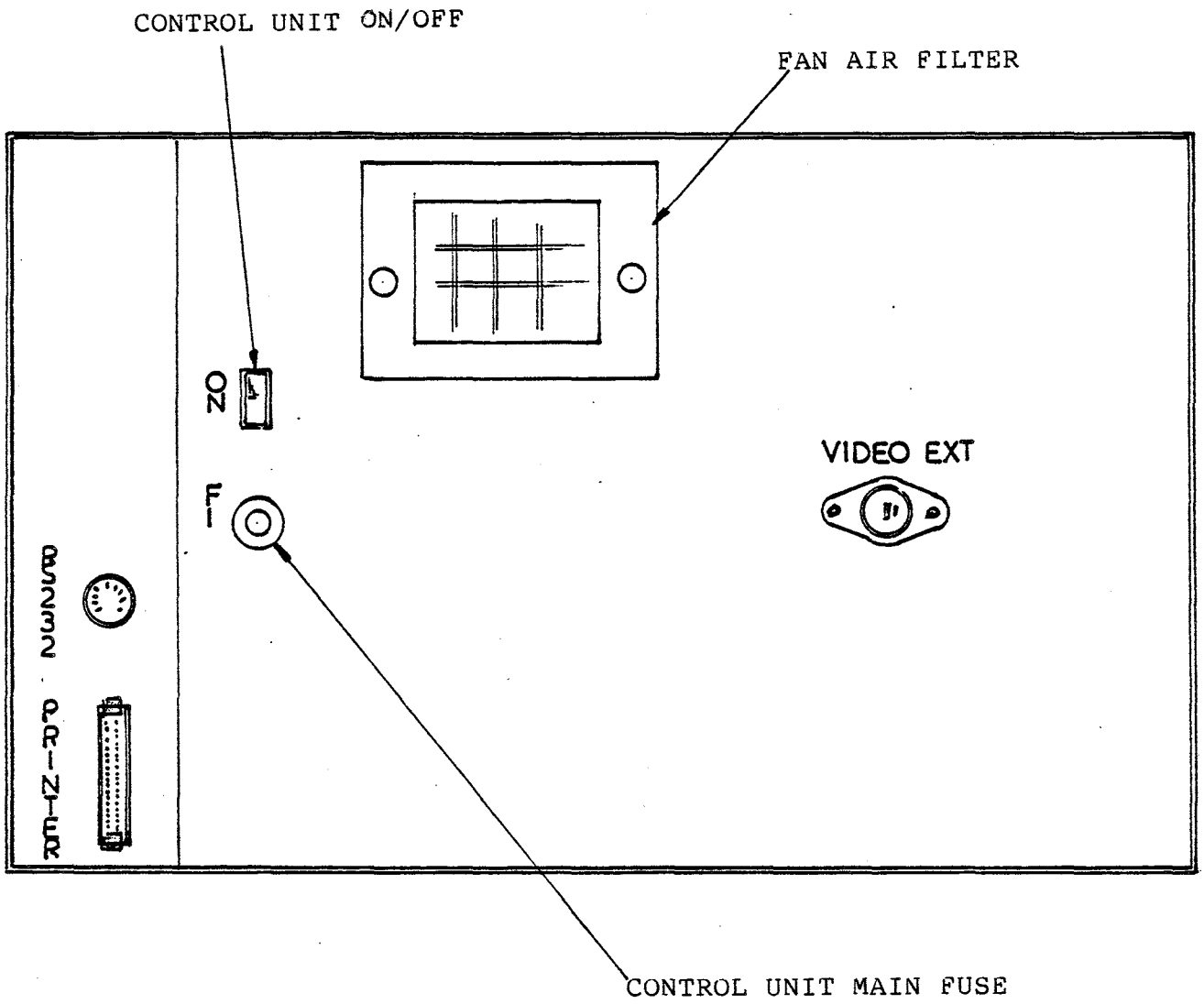
The directional arrow keys represents the movement of the tool. If you want the tool to move to the left parallel to the Z axis (Z plus), then depress the button with the left horizontal arrow. Similarly to move the X axis then the appropriate vertical arrow key is selected.

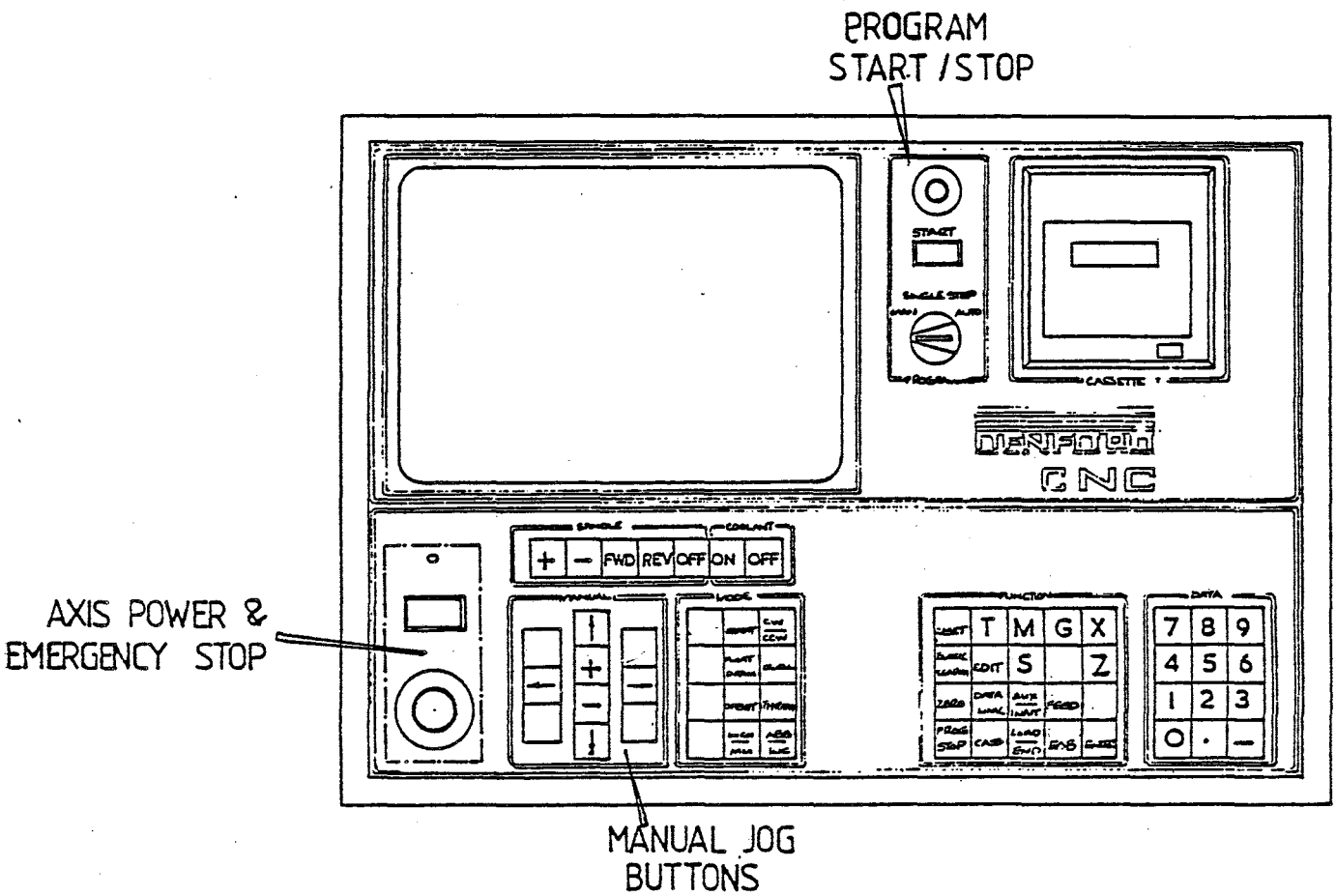
Any attempt to jog to a position outside the machine parameters the control will automatically reduce the jog speed into creep feed, before the overtravel limit is encountered. Then the screen will respond with "MOVE EXCEED MACHINE LIMIT". Depressing the reset key will clear the screen which responds with "PRESS ZERO TO DATUM THE MACHINE". Depress the zero key and datum procedure will commence. Normal operation is restored.

FRONT VIEW OF CNC CONTROL UNIT

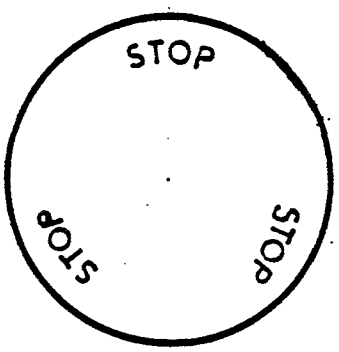


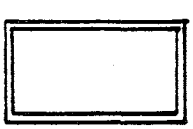
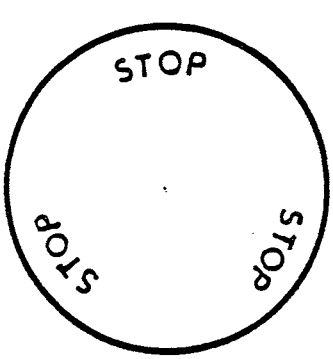
REAR VIEW CNC CONTROL UNIT

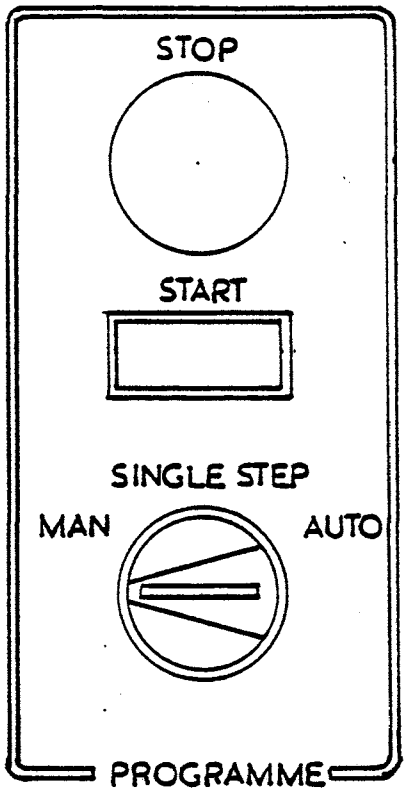


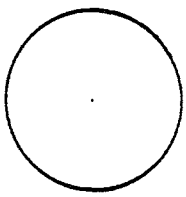
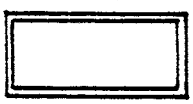
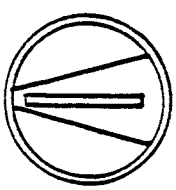

PROGRAM
START / STOP
AXIS POWER &
EMERGENCY STOP
MANUAL JOG
BUTTONS
START
CASSETTE
CNC
+
−
FWD
REV
OFF
ON
OFF
T
M
G
X
S
Z
7
8
9
4
5
6
1
2
3
0
.
−

AXIS POWER AND EMERGENCY STOP

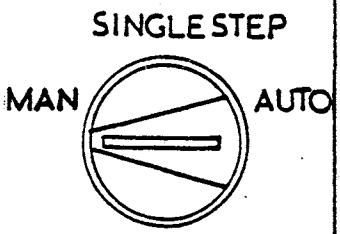


KEY	FUNCTION
	CONTROL POWER L E D.
	AXIS POWER BUTTON. THIS BUTTON ENERGIZES DRIVE MOTORS. SPINDLE DRIVE MOTOR.
	EMERGENCY STOP EACH TIME EMERGENCY STOP IS USED IT WILL KILL POWER TO ALL DRIVE MOTORS. THE MEMORY IS NOT AFFECTED. POWER IS TURNED BACK ON BY UNLOCKING EMERGENCY STOP AND DEPRESSING THE AXIS POWER BUTTON.



KEY	FUNCTION
STOP 	DEPRESSING THE STOP BUTTON WILL HALT THE AXIS MOVEMENT IN THE CURRENT BLOCK. WHILST IN AUTO OR SINGLE STOP EXECUTION CAN BE RESTARTED USING THE START BUTTON. DEPRESSING THE STOP BUTTON WILL KILL ANY MDI MOVE AND CLEAR THE BLOCK.
START 	PROGRAM START BUTTON WILL EXECUTE THE CURRENT PROGRAM IN MEMORY OR EXECUTE THE NEXT BLOCK IN SINGLE STEP MODE.
SINGLE STEP MAN AUTO 	THREE POSITION KEY SWITCH MAN POSITION - SELECT MANUAL ALLOWS THE USER TO ENTER NEW DATA, FOR MDI MOVES, ENTERING PROGRAMS, EDITING, CASSETTE ENTRIES AND DATA LINK. IN THIS MODE THE USER CAN MOVE ANY AXIS OR BOTH SIMULTANEOUSLY, DEPENDING ON REQUIREMENTS. STATING CO-ORDINATES FROM MACHINE FIXED DATUM, FLOATING DATUM AND MACHINE OFFSETS DO NOT AFFECT MDI MOVES.

Continued .....



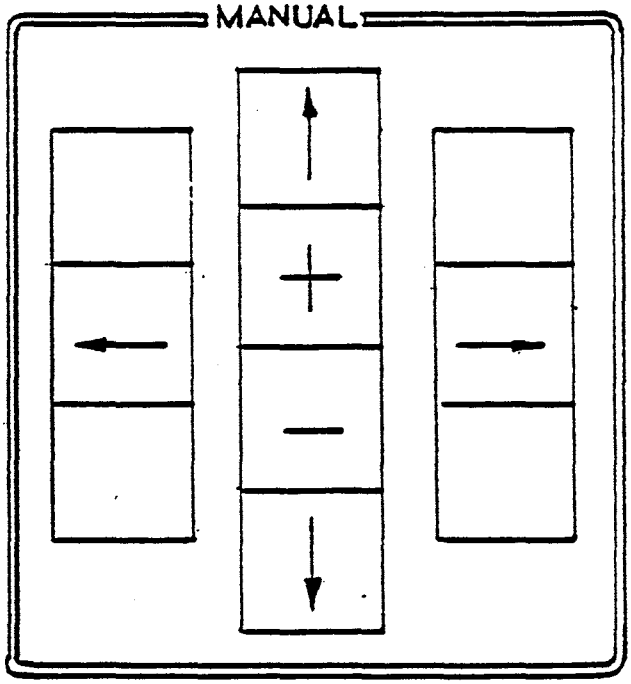
SINGLE STEP

ALLOWS THE PROGRAM IN MEMORY TO BE EXECUTED ONE BLOCK AT A TIME. IN SINGLE STEP MODE, WITH THE DEPRESSION OF THE START BUTTON, THE MACHINE WILL EXECUTE ONE BLOCK OF INFORMATION ONLY AND STOP. IN ORDER TO EXECUTE THE NEXT BLOCK THE START BUTTON WILL ONCE AGAIN HAVE TO BE DEPRESSED.

AUTO

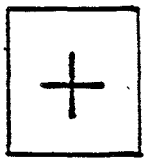
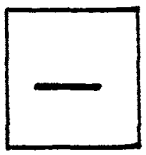
WHEN THE START BUTTON IS DEPRESSED, THE MACHINE WILL EXECUTE EACH BLOCK OF THE PROGRAM UNTIL EITHER THE END OF THE PROGRAM, PROGRAM STOP, OR A TOOLCHANGE IS REACHED. OPERATION CAN BE CONTINUED BY DEPRESSING THE START BUTTON.

MANUAL JOG CONTROL

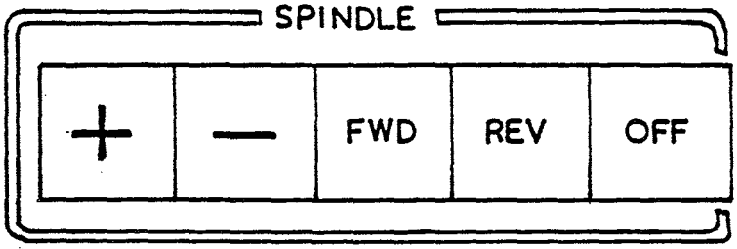


KEY	FUNCTION
→	PRESS THIS KEY TO MOVE THE TOOL AWAY FROM THE CHUCK.
←	PRESS THIS KEY TO MOVE THE TOOL TOWARDS THE CHUCK.
↑	PRESS THIS KEY TO MOVE THE TOOL AWAY FROM THE OPERATOR.
↓	PRESS THIS KEY TO MOVE THE TOOL TOWARDS THE OPERATOR.
+	THE + KEY WILL INCREASE MANUAL JOG FEED. HOLD DOWN THE APPROPRIATE ARROW KEY. THIS WILL SELECT THE SLOWEST JOG FEED. AT THE SAME TIME PRESS THE + KEY TO ACCELERATE THE JOG FEED. CONTINUALLY HOLDING DOWN THE + KEY WILL RAMP THE FEED UP TO ITS MAXIMUM. SUCCESSIVE PRESSES OF THE + KEY WILL GRADUALLY INCREASE AND STORE THE NEW FEED.

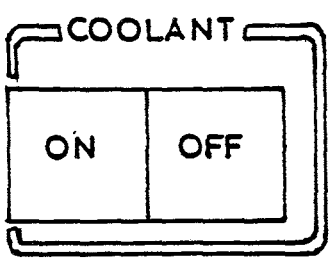
Continued .....

KEY	FUNCTION
	ALTERNATIVELY THE + KEY CAN ACT AS FEED RATE OVERRIDE WHEN RUN IN AUTO. PROGRAMMED FEED RATES WILL BE INCREASED AND REMAIN EFFECTIVE UNTIL A NEW FEED IS READ IN A SUCCESSIVE BLOCK.
	THE - KEY WILL DECREASE MANUAL JOG FEED. OPERATION PROCEDURE AS FOR THE + KEY. ALTERNATIVELY THE - KEY CAN ACT AS PROGRAM FEED RATE OVERRIDE REDUCING PROGRAM FEED RATE. EFFECTIVE UNTIL NEW FEED IS READ.

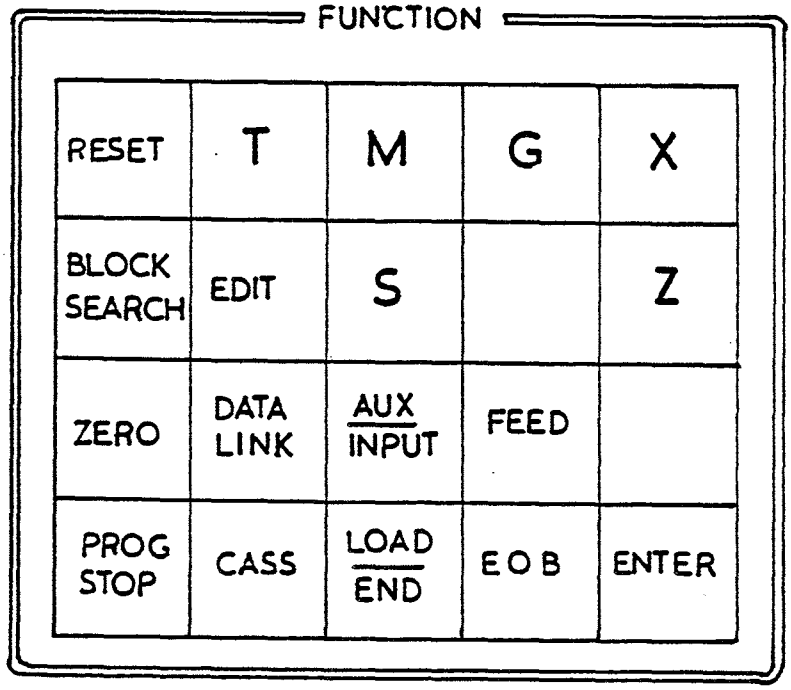
MANUAL SPINDLE CONTROL KEYS



KEY	FUNCTION
+	WILL MANUALLY INCREASE SPINDLE SPEED.
—	WILL MANUALLY DECREASE SPINDLE SPEED.
FWD	SELECTS FORWARD ROTATION OF SPINDLE. WHEN IN PROGRAM LOAD MODE, PRESSING FWD KEY WILL SELECT M03 COMMAND. VDU WILL PROMPT THE USER TO INPUT AN RPM VALUE.
REV	SELECTS REVERSE ROTATION OF SPINDLE. WHEN IN PROGRAM LOAD MODE, PRESSING REV KEY WILL SELECT AN M04 COMMAND. VDU WILL PROMPT THE USER TO INPUT AN RPM VALUE.
OFF	SELECTS SPINDLE OFF. WHEN IN PROGRAM LOAD MODE, PRESSING OFF KEY WILL SELECT AN M05 COMMAND. SPINDLE OFF.



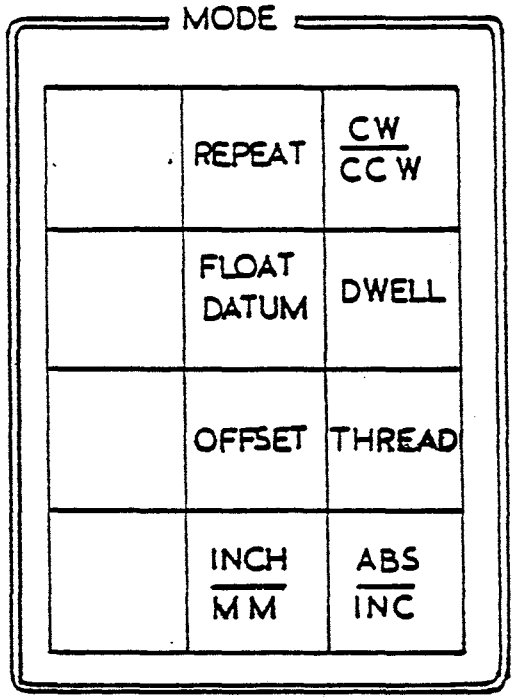
ON	SELECTS COOLANT ON. WHEN IN PROGRAM LOAD MODE, PRESSING THE COOLANT ON KEY WILL SELECT M08 COOLANT ON COMMAND.
OFF	SELECTS COOLANT OFF. WHEN IN PROGRAM LOAD MODE, PRESSING THE COOLANT OFF KEY WILL SELECT M09 COOLANT OFF COMMAND.



KEY	FUNCTION
RESET	TO RESET FROM THE CURRENT MODE OR CANCEL THE MOST RECENT ENTRY.
T	IF THE CONTROL IS SET TO MDI AND THE T KEY IS PRESSED, A TOOL SELECTION MENU WILL APPEAR ON THE SCREEN FOR TOOL SETTING AND EDITING TOOL LENGTH OFFSETS, (SEE SECTION 22). IF THE CONTROL IS IN PROGRAM LOAD MODE THE T KEY CAN BE PROGRAMMED AS TOOLCHANGE M06 BLOCK. UPON SWITCHING THE CONTROL ON FROM COLD, PRESSING THE T KEY GIVES A SYSTEM TEST DISPLAY CHECKING INPUT SIGNALS AND MACHINE MOUNTED SWITCHES.
M	MISCELLANEOUS FUNCTION, REFERRED TO AS M FUNCTION. BY PRESSING M KEY THEN THE ENTER KEY, A LIST OF M CODES WILL BE DISPLAYED ON THE SCREEN.
G	PREPARATORY FUNCTIONS, REFERRED TO AS G FUNCTION, PRESS G KEY THEN THE ENTER KEY. A LIST OF G CODES WILL BE DISPLAYED ON THE SCREEN.
BLOCK SEARCH	THIS KEY WILL ALLOW THE PROGRAM TO BE EXECUTED FROM A SPECIFIC BLOCK IN THE PROGRAM.
EDIT	EDIT KEY PERMITS FULL EDITING FACILITIES OF THE PROGRAM IN MEMORY. (SEE SECTION 31.)

KEY	FUNCTION
S	S KEY GIVES A DIAGNOSTIC CHECK, UPON STARTING FROM COLD BEFORE AXIS POWER IS APPLIED. THE SOFTWARE VERSION AND DATE WILL BE DISPLAYED ON THE SCREEN.
X	X AXIS KEY FOR X AXIS MOVES.
Z	Z AXIS KEY FOR Z AXIS MOVES.
ZERO	ZERO KEY IS USED TO DATUM THE MACHINE. THIS DRIVES THE MACHINE TO ITS MAXIMUM TRAVEL FOR EACH AXIS, UPON STARTING FROM COLD OPERATION YOU CANNOT CONTINUE UNTIL MACHINE IS DATUMED.
DATA LINK	SELECTS A DATA LINK TO EXTERNAL EQUIPMENT, EG, AN EXTERNAL COMPUTER, TRANSMIT AND RECEIVE PROGRAMS OR PRINT PROGRAMS.
AUX INPUT	AUXILIARY OUTPUTS. THIS ALLOWS ANY OF THE FOUR AUXILIARY OUTPUT RELAYS TO BE OPERATED. AUXILIARY INPUTS. THIS INSTRUCTION ALLOWS THE PROGRAM TO BE HALTED BETWEEN MACHINING OPERATIONS. THE PROGRAM WILL ONLY PROCEED BEYOND THIS POINT IF ANY OF THE SIX AUXILIARY INPUTS ARE PROGRAMMED TO RECEIVE AN INPUT SIGNAL.
FEED	FEED KEY. USE TO SELECT A FEED RATE TO EXECUTE A MOVEMENT FEED RATES FROM 0 TO 1500 MM/MIN. FEED RATES FROM 0 TO 60 IN/MIN.
PROG STOP	PROGRAM STOP BUTTON OR FEED HOLD. WHEN LOADING A NEW PROGRAM INTO MEMORY, THE PROGRAM STOP BUTTON IS USED AS A STOP IN THE PROGRAM M00. ADDITIONALLY, WHEN EXECUTING A PROGRAM IN AUTO OR SINGLE STEP, DEPRESSING THE PROGRAM STOP BUTTON WILL HALT THE CYCLE OF THE CURRENT WORK, OPERATION CAN BE CONTINUED BY PRESSING THE START KEY.

KEY	FUNCTION
CASS	CASSETTE KEY PRESS CASS KEY AND A MENU OF CASSETTE FUNCTIONS WILL BE LISTED ON THE SCREEN. (SEE SECTION 32.)
LOAD END	PROGRAM LOAD KEY TO ENTER A PROGRAM INTO MEMORY OR END A PROGRAM LOADING SEQUENCE.
EOB	END OF BLOCK KEY END OF CURRENT LINE OF INFORMATION.
ENTER	ENTER KEY INFORMATION IS ACCEPTED INTO MEMORY AFTER ENTER HAS BEEN PRESSED.

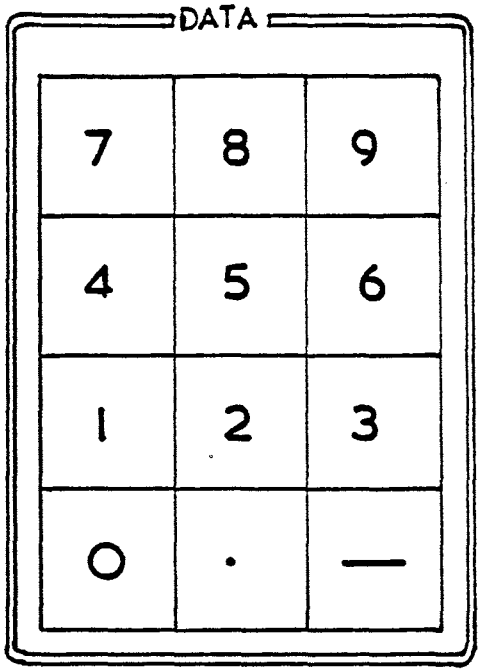


KEY	FUNCTION
REPEAT	REPEAT FACILITY ENABLES SPECIFIED BLOCKS OF A PROGRAM TO BE REPEATED UP TO 99 TIMES WITH SPECIFIED OFFSETS. (ALLOWS NESTING OF UP TO FOUR LEVELS.) (SEE LATER TEXT.)
CW / CCW	CIRCULAR INTERPOLATION IS SELECTED USING THIS KEY. PRESS ONCE FOR G02 CLOCKWISE, PRESS AGAIN FOR G03. AFTER DEFINING THE END POINTS OF THE CIRCULAR MOVE, BY DEPRESSING CW/CCW KEY ALLOWS THE INPUT OF THE CIRCLE CENTRE CO-ORDINATES, XC AND ZC (ARC CENTRE OFFSETS).
FLOAT DATUM	A FLOATING DATUM BLOCK G99 WILL CAUSE THE CONTROL TO ESTABLISH A DATUM POSITION, ALL AXES ARE SET TO ZERO ABOUT ITS CURRENT POSITION. FLOATING DATUM IS ONLY PERMITTED AS PART OF A PROGRAM LOAD SEQUENCE, THE DISPLAYED POSITION WILL BE RELATIVE TO THIS DATUM IF MACHINE OFFSETS (G55) ARE ZERO.
DWELL	DWELL SELECTS A PROGRAMMABLE DWELL, G04 IN THE RANGE 0.1 TO 9999.9 SECONDS.
OFFSET	SELECTS A MACHINE OFFSET G55. SET OUTSIDE THE PROGRAM IN MEMORY, AND ALLOWS THE DATUM TO BE ESTABLISHED ON THE COMPONENT. THE OFFSET VALUE IS A DISTANCE FROM THE MACHINE ORIGIN (X0, Z0) TO THE POSITION ON THE COMPONENT WHERE THE DATUM IS DESIRED.

