

NORTH EAST ELECTRONICS LTD

SMCU INSTALLATION GUIDE (Version 2)

OCTOBER 1987

NORTH EAST ELECTRONICS LTD  
AUTOMATION HOUSE  
OTTERBURN TERRACE  
JESMOND  
NEWCASTLE-ON-TYNE  
NE2 3AW

TEL:- (091) 2818387

## SMCU - Stepper Motor Control Unit

### Introduction

#### Main Features

The North East Electronics SMCU has been designed as an interface unit to enable personal computers to control machines.

The SMCU can precisely control from 1 to 3 axes of machine movement providing full axes linear interpolation and circular interpolation on any 2 selected axes, the 3rd axis operating linearly. Additionally, the SMCU provides programmable control of (optionally 6) relays (auxiliaries) and can monitor 4 user assigned inputs. The SMCU has datum and overtravel inputs for 3 axes. An optional programmable analogue output (0 to 10 volts in 255 steps) is available.

SMCU's are supplied together with an 8 key hand held keypad with keys permitting machine jogging, auxiliaries 1 to 4 switching, selection of program 1 to 4 for execution, START and STOP program execution, machine datuming, and digitising of machine positions.

Generally the SMCU receives data from a personal computer via a RS232 serial line defining the required control sequence. The data may be executed immediately or may be stored in the SMCU 8K byte "battery backed" memory for subsequent execution either by keypad selection or by command from the computer.

Optionally, SMCU's can be supplied preprogrammed with up to 15 customer specific control sequences in EPROM obviating the need for a personal computer and associated software, program execution being selected by the keypad or RS232 Interface.

Contact NEE for further details.

#### Personal Computer Mode

North East Electronics can supply suitable 'menu driven' personal computer software for a range of personal computers which is comprehensive, easy to use, and also provides a graphical display of the coordinates of the control program.

Full program edit functions are included which allow program blocks to be added, deleted, altered or replaced.

Before running the SMCU programs can be graphically displayed for checking purposes and then either run under control of the computer or downloaded to the SMCU RAM and executed by using the keypad.

At present software is available for

- a) Amstrad CPC 6128      b) BBC "B"      c) IBM PC or compatible

Selective plane switching to give circular interpolation on any 2 axes is only available on (c).

## Contents

1. Connecting to your SMCU
2. System Tests
3. Error Indicator
4. Keypad Operation
5. Setting Internal Assign Switches
6. Circuit Diagrams

## Sheet Contents

- 1 Processor
  - 2 Auxiliaries/Spindle
  - 3 Datums/Overtravels/Inputs
  - 4 Power Supply
7. Maintenance and care of your SMCU

1. Connecting to your SMCU
  - 1:1 Rear Panel Connectors
  - 1:2 Signal Requirements
  - 1:3 Cabling Requirements

HIGH POWER DRIVE	
PIN	15 WAY 'D' SKT.
A	2A
B	2B
C	1B
D	1A
E	2A
F	2B
G	1B
H	1A
J	2A
K	2B
L	1B
M	1A
N	
P	
R	
S	OFF
T	COMM.
U	ON
V	EARTH

REMOTE  
DRIVE  
POWER  
(LINK 'S' TO 'U'  
(IF NOT USED)

KEYPAD	
PIN	9 WAY 'D' SKT.
1	COMMON
2	JOG
3	X-
4	Z-
5	RESET
6	Y-
7	Y+
8	Z+
9	X+

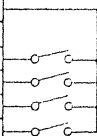
RS232 PORT	
PIN	7 PIN DIN SKT.
1	
2	0V
3	
4	CTS
5	RTS
6	DATA IN
7	DATA OUT

MOTORS -	
PIN	15 WAY 'D' SKT
1	2A
2	2B
3	1B
4	1A
5	2A
6	2B
7	1B
8	1A
9	2A
10	2B
11	1B
12	1A
13	OFF
14	COMM
15	ON

REMOTE  
DRIVE  
POWER  
(LINK 13 TO 15)  
(IF NOT USED)

MAINS INPUT	
CORE	3 PIN IEC
BROWN	LIVE 240V a.c.
BLUE	NEUTRAL
Gr/Yw	EARTH

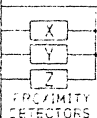
AUXILIARIES/INPUTS	
PIN	25 WAY 'D' PLUG
1	AUX 1 COM.
2	AUX 1 N/C
3	AUX 1 N/O
4	AUX 2 COM.
5	AUX 2 N/C
6	AUX 2 N/O
7	AUX 3 COM.
8	AUX 3 N/C
9	AUX 3 N/O
10	AUX 4 COM.
11	AUX 4 N/C
12	AUX 4 N/O
13	
14	0VI
15	9VI
16	I/P1
17	I/P2
18	I/P3
19	I/P4
20	
21	
22	
23	
24	
25	



OPTION	
SPINDLE OUTPUT	
PIN	8 WAY OM
A	EARTH
B	SWITCHED LIVE
C	SWITCHED NEUT
D	FWD LIVE
E	FWD NEUTRAL
F	
G	
H	

OPTION	
ANALOGUE OUTPUT	
PIN	8 WAY OM
A	+12V IN
B	0V IN
C	ANALOGUE OUT
D	START COMMON
E	START OUT
F	REV
G	FWD/REV COMM.
H	FWD