Continued .....

KEY	FUNCTION
OFFSET	PROGRAM OFFSET G54 CAN BE USED TO OFFSET PARTS OF THE PROGRAM DURING PROGRAM LOAD SEQUENCE. THESE ARE INCREMENTAL IN OPERATION AND RESET TO ZERO EVERY TIME THE PROGRAM IS EXECUTED.
INCH / MM	SELECTS INCH OR METRIC UNITS.
ABS / INC	SELECTS ABSOLUTE OR INCREMENTAL INPUT. NOTE: ALLOWS INCREMENTAL INPUT, BUT DISPLAYS AS ABSOLUTE.
THREAD	WILL PROMPT FOR: 1. THREAD ANGLE (INTERNAL OR EXTERNAL). 2. DIA. OF THREAD. 3. PITCH OF THREAD. 4. DEPTH OF THREAD. 5. NO. OF CUTS. 6. LENGTH OF THREAD. 7. START POINT OF THREAD ON THE Z AXIS. ENTER EACH BLOCK OF INFORMATION IN TURN AS PROMPTED ON THE VDU.

NUMERICAL DATA KEYS



KEY	FUNCTION
0 TO 9	NUMERICAL DATA KEYS.
.	DECIMAL POINT KEY.
—	MINUS SIGN KEY.

SECTION 15

MACHINE CODES (M FUNCTION AND G CODES)

The PNC 3 can be programmed by using both M and G codes or programmed direct using the dedicated keys (keyword system). A complete list of M and G codes follows, some of these codes are option dependant.

M functions for use outside of Program

M03 Spindle Forward
M04 Spindle Reverse
M05 Spindle Stop
M06 Tool Change
M08 Coolant On
M09 Coolant Off
M20 Auxiliaries
M21 Input

M functions available inside the Program

M00 Program Stop
M02 End of Program
M03 Spindle Forward
M04 Spindle Reverse
M05 Spindle Stop
M06 Tool Change
M08 Coolant On
M09 Coolant Off
M20 Auxiliaries
M21 Input

G codes for use outside of Program

G00 Linear Rapid Traverse
G01 Linear
G02 Circular CLW
G03 Circular CCLW
G04 Dwell
G27 Tool Change Position
G33 Thread
G55 Machine Offset
G70 Imperial Units
G71 Metric Units

G90 Absolute Input

G91 Incremental Input

G98 Absolute Datum (Machine Reference Point)

G codes for use inside the Program

G00 Linear Rapid Traverse

G01 Linear

G02 Circular CLW

G03 Circular CCLW

G04 Dwell

G27 Tool Change Position

G33 Thread

G54 Program Offset (replaces G55)

G70 Imperial Units

G71 Metric Units

G81 Repeat Function

G90 Absolute Input

G91 Incremental Input

G98 Absolute Datum (Machine Reference Point)

G99 Floating Datum

MISCELLANEOUS FUNCTIONS

One M function is permitted per block.

M and G codes cannot be entered on the same line.

M00 Programme Stop

When a program stop occurs then no further motion occurs until the cycle start key is depressed. Spindle speed and coolant remain unaffected by this function.

M02 or M2

This function will end the program. On reaching this point the spindle and coolant will stop.

M03 or M3

This function starts the spindle rotation in clockwise direction. Then the desired rpm value can be entered. It is cancelled by M06, M05 or M02. Spindle direction cannot be changed whilst the spindle is rotating.

M04 or M4

This function starts the spindle rotation in counter-clockwise direction. Then the desired rpm value can be entered. It is cancelled by M06, M05 or M02.

M06 or M6 Tool Change

This function causes the spindle to stop before tool changing can be accomplished. Previous spindle speed will be stored in memory. Coolant control is unaffected. M06 and the tool number calls up the appropriate tool length offset from the tool library. (If indexing toolpost is fitted it will automatically index to the appropriate tool.)

M08 or M8 Coolant On

This function selects flood or mist coolant which will then be on until cancelled by M09 or M02.

M09 or M9 Coolant Off

This function cancels coolant function.

M20

This function allows any of the four integral relays to be controlled either ON or OFF.

M21

This function allows the control to monitor six user assigned input signals.

PREPARATORY FUNCTION G CODE

One G code is permitted per block.

M and G cannot be entered on the same line.

G00 or G0 Rapid Traverse

All motions rapid traverse in linear mode.

G01 or G1 Linear Interpolation

Is the mode of program to move the tool in a straight line that is parallel to an axis or at some angle to an axis. Depressing X or Z key will default to G01 linear mode.

G02 or G2 Circular Clockwise

Is to be used when the tool is to follow the path of a circular arc while moving in a clockwise direction for X and Z axis.

G03 or G3 Circular Counterclockwise

Is to be used when the tool is to follow the path of a circular arc while moving in a counter-clockwise direction for X and Z axis.

G04 or G4 Dwell

No movement will occur while a timed dwell is performed.

G33 Thread

This function allows a canned threading cycle to be executed.

G54 Programme Offset

This function allows an incremental offset within the program. It is cancelled by M02.

G70 Imperial Units

This function selects inch units for the program.

G71 Metric Units

This function selects metric units for the program.

G81 Repeat Function

This function selects a repeat loop which will allow a programmed sequence to be repeated with specified offsets.

G90 Absolute Input

This function selects absolute format.

G91 Incremental Input

This function selects incremental mode, and allows incremental input with absolute display.

G98 Absolute Datum (Machine Reference Point)

This function allows the control to return to its machine reference position for each axis in turn (X then Z) at a default feed rate.

G99 Floating Datum

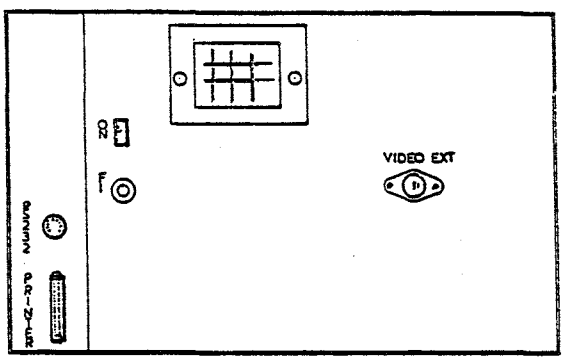
This function allows the control to establish a position where all axes are zero.

STARTING THE MACHINE

Initially starting Easiturn from a cold start.

1. Set the mains isolator at side of machine column for "ON" position.
2. Switch "ON" the power to CNC control (figure 1). This switch is located at the rear of control unit, a red LED on the front panel will indicate power is on.

FIGURE 1

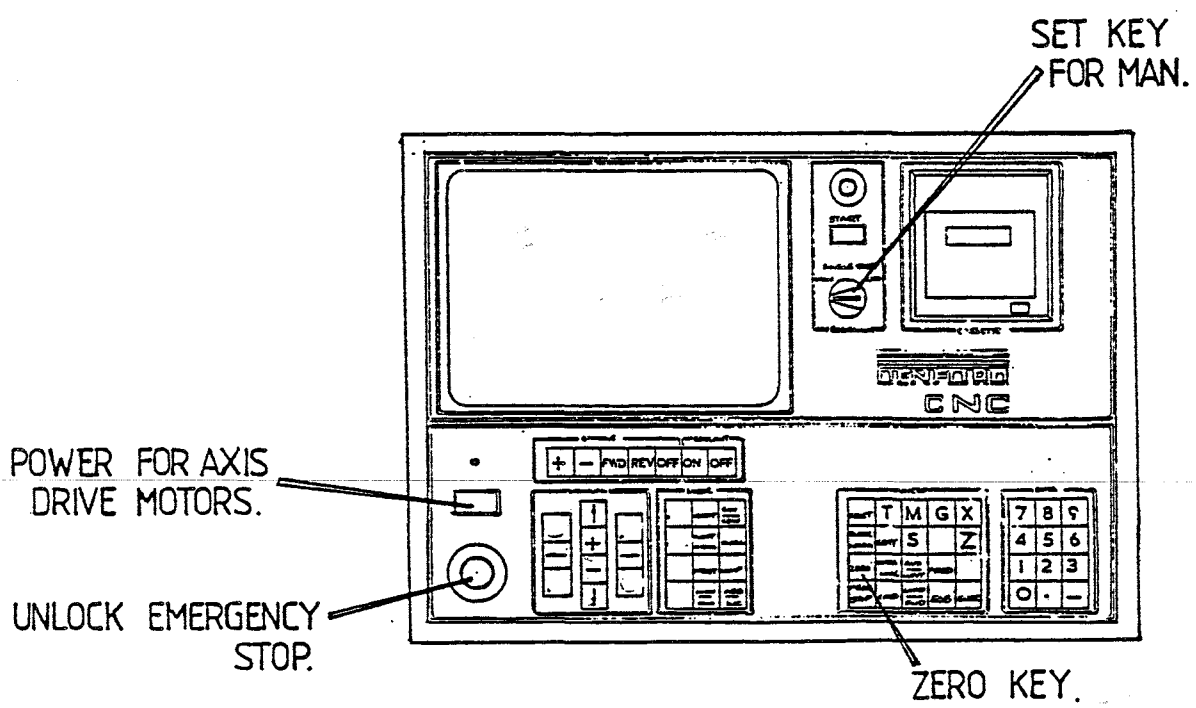


REAR VIEW

CNC CONTROL UNIT

The VDU will prompt the user to press <ZERO> to datum the machine.

3. Unlock the emergency stop button on front panel (figure 2).
4. Set the key for MAN position. This allows manual data input (figure 2).



5. Depress the square green button for power to axis drive motors and spindle motor.

6. Depress ZERO key on the function section of the keyboard.
This drives X and Z respectively to machine limit, the maximum movement on each axis. The control has built in machine limits from this position.

INCH	MM
X 6.889"	X 175
Z 18.897"	Z 480

The machine will default to inches or millimetres depending on factory setting.

SECTION 17

MOVEMENTS AND ASSOCIATED FEED INPUT

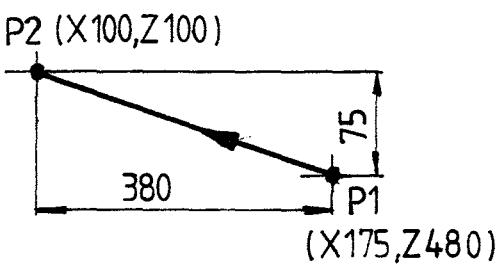
A movement in one or more axes can be input by pressing the desired axis key followed by the required dimensions. These co-ordinate dimensions and associated FEEDS may be input either as a single block of data which is to be executed immediately or as blocks of data which forms part of a programmed sequence.

Before co-ordinate dimensions keyed into the PNC 3 are executed a check is made to ensure that the machine parameters are not exceeded, should this be the case a warning message is displayed. RESET restores normal operation.

The required FEED is keyed in as millimetres per minute or inches per minute.

If no feed is programmed the default feed of 234 mm/min is assumed.

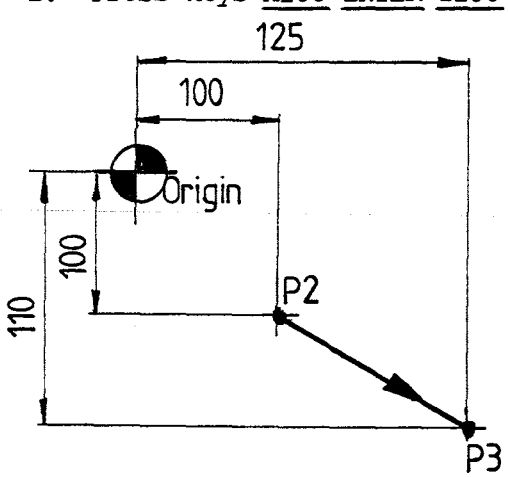
MANUAL MOVE IN ABSOLUTE MODE FROM MACHINE FIXED DATUM



P_1 = machine at absolute datum X175mm 480mm
P_2 = A point X100 and Z100 from origin (X0,Z0)
A manual move from P_1 to P_2 at
150 mm/min

Proceed as follows:-

1. Set the MAN, S step, auto key TO MAN position.
   This allows manual data input.
2. Press keys X100 ENTER Z100 ENTER F150 ENTER EOB



A manual move from P_2 to P_3 at
500 mm/min

Press keys X110 ENTER Z125 ENTER F500 ENTER EOB

* NOTE: X and Z manual data entries are always co-ordinates from the machine fixed datum, therefore X and Z data entries are always positive and any negative dimension would be outside machine limits and control will display "MOVE EXCEEDS MACHINE LIMIT".

IMPORTANT: Never drive the axes to X zero Z zero, unless tool offsets have been set. This is because X0 Z0 is a position to the left and rear of the chuck and may result in a collision between tool and chuck. Always ensure that the moveable limit switch stop is positioned to prevent the above happening.

CIRCULAR INTERPOLATION

Circular movements for X and Z axes are defined by using G02 for clockwise or G03 for counter-clockwise and are limited to quadrant boundaries OR, by using CW/CCW key, alternative depression of the key changes the code from clockwise to counter-clockwise. Define the end points of the circular movement. Press CW/CCW key and input the circle centre origin co-ordinates (XC and ZC).

If you are programming in absolute mode the circle centre origin is the measured distance from the program datum to the circle centre. Alternatively, if you are programming in incremental the + OR - of the circle centre dimension is determined by the incremental distance from start point to arc centre.

When a circular block is to be entered, G02 for clockwise or G03 counter-clockwise. Enter G02 OR G03 and the code is given on the screen, depress the enter key to continue. The program block grid will then appear on the screen and input can commence.

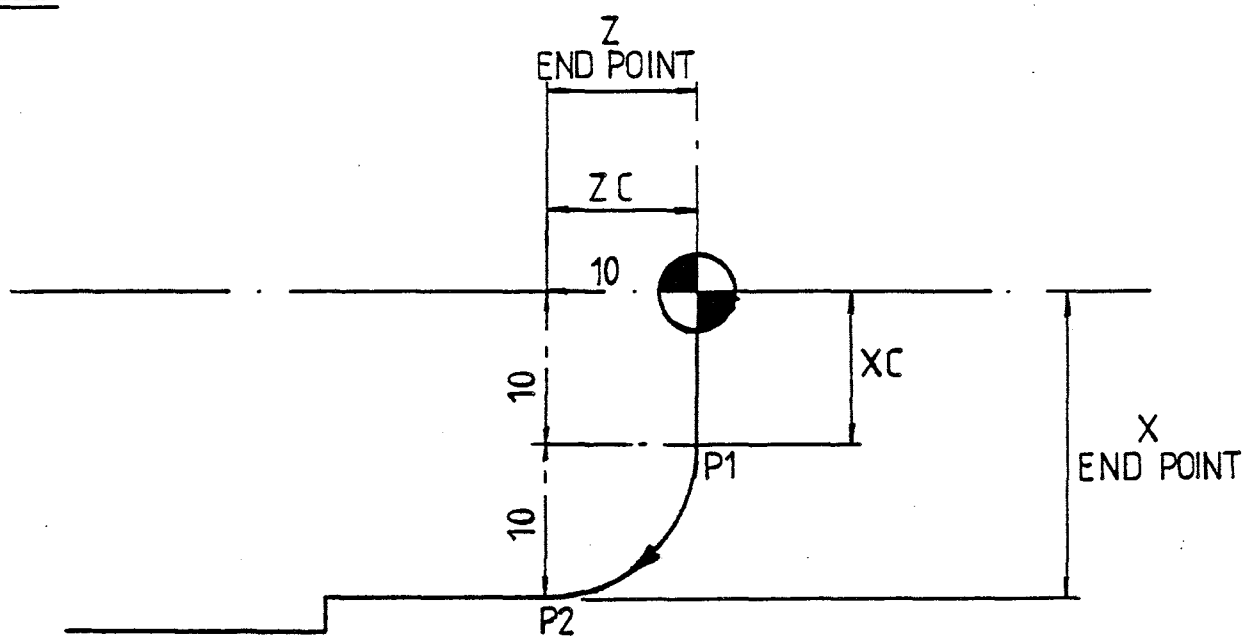
Enter first the end points, X and Z and a feedrate. To input the circle centre origin, about which the circular movement is to act, press CW/CCW key, the prompt will then request the input of circular centre XC and ZC. When complete, the EOB key is used to signify the end of input for that block.

If incorrect or impossible end points are programmed, the control will respond with error in circle centre.

NOTE: When calculating end points and circle centres these must be accurate to $\mp$0.003 mm. Make sure that the radius at the start is equal to the radius at the end point. Circle centres can be established outside machine limits, although the start point and end points must be within the machine limits.

G02 CLOCKWISE

ABSOLUTE

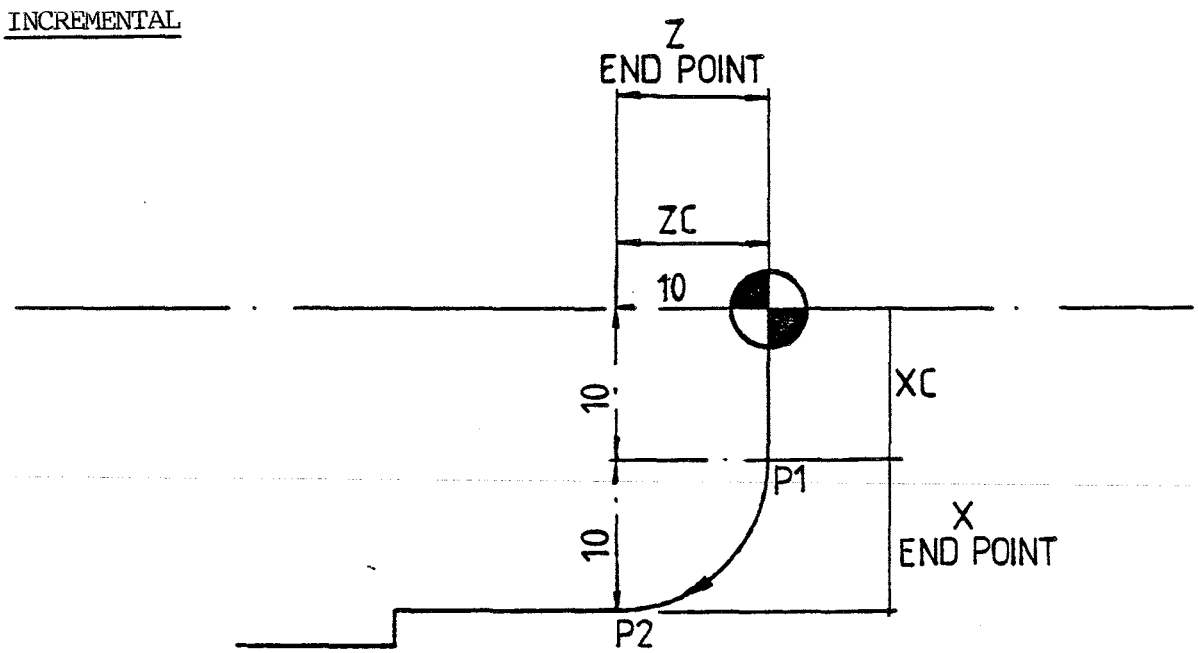


Absolute

P1 = G01 X10 Z0 F500

P2 = G02 X20 Z-10 F150 CW/CCW XC10 ZC-10

INCREMENTAL



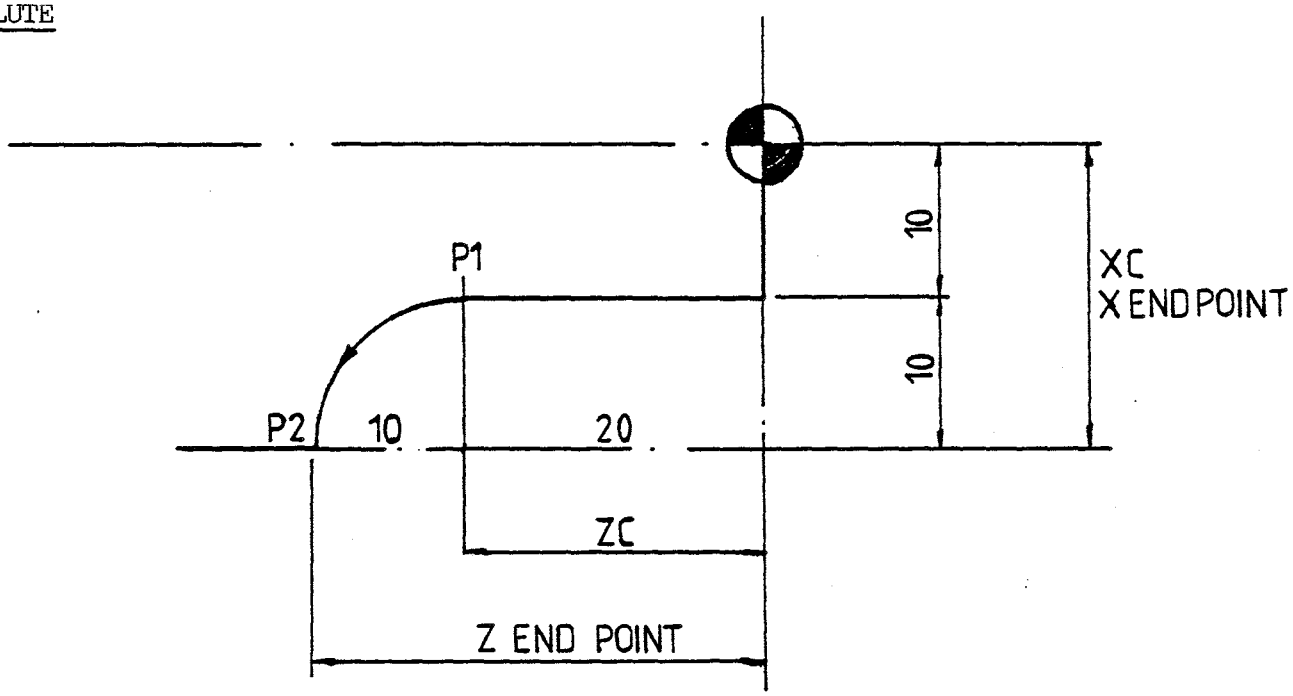
Incremental (Control will allow incremental input, but executes and displays in absolute format.)

P1 = G01 X10 Z0 F500

P2 = G02 X10 Z-10 F150 CW/CCW XC0 ZC-10

G03 COUNTER-CLOCKWISE

ABSOLUTE

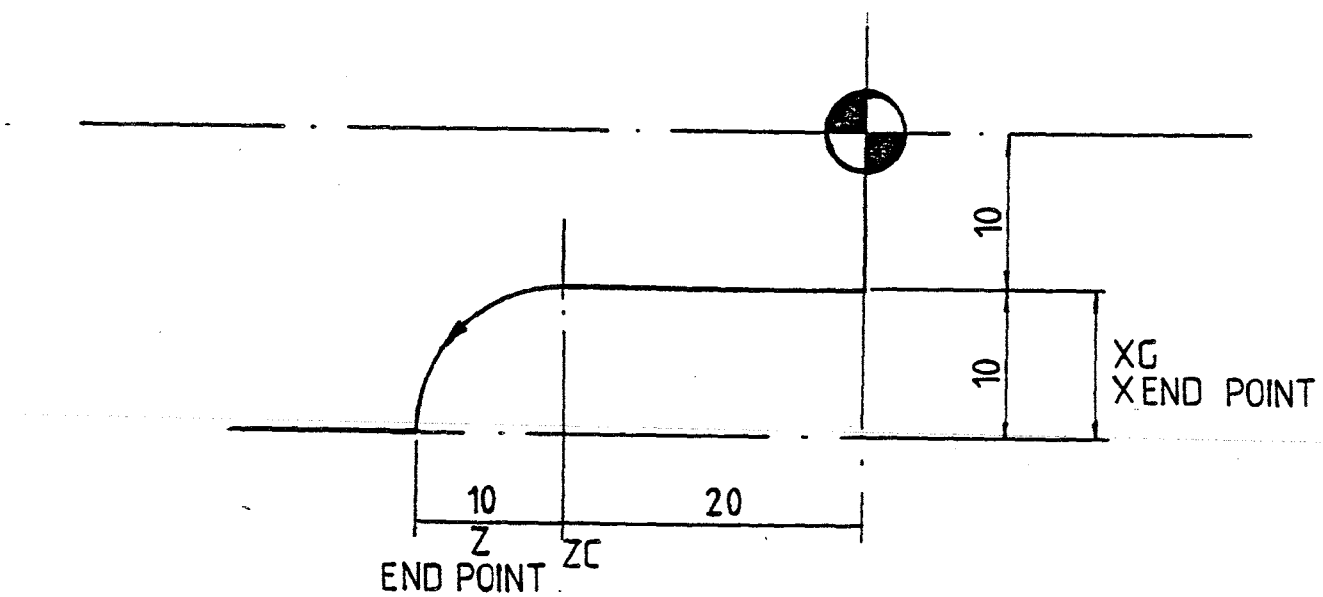


Absolute

P1 = G01 X10 Z-20 F500

P2 = G03 X20 Z-30 F150 CW/CCW XC20 ZC-20

INCREMENTAL



Incremental

P1 = G01 X10 Z-20 F500

P2 = G03 X10 Z-10 F150 CW/CCW XC10 ZC0

SECTION 19

G55 MACHINE OFFSET

Under normal operation, it is not necessary to set a G55 machine offset.

The Z-0 is set by using the tool length offset (see section on setting tool offsets) on the face of the blank to be machined.

Use the G55 only on a "dry run" to checkout the program prior to machining.

If G55 is to be used:-

G55 machine offset is only permitted outside a program mode. A machine offset offsets the program in memory and does not affect manual data moves.

To set a zero or datum from the component the user must enter the machine offset G55 required for the zero position. These values can be taken from the digital readout on the screen.

G55 machine offsets must be entered into the control after the program is loaded into memory. When entering a new program all previous G55 machine offsets are reset to zero.

G55 machine offsets only affect the program in memory. All manual data entries are calculated and executed from machine fixed zero.

A G55 value will not be saved on cassette with the program in memory.

FLOAT DATUM G99

Float datum is only permitted as part of program load sequence.

Float datum allows the programmer to set up a secondary datum within the program. A float datum block will establish a datum position with all axes set to zero about its current position. All subsequent blocks will be relative to this datum position. The digital readout will be relative to this datum position. If G55 machine offsets are zero Z0 tool length offsets will also be relative to this datum position.

SECTION 21

TOOL LENGTH OFFSETS

This feature can be used with a quick change tooling system, or an eight station indexing toolpost.

Tool length offsets are described as a measured distance from the machine fixed zero to a plane at which the part is programmed.

The ability exists to use 16 tools with independant lengths in one program. To program the X and Z axis we must know where the tip of the tool is at all times. This is done by the program loading up tool number and using the tool length offsets stored in the tool library. The control automatically adds or subracts the tool length and places the tool point at the desired location.

If a move Z-3 is programmed using tool 1 the tool moves -3 from Ø0.

Similarly if a move Z6 is programmed the tool moves +6 from Ø0.

This feature eliminates the need for preset tooling, each tool offset may be set on the machine.

SETTING AND RECORDING THE TOOL OFFSETS

Put tool number 1 into the quick change toolholder and load into toolpost.
Set the key for manual mode and depress the 'T' key. The screen will display a tool setting menu:-

1. Display and edit tool offsets.
2. Set tool offset.
3. Change current tool.

Choose mode 2 from the menu (set tool offset).
The VDU will prompt the user to enter the number of the tool to be set.
When the tool number is entered, the screen will display the following:-

1. Front tool / Manual change.
2. Rear tool / Manual change.
3. Rear tool / Auto change.
4. Front tool / Auto change.

Choose option 1 from the menu (Front tool / Manual change).
When the number is entered the current offsets for that tool will be displayed and the prompt will change to:-

Use jog key to face workpiece.

Press enter to fix offsets.

Using the axis jog keys advance the tool until it just touches the face of the workpiece and take a light skim to face off. Without moving the "Z" axis, press the enter key to fix the offset. This causes the actual Z position of the tool to be loaded as the Z offset for that tool, and consequently the Z axis digital readout changes to zero.

The prompt will now change to:-

Use jog key to turn workpiece then measure diameter.

Enter measured diameter.

Using the axis jog keys, advance the tool until it just touches the outside diameter of the workpiece. Take a light cut on the O/D, stop the spindle, and then measure this diameter accurately with a micrometer. Press the X key and enter the diameter measurement into the memory. The control then automatically halves this measurement into a radial dimension from the centre line of the workpiece.

The prompt will now change to:- Enter tool number.

Either enter a new tool number and follow the sequence through again for a second tool, or press reset to exit the tool setting menu.

SECTION 22

DISPLAY AND EDIT TOOL OFFSETS

The current tool offsets can be displays by pressing the T key followed by selection 1 from the menu. Each tool has its own length (Z) and diameter offset.

All 16 pairs of offsets will be displayed and the control will prompt the user to enter a tool number. The letters next to the tool number indicate whether tool is front or back and manual or auto (eg, FM indicates tool is front tool with manual change).

If the user does not want to edit any of the tool offsets, then simply pressing reset at this point will return to the previous menu.

Tool offset editing can be accomplished by entering the tool number to be edited and pressing enter.

The selected tools offset will then appear on the screen and the prompt will change to "ENTER TOOL OFFSET changes" followed by "Z" indicating the axis to be changed. Values entered at this point are incremental and will be added OR subtracted to the current offset.

If it is required to reduce the offset then a negative value must be entered. To increase the offset then a positive value must be entered.

When enter is pressed the prompt will change to X and the offset value can be changed in the same way.

NOTE: When a tool is edited the control also assumes that the tool is to become the current tool and the digital readout will change and display position will change accordingly.

SECTION 23

SPINDLE SPEED CONTROL

Easiturn is fitted with programmable spindle speed control, the following codes can be used.

M03 Spindle Foward
M04 Spindle Reverse
M05 Spindle Stop

Additionally these features can be selected by using the dedicated spindle keys FWD, REV, OFF situated directly below the screen.

When FWD or REV or M03 or M04 is selected the control will prompt the user to enter a spindle speed in RPM. It will also display the allowable speed range as part of the prompt. If the user tries to execute a spindle forward block while the spindle is already turning in reverse (or vise-versa) an error message will be displayed indicating that the spindle must be stopped first. Spindle speed changes can be executed at any time providing the direction of rotation is kept the same.

Also the spindle speed override keys (marked +, -) can be used at any time to increase or decrease the spindle speed. If the + key is used to start the spindle from rest, the direction will be the same as when it was last rotating, (with a default to forward when the control is first powered up).

COOLANT CONTROL

Coolant can be switched on or off as required using the dedicated coolant on/off keys (situated just below the screen) or using the following codes.

M08 Coolant On
M09 Coolant Off

Additionally, the same keys can be used during a program load sequence to enter a program block which turns the coolant on or off, in which case the coolant will automatically be turned on or off by the PNC 3 when that block in the program is executed.

PROGRAMMING

SECTION 24

ABSOLUTE/INCREMENTAL G90/G91

The mode of the machine can be altered to and from absolute and incremental by pressing the abs/inc key or stating the appropriate G code. The default condition is always absolute format. The current mode of the machine is displayed in the top right hand area of the screen, along with the current units inch or mm. In absolute mode all co-ordinates refer to absolute positions from the origin.

In incremental mode any keyed in co-ordinates are added to the previous co-ordinates or the current position, therefore it is incremental input with absolute display and execution.

During EDIT mode, the new data keyed in will be related to the data in the previous block.

ENTERING A NEW PROGRAM

Easiturn's memory will store 500 blocks of information. To enter a new program into memory set the key to Man position and depress the LOAD/END key.

The VDU will prompt the user for a program number which will be assigned to the new program. This can be any number with a maximum of six digits. Key in the new number and press enter to accept the data. The control is now set to load mode, this enables the control memory to be loaded with a series of blocks which will be executed consecutively when the program is run. To end the program load sequence, depress the LOAD/END key, which will add M02 onto the end of the program and end loading. Alternatively, keying in M02 will end program loading.

Two different load operations are possible when the memory is loaded. Depress the LOAD/END key and depress enter key, the VDU will prompt the user:-

1. load memory from keyboard,
2. continue memory load from keyboard.

1. Load is used to enter a new program into memory. Any previously loaded program is overwritten, ie destroyed.

2. Continue memory load from keyboard, enables an existing program to be continued, ie extended, and will cancel the end program code, loading will commence from the last block in memory.

   Upon completion of a load or a continue memory load, the control displays the program number, how many blocks there are in memory and how much memory remains for a period of six seconds after which the control displays normal data. Any key pressed clears the memory status display.

   Should too much program data be keyed into the control, such that the memory becomes full, "memory is full" is displayed and no more data can be entered. The reset key will restore normal operation.

   Once EOB has been entered it is not possible to step back and update erroneous data without ending the loading sequence and calling up edit mode. (See Edit Section Page 64.)

   See edit text.

REPEAT G81

The repeat facility enables specified sections of a programmed sequence to be repeated with specified offsets. The repeat facility is only permitted within a programmed sequence. The data required to specify a repeat is:-

1. The start block number to be repeated, this must be linear block with both axes defined. X and Z dimension within the start block.
2. The end block number to be repeated.
3. The number of repeats required.
4. The required offset dimension, this being incremental offset for each repeat loop.
5. Feed. Entering a feed into the repeat loop will change all feeds programmed within the loop to the new feedrate.
   Omitting a feedrate value will leave all feeds as initially programmed.

Repeats may be programmed up to a nested level of four with a maximum repeat loop 99 times.

Should this level be exceeded "Nest error in repeat levels" is displayed. The reset key restores normal operation.

When each repeat is programmed the control checks all the dimensions being repeated, adding the programmed offset to the number of repeats to ensure that the machine limits are not exceeded. This process may take a few seconds. Should the limits be exceeded, "Move exceed machine limit" is displayed, the reset key restores normal operation and corrected data keyed in before program can continue.

Below is the information required for a repeat block.

G81 REPEAT FROM....TO....REP....OFFSET....FEED....

G81 - REPEAT CODE
FROM - START BLOCK FROM WHERE REPEATING WILL COMMENCE
TO - END BLOCK OF REPEAT LOOP
REP - ENTER THE NUMBER OF REPEATS, MAXIMUM 99
OFFSET - ENTER X OR Z INCREMENTAL OFFSET FOR EACH LOOP
FEED - ENTERING A FEEDRATE VALUE WILL REPLACE ALL FEEDRATES WITHIN THE LOOP

THREAD G33

Threading blocks can be programmed either by keying G33 and pressing ENTER or by pressing the THREAD key. The PNC 3 will then display the following menu:-

1. 0 DEG EXTERNAL	2. 0 DEG INTERNAL
3. 55 DEG EXTERNAL	4. 55 DEG INTERNAL
5. 60 DEG EXTERNAL	6. 60 DEG INTERNAL

The user should press 1 or 2 for plunge screwcutting depending whether an external or internal thread is to be cut, or number 3 to 6 if compound angle screwcutting is to be used. - Choose correct angle of thread, and either external or internal.

The following six parameters must now be entered to define the thread:-

1. The thread diameter must be entered. This diameter always refers to the largest diameter of the thread (see diagram) whether the thread is external or internal.

2. The pitch must be specified. The pitch must be kept in the range 0.1 mm to 6.4 mm.

3. The depth of thread must be specified.

4. The number of cuts, i.e. the number of passes along the thread length that the tool will make to reach the desired depth. If the thread form is 0° then the amount of material removed in each pass is equal. If the thread form is 55° or 60° then the amount of material removed in each pass is gradually reduced, i.e. the first pass cut is reasonably deep and the last cut is suitably fine. At the same time the PNC 3 calculates the angle required to ensure the tool cuts on one face only. To ensure a good finish to the thread, the PNC 3 will automatically add three finishing passes at the full depth. The number of cuts must be in the range 1 to 99.

5. The length of the thread must be specified. The length can either be a positive or a negative value, defining it to be either to the right or to the left of the start position.

6. And finally the start position in the Z axis must be defined. Note that the PNC 3 will actually position the tool 3 mm away from the start position at the beginning of a thread block. This ensures that the correct feedrate for the thread can be achieved before the actual start point is reached.

For a thread block to execute properly, the spindle must be rotating at the correct rpm. There is a minimum spindle speed of 100 rpm fixed by the fact that the spindle motor does not rotate smoothly below this figure. The maximum spindle speed varies with the desired pitch according to the formula:-

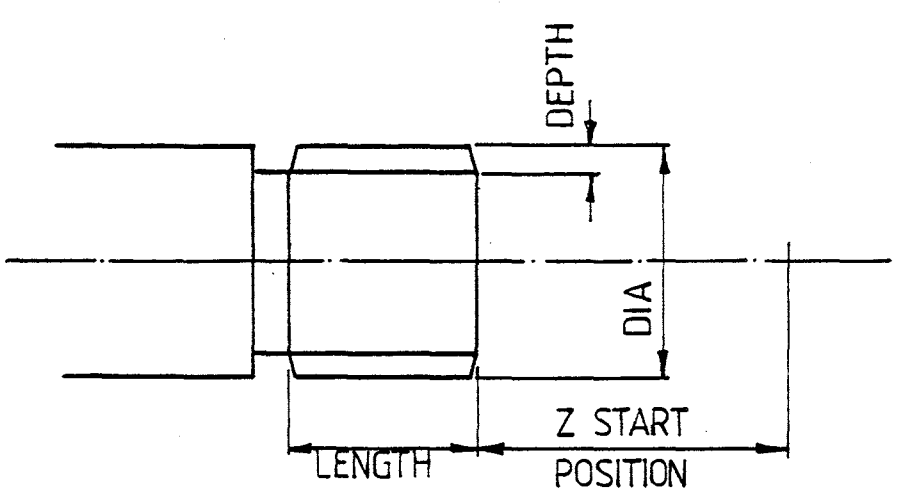
Maximum Speed = 1100/Pitch mm rpm - 10%

But this is subject to a fixed overall maximum of 500 rpm

i.e. Pitches of less than 2.0 mm cannot be cut at more than 500 rpm (see diagram over page).

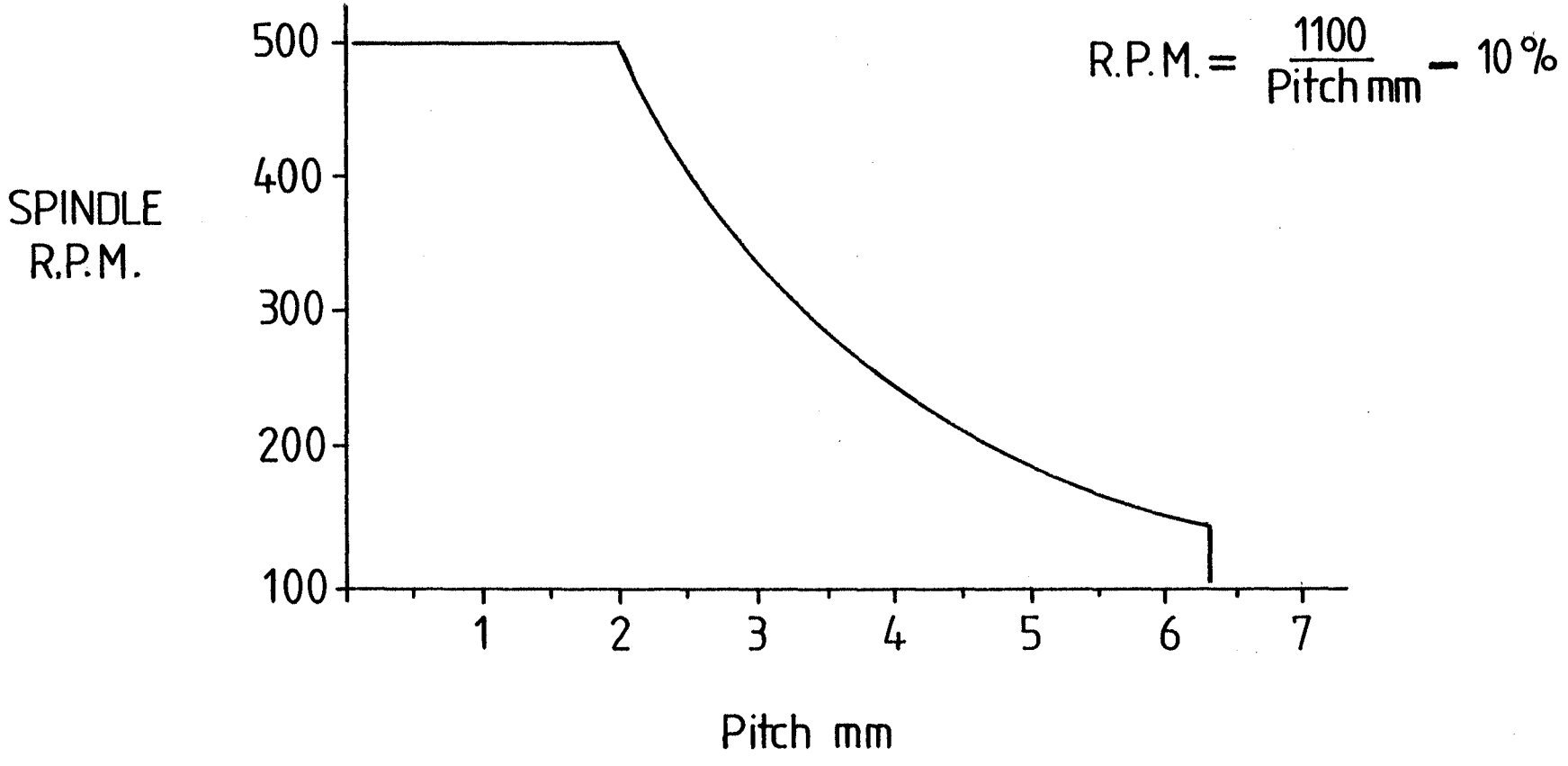
When a thread block is executed, the PNC 3 will move the tool from its present position to a point 3 mm away from the start point in a straight line at the maximum feedrate. It will then make the screwcutting pass, stop, bring the tool out to a clearance point 0.5 mm away from the work, in X axis then move back to the start position in Z before repeating the screwcutting pass at an increased depth. All moves except each screwcutting pass will be carried out at the maximum feedrate. The clearance position will, of course, vary depending on whether a front or back tool is used or whether an internal or external thread is being cut.

The following diagram shows the relationship of the depth, length, diameter and start position of the thread block.



PNC 3
LATHE SCREWCUTTING

PERMISSIBLE SPINDLE SPEEDS



$$R.P.M. = \frac{1100}{\text{Pitch mm}} - 10\,\%$$

SECTION 27

OFFSET FUNCTION

OFFSET FACILITY

Two offset functions are permitted, G55 is a machine offset, set outside the program and will act upon the memory allowing the start position to be established at any point within the machine limits and used to offset the entire program. This facility can be used to establish a datum on the component or used as a dry run facility. Entering a new program into memory will automatically reset any previous machine offsets, G55 to zero.

Program offset G54 can be used inside a program loading sequence to offset parts of the program and is incremental in operation.

SECTION 28

AUXILIARY FUNCTIONS

Auxiliary functions allow user assigned devices to be controlled, ie switched on and off by the four integral PNC 3 auxiliary relays. Three types of auxiliary functions are supplied.

The three types are:

a) ON/OFF Auxiliary Number 3 and 4
b) MOMENTARY Auxiliary Number 2
c) PULSED Auxiliary Number 1

a) ON/OFF auxiliaries are set when programmed. If the auxiliary is programmed ON it will remain ON until programmed OFF. Such auxiliaries could be used to, for example, control lubricant.

b) MOMENTARY auxiliaries are switched ON (if programmed to be on) only when the machine is at a programmed position. When the axes are moving momentary auxiliaries are always OFF. This type of auxiliary can be used to, for example, provide a table locking signal or to activate a rotary table to index for a milling operation.

c) PULSED auxiliaries provide a pulse output of 50 milliseconds (if programmed ON) each time the machine completes a program block.

To program auxiliaries, key in M20 or press the AUX/INPUT Key once followed by <ENTER> . The PNC 3 will prompt the user to select the auxiliaries that are to be programmed ON. If more than one auxiliary is to be on, the decimal point key can be used to separate the numbers being input. Pressing <ENTER> will cause the prompt to change to invite the user to select auxiliaries that are to be programmed OFF. More than one auxiliary can be programmed off by repeatedly entering numbers. When the auxiliaries have been set up ON or OFF, as desired, pressing <EOB> will end that block of information.

SECTION 29

INPUT FACILITIES

The PNC 3 is equipped to be able to monitor seven user assigned input signals from external switches. The condition of the switches may be checked to see if they are open or closed during program execution. If the switches are not in the programmed state, sequence execution waits until the switch signals are as programmed before proceeding. Switch levels may be programmed to be closed (ON) or open (OFF). These inputs could be used, for example, to check if safety guards are in the correct position before movement, or to check the position of an auxiliary controlled hydraulic table, or to make the PNC wait for some external signal from a robot before proceeding.

To program inputs, key in M21 or press the AUX/INPUT key twice followed by < ENTER > . The inputs to be ON are entered first, in the same way as auxiliaries, using the "." key as a separator if necessary. When < ENTER > is pressed the inputs to be OFF can be entered in the same way. Pressing < EOB > will end that block of information.

The auxiliary outputs and the inputs enable the PNC 3 to function not only as a precise positioning control system but also as a sequence controller.

SECTION 30

DWELL FUNCTION

When a G04 dwell preparatory function is called up, a variable time delay from 0.1 to 9999.9 seconds can be programmed and signifies that no movement of the machine is to occur while this block is being performed.

G04 dwells can be programmed inside a program load sequence or outside the programmed sequence.

SECTION 31

EDIT FACILITY

The edit facility enables a program in memory to be edited. To select edit mode set the key for Man position and depress the Edit key. When edit mode is selected the user may choose to display any block of data. Key in the desired block number to be edited and depress enter key. Seven edit functions are permitted in edit mode.

They are:-

1. Previous
2. Next
3. Replace
4. Delete
5. Add
6. Alter
7. Search.

During edit mode three blocks will be displayed, the current block and the two previous blocks plus the system editor, along the bottom of the screen. The selected function is performed on the bottom block.

FUNCTIONS

1. Previous — Depression of key 1 - Decrease the block numbers displayed by 1. Therefore each time key 1 is depressed the previous block will be displayed.

2. Next — Depress key 2 - Increments the block numbers displayed by 1. Therefore each time key 2 is depressed the next block will be displayed.

3. Replace — Depress key 3 - Replace function. The current block displayed can be replaced by a new block on the same line number. Keying in the new block and accepting the data with EOB key.

4. Delete — Depress key 4 - The current block displayed will be deleted from the program and all block numbers will decrease by one.
   Action All blocks will automatically be renumbered but block numbers, within a repeat block G81, are not updated.

5. Add — Depress key 5 - Add a new block into the program. A new block will be inserted into the program on the current line number. The current block will move down one and all block numbers after the current block will automatically renumber.

If it is desired to add a block or a number of blocks to the end of a programmed sequence, the LOAD continue facility should be used.

Note Block numbers are automatically renumbered, and therefore the start and end blocks within a G81 repeat block will have to be reassigned.

6. Alter — Depress key 6 - To alter the current block. This allows the user to alter existing data. Alter mode cannot change the status of a block, ie G01 cannot be altered into G02. If any attempt is made to alter data that is not permitted, the system will display "use replace function", the reset key will restore normal edit mode.

Feed rates cannot be altered directly as any one of the accompanying X or Z data must be keyed in first before the feed can be accepted.

7. Search — Depress key 7 - Block search. The system will display the number of blocks in the program. Key in the appropriate block number and depress enter and that block will be displayed.

8. RESET — The reset key will cancel edit mode and return to normal operation.

SECTION 32

CASSETTE OPERATIONS

The integral magnetic cassette recorder enables programs to be permanently stored for future use.

Six different cassette operations are possible:

1. Rewind cassette
2. Erase cassette
3. Find the end of cassette data
4. Load program from cassette
5. Continue program load from cassette
6. Store program to cassette.

When the CASSETTE facility is initially selected a check is made to see if there is a cassette in the unit, if not "NO TAPE LOADED" is displayed, depression of RESET restores normal operation. If the cassette tape "clear leader" is detected when a cassette operation is selected the PNC 3 runs the cassette for five seconds, if the clear leader is still detected Tape Error is displayed, depression of RESET restores normal operation. If the clear leader has passed the cassette read head the selected cassette operation continues. Some cassette tapes have very long clear leaders and it may be necessary to reselect the cassette operation required, thus giving the cassette tape a further five seconds to pass the clear leader. If the end of tape clear leader is detected during a cassette operation, eg during a cassette load "TAPE ERROR" is displayed, depression of RESET restores normal operation.

1. REWIND CASSETTE enables a cassette to be rewound to the start, ie to the clear leader, this operation should be performed prior to recording onto a new cassette and it should be performed before a cassette program is loaded into PNC 3 memory. The rewind operation may be stopped by pressing the RESET key.

   If important data is to be stored which must not be overwritten, cassettes can be protected by punching out two holes at the top of the cassette.

   If a cassette having had the two holes made is placed in the PNC 3 and effort is made to record a program, the message "CASSETTE IS WRITE PROTECTED" will be displayed.

2. ERASE CASSETTE enables a cassette to be erased, ie cleared of programs. The cassette should first be rewound using option 1, ie rewind cassette. When a cassette is erased "PROGRAM END" is recorded at the start of the cassette to indicate that this is the end of the cassette. The cassette erase operation takes approximately three minutes for a 50 ft long cassette tape.

3. FIND END OF CASSETTE DATA. This command brings the tape to the end of the recorded programs, ie to the message "Program end found", the cassette is then ready for other programs to be stored. Depress the RESET key, returns to cassette menu.

4. LOAD PROGRAM FROM CASSETTE enables a program which is on the cassette tape to be loaded from the cassette into PNC 3 memory. The operator may now look for the next cassette program identifier located by depressing key 4. The program number is requested and by giving the program number and pressing the ENTER Key the PNC 3 will search for the number, displayed in turn the numbers of the programs on tape which are found, until the program required is found or until the tape end is found. Depressing ENTER key will load the program into memory.

   If the program number is not known, by pressing key 4 followed by ENTER the first program on tape will be found and its program number displayed. Press ENTER key to load into memory or press any other key to proceed to the next program on tape. This procedure may be carried on until tape end is found. Depression of RESET restores the cassette menu.

   When data is loaded from the cassette unit into PNC 3 memory, a check is made on the validity of the data and if an error was detected during the load process "TAPE ERROR" is displayed, and the memory will not be loaded. If RESET is pressed, normal operation is resumed.

   Cassette data is validated as follows: when a program or an identifier is stored onto the cassette tape an algorithm is recorded at the end of the data. When the program or identifier data is subsequently loaded into PNC 3 memory the same algorithm is computed and the numerical result is compared with the pre-recorded value, if a difference is detected "TAPE ERROR" is displayed.

5. CONTINUE PROGRAM LOAD FROM CASSETTE. This facility enables program data contained in PNC 3 memory to be continued, ie extended, by a program previously recorded onto tape. This facility enables programs to be "merged" to form larger programs.

6. STORE PROGRAM TO CASSETTE. This facility enables program data contained in PNC 3 memory to be stored using the integral cassette recorder onto cassette tape. The program is stored after a cassette identifier has been keyed in. The cassette identifier (Program number) can be from one to six numerals.

   Each program is stored as four elements separated by blank tape.

   i) The cassette program identifier.
   ii) The program.
   iii) The tool offsets associated with the program.
   iv) A cassette end "END".

   The cassette end is stored to enable the end of the recorded tape to be found when additional programs are to be stored, as each cassette tape can contain many programs. When a program is stored the cassette tape is initially rewound for a short time and then the three elements are recorded, this removes any previously recorded cassette END.

   It is strongly recommended that more than one recording of the program is made in case one copy becomes corrupted.

SECTION 33

DATA LINK FACILITY

Four operations are possible using the Data Link. They are:-

1. Load program from data link. (RS232C serial link).

2. Continue program load from data link. (RS232C serial link).

3. Store program to data link. (Enhanced RS232C option only).

4. Print program, ie transmit program to printer. (Centronics compatible parallel link.)

Note: 2, 3 and 4 are possible only if the PNC 3 memory is loaded.

1. Enables a program to be loaded into PNC 3 memory from an external device either one block at a time or as a full program. Any program previously contained in PNC 3 memory is overwritten, ie destroyed. The format of the program data is shown in the RS232C interface specification.

2. Enables an additional program from an external device to be added to a program that already exists in PNC 3 memory. The format of the program data is shown in the RS232C interface specification.

3. Enables the contents of PNC 3 memory to be transmitted to an external device. The memory contents are transmitted as "ASCII" characters in a similar format to that used by 1. and 2. above.

4. Enables the contents of PNC 3 memory to be transmitted to any printer with 80 columns or more which has a standard Centronics parallel interface.

5. With PNC 3's version 3.39 onwards. If 1. or 2. is selected, the user will be prompted to specify either Host Computer or Paper Tape. The difference between these two options is explained in the following section entitled "PNC 3 Enhanced RS232C Interface Specification".

TRANSMIT PROGRAM TO DATA LINK

When function 4 is selected in the DATA LINK menu, the PNC 3 responds with a menu:-

1. COMPLETE PROGRAM

2. PART OF PROGRAM

If 1 is selected then the whole of the program in memory is transmitted via the RS232c link.

If 2 is selected then the user is requested to enter the start and end blocks. When this has been done, the portion of the program selected is transmitted via the RS232c link.

(NB. During transmission the message "Storing to RS232c Serial Data Link" is displayed.)

The data transmitted by the PNC 3 is exactly the same as it expects to receive when loading from the RS232c link, including block numbers at the start of each block.
i.e.
<STX> Nnnnnn G--------- <CR><LF>
where nnnnn is the block number

During transmission the RxDa line is used as a busy signal thus:-

if RxDa is high (4V to 12V) then the PNC 3 will transmit
if RxDa is low (-12V to 0V) then transmission is inhibited at the end of the current character and the PNC 3 will wait for a low level before continuing to transmit.

After the last block in the program has been sent to the serial link, the PNC 3 will transmit an M02 block to signify the end of the program.

If the PNC 3 is to be used with a Portazip type paper tape punch, the following connections should be used.

PNC 3		PORTAZIP	
7 PIN DIN		SIGNAL	25 WAY D TYPE
2	Ov COMMON	7	
6	DATA FROM PNC 3	3	
7	BUSY LINE	4	

NB. These connections are only suitable for storing to paper tape.

PAPER TAPE

When serial load from tape is selected, the PNC 3 will operate using an Xon/Xoff type protocol as follows:-

1. When the PNC 3 is ready to read a block from the serial link it will transmit a <DC1> character (=11H).

2. The PNC 3 will read characters until it reads a <CR>, whereupon it will transmit a <DC3> character (013H).

3. Once the block has been decoded, the PNC 3 will transmit either an <ACK> character or a <NAK> followed by a error code number.

4. The PNC 3 will then continue as in step 1 by transmitting a <DC1> character.

5. The e eption to the above sequence is when an M02 block is received by the PNC 3, in which case no <DC1> is transmitted and the PNC 3 returns to MDI mode.

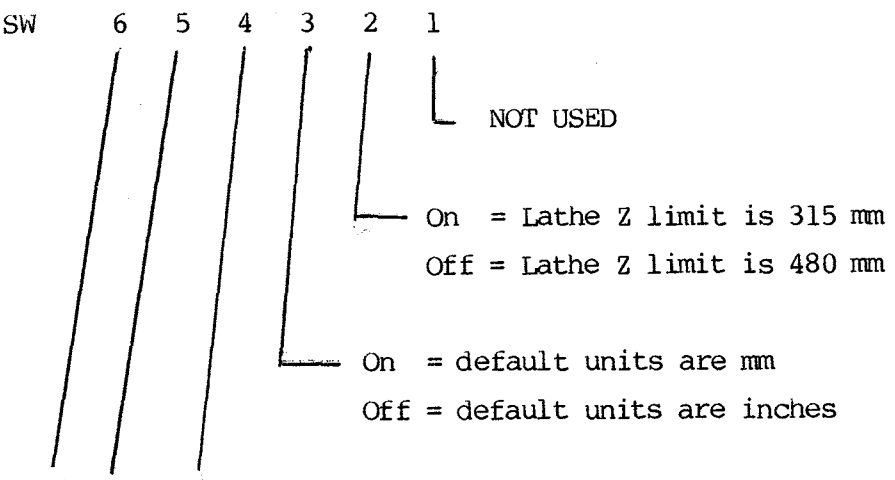
If the PNC 3 is to be used with a Portazip type paper tape reader, the following connections should be used.

PNC 3		PORTAZIP
7 PIN DIN	SIGNAL	25 WAY D TYPE
2		Ov COMMON 7
6	DATA FROM PNC 3	3
7	DATA TO PNC 3	2

NB. These connections are only suitable for reading paper tape using Serial Load. For tape punching using Serial Store see the relevant section of this manual.

INTERNAL SWITCH SETTINGS

There are six switches in a dual-in-line (d.i.l.) package that are used to configure a number of options inside the PNC 3 at power on. These switches are mounted on the interface board and are only accessible when the PNC 3's cover has been removed. When the cover has been removed by undoing the fixing screws and sliding it forward, the interface board can be seen at the right hand side of the PNC 3. The dil switches are mounted in the bottom right hand area of the interface board. The meanings of each switch are as follows:-



Baud rate selection

On	On	On	=	75 Baud
On	On	Off	=	110 Baud
On	Off	On	=	150 Baud
On	Off	Off	=	300 Baud
Off	On	On	=	1200 Baud
Off	On	Off	=	2400 Baud
Off	Off	On	=	4800 Baud
Off	Off	Off	=	9600 Baud

NB. On = Switched closed
Off = Switch open

PNC 3 RS232 Interface Specification

Section A Input to PNC 3

The enhanced RS232 interface allows a host computer to use all the facilities of the PNC 3. The enhanced specification includes comprehensive error message transmission. Each block must start with <STX> and end with <CR> but these characters have been omitted from the following text for clarity.

(N.B. STX = 02H, CR = ODH)

The PNC will ignore the following characters: General comments of the STANDARD RS232 Interface Specification apply.

Null	00H
Tab	09H
Space	20H
Delete	7FH

As with the standard interface, blocks with "L" as the last character before the <CR> will not be executed directly but will be loaded into the PNC 3's internal memory.

1. Linear Moves

   G01 Xnnnn Znnnn FXnnnn

2. Circular Moves

   Clockwise

   G02 Xnnnn Znnnn FXffff CXcccc Zcccc

   Counter-Clockwise

   G03 Xnnnn Znnnn FXffff CXcccc Zcccc

   nnnn = X or Z position in mm or inches
   ffff = Feedrate in mm/min or ins/min
   cccc = XZ circle centre point in mm or inches

3. Dwell

   G04 Ddddd

   Where dddd - dwell time in the range 0.1 to 9999.9 seconds.

4. Thread Cutting Move

   Internal Thread

   G33 A<angle>I<diameter>P<pitch>D<depth>C<cuts>L<length>Z<start>

   External Thread

   G33 A<angle>E<diameter>P<pitch>D<depth>C<cuts>L<length>Z<start>

5. Offsets

   Program Offsets

   G54 Xnnnn ZnnnnL

   Machine Offsets

   G55 Xnnnn Znnnn

6. Imperial Units

   G70

7. Metric Units

   G71

8. Repeat Loops

   G81R<start blk>E<end blk>N<no of times> Xnnnn Znnnn FXffff L

   Where the X and Z dimensions are optional incremental offsets and the FX and FZ values are optional feedrates.

9. Absolute Units

   G90

10. Incremental Units

    G91

11. Absolute Datum

    G98

12. Floating Datum

    G99L

13. Program Stop

    M00L

14. Spindle Speed Control

Spindle Forward

M03 S<spindle speed forward rpm>

Spindle Reverse

M04 S<spindle speed reverse rpm>

15. Spindle Stop

M05

16. Tool Change

M06 T<tool number>

17. Coolant Control

Coolant On

M08

Coolant Off

M09

18. Auxiliary Output and Input Control

Aux Outputs

To turn auxiliary n on

M20 A<n>+

To turn auxiliary n off

M20 A<n>-

Combinations of different auxiliaries to be on/off can be built up

eg

M20 A1+A2-A3+A4-

will turn on Aux 1 and Aux 3 and turn off Aux 2 and Aux 4.

Note: The auxiliaries do not necessarily have to be input in order.

Inputs

To wait for input n to be high

M21 I<n>+

To wait for input n to be low

M21 I<n>-

Combinations of conditions can be tested

eg

M21 I1+I2+I3-I4-

will wait until Inputs 1 and 2 are high and Inputs 3 and 4 are low.

Note: The inputs do not necessarily have to be input in order.

19. To Run a Program

B	will cause the whole program to be executed
B<nnnn>	will cause the program to be executed from block nnnn

20. To Erase a Program (ie to clear PNC 3 memory)

E	will erase the program

Section B Output from PNC 3

1. Providing the PNC 3 has received valid data as specified in Section A it will respond with the character <ACK>
   <ACK> = 06H

   This signifies that the PNC 3 is ready to receive more data.

2. If some error has occurred, the PNC 3 will respond with the following:-

   <NAK>nn
   where nn is a two digit error code
   <NAK> = 15H

   The PNC 3 will then be ready to receive more data.
   The error codes are defined in the following table.

3. If reset is pressed on the PNC 3 while in RS232C mode with the PNC 3 waiting for data then it will transmit a <BEL>(07H) and return to MDI mode.

PNC 3 RS232 ERROR CODES (Enhanced specification only)

Error No.	Meaning
01	Parity error in received character
02	Illegal G code received
03	Illegal M code received
04	Illegal character for this block
05	Move exceeds machine limits
06	Block not complete successfully
06	This block not allowed to execute immediately (Must be ended with L)
08	This block not allowed in a program
09	Attempt to run to non existant block
10	PNC memory full
11	Block too big for input buffer
12	X axis drive system fault
13	
14	Z axis drive system fault
15	W axis drive system fault
16	Incomplete block received
17	Error in input co-ordinate
18	Error in input feedrate
19	X and Z moves not present in circular move
20	Position not known machine must be driven to datum
21	Circular move not within a quadrant
22	Dwell value error
23	
24	Tool number error
25	Auxiliary selection error
26	Input selection error
27	Repeat start block error
28	Repeat end block error
29	Number of repeats error
30	Nest error in repeat levels

Error No.	Meaning
31	Error in repeat offsets
32	Error in offset block
33	Spindle speed input exceeds limits
34	Spindle direction is opposite to present direction (stop spindle first)
35	Error when driving to datum
36	Threading input error
37	Spindle speed wrong for threading
38	Spindle drive system error
39	Number of cycles error
41	Thread angle incorrect

EXAMPLES

PNC3 Maintenance Manual

1/ PNC3 Control Unit Information

a) Built in diagnostics / Fault messages

b) Preliminary Fault Finding

c) Block diagram of control unit

d) Basic operation of control unit

e) Basic operation of Printed circuit boards

f) Block diagrams of Printed circuit boards

g) Circuit diagrams of printed circuit boards

h) Circuit board layouts

j) PNC3 Internal connections/wiring

k) PNC3 PORT details

l) Error messages

1/ a) Built in Diagnostics / Fault messages.

Each time the PNC3 stepper motor control unit is switched on the control unit carries out a self test procedure which checks the following:

1) System RAM (Random Access Memory)
2) System EPROM (Electrically Programmable Read Only Memory)
3) Keyboard is tested for short circuit Keys

1) The system RAM is checked in 2 stages

   a) Stage 1 checks if the 1st 256 bytes are operating correctly if not the test continues until the power is removed. If this RAM section is OK then
   b) Stage 2 checks the remaining 5.75K bytes. If an error is detected the faulty IC (integrated Circuit) number is displayed on the VDU (Visual Display Unit). If the RAM is OK testing proceeds.

2) The system ROM is checked to ensure that all ROMs are functioning correctly. If an error is detected the program version number together with a list of ROM numbers with their actual and correct checksums is displayed. If the ROM is OK testing proceeds.

3) program versions 3.14 onwards carry out a Keyboard test to ensure that there are no short circuit Keys. If a short circuit Key is found its number is shown on the VDU.

   Note The RAM, ROM and Key numbers are as labelled on the Processor/Keyboard printed circuit board issue 2 onwards which is located behind the front panel.

System Fault Diagnosis (Operator checks)

A number of system checks may be carried out by the operator to check that various parts of the complete machine are functioning. The following checks can only be made prior to the machine being ZEROed:-

1) System EPROM checks
2) Keyboard tests
3) Input signals test
4) RS232 Serial Link test (to be added)

NOTE - Each test is ended by pressing the 'RESET' Key.

1) System EPROM can be checked by pressing the 'S' Key. The display will then show the program version number together with a list of ROM numbers with their actual and correct checksums which should always agree.

2) If the PNC3 stepper motor control unit is switched on whilst a Key is depressed on the keyboard the control will do a Keyboard test where the number of each Key depressed is displayed. Only one Key should be depressed at once. A faulty Key will result in either no Key number being displayed if the Key is open circuited, or the faulty Key number will always be displayed if the Key is short circuited.

3) The PNC3 stepper motor control unit uses many input signals some of which come from the machine being controlled. These signals are arranged as 'ports' having in general 8 bits.

   The input ports used are:-

   a) PC - Datum markers, spindle speed sensors and spares
   b) PD - Machine input switch signals
   c) PE - Printer Status and control unit 'assign' switches
   d) P4A - Axis step and direction signals
   e) P4B - Axis drive fault and overtravel signals
   f) P6 - Optional additional Serial Link (not normally fitted)
   g) POR - machine control switches and Cassette unit status

a)PC - Port C is used for the Datum Signals from each of the axes and for the spindle speed sensors (only used on programmable spindle speed systems)

bit assignments:-

	7	6	5	4	3	2	1	0
LATHES:	Spindle encoder 200/rev 1=HOLE	Spindle encoder 1/rev 1=HOLE	Z Datum 1=METAL	X Datum 1=METAL	SPARE	SPARE	SPARE	SPARE
MILL:	Spindle encoder 1/rev 1=metal	Z Datum 1=metal	Y Datum 1=metal	X Datum 1=metal	Spare	Spare	Spare	Spare

b)PD - Port D is used for the machine input switch signals

bit assignment:-

7	6	5	4	3	2	1	0
INPUT 7	INPUT 6	INPUT 5	INPUT 4	INPUT 3	INPUT 2	INPUT 1	INPUT 0
0=CLOSED	0=CLOSED	0=CLOSED	0=CLOSED	0=CLOSED	0=CLOSED	0=CLOSED	0=CLOSED

e)PE - Port E is used for the printer Status signals and for the unit 'assign' switches. IMPORTANT:- If the unit assign switches are changed they must be set back to their original settings at the end of the test or certain characteristics of the control unit will change.

bit assignment:-

7	6	5	4	3	2	1	0
PRINTER /ACK 0=ACK	PRINTER BUSY 1=BUSY	SWA 6 1=ON	SWA 5 1=ON	SWA 4 =ON	SWA 3 1=ON	SWA 2 1=ON	SWA 1 1=ON

d)P4A - Axis step and direction signals. These signals are used by the control unit to control the stepper motors.

bit assignments:-

7	6	5	4	3	2	1	0
4th axis DIR'N 1=+VE	3rd axis DIR'N 1=+VE	2nd axis DIR'N 1=+VE	1st axis DIR'N 1=+VE	4th axis STEP 1-STEP	3rd axis STEP 1=STEP	2nd axis STEP 1=STEP	1st axis STEP 1=STEP

e)P4B - Axis drive faults and overtravels. Note the axis drive fault signals are only active if the stepper motor drives are switched ON.

bit assignments:-

7	6	5	4	3	2	1	0
4th axis drive fault 1=OK	3rd axis drive fault 1=OK	2nd axis drive fault 1=OK	1st axis drive fault 1=OK	4th axis over/ travel 1=OK	3rd axis over/ travel 1=OK	2nd axis over/ travel 1=OK	1st axis over/ travel 1=OK

f)P6 Port 6 is used by the optional additional serial link.

g)POR - Port 0 Read is used for the Machine Control switches and for the digital cassette status signals.

7	6	5	4	3	2	1	0
Machine STOP	AUTO/ MANUAL	START	Cass clear leader	Cass Data	Cass present	Cass File protect	Machine Single step
1=stop	0=AUTO	0=START	1=CLR LDR	0=DATA	0=CASS pres	1=FILE Protect	0=SINGLE STEP

1/b) Preliminary Fault Finding

The following symptoms of basic problems with the control unit are included as a fault finding aid. Before attempting to resolve more complex problems the user should become familiar with information in the maintenance manual.

NOTE System power must always be removed from the control unit before removing/disconnecting or replacing any components/connectors etc. The control unit may be operated if necessary with the outer cover removed but great care must be taken as dangerous high voltages are then exposed.

SYMPTOM	CHECK	NORMAL	ABNORMAL
1/Unit fails to function when switched ON	a) Main Power ON b)ON switch on unit rear is ON c)Fuse F1 on unit		
	d)Power ON indicator on front panel	ON i.e. power is present If no display after 2 mins remove power, remove control unit cover and check internal connections	OFF Wait for 2 minutes a)if no display remove power, remove control unit cover and check all internal connections. b)If display comes on replace ON indicator
	e)Check 3 green DC power indicators on power distribution board.	all ON go to 1K)	one or more off. Check relevant fuses on power distribution board.
	f)Remove interface board and PLD on power distribution	all 3 green indicators ON	one or more off - Replace Power Distribution board
	g)Replace PLD on power distribution board	all 3 green indicators ON	if +12v indicator off Replace VDU driver board at L.H.S. of unit.
	h)Replace Interface board and remove PLD on interface board	all 3 green indicators ON	if +5v OR 12VI indicator off. Replace interface board.

SYMPTOM	CHECK	NORMAL	ABNORMAL
	j)Replace PLD	all 3 green indicators ON	+5v indicator OFF- Replace Processor/ Keyboard
	k)Ensure PROGRAMME switch set to MANUAL. Depress Green On switch above STOP switch.	Stepper Motors should 'energise'	Stepper Motors do not energise goto m
	l)Press 'ZERO' Key	Machine moves towards Zero. Press PROG STOP Key. Check wiring to VDU. Replace VDU driver board at L.H.S of unit. Replace PNC3-VDU board.	go to H Nothing happens - replace processor board.
	m)Check green indicators at lower L.H.S. of unit	all On Remove power Check Motor connections X,Y,Z as applicable at rear of drive on PCB	one only off- Check relevant fuse on PCB on rear of drives. All off - proceed
	n)check 2 green supply indicators on PCB at rear of drives	both on	one or more off - check fuses on PCB. and supply
	p)check Red indicators on Drives	all OFF	one or more ON - consult Drive handbook Section 5
Unit Displays RAM ERROR when switched ON	Remove Outer cover and front panel and replace Processor/ Keyboard		

SYMPTOM	CHECK	NORMAL	ABNORMAL
Unit Displays XX Keypressed when switched ON	Remove Outer cover and front panel and replace respective Key on Processor/Keyboard OR replace Processor/Keyboard.		
Machine fails to Move when 'ZERO' pressed	Does display change when ZERO is first pressed to 'machine moving to datum'	YES Remove outer cover, check all connections, go to m.	Display does not change proceed, OR if error message displayed see error messages.
	Ensure display indicates Manual Mode	MDI shown at top Right of VDU. Carryout Keyboard test - see Built in diagnostics. If OK replace processor/keyboard.	MDI not shown - check setting of PROGRAMME switch should be set to MANUAL. Replace switch.
MACHINE moves when ZERO is pressed but runs into a machine limit before datum is reached	Press PROG.STOP. Carryout checks detailed in system diagnostics by operating respective overtravel switches (if fitted) and by placing a ferrous object over each datum detector in turn.	All relevant port signals should change as indicated in system diagnostics	Any abnormalities should be corrected by a)checking the system wiring b)Replacing the defective component
OTHER FAULTS	Please obtain as much relevant information about the faults as possible and obtain ROM checksums (see 1/ a)? before contacting the supplier.		
Unit Displays 'ROM ERROR' when switched ON	Remove Outer cover and front panel of unit ensure all integrated circuits are 'plugged in' correctly. If fault presists, replace EPROMS. If fault persists Replace Processor/Keyboard.		

1.d) Basic Operation of Control Unit

The PNC3 Control Unit consists of a number of elements housed in a purpose built cabinet. The elements are shown in the Block diagram of the control unit.

Main power either at 220/240vac 50/60hz or at 110/120vac 50/60hz single phase is fed to the power distribution board then via the rear panel mounted 'ON' switch and fuse to the power supply components wich generate DC power for the system.

If the rear panel switch is ON power is supplied via the logic transformer to the +5, +12, 12VI and -8 volt supplies which power the computer section and the VDU.

The +5 +12 and 12VI supplies each have an indicator and a fuse. The +5, 12VI and -8volt supplies supply the computer section. The 12volt supply supplies the VDU unit.

The computer section comprises the interface board, the processor/keyboard, the PNC3 VDU board, the cassette unit and the programme control switches.

The processor/keyboard consists of a 8 bit microprocessor, associated EPROM and RAM together with control logic, and a 61 character keyboard. The processor/keyboard controls all functions and characteristics of the control unit enabling programes defining the components to be produced to be loaded into its memory then edited/stored as desired and executed sequentially one instruction at a time as required. The processor/keyboard also provides all messages to be displayed on the integral VDU which is driven by the VDU drive board via the PNC3 VDU board. The PNC3 VDU board generates the display on the VDU and the display in updated/changed as required by the processor/keyboard.

The interface board contains all the PORTS, up to 4 axes of control electronics, up to 8 input switch monitoring, datum detector monitors, a single analogue output channel, an optional additional RS232 serial port,and a parallel printer port. Optical isolators are fitted to all machine input and output signals to minimize any adverse effects from electrical interferance.

Power to the stepper motor drive system is supplied via the front panel mounted STOP and ON switches, to the drive transformer. The drive transformer and associated components provides +24volts and +55volts DC to power the drive units which in turn power the stepper motors. The drives are high performance bopolar chopper types, CD20 models generally being fitted. The drives have internal protection and fault monitoring circuiting. (For more details consult the DIGIPLAN CD20 instruction manual).

The control system is connected to the machine by the system connections which are generally made through the centre of the machine arm upon which the control unit is mounted.

1/ e) Basic Operation of printed circuit boards.

Power Distribution Board.

The power distribution board contains the latching drives mains relay, the logic power mains filter, the +12volt, +5volt, +12volt isolated and -8volt supplies.

Single phase 110-120vac or 220-240vac 50/60hz is supplied to the PNC3 control unit via the switch and mains fuse F1 mounted on the rear panel. Main power is then taken to the front panel mounted STOP switch, ON switch and ON indicator and also to the mains filter which filters the mains supply to the logic transformer powers supplies.
The logic transformer supplies power for the following supplies:-
a) The +12volt 2 amp supply which powers the VDU drive board and CRT.
b) The +5volt 2.5amp supply which powers the interface, PNC3 VDU and Processor/keyboard printed circuit boards.
c) The 12 volts 1 amp isolated supply which powers optial isolators for the overtravel switches, the input switches, machine datum detectors and relays and also the relay drives.
d) The low current -8volt supply which is used as a negative supply for the RS232 serial link.
Note: Three green indicators on supplies a),b), and c) indicate if the supply is ON.

The latching mains relay latches the stepper motor drive system mains power after the ON switch on the front panel is pressed. The front panel power ON indicator is powered via a diode D1 and resistor R1 from a 110vac supply from the logic transformer.

Interface Board.

The interface board contains the axis movement control electronics, overtravel and stepper motor drive fault monitoring electronics, spindle speed control logic (consisting of an analogue voltage), an RS232 port, auxilliary relays, datum detector monitoring, input switch monitoring, printer control and assign switches.

The numerous facilities of the control unit are arranged as a series of ports. The ports used are:-

Port	Function
0	KM3701 Continuos Path Controller
2	Programmable timer 1
3	Programmable timer 2
4A	Axis step/direction monitoring signals
4B	Axis overtravel and drive fault signals
4C	Axis acknowledge signals and reset signals
4D	Axis boost and direction control signals
5	Enables the auxiliary and spindle speed control functions to operate
6	Optional RS232 link
7	Extension board 1 (option)
8	Auxiliary 1-8 control
9	Auxiliary 9-16 control
A	Spindle speed control (Analouge output)
B	Printer Data
C	Datum Detector and spare monitor signals
D	Input switch monitor signals
E	Unit ansign switch and printer status signals
F	Extension board 2 (option)

A complete list of the port signals is included at 1/ k).
All machine control and monitoring signals are fed via optical isolators thus breaking any direct electrical link between the machine and control unit.

Control of the XY axes is provided by the programmable timers (which control movement speed) and the KM3701 2 axes continuous path controller (which controls the XY axis movement direction).

The Z and 4th axis controller is provided using the programmable timers. Movement of any axis is inhibited if that axis has an overtravel condition in the direction in which movement is attempted or if that axis has a drive fault. Movement pulses produced by the KM3701 are "smoothed" by IC30 which is generally used as a divide by 4 element (dependant on board linking). IC's 15 and 17 are used to provide a movement pulse of approx 25 micro-secs to be compatible with the stepper motor drive unit.

VR1 and VR2 (if fitted) set the maximum speed of movements.

Axis movement is monitored by the control unit enabling the precise position of the machine to be found. Each movement step together with its direction is monitored by the processor via PORTS 4A and 4C. Port 4D is used to control the movement direction of the Z and 4th axis and also sets the axis 'boosts' which are generally used to increase the power fed by the stepper motor drive to the stepper motor during motor accelerations.

Axis overtravel signals provided by optional machine mounted switches are fed via optical isolators to the axis overtravel logic which monitors the overtravel switches dependant on the direction of machine movement required. The resultant signals are used to enable/disable the output step signals to the relevant axes and the signals are also taken to port 4D.

The stepper motor drives fitted provide a fault signal if a drive/motor fault is detected. The fault signals are fed via optical isolators to also enable/disable the output step signals to the reteuant axes and to PORT 4D enabling the processor to monitor the signals.

The data bus buffering/control and port decoding provide the necessary signals to enable the other components on the interface board to function correctly.

The spindle speed control is accomplished by PORT A, optical isolators IC59 to IC62, IC64 a low power digital to analouge convertor and IC's 63, 65 low power op-amps. IC's 59 to 65 are powered by the supply provided by the spindle speed control unit which is external to the PNC3 controller, a 10 to 12v DC supply of typically 2milliamps being required. VR3 enables the output signal on PLH pin 3 to be set. (This control is factory set to provide the required maximum speed when the control is demanding maximum speed.)

The optional additional RS232 Serial Link uses an 8251 Serial Controller.

Ports 8 and 9 are used to control relays via optical isolators and high current relay driver circuits. Relays 1 to 10 and 14 to 15 are conventional relays capable of switching 1amp. Relays 11 to 13 are Solid State Relays which can switching only AC current up to 1 amp and are ideally switched to switching power to inductive loads because these relays are zero voltage switches.

Both the spindle speed control and auxiliary control have the added protection of only functioning if the processor has accessed Port 5 after initial power up. At power up IC1 pt2 is reset removing the output enable from PORTS 8,9 and A thus disabling them. The outputs are enabled when the processor accesses PORT 5 and sets IC1 driving the o/p ON signal low.

Datum detector signals are derived from a proximity detector equivilant to the TURCK Bi 1 G08 YO. The proximity detectors are the inductive type. When no metal is detected the detector stops oscillating and acts as a high resistance. When metal is detected the detector acts as a low resistance. The detectors are powered by approx 8volts from the PNC3 control unit.

Signals from the detectors are fed via transistor amplifiers then via optical isolators to PORT D.

Printer data is fed via PORT B to the printer connector on the rear of the control unit. The printer strobe signal is produced by PORT 4D bit 4. Printer status is monitored by PORT E which is connected to the printer BUSY and ACK signals. PORT E is also used by the 6 control asign switches which are used to select certain facilities of the control unit.

processor / Keyboard.

The Processor/keyboard controls all PNC functions i.e. data input and display, machine status monitoring and display, machine positioning/control and cassette unit control.

At the heart of the processor board is an 8085 8 bit microprocessor. The microprocessor sequentially obeys instructions contained in the Electrically Programmable Read Only Memory (EPROM). These instructions which are put into the EPROM's during manufacture are stored in a coded form. The instructions characterize and control all of the operations which the control unit is capable of.

Random Access Memory (RAM) is read/write memory, this is used to store both data required by the EPROM programme and also positioning, spindle control, auxilliary and input section information.

The cassette control ports control the storage and retrieval of data to/from the integral digital cassette unit.

The programme control switch port enables the settings of the programme control switches to be monitored.

The processor/keyboard also includes a 61 character keyboard which is monitored by the 8085 microprocessor via the keyboard ports. The keyboard is multiplexed by the output port P2W and keypressed data is read by the input port P1R.

The 8085 microprocessor communicates with the PNC3 VDU board via connector C and with the INTERFACE board via connector D.

All control signals, address, data and restart signals are buffered.

Basic Operation of PNC3 VDU Board

The PNC3 VDU board generates the composite video signals to produce the VDU display.

The PNC3 VDU board consists of address, control and data bus buffers/decoders, a character generator/data interface, page memory, extended character generator memory and buffer decoders, a video interface and display clock, and a video driver.

Characters to be displayed together with their attributes e.g. reverse video, are stored in page memory which stores 25 rows of 40 characters. The memory is arranged to be 1K x 16 bits. The video display is generated by the display clock and video interface which accesses sequential locations of page memory to determine which character is to be displayed together with its attributes. Data determining the formation of each character is obtained by the video interface either from the character generator or from the extended character generator memory dependant upon a character definition attribute bit.

Characters to be displayed are stored in page memory into their correct display position by the Processor/Keyboard via the buffers/decoders and the data interface. These characters may be read by the processor/keyboard using the same components.

The video driver combines the full intensity and half intensity signals with the picture sync signals to produce 1v composite video on two output lines one of which is connected to the VDU driver board and the other to the extension video socket on the rear of the control unit.

1/ j) PNC3 Internal Connections

PROCESSOR BOARD CONNECTORS

PLA - PROGRAM CONTROL SWITCHES

PIN	SIGNAL
1	/SINGLE STEP
2	/START
3	MAN/AUTO
4	/STOP
5	0VOLTS

SKE - CASSETTE UNIT SIGNALS

PIN	SIGNAL
1	POLARISING
4	DATA TO CASSETTE
5	/CASS PRESS
6	WR/RD
7	/FILE PROTECT
8	+5V
9	0V
10	EARTH
11	RWD/FWD
12	SL/FST
13	DATA FROM CASSETTE
14	CL LDR
15	STOP/GO
16	+5V

PROCESSOR BOARD CONNECTORS

CONNECTOR C - PNC3 VDU BOARD CONNECTOR

PIN	SIGNALS		
	ROW A (RH)	ROW B	Row C (LH)
1	+5V	+5V	+5V
2	SPARE	SPARE	RDY
3	HOLD	SPARE	SPARE
4	RSTOUT	/WR	CLK
5	IO/M	/INTA	/RD
6	HOLDA	ALE	D7
7	D6	D5	D4
8	D3	D2	D1
9	D0	A15	A15
10	A14	A13	A13
11	A12	A11	A11
12	A10	A9	A9
13	A8	A0	A1
14	A2	A3	A4
15	A5	A6	A7
16	0V	0V	0V

PROCESSOR BOARD CONNECTORS

CONNECTOR D

PIN	SIGNAL LHROW	PIN RHROW	SIGNAL
1	+5V	26	+5V
2	SER IN	27	SER OUT
3	RST 7.5	28	RST 6.5
4	RST 5.5	29	INTR
5	SPARE	30	SPARE
6	SPARE	31	SPARE
7	RDY	32	HOLD
8	SPARE	33	SPARE
9	RST OUT	34	/WR
10	CLK	35	IO/M
11	/INTA	36	/RD
12	HOLD A	37	ALE
13	D7	38	D6
14	D5	39	D4
15	D3	40	D2
16	D1	41	D0
17	A15	42	A14
18	A13	43	A12
19	A11	44	A10
20	A9	45	A8
21	A0	46	A1
22	A2	47	A3
23	A4	48	A5
24	A6	49	A7
25	0V	50	0V

INTERFACE BOARD CONNECTORS

SKA - EXTENSION BOARD 1

PIN	SIGNAL
1	+5V
2	DB7
3	DB6
4	DB5
5	DB4
6	DB3
7	DB2
8	DB1
9	DB0
10	/P7
11	/WR
12	/RD
13	A9
14	A8
15	SPARE
16	0V

SKB - AXIS OVERTRAVEL SIGNALS

PIN	SIGNAL
1	OVI
2	-XOT
3	+XOT
4	-YOT
5	+YOT
6	POLARISING
7	-ZOT
8	+ZOT
9	-WOT
10	+WOT

INTERFACE BOARD CONNECTORS

PLC - STEPPER MOTOR DRIVE SIGNALS

PIN	SIGNAL
1	OV DRIVE
2	+24V DRIVE
3	X DRIVE FAULT
4	X BOOST
5	X DIRN
6	X STEP
7	OV DRIVE
8	
9	Z DRIVE FAULT
10	Z BOOST
11	Z DIRN
12	Z STEP
13	
14	OV DRIVES
15	+24V DRIVE
16	Y DRIVE FAULT
17	Y BOOST
18	Y DIRN
19	Y STEP
20	OV DRIVE
21	
22	T DRIVE FAULT
23	T BOOST
24	T DIRN
25	T STEP
26	

PLD - SEE PROCESSOR BOARD CONNECTORS - CONNECTOR D

INTERFACE BOARD CONNECTORS

SKE - DC POWER SUPPLIES

PIN	SIGNAL
1	12VI
2	12VI
3	OVI
4	OVI
5	-8V
6	
7	
8	
9	+5V
10	+5V
11	+5V
12	+5V
13	OV
14	OV
15	OV
16	OV

PLF - OPTIONAL ADDITIONAL (RS232 LINK)

PIN	SIGNAL
1	-
2	/TXD
3	/RXD
4	RTS
5	CTS
6	DSR
7	OV
20	DTR

INTERFACE BOARD CONNECTORS

PLG - AUXILLIARY FUNCTION CONNECTIONS

PIN	SIGNAL	
1	AUX 10 N/O	
2	AUX 9 N/O	
3	AUX 2 N/O	
4	AUX 1 N/O	
5	AUX 11-14 COMMON	*
6	AUX 9,10 COMMON	
7	AUX 1-4 COMMON	
8	AUX 3 N/C	
9	AUX 12 N/O	
10	AUX 11 N/C	
11	AUX 3 N/O	
12	AUX 4 N/O	
13	AUX 14 N/O	*
14	AUX 13 N/O	*
15	AUX 6 N/O	
16	AUX 5 N/O	
17	AUX 16 N/C	
18	AUX 15,16 COMMON	
19	AUX 5,6 COMMON	X
20	AUX 6 N/C	
21	AUX 16 N/O	X
22	AUX 15 N/O	
23	AUX 8 N/O	
24	AUX 7 N/O	

* These auxilliaries are SOLID STATE RELAYS suitable for 110-240vac only

X LINKS may be made a PCB changing the function of these pins

PLH - ANALOGUE OUTPUT (Normally Spindle Control)

PIN	SIGNAL
1(LH)	10 - 12V DC
2	-
3	ANALOGUE OUT
4	-
5(RH)	OV DC

SKJ - Extension Board Connector
As SKA but pin 10 is /PF

SKK - INPUT SWITCH SIGNALS

PIN	SIGNAL
1	OVI
2	POLARISING
3	INPUT 0
4	INPUT 1
5	INPUT 2
6	INPUT 3
7	INPUT 4
8	INPUT 5
9	INPUT 6
10	INPUT 7

PLL - SPARE SIGNALS

PIN	SIGNAL
2	OVI
2	-
3	-
4	SPARE 0
5	SPARE 1
6	SPARE 2
7	SPARE 3
8	-

INTERFACE BOARD CONNECTORS

SK11 - RS232 LINK

PIN	SIGNAL
2	0VOLTS
6	SERIAL DATA FROM PNC3
7	SERIAL DATA TO PNC3

PLN - DATUM DETECTOR SIGNALS

PIN	SIGNAL
1	8VI
2	SPARE INPUT
3	X AXIS DATUM
4	Y AXIS DATUM
5	Z AXIS DATUM
6	T AXIS DATUM

PLP - PRINTER SIGNALS

PIN	SIGNAL
1	DATA STROBE
2	DATA 0
3	DATA 1
4	DATA 2
5	DATA 3
6	DATA 4
7	DATA 5
8	DATA 6
9	DATA 7
10	/ACK
11	BUSY
14-25	0 VOLTS

1/ k) PNC3 PORT DETAILS

Processor/Keyboard Ports

PVDU	Addr C0 - C4	VDU Controller I/O
P0R	Addr D8	I/P Cassette status, PROGRAMME switches

Bit Allocation:-

7	6	5	4	3	2	1	0
/STOP	/AUTO	/START	CLR.LDR	DATA IN (FROMCASS)	CASS. PRES.	FILE PROTECT	/S.STEP

P0W	Addr D8	O/P Cass. Control

Bit Alloc:-

7	6	5	4	3	2	1	0
Spare	ExtMem ACC	Spare	DataOut (ToCass)	Slow Fast	Rewind Forward	WR RD	Stop Go

P1R	Addr D9	Keyboard Inputs (row signals)
P2W	Addr DA	Keyboard Output Digit Selects

Interface Board Ports

P01	Addr A0 - A7	KM3701 I/O (Note KMreset is on P4C bit 6)
P2	Addr A8 - AB	Range Timer (I/O)
P3	Addr AC - AF	Feed Timer (I/O)
P4A	Addr B0	Step and Dirn I/P's

Bit Allocation:-

7	6	5	4	3	2	1	0
$Tdir^n/n$	$Zdir^n/n$	$Ydir^n/n$	$Xdir^n/n$	Tstepin	Zstepin	Ystepin	Xstepin

P4B	Addr B1	Overtravels and Drivefaults

Bit Allocation:- -VE LOGIC

7	6	5	4	3	2	1	0
/Tdrive fault	/ZDF	/YDF	/XDF	/Tover travel	/ZOT	/YOT	/XOT

P4C	Addr B2	Axes ACK, KMRESET, CLK Select (O/P's)

Bit Allocation:-

7	6	5	4	3	2	1	0
CLKSEL	KMRES	Spare	Spare	TACK	ZACK	YACK	XACK

P4D	Addr B3	Axes BOOSTS, Z & T DIRNS, Printer Strobe (O/P's)

Bit Allocation:0

7	6	5	4	3	2	1	0
Tdirn	Zdirn		Printer Strobe	/Tboost	/Zboost	/Yboost	/Xboost

P5 Addr B4 Latch to initiallise Ports 8,9,A

P6 Addr B8 - B9 8251A Serial Port (I/O)

P7 Addr BC - BF 1st (Upper) Extension Board

P8 Adder 80 O/ Auxilliarys 0 - 7

Bit Allocation:- -VE LOGIC

7	6	5	4	3	2	1	0
AUX7	AUX6	AUX5	AUX4	AUX3	AUX2	AUX1	AUX0

P9 ADDR 84 O/P Auxilliarys 8 - 15

Bit Allocation:- -VE LOGIC

7	6	5	4	3	2	1	0
AUX15	AUX14	AUX13	AUX12	AUX11	AUX10	AUX9	AUX8

PA Addr 88 O/P Spindle Speed

Bit Allocation:- -VE LOGIC

7	6	5	4	3	2	1	0
MSB							LSB

PB Addr 8C O/P Data to printer

Bit Allocation:-

7	6	5	4	3	2	1	0
DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0

PC Addr 90 I/P Machine datums and spare inputs

Bit Allocation:-

7	6	5	4	3	2	1	0
ZMKR	ZMKR	YMKR	XMKR	SPARE	SPARE	SPARE	SPARE

PD Addr 94 I/P Switches

Bit Allocation:- -VE

7	6	5	4	3	2	1	0
I/P7	I/P6	I/P5	I/P4	I/P3	I/P2	I/P1	I/P0

PE Addr 98 I/P Printer Status, Assign Switches

7	6	5	4	3	2	1	0
PRINTER /ACK	PRINTER BUSY	SWA6	SWA5	SWA4	SWA3	SWA2	SWA1

PF Addr 9C - 9F 2nd (Lower) Extension Board

2/ a) Built in machine diagnostics.

The Control Unit has a built in machine diagnostic program which enables the maintenance engineer to test all machine mounted switches and detectors together with their associated wiring.

All signals to and from the control unit are organised into ports each of which is generally 8 bits wide.

Signals received by the control unit may be checked by:-

a) Removing power from the control unit
b) Switching the control unit ON
c) Setting the programme switch to MANUAL
d) Depressing the T (Test) Key
e) At this point all signals necessary for the correct operation of the control unit are displayed in a 'port map'. Each of the ports together with the function of each of the bits is detailed in section 1,a,3.

2/ k) PNC3 Auxilliary Board Information.

The PNC3 Ancilliary board is a printed circuit board which may be mounted in single phase powered systems and contains compenents associated with the mains supply.

Connector Details:-

1) SKA connects to the mains connector CO1 from PNC3 pins 1 to 11.

2) 12 way connector block TB1 signals:-

pin 1,2,3 - Earth, live and neutral (220v-240v AC)
4 - Earth
5 - 0v (24vac supply)

6 - 24vac if PNC3 is on
7 - Earth
8 - LUBA
9 - LUBB
10 - Earth

11 - CLNTA
12 - CLNTB

Notes

LUBA and LUBB signals may be used in 2 ways

a) For single phase lubricantion system (if option is fitted) LUB relay R3 is fitted and this relay switches the live (via the LUB fuse) and the neutral to LUBA and LUBB terminals respectively. S1 and LUB FUSE are fitted.

b) For 3 phase lubrication systems (if option is fitted) LUB relay R3 is not fitted and links are fitted i.e. pin 3 is linked to 4 and pin 7 is linked to 8. LUB fuse is not fitted suppresor S1 is fitted (pins of relay base are counted clockwise from pin 1).

CLNT A are CLNT B signals:- above comments apply except that the coolant relay is R2, suppresor is S2 and fuse is labelled CLNT.

PLB This plug connects to the 24v transformer.

TB2 This terminal block provides signals for the low volt lamp.

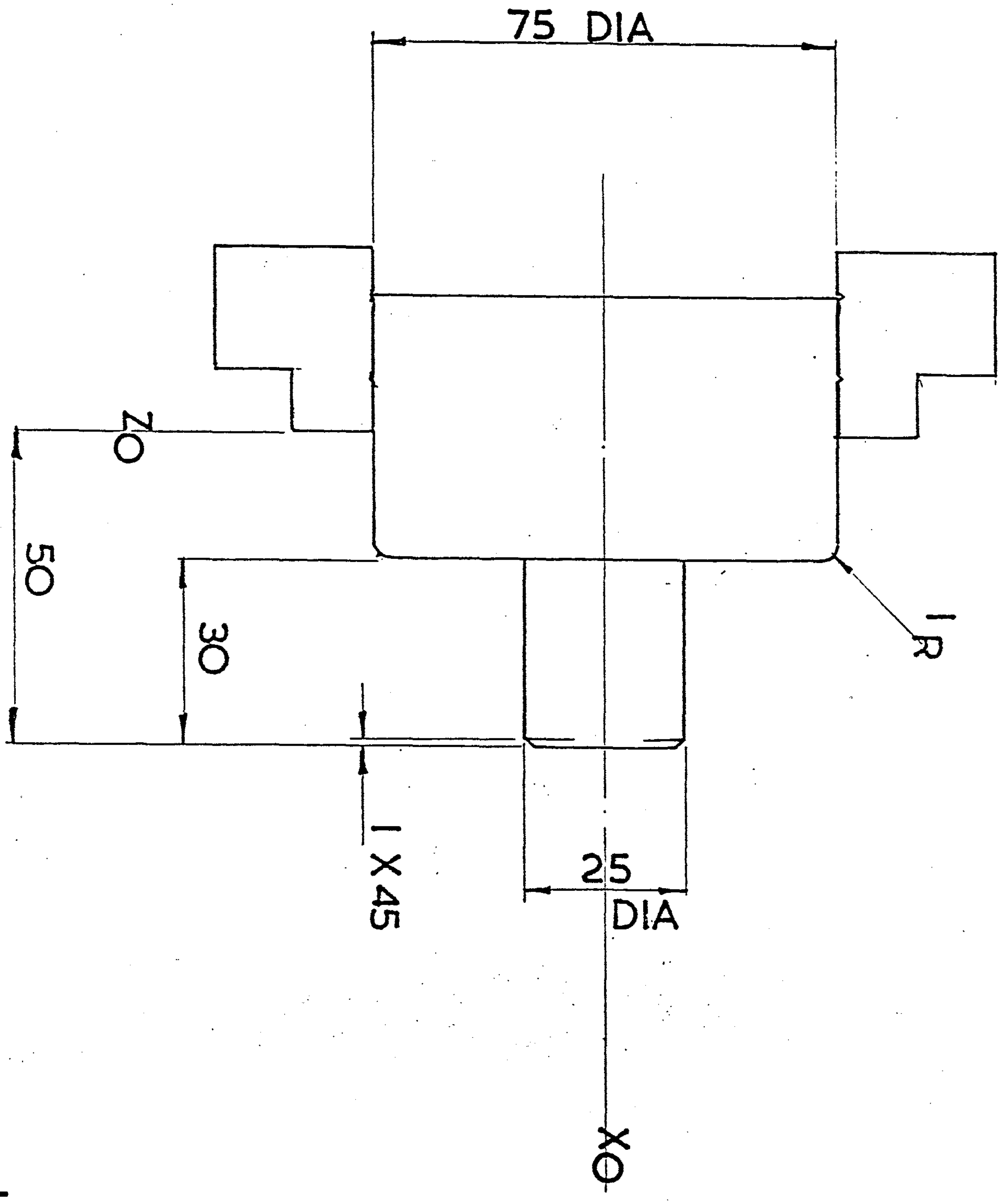
L1 Indicates if 24vac is ON.

DRAWING No.	1
DESCRIPTION	TEST PIECE
PROGRAMME No.	1
MATERIAL	MILD STEEL
PROGRAMME BY	
DATE	7.10.83

EASITURN 3

TOOLING & SETTING DATA

N	G	M	X	Z	X Z FEED	CIRCULAR MOVEMENT XC	CIRCULAR MOVEMENT ZC	REMARKS
01	71							MM UNITS
02		06						TOOL 1
03		08						COOLANT ON
04		03						SPEED 900
05	00		36.5	53.0				RAPID TRAVERSE
06	01			20.2	60			
07	01		37.0		300			
08	00			53.0				RAPID TRAVERSE
09	81		REPEAT	START BLOCK 5	END BLOCK 8 REP 19 X - 1.25			
10	01		11.5	53.0				
11	01			50.0	120			
12	01		12.5	49.0	90			
13	01			20.0				
14	01		36.5					
15	02		37.5	19.0		36.5	19.0	CIRCULAR CLW
16	00		75.0	100.0				RAPID TRAVERSE
17		05						SPINDLE OFF
18		09						COOLANT OFF
19		02						END OF PROGRAM.



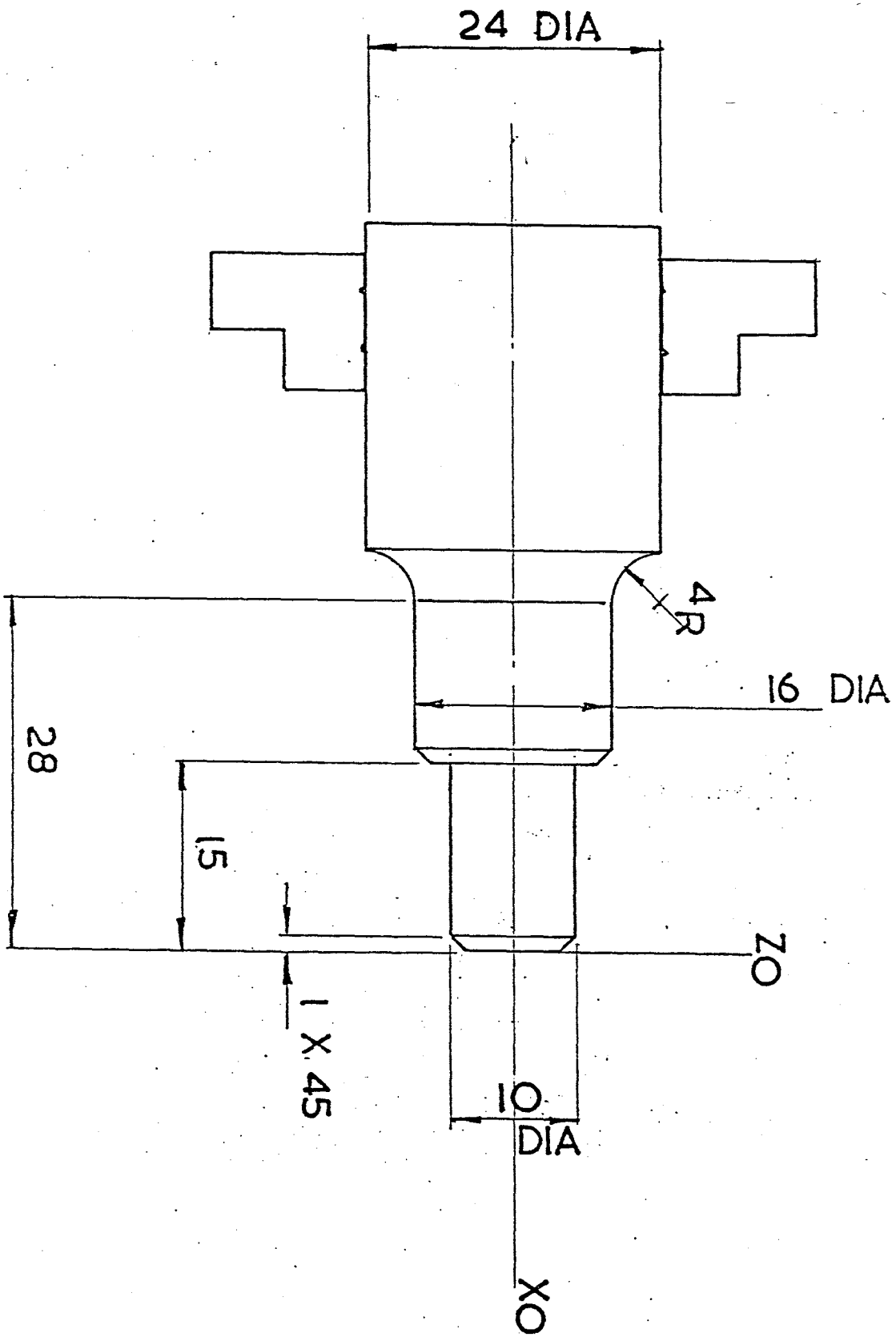
DRG Nº 1

DRAWING No.	2
DESCRIPTION	TEST PIECE 2
PROGRAMME No.	2
MATERIAL	MILD STEEL
PROGRAMME BY	
DATE	7.10.83

EASITURN 3

TOOLING & SETTING DATA

N	G	M	X	Z	X Z FEED	CIRCULAR MOVEMENT XC	CIRCULAR MOVEMENT ZC	REMARKS
01	71							MM UNITS
02		06						TOOL 1
03		03						SPEED 1400
04		08						COOLANT ON
05	00		50.0	50.0				RAPID TRAVERSE
06	01		10.0	3.0				
07	01			-28.0	90			
08	03		12.0	-30.0		12.0	-28.0	CIRCULAR ACLW
09	00							RAPID TRAVERSE
10	01		8.0					
11	01			-15.0	90			
12	01		8.5					
13	01			-28.0				
14	03		12.0	-31.5		12.0	-28.0	
15	00			3.0				RAPID TRAVERSE
16	01		5.5					
17	01			-15.0	90			
18	01		6.0		300			
19	00			3.0				RAPID TRAVERSE
20	01		0.0					
21	01			0.0	150			
22	91							INCREMENTAL
23	01		4.0		90			
24	01		1.0	-1.0				
25	01			-14.0				
26	01		2.0					
27	01		1.0	-1.0				
28	01			-12.0				
29	03		4.0	-4.0		4.0	0.0	
30	90							
31	00		50.0	50.0				RAPID TRAVERSE
32		05						SPINDLE OFF
33		09						COOLANT OFF
34		02						END OF PROGRAM.



DRG No. 2

DRAWING No.	3
DESCRIPTION	TENSILE TEST PIECE
PROGRAMME No.	3
MATERIAL	MILD STEEL
PROGRAMME BY	
DATE	7.10.83

EASITURN 3

TOOLING & SETTING DATA

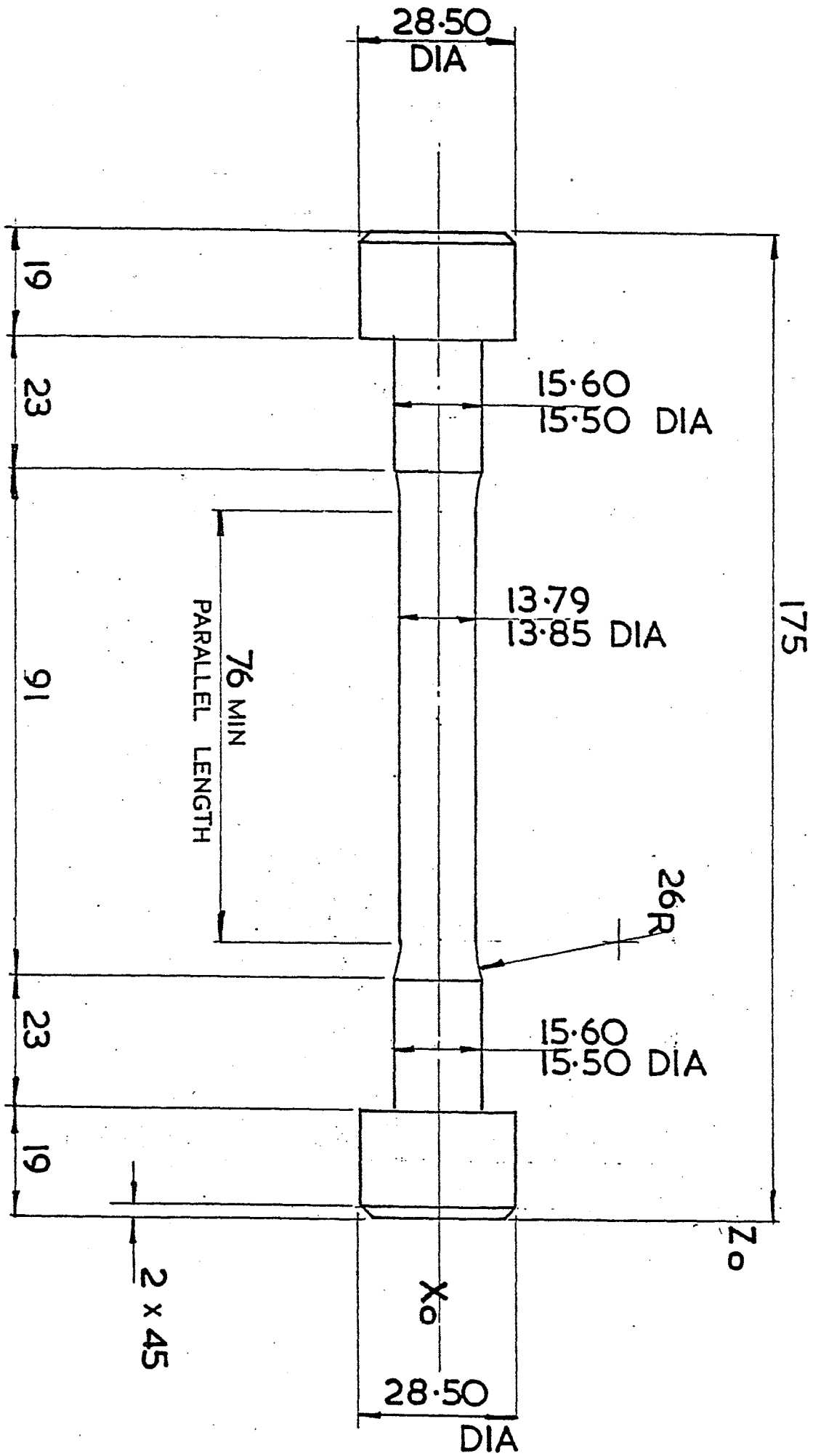
N	G	M	X	Z	X Z FEED	CIRCULAR MOVEMENT XC	CIRCULAR MOVEMENT ZC	REMARKS
01		06						TOOL 1
02		03						SPEED 1300
03		08						COOLANT ON
04	00		16.0	-20.0				RAPID TRAVERSE
05	01		14.25		75			
06	01		12.25	-22.0	45			
07	01			-153.0	75			
08	01		14.25	-155.00				
09	00			-20.00				RAPID TRAVERSE
10	01		10.0	-24.0	45			
11	01			-150.75	75			
12	01		14.25	-155.00				
13	00			-20.0				RAPID TRAVERSE
14	01		8.0	-26.25	45			
15	01			-148.75	75			
16	01		14.25	-155.0				
17	00		50.0	-27.0				RAPID TRAVERSE
18		06						TOOL 2
19	01			-31.0	750			
20	00		8.5					RAPID TRAVERSE
21	01		7.775		30			
22	01			-42.0	75			
23	03		6.91	-48.65		32.91	-48.65	CIRCULAR ACLW
24	01			-126.35				
25	03		7.775	-133.00		32.91	-126.35	CIRCULAR ACLW
26	01			-148.00				
27	00		50.0					RAPID TRAVERSE
28	01			0				
29		06						TOOL 3
30	00			-32.8				RAPID TRAVERSE
31	01		14.25	-32.8				
32	01		7.775		30			
33	00		14.25					RAPID TRAVERSE
34	81		REPEAT	ST. BLOCK	31	END BLOCK 33		REPEAT 1 Z3
			CONTINUED					

DRAWING No.	3
DESCRIPTION	TENSILE TEST PIECE
PROGRAMME No.	3
MATERIAL	MILD STEEL
PROGRAMME BY	
DATE	7.10.83

EASITURN 3

TOOLING & SETTING DATA

N	G	M	X	Z	X Z FEED	CIRCULAR MOVEMENT XC	CIRCULAR MOVEMENT ZC	REMARKS
35	81		REPEAT	START BLOCK	31	END BLOCK	33	REPEAT 1 Z-120.2
36	81		REPEAT	START BLOCK	31	END BLOCK	33	REPEAT 1 Z-123.2
37	01		50.0	0	1500			
38		09						COOLANT OFF
39		05						SPINDLE OFF
40		02						END OF PROGRAM.


28·50
DIA
19
23
15·60
15·50 DIA
91
76 MIN
PARALLEL LENGTH
13·79
13·85 DIA
175
26R
23
15·60
15·50 DIA
19
2 x 45
Zo
Xo
28·50
DIA

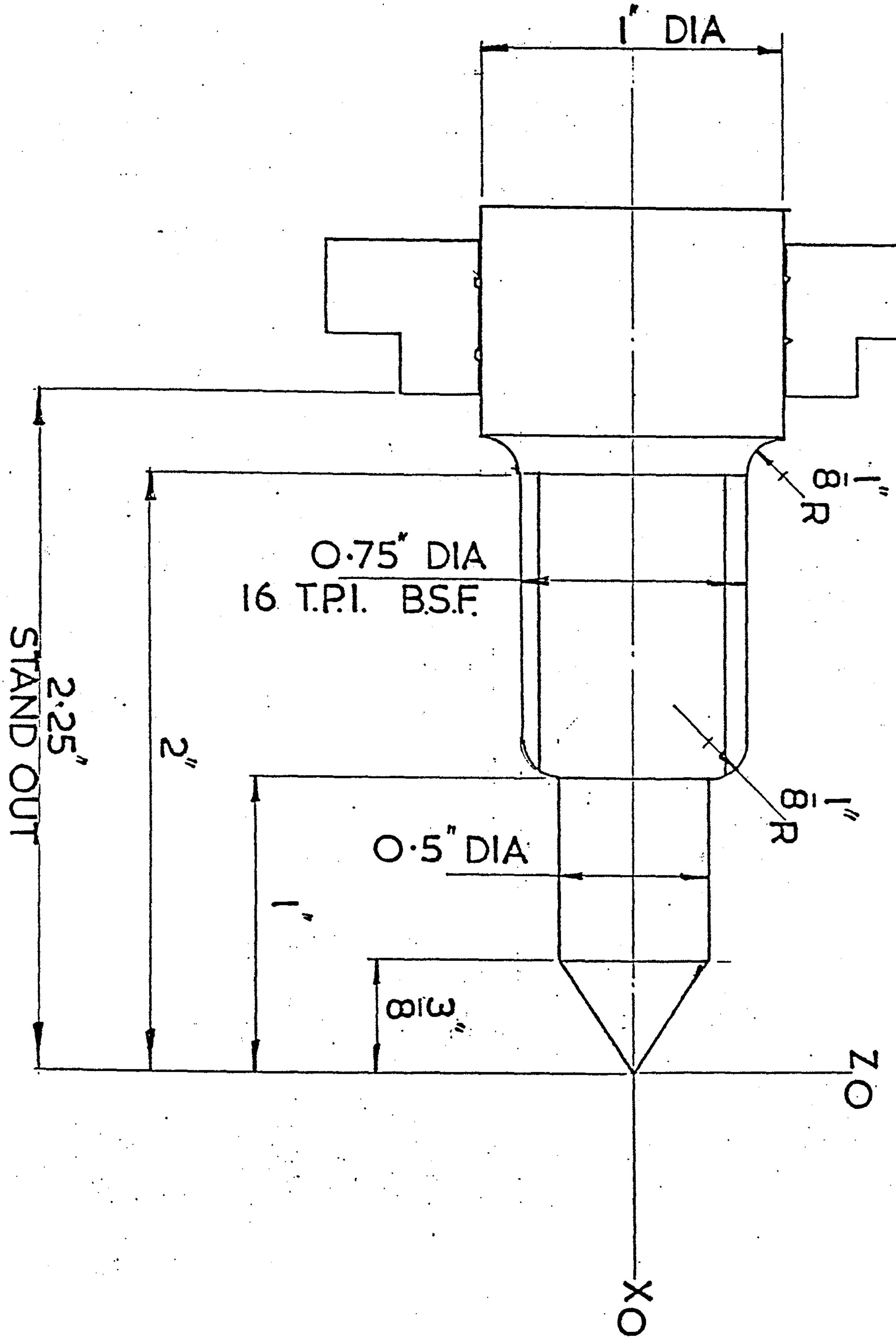
DRG No. 3

DRAWING No.	4
DESCRIPTION	EX.4.
PROGRAMME No.	4
MATERIAL	MILD STEEL
PROGRAMME BY	
DATE	7.10.83

EASITURN 3

TOOLING & SETTING DATA

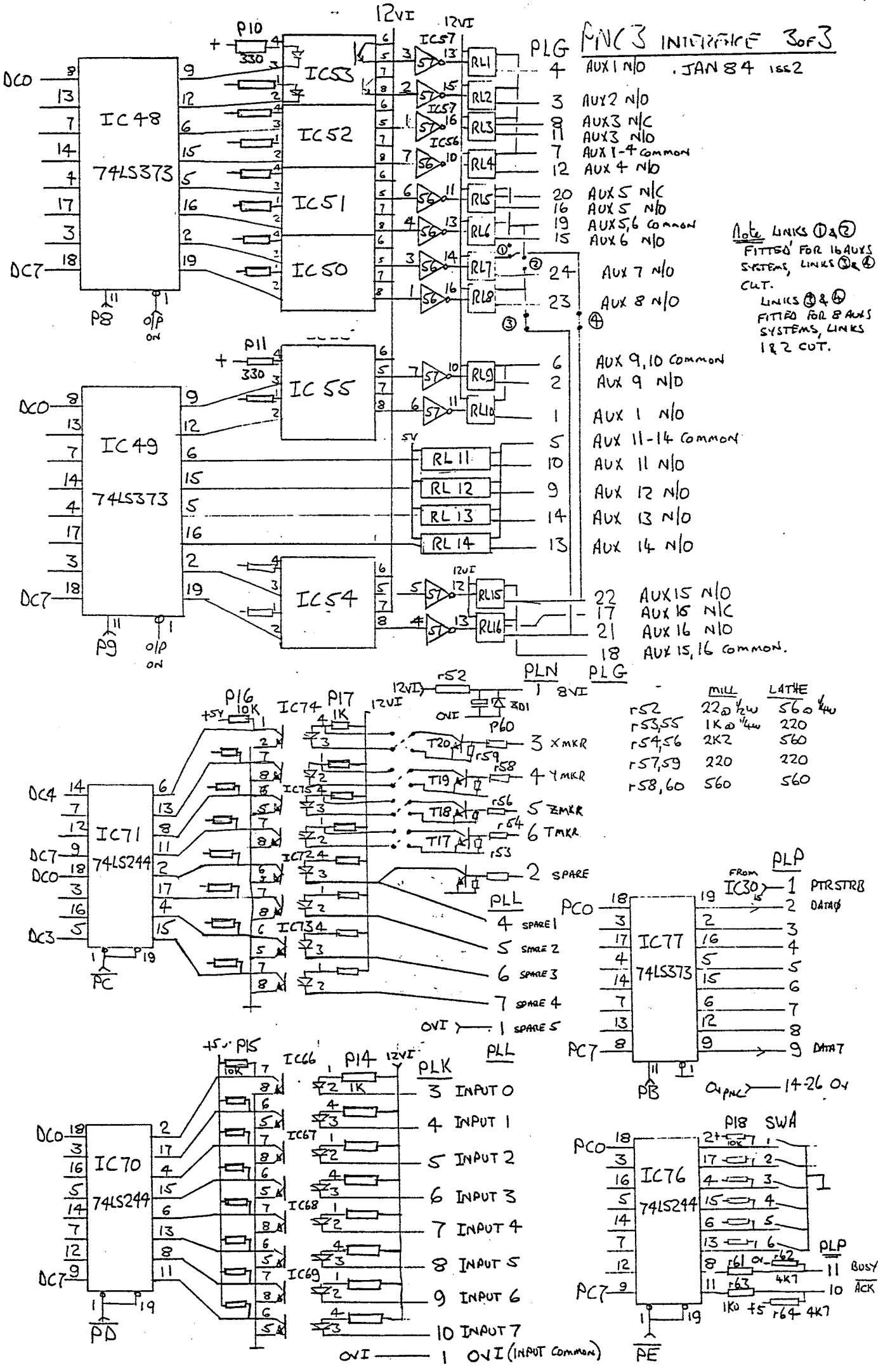
N	G	M	X	Z	X Z FEED	CIRCULAR MOVEMENT XC	CIRCULAR MOVEMENT ZC	REMARKS
01	71							INCH UNITS.
02		06						TOOL 1
03		03						SPEED 1500
04	01		0.40	0.10	60			
05	01			-2.00	3			
06	01		0.500	-2.125				
07	01			0.10	60			
08	01		0.275					
09	01			-1.00	3			
10	01			0.10	60			
11	01		0.1					
12	01			0.00	4			
13	01		0.25	-0.35	1.5			
14	01			0.1	60			
15	01		0.00					
16	01			00	5			
17	01		0.25	-0.375	2.5			
18	01			-1.00				
19	02		0.375	-1.125		0.25	-1.125	CIRCULAR CLW
20	01			-2.00				
21	03		0.50	-2.125		0.50	-2.00	CIRCULAR ACLW
22	01		2.00	1.25	60			
23		06						TOOL 2
24		03						SPEED 400
25	01		0.375	-1.000	60			
26	33		DIA. 0.75"	PITCH'062	DEPTH	0.04	CUTS 18	LENGTH - .75 START -1
27	01		2.0	1.25	60			
28		02						

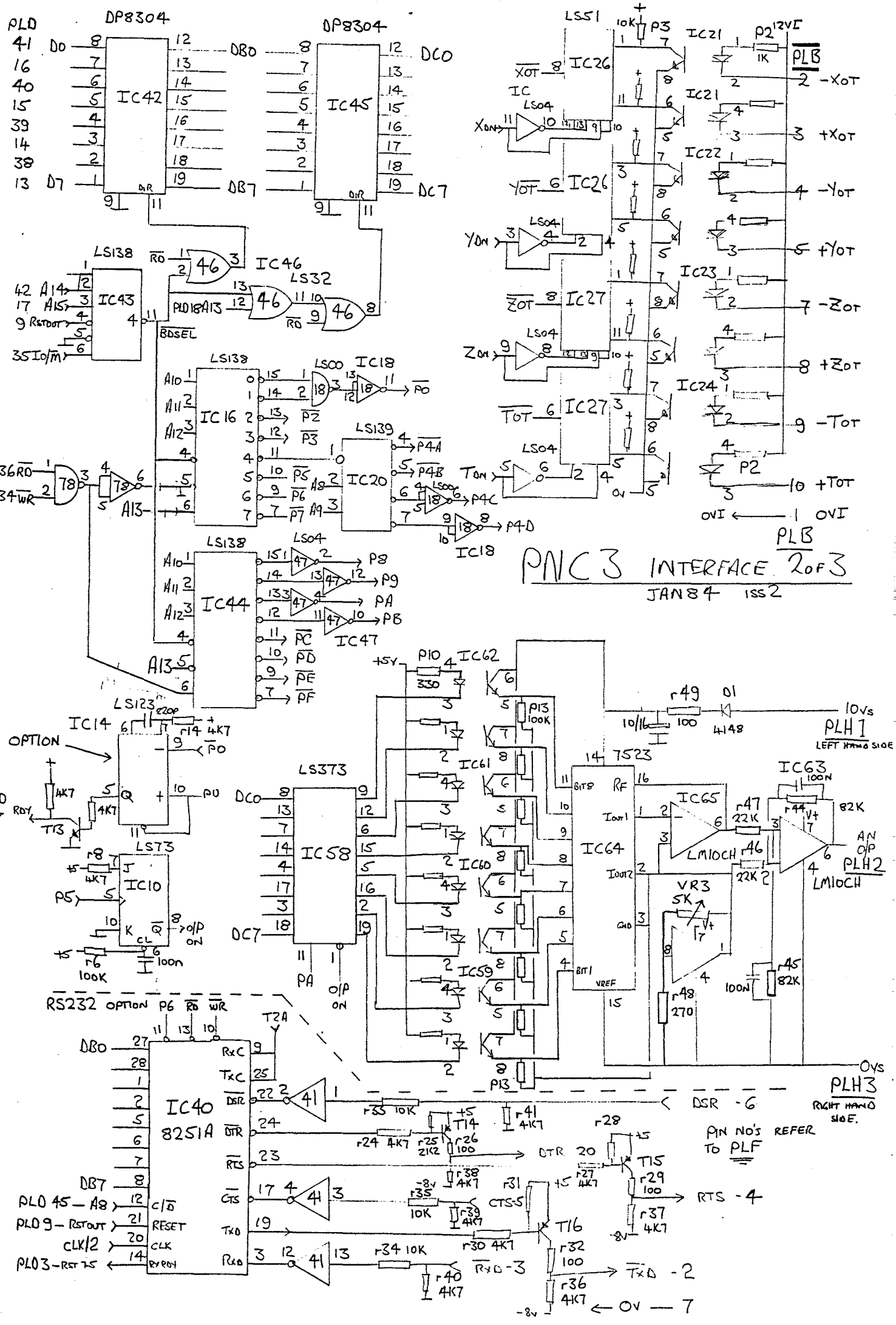


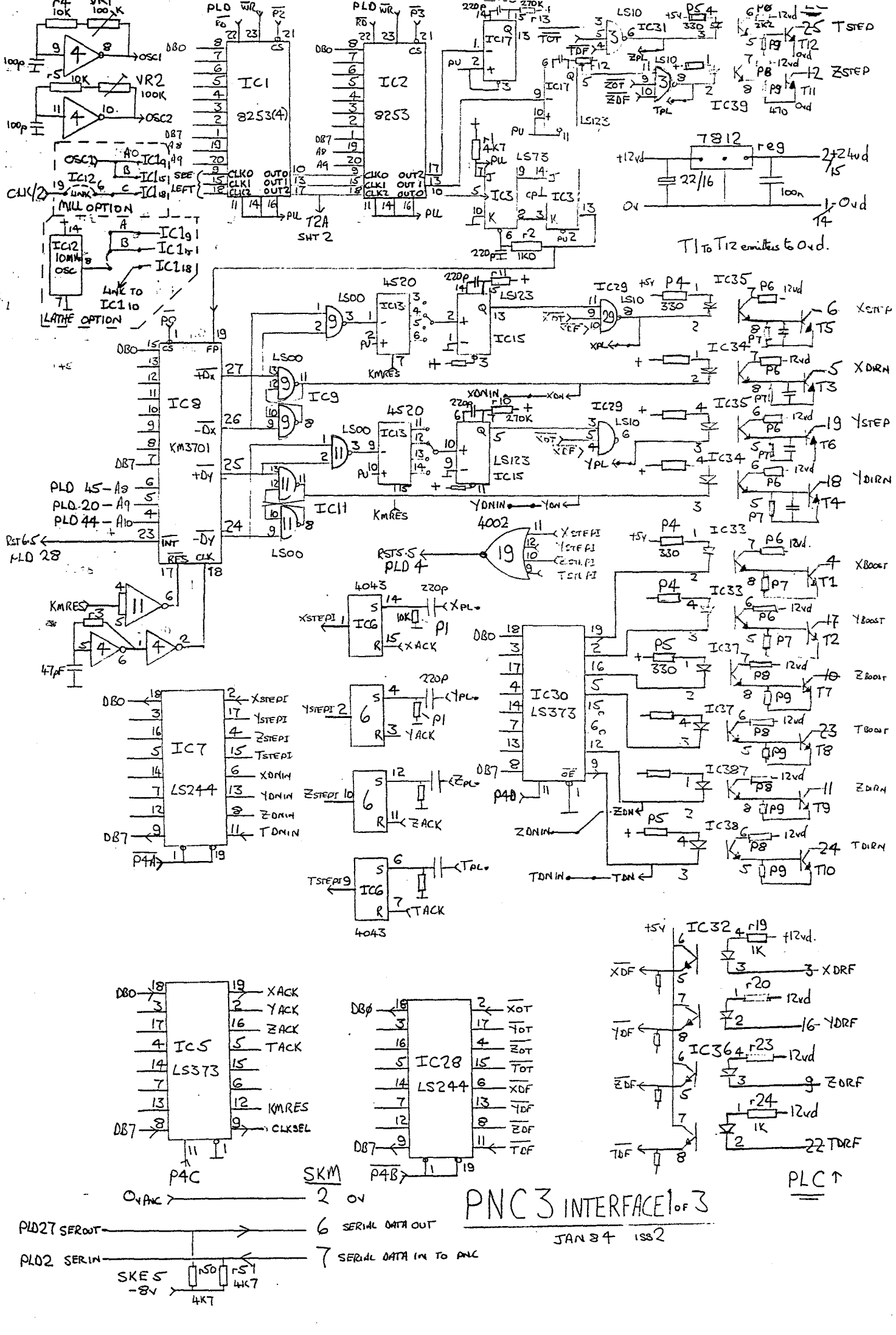
DRG Nº 4

PNC3 INTERFACE 3 OF 3

AUX 1 N/O . JAN 84 ISS2

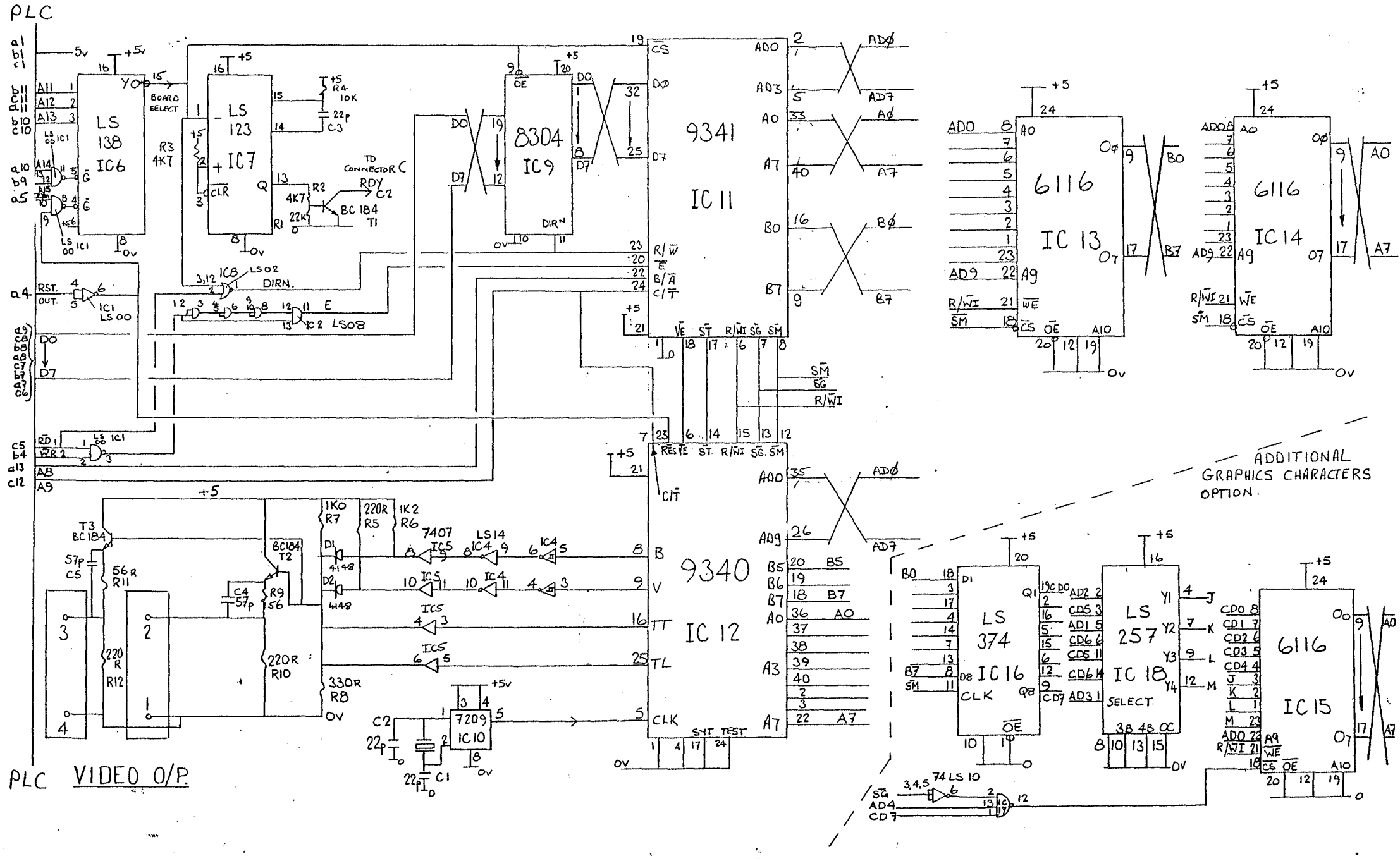


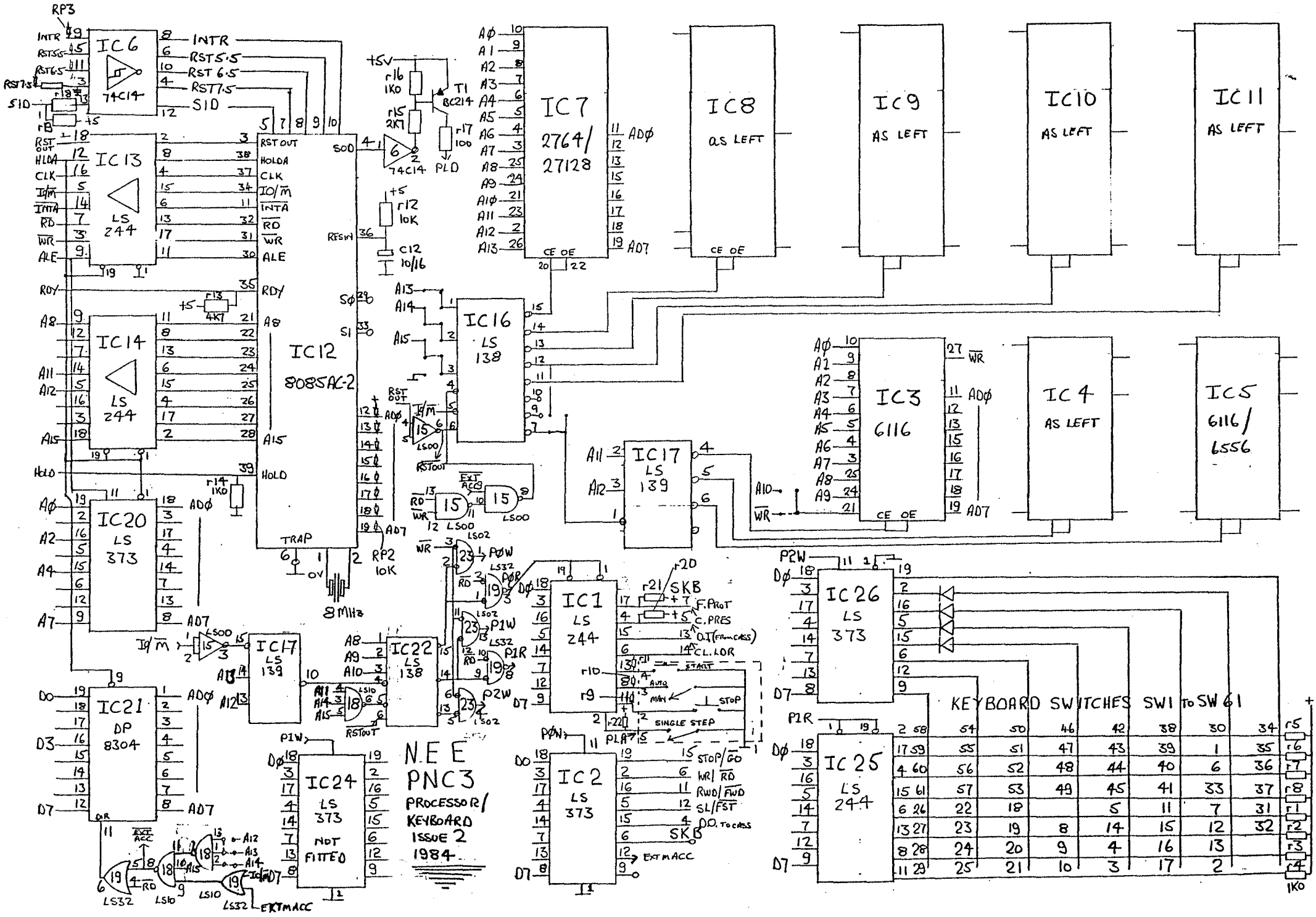

PLD
41
16
40
15
39
14
38
13
DP8304
IC42
DB0
DB7
DP8304
IC45
DC0
DC7
LS138
IC43
LS32
IC46
LS138
IC16
LS00
IC18
LS139
IC20
LS138
IC44
LS04
IC47
LS123
IC14
OPTION
LS373
IC10
LS373
IC58
IC62
IC61
IC60
IC59
7523
IC64
IC65
LM10CH
IC63
LM10CH
VR3
5K
LS51
IC26
IC27
IC21
IC22
IC23
IC24
P2
12VI
PLB
-XOT
+XOT
-YOT
+YOT
-ZOT
+ZOT
-TOT
+TOT
OVI
PLB
PNC3 INTERFACE 2OF3
JAN84 ISS2
PLH1
LEFT HAND SIDE
PLH2
AN O/P
PLH3
RIGHT HAND SIDE.
AN NO'S REFER TO PLF
RS232 OPTION P6 RD WR
IC40
8251A
T24
DSR -6
DTR 20
RTS -4
RXD -3
TXD -2
0V — 7


IC1
8253(4)
IC2
8253
IC8
KM3701
IC9
IC11
IC13
IC15
IC17
IC29
IC31
IC34
IC35
IC39
IC7
LS244
IC5
LS373
IC28
LS244
IC30
LS373
IC32
IC364
IC387
IC38
IC6
4043
4002
7812 reg
MILL OPTION
LATHE OPTION
T1 TO T12 emitters to 0vd.
PNC3 INTERFACE 1 OF 3
JAN 84 ISS2
PLC ↑
SKM
2 0V
6 SERIAL DATA OUT
7 SERIAL DATA IN TO PNC
SKE5
-8V

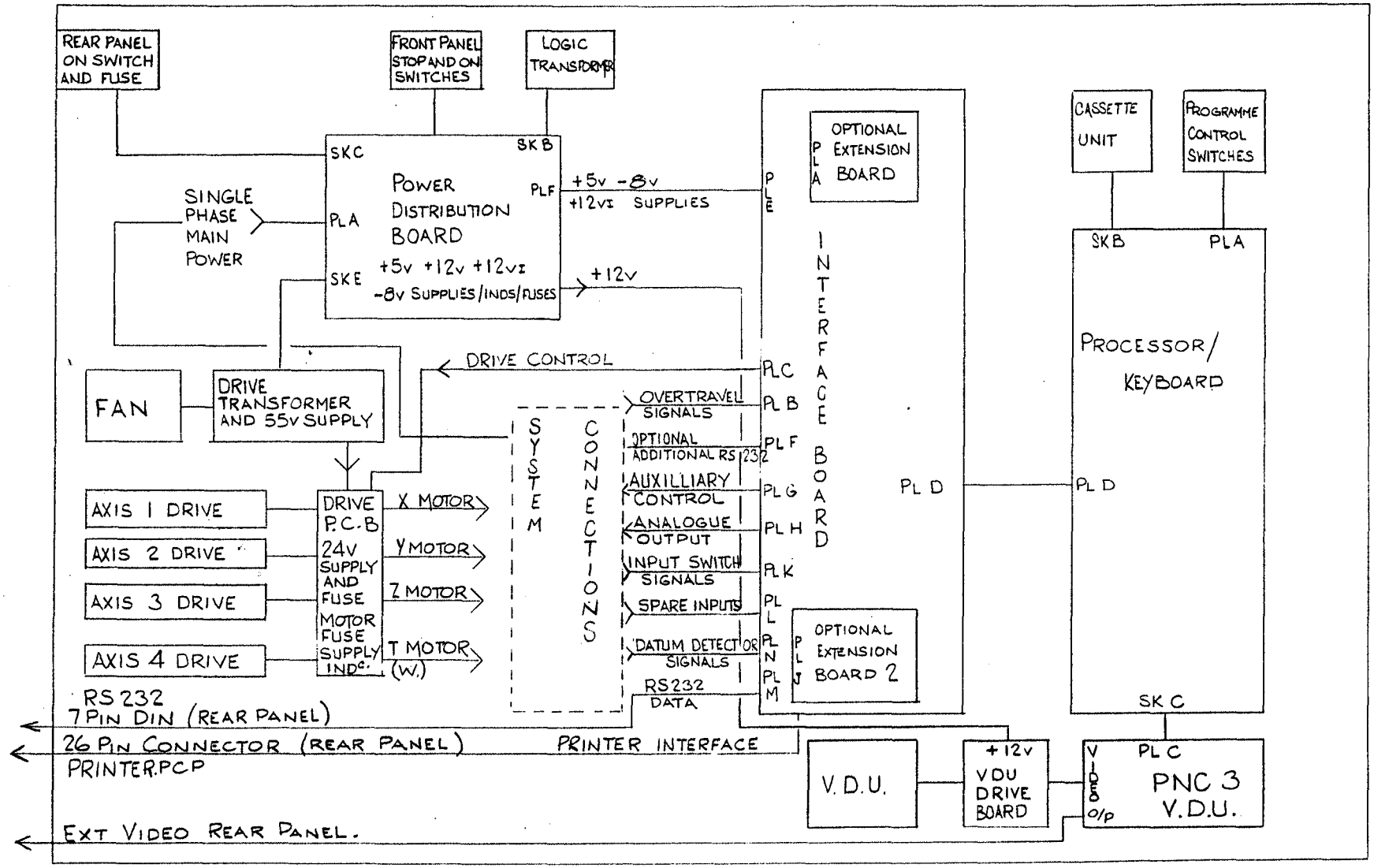
PNC 3 VDU

ISS 1 JAN 84

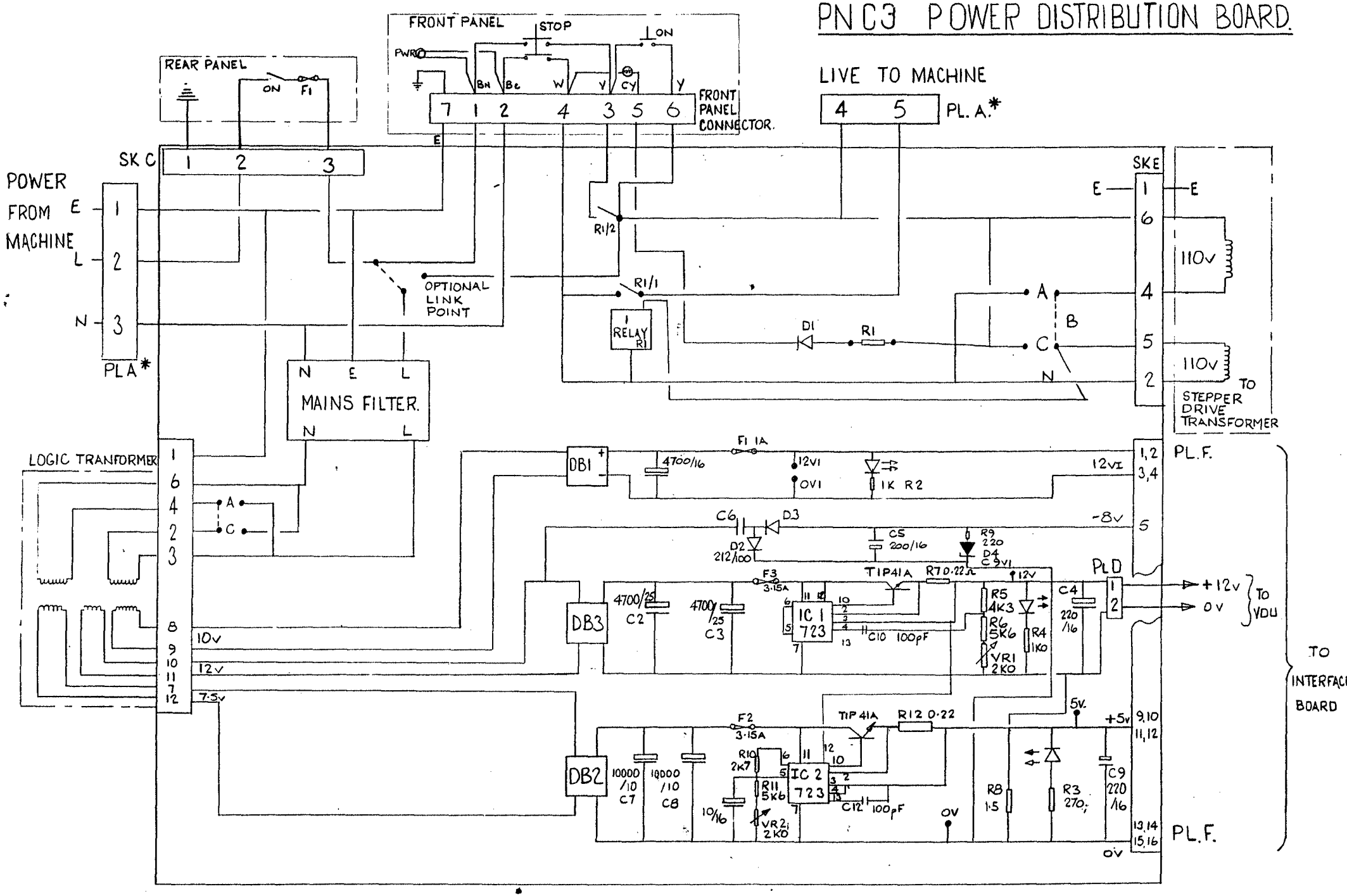


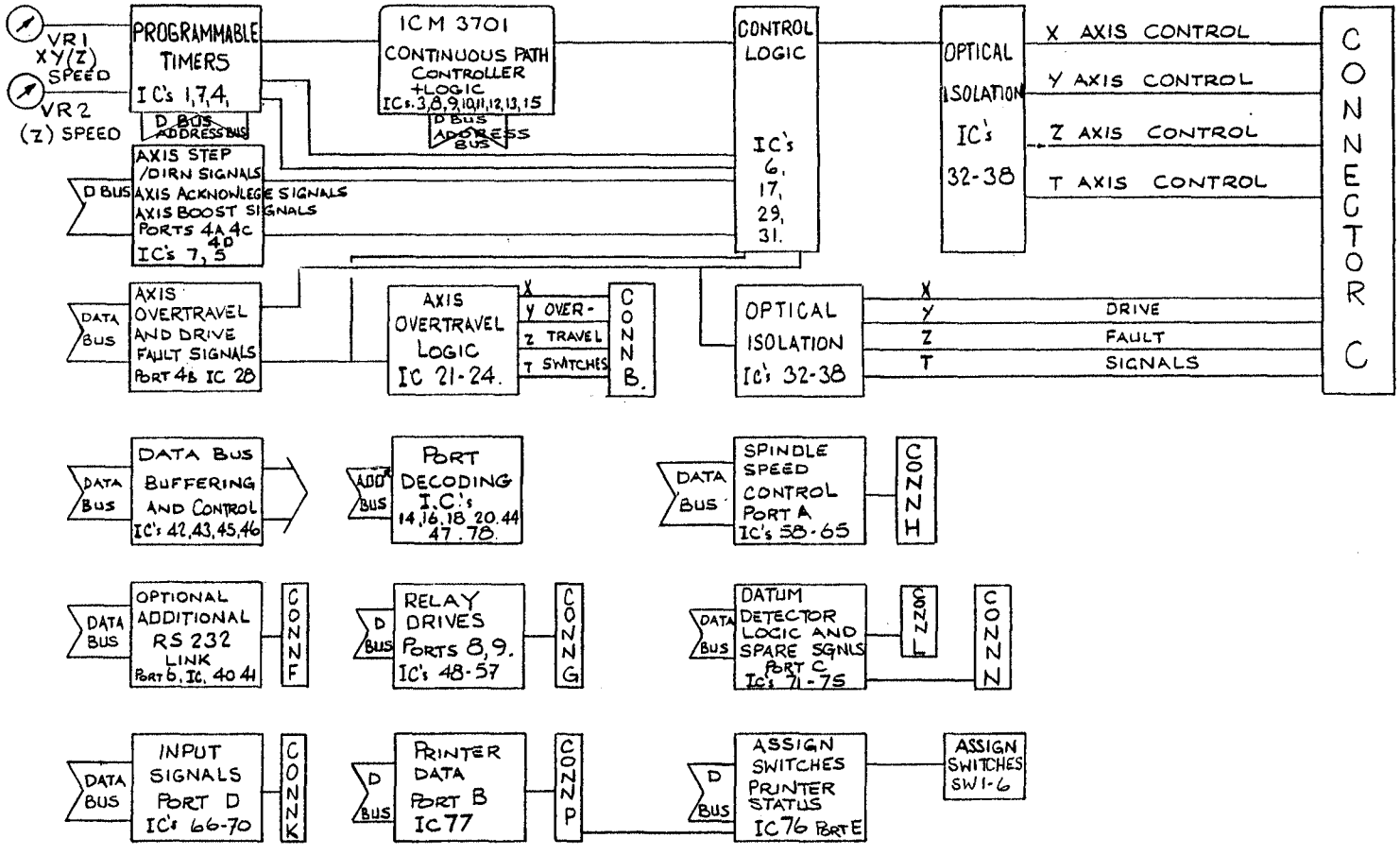

N.E.E
PNC3
PROCESSOR/
KEYBOARD
ISSUE 2
1984.
KEYBOARD SWITCHES SW1 TO SW61
IC1 LS 244
IC2 LS 373
IC3 6116
IC4 AS LEFT
IC5 6116/ 6556
IC6 74C14
IC7 2764/ 27128
IC8 AS LEFT
IC9 AS LEFT
IC10 AS LEFT
IC11 AS LEFT
IC12 8085AC-2
IC13 LS 244
IC14 LS 244
IC16 LS 138
IC17 LS 139
IC20 LS 373
IC21 DP 8304
IC22 LS 138
IC24 LS 373 NOT FITTED
IC25 LS 244
IC26 LS 373
8MHz
EKTMACC

BLOCK DIAGRAM OF PNC 3 CONTROL UNIT.

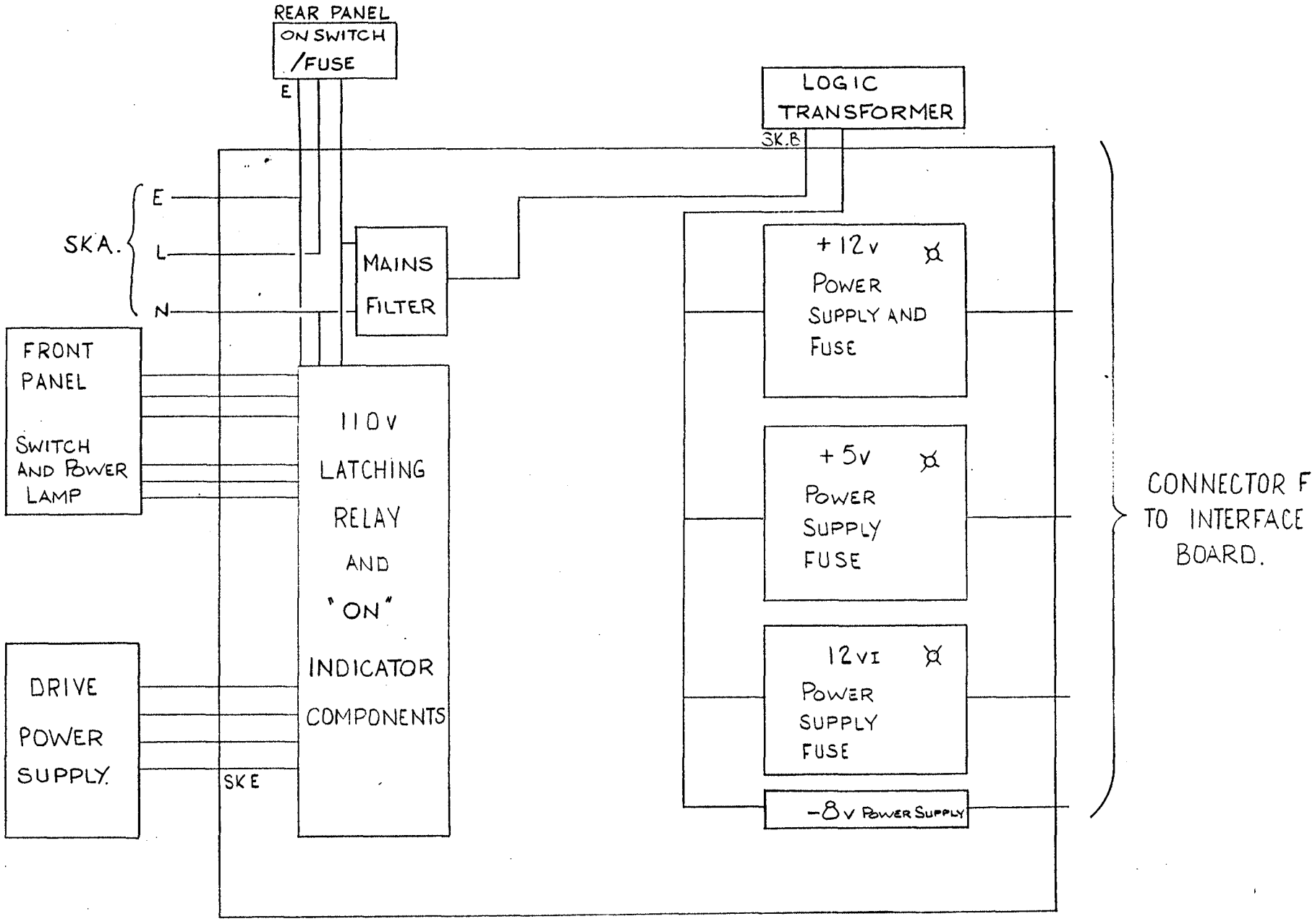


PNC3 POWER DISTRIBUTION BOARD



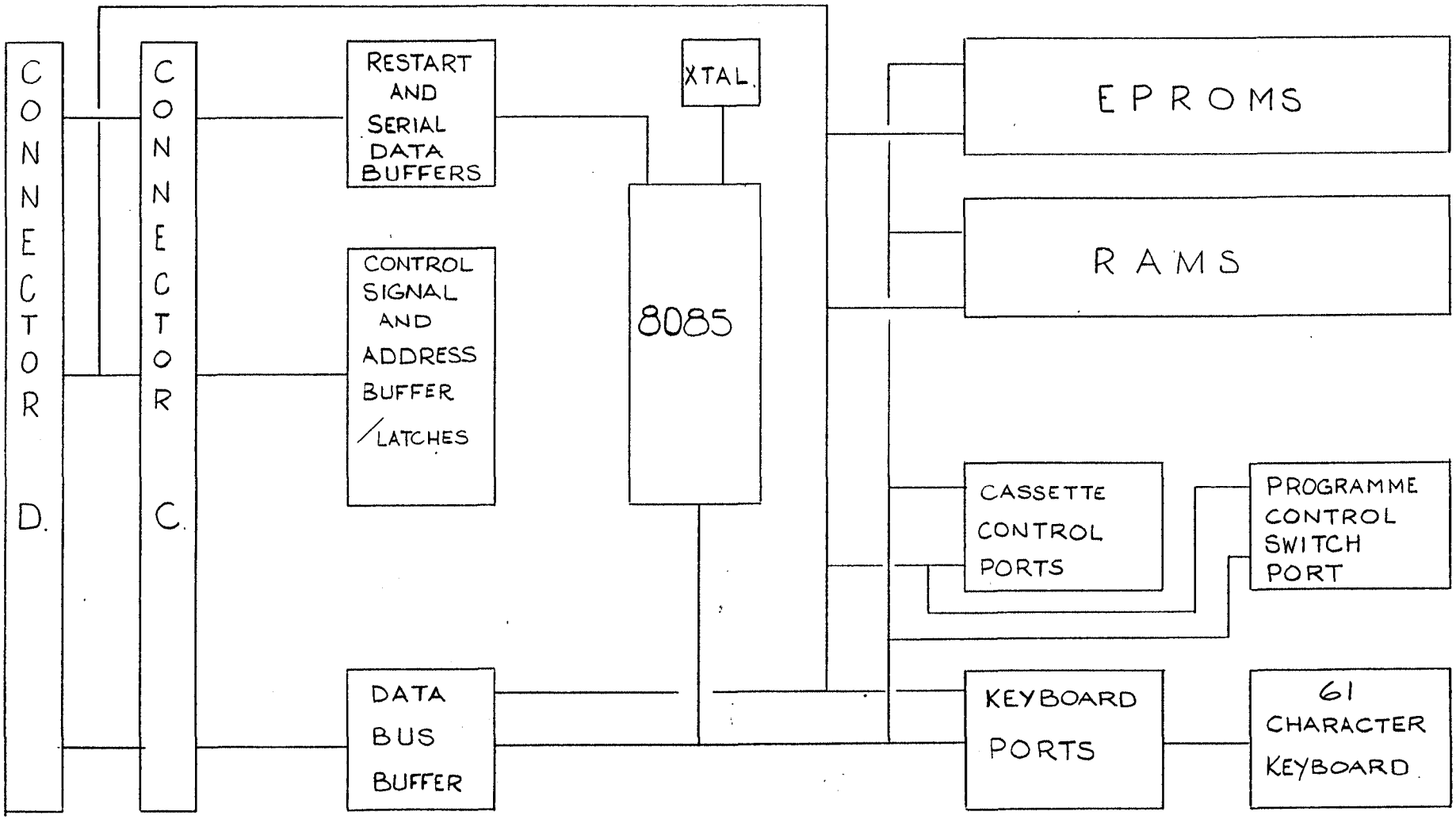


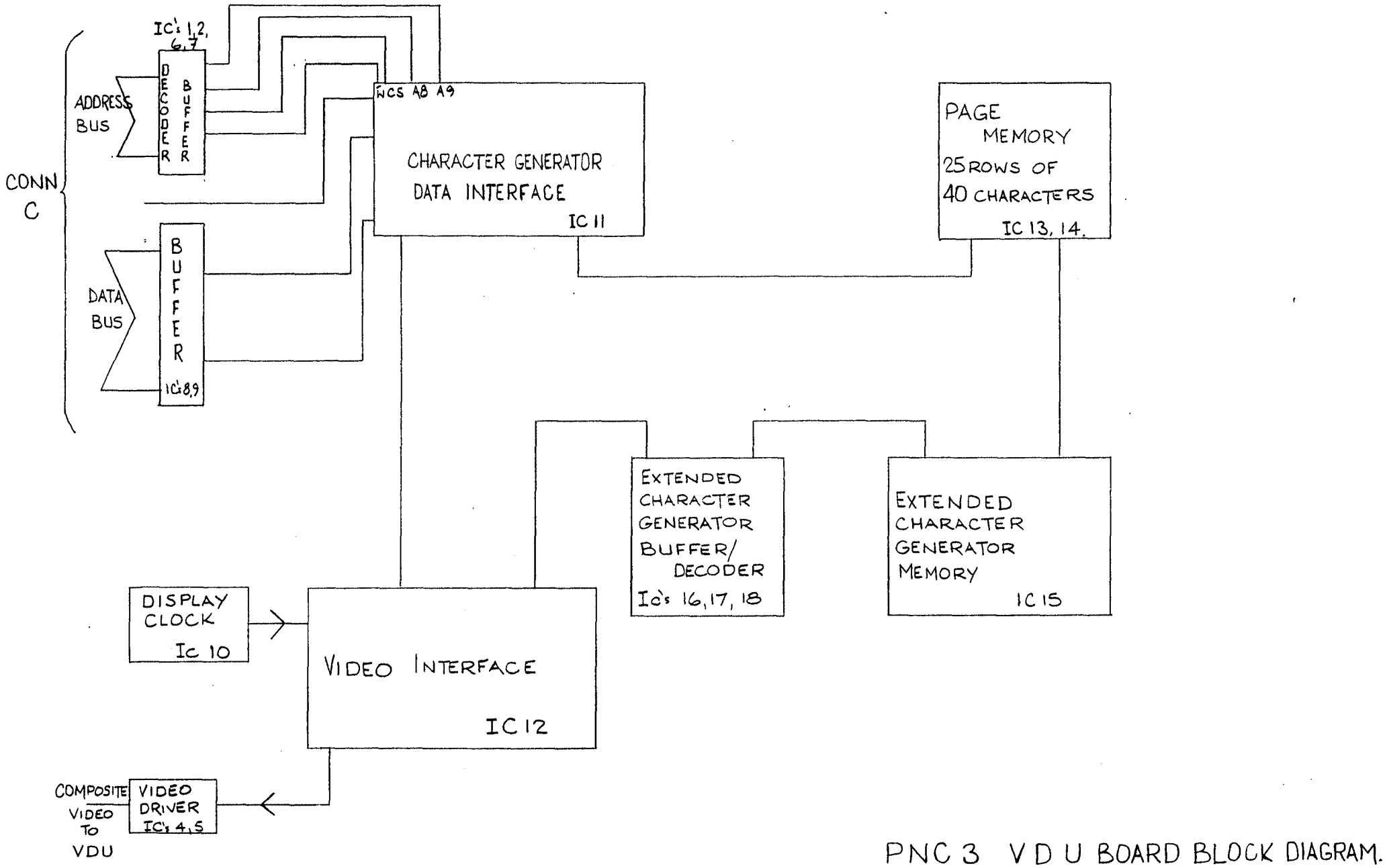
PNC 3 INTERFACE BOARD



BLOCK DIAGRAM OF POWER DISTRIBUTION BOARD.

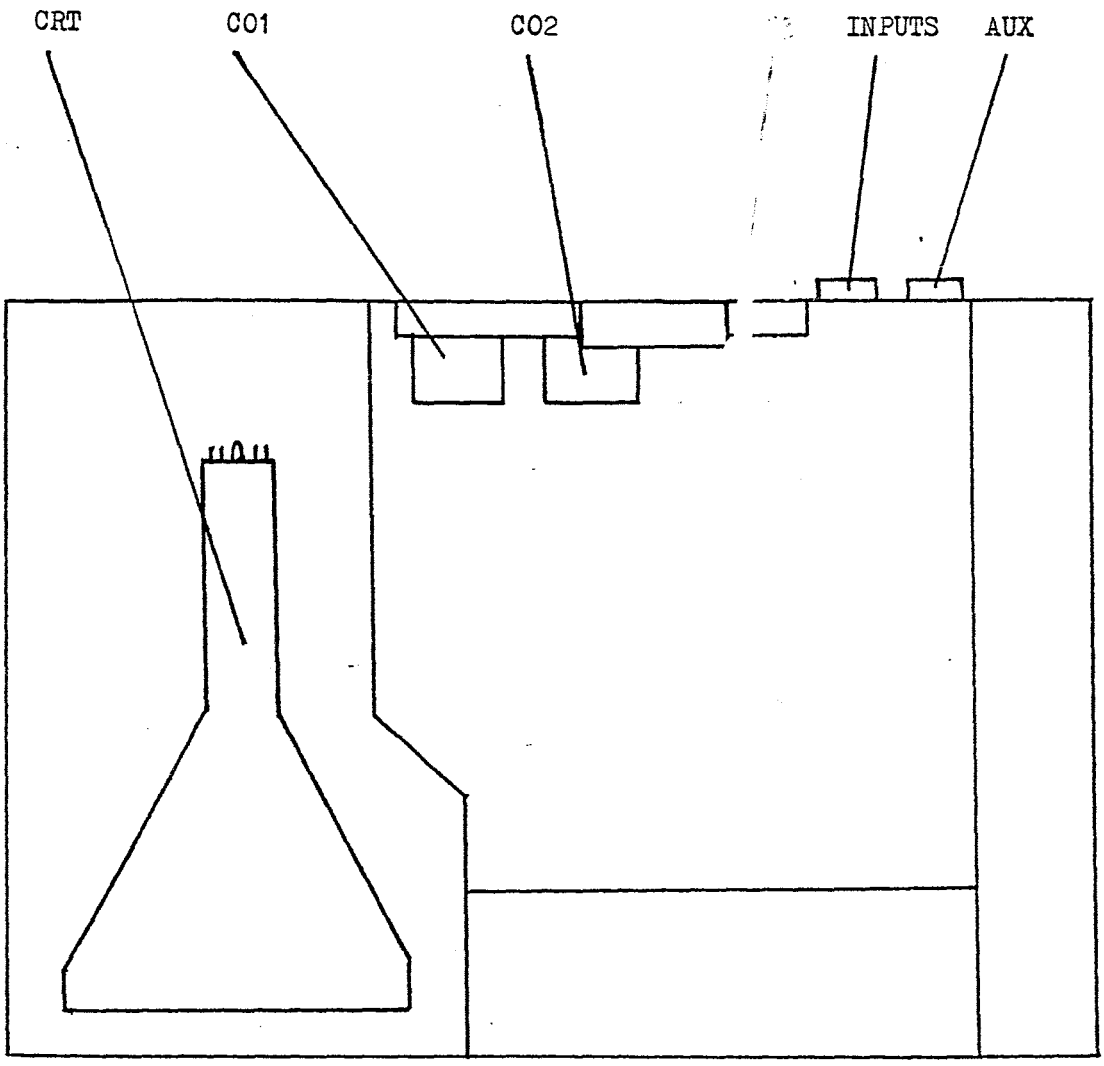
PNC PROCESSOR BOARD BLOCK DIAGRAM

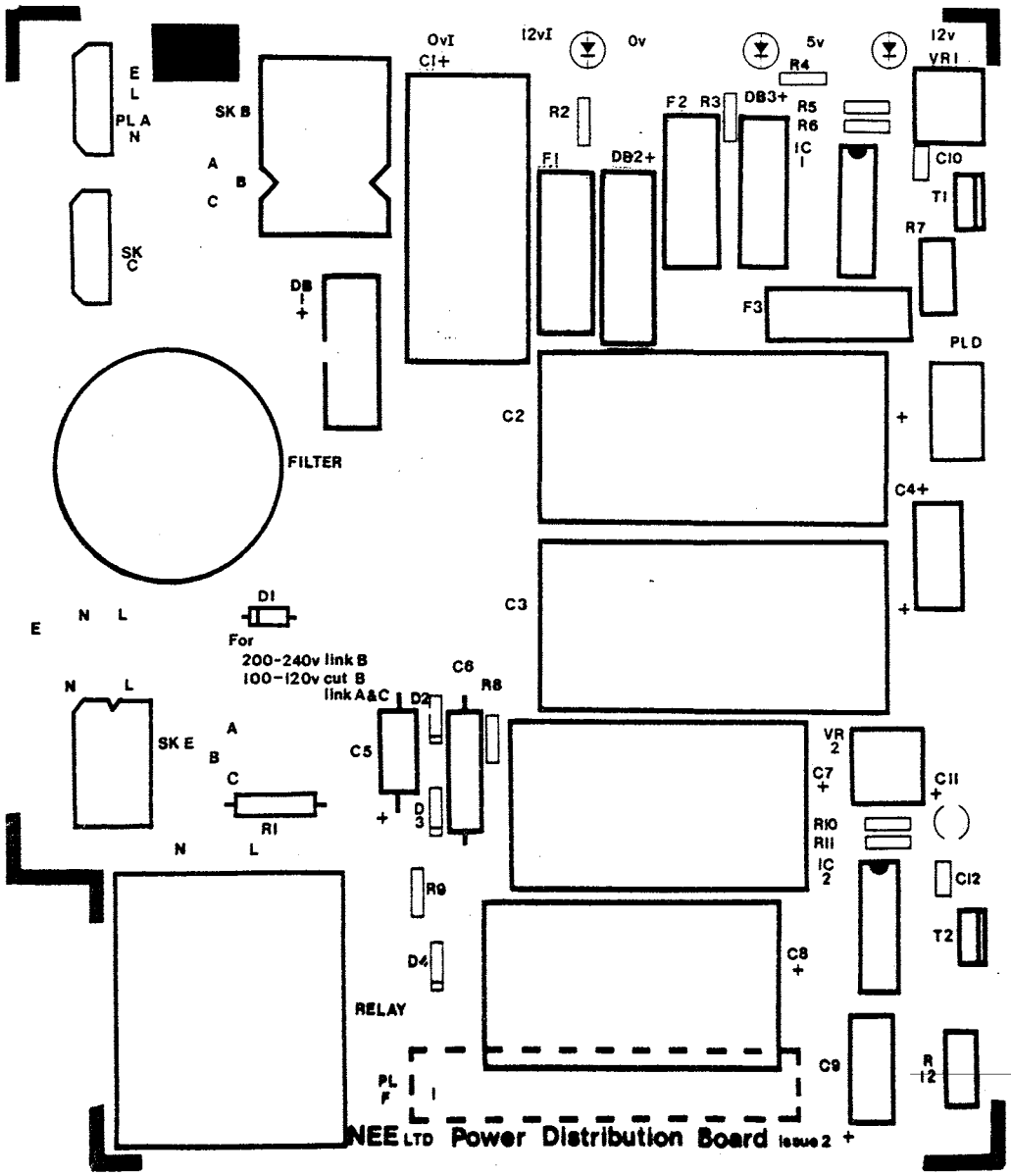


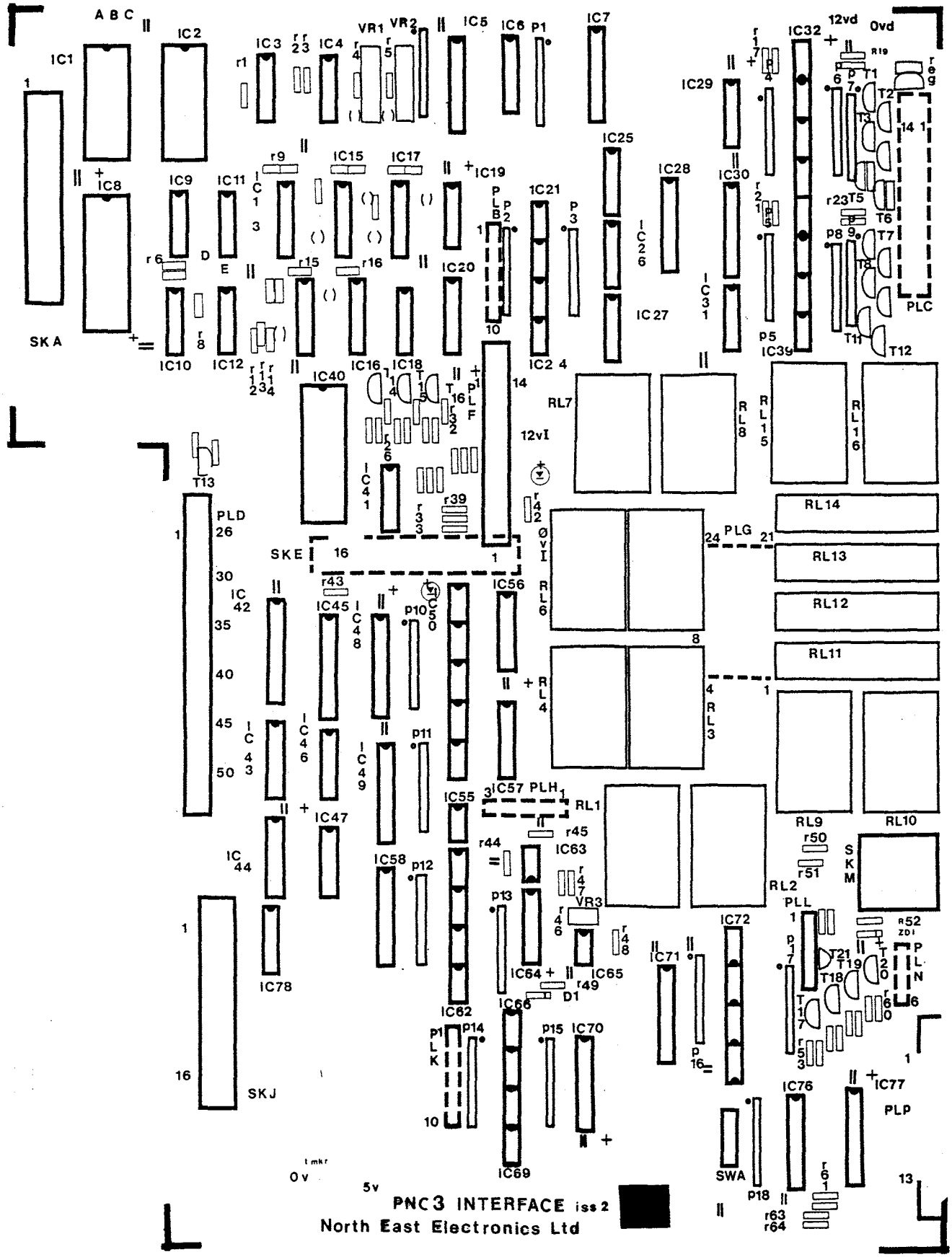


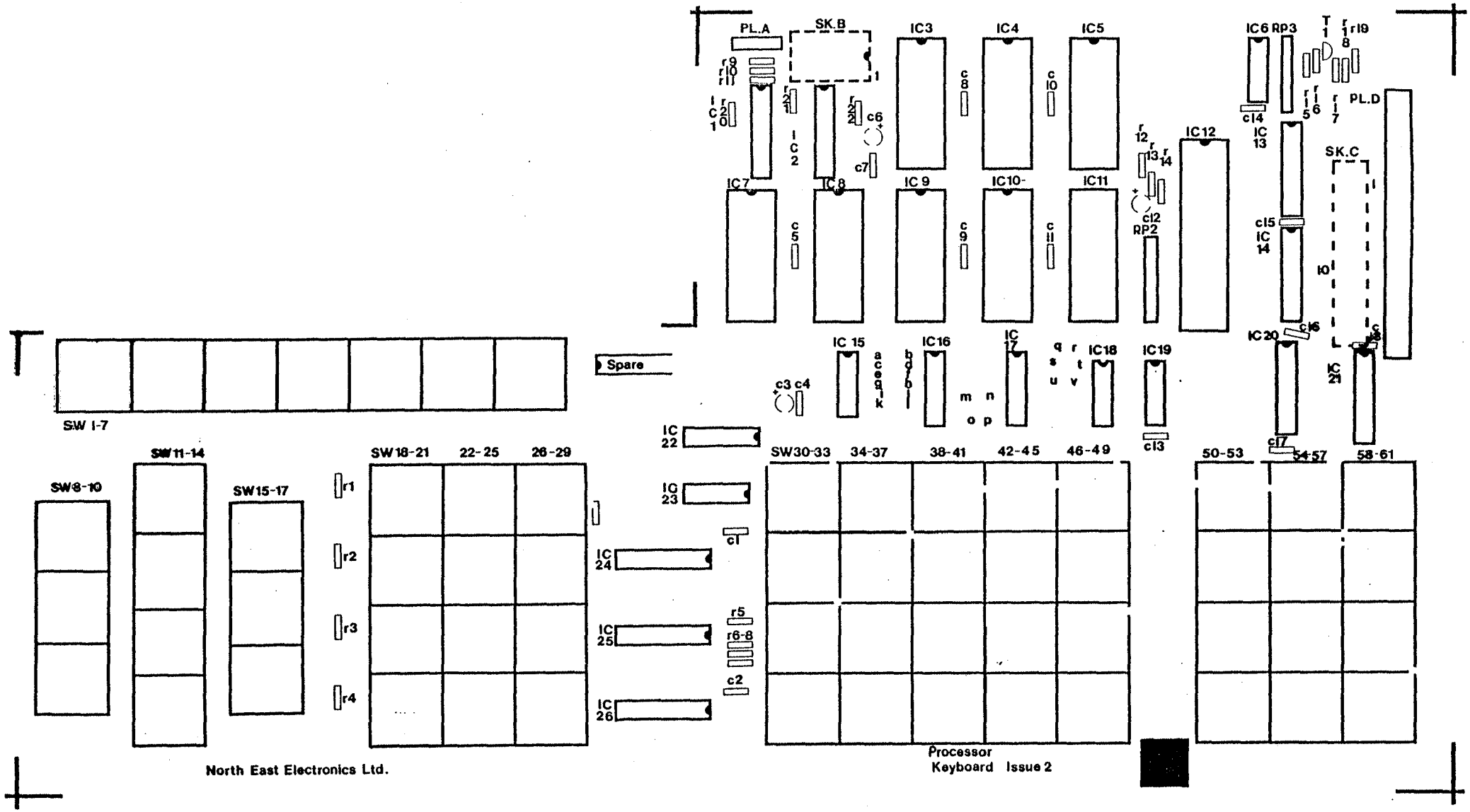
PNC 3 V D U BOARD BLOCK DIAGRAM.

PNC 3 External Connections Layout




E
L
PL A
N
SK B
A
B
C
SK
C
OvI
C1+
12vI
0v
5v
12v
VR1
R4
R2
F2
R3
DB3+
R5
R6
IC
1
F1
DB2+
C10
T1
R7
DB
1
+
F3
PLD
C2
+
FILTER
C4+
C3
+
D1
For
200-240v link B
100-120v cut B
link A&C
E
N
L
C6
R8
N
L
SK E
A
B
C
D2
C5
D
3
VR
2
C7
+
C11
+
RI
R10
R11
IC
2
C12
R9
T2
D4
C8
+
RELAY
C9
R
12
PL
F
I
+
NEE LTD Power Distribution Board Issue 2


A B C
IC1
IC2
IC3
IC4
VR1
VR2
IC5
IC6
P1
IC7
IC8
IC9
IC11
IC10
IC12
IC15
IC17
IC19
IC20
IC16
IC18
IC21
IC24
IC25
IC26
IC27
IC28
IC29
IC30
IC31
IC32
IC39
12vd
0vd
SKA
PLC
IC40
12vI
RL7
RL8
RL15
RL16
RL14
RL13
RL12
RL11
RL9
RL10
RL1
RL2
RL6
RL4
RL3
T13
PLD
SKE
IC42
IC43
IC46
IC47
IC44
IC45
IC48
IC49
IC50
IC56
IC57
PLH
IC55
IC58
IC62
IC63
IC64
IC65
IC66
IC69
IC70
IC71
IC72
IC76
IC77
IC78
SKJ
PLK
PLG
SKM
PLL
PLN
PLP
SWA
0v
5v
PNC3 INTERFACE iss 2
North East Electronics Ltd


PL.A
SK.B
IC3
IC4
IC5
IC6
RP3
T1
r19
r18
r16
r17
PL.D
c14
IC13
SK.C
IC12
r12
r13
r14
IC7
IC8
IC9
IC10
IC11
c12
RP2
c15
IC14
IC20
c16
IC21
IC15
IC16
IC17
IC18
IC19
c13
c17
Spare
SW 1-7
SW8-10
SW11-14
SW15-17
SW18-21
22-25
26-29
SW30-33
34-37
38-41
42-45
46-49
50-53
54-57
58-61
IC22
IC23
IC24
IC25
IC26
c1
c2
r1
r2
r3
r4
r5
r6-8
North East Electronics Ltd.
Processor
Keyboard Issue 2

DENFORD MACHINE TOOLS LTD BRIGHOUSE WEST YORKSHIRE

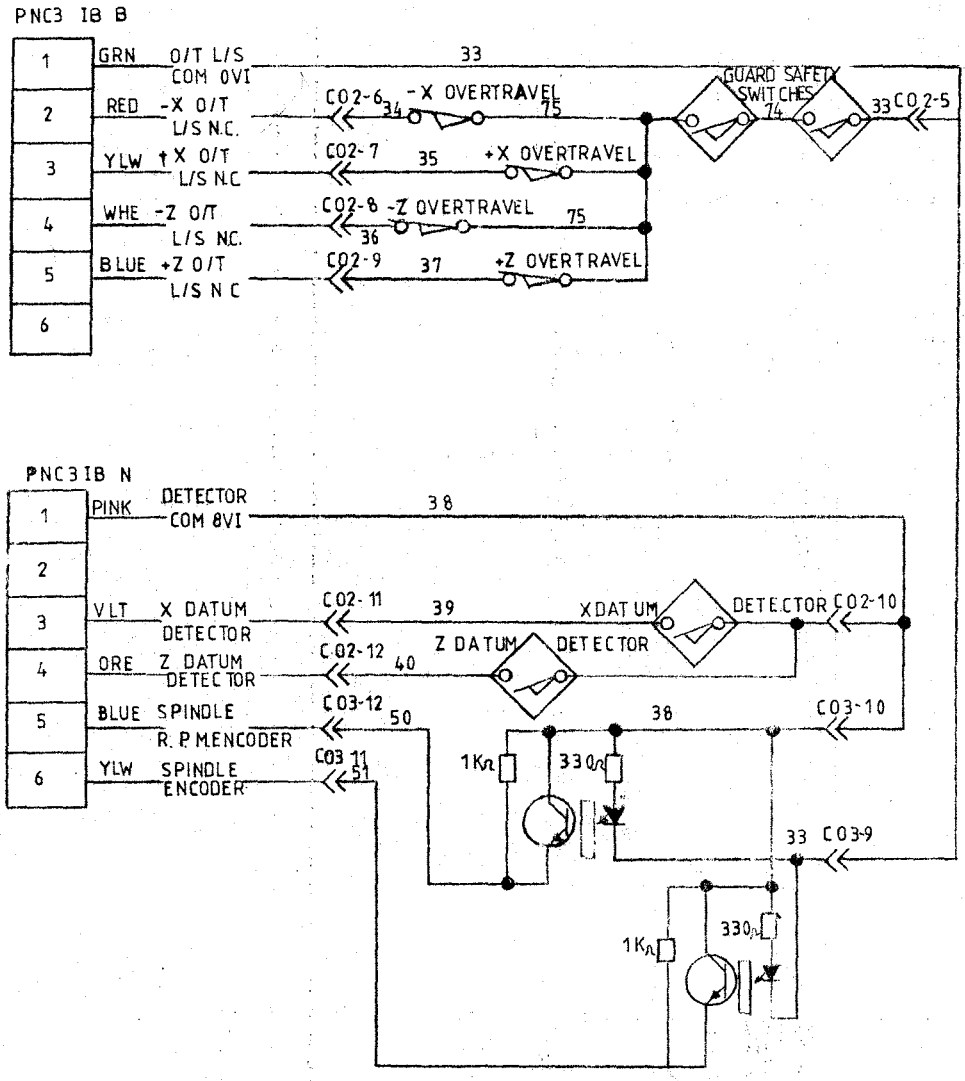
DRN. BY: K S DATE: 13-6-84

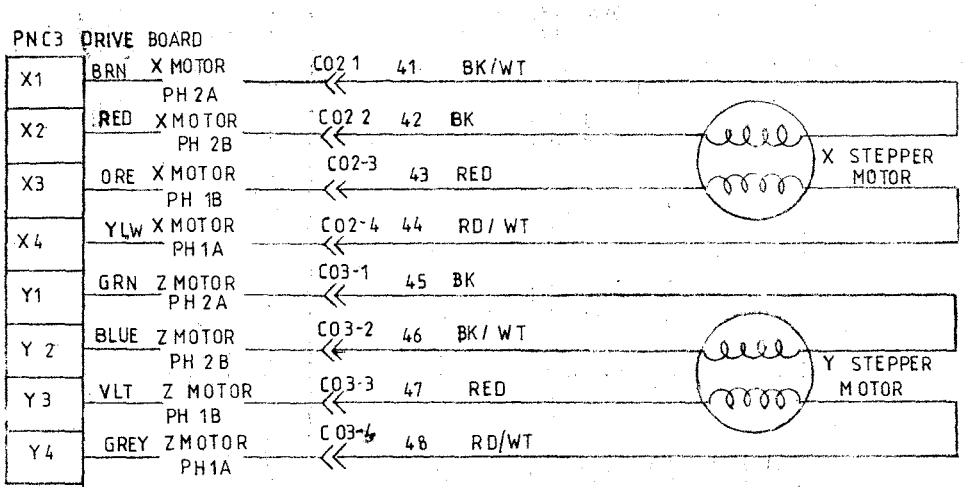
TRCD. BY: DATE:

EASITURN WIRING DIAGRAM SCHEMATIC Nº2 WITH GUARD SWITCHES

A3-300045

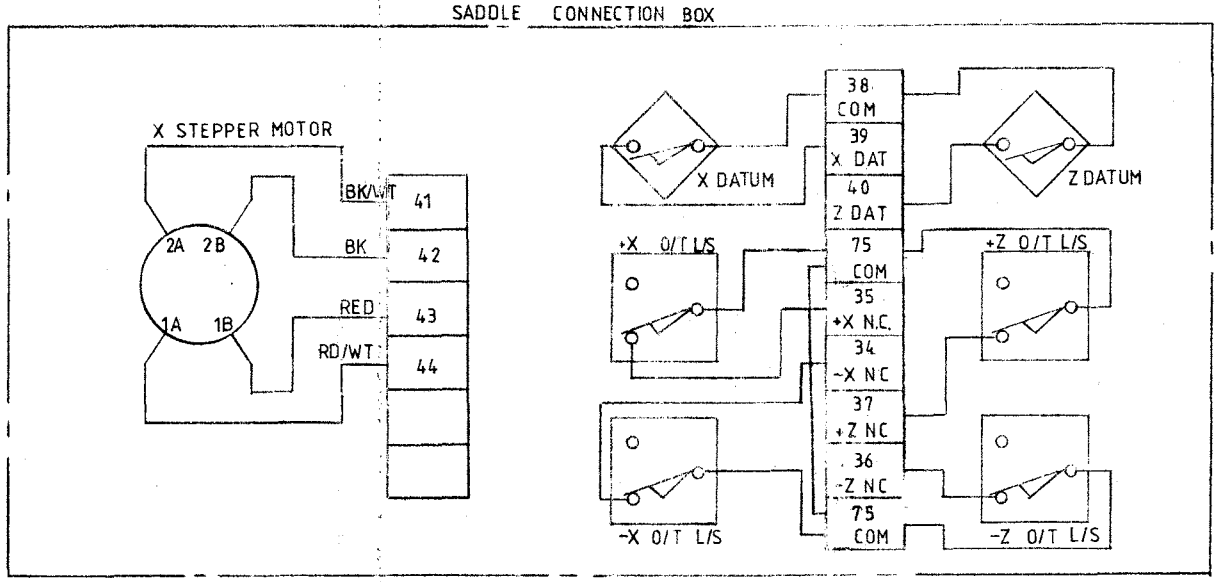
SHEET No. OF CONT. ON SHEET No.



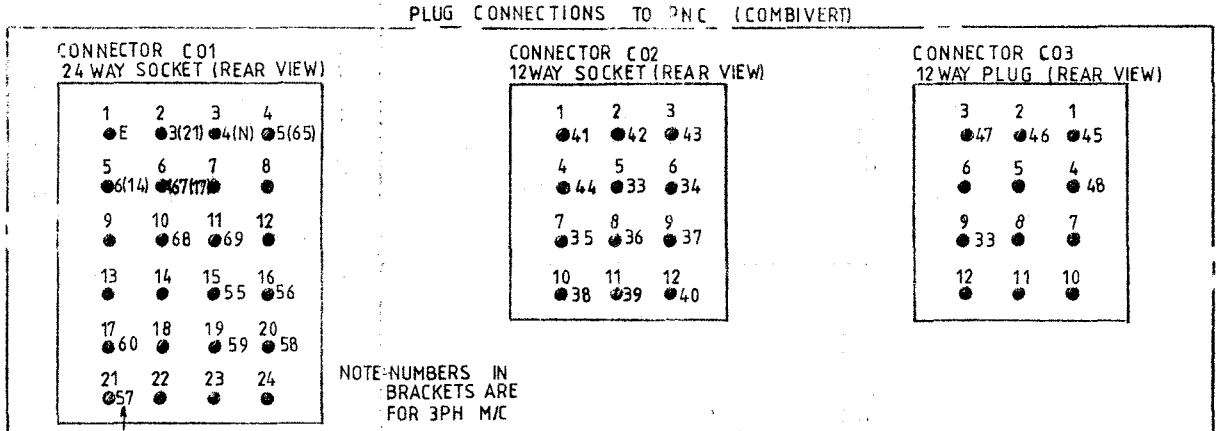


DENFORD MACHINE TOOLS LTD BRIGHOUSE WEST YORKSHIRE

SADDLE CONNECTION BOX

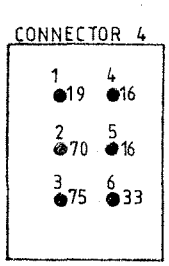


PLUG CONNECTIONS TO PNC (COMBIVERT)

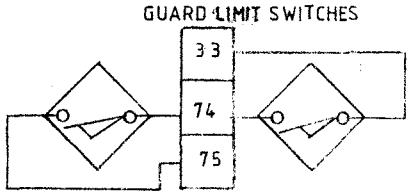


ONLY USED ON MACHINES WITH COMMANDER SPINDLE DRIVES

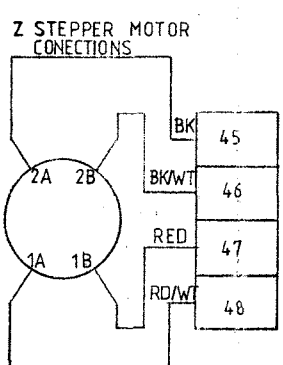
CONNECTOR 4



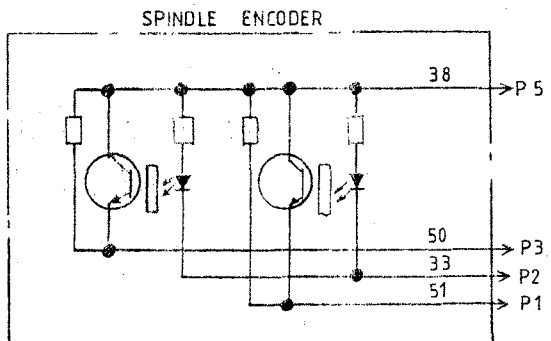
GUARD LIMIT SWITCHES



Z STEPPER MOTOR CONECTIONS



SPINDLE ENCODER



EASITURN WIRING DIAGRAM N° 2 WITH GUARD LIMIT SWITCH

DRN. BY: K STANTON DATE: 18-6-84

TRCD. BY:

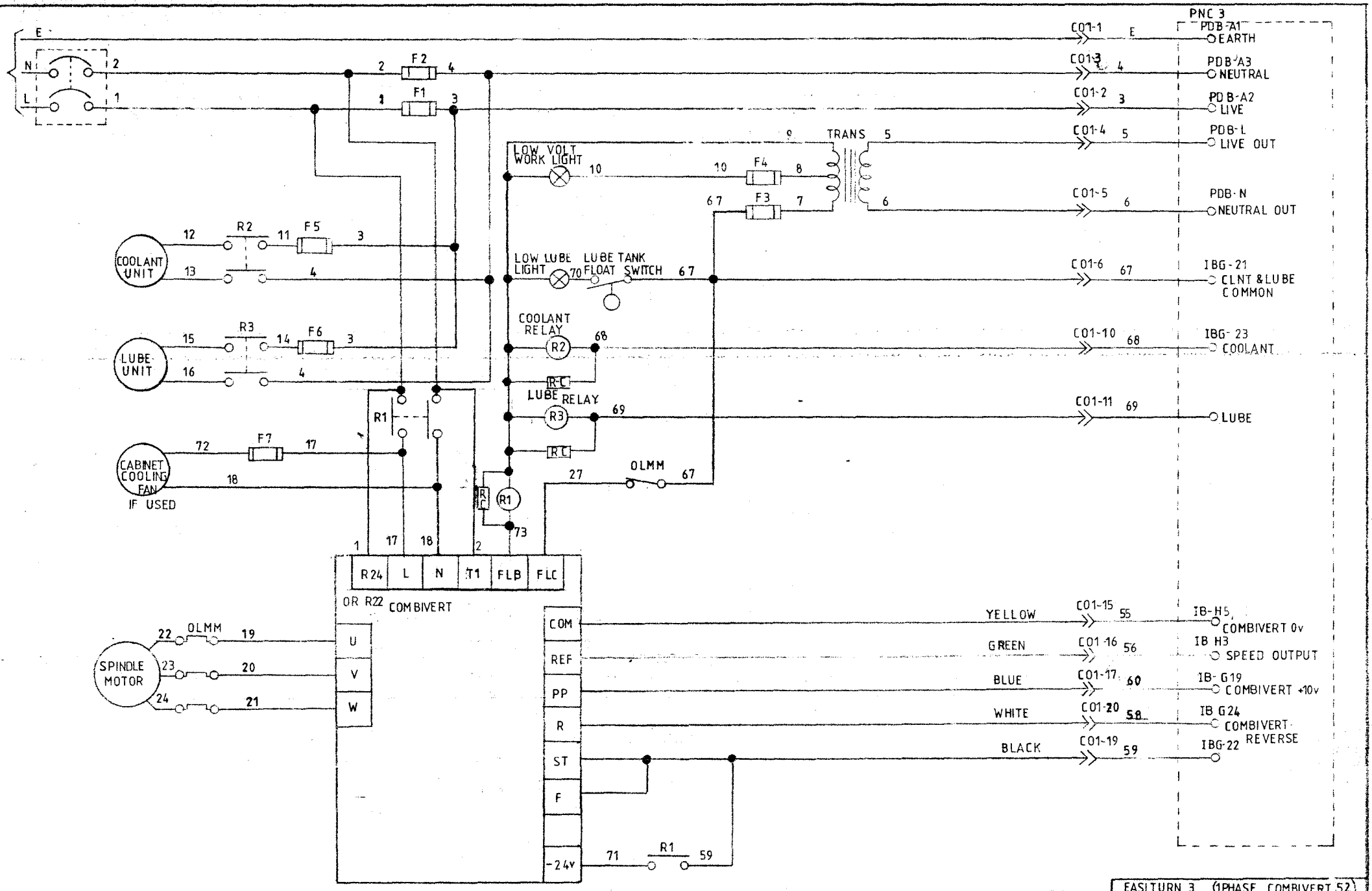
DATE:

A3-30046

SHEET No.

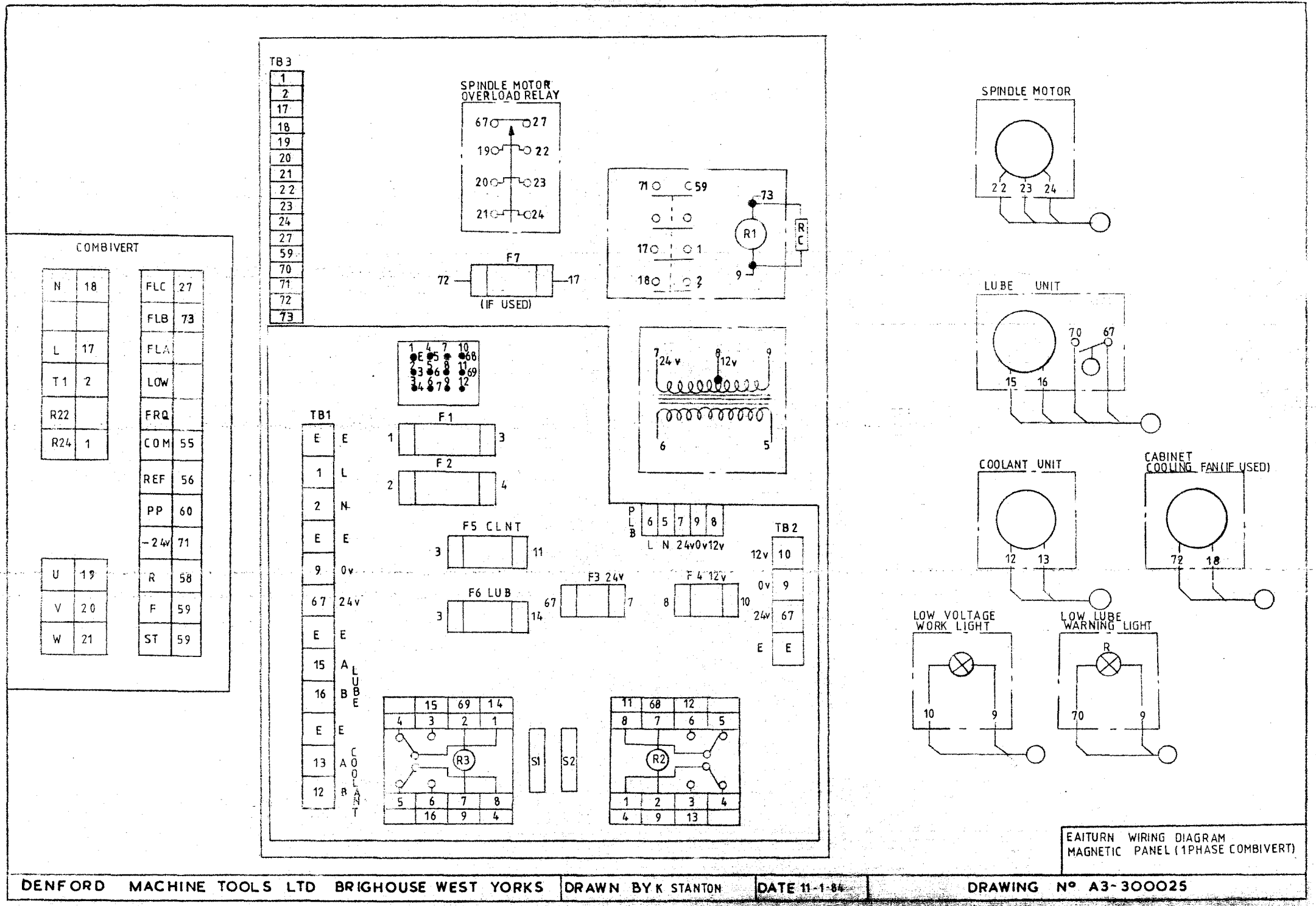
OF

CONT. ON SHEET No.



EASITURN 3 (1PHASE COMBIVERT 52)
WIRING DIAGRAM SCHEMATIC N°1

DENFORD MACHINE TOOLS LTD BRIGHOUSE WEST YORKSHIRE	DRAWN BY K STANTON	DATE 10-1-84	DRAWING N°A3-300024



EAITURN WIRING DIAGRAM
MAGNETIC PANEL (1PHASE COMBIVERT)

DENFORD MACHINE TOOLS LTD BRIGHOUSE WEST YORKS	DRAWN BY K STANTON	DATE 11-1-84	DRAWING Nº A3-300025