DATUMS / O.T.s	
PIN	15 WAY 'D' PLUG
1	0VI
2	9VI
3	X DAT
4	Y DAT
5	Z DAT
6	
7	12VI
8	
9	0VI (12V COM.)
10	-X O/T
11	-X O/T
12	-Y O/T
13	-Y O/T
14	-Z O/T



OVERTRAVEL SWITCHES  
ARE NORMALLY CLOSED

NORTH EAST ELECTRONICS

NOTES	
S.M.C.U.	
REAR PANEL CONNECTORS	
SHEET 1 OF 1	15/7/87
REV 5	C.E. CHKD:14/8/

## 1.2 Signal Requirements

- i) Mains
- ii) Motors
- iii) RS232 port
- iv) Auxiliaries and inputs
- v) Datums/overtravels
- vi) Keypad
- vii) Analogue Output (Option)
- viii) Spindle Output (Option)

### i) Mains Connector

Brown-Mains power to SMCU at either 110-120vac  $\pm$  10% or 220-240vac  $\pm$  10% at 50-60Hz. The current required is dependant upon the number and type of drives fitted. Due to the type of power supply fitted, the power-on current surges can be very high necessitating the use of antisurge fuses.

Fuses should be rated at 3.15A or 10A HBC when spindle control contactors are fitted.

Blue-Neutral

Yellow/Green-Safety Earth

### ii) Motors connections for 2 phase motors

The SMCU is fitted with integral 2 phase stepper motor drives for from 2 to 3 axis systems of the SD or CD range, these drives generally being operated in the half step i.e. 400 steps/rev mode, which reduce possible motor resonance problems. Microstepping drives are available to give either 1000 or 2000 steps per motor revolution. Compatible stepper motors may be connected to operate in series or parallel mode. In general the series mode produces higher torque at low speed than the parallel mode and lower torque at high speed than the parallel mode. The parallel mode produces a more constant torque over a wider speed (motor rpm) range than the series mode. The actual torque produced is a function of the drive used and the motor characteristics. Motor manufacturers' motor performance graphs should be consulted together with stepper drive performance graphs to enable a satisfactory drive/motor combination to be selected. Details available from PKS Digiplan of Poole Dorset or NEE.

When stepper motors are connected to the SMCU it is important that:-

- a) Sufficiently high current rated connecting cable is used.
- b) The cable length is kept reasonably short.
- c) There are no "short circuits" in the motor wiring either between motor phases or from any motor phase to machine ground ("shorts" could result in expensive damage to the stepper motor drive which is not covered by the guarantee!)
- d) Unused motor leads are well insulated from each other and from machine ground.

The stepper motor drive manual gives more details for drive power operation and the selection and wiring of stepper motors.

iii) RS232 connector - Serial link:

pin 2 0v - SMCU system 0 volts. Note it is important that electrical interference is not preset on this connection as it could impair the performance of the SMCU system. A screened cable must be used.

pin 3 +5v pulled up through a 4K7 resistor.

pin 4 CTS - Clear To Send - (Option) A high (>+3v) on this input indicates that the external device connected to the RS232 interface can accept RS232 data from the SMCU via the serial data output (pin 7).

pin 5 RTS - Ready To Send - (Option) If the SMCU is ready to receive RS232 data on it's serial data input (pin 6) this pin is held high at > +6v.

pin 6 RxD - Serial Data Input - Serial data to the SMCU should be provided at RS232 levels at Baud rates etc as set by the change baud rate feature (see operation manual) or if the serial data is transmitted following an SMCU 'full reset' at the Baud rate etc selected by SW1 to SW4 for early systems (see section 5), or at 300 baud, odd parity, 7 data bits for later SMCU's. The format of the data must be as specified in the RS232 Serial Interface description in the operating manual.

pin 7 TxD - Serial Data Out - Serial Data from the SMCU is provided at RS232 levels. Baud rate etc is the same as that selected for Serial data input. The format of the data is as specified in the operating manual.

iv) Auxiliaries and Inputs

Auxiliaries:

Auxiliary functions permit external processes to be controlled by the SMCU via volt free contacts of the auxiliary relays. All the auxiliary relays operate in the ON/OFF mode i.e turn ON when instructed in the program and remain ON until turned OFF later in the program.

All auxiliaries are of the single pole change over configuration and contacts are rated at 240vac at 1 Amp. Inductive loads must be suppressed.

Inputs:

Input signals permit user program execution to be held until the input signals are as programmed. This facility enables events external to the control unit to control the sequence. Input signals are provided by microswitches which are connected between OVI (pin 14) and the respective input pin (pins 16 to 19). If the input is programmed to be ON, then the user program execution will wait until the respective input switch closes and similarly if the input is programmed to be OFF the user program execution waits until the switch input switch opens. Max o/c voltage 15vdc, max s/c current 15mA.

v) Datums and Overtravels:

(a) Datums

The SMCU if supplied as a control for a machine with a fixed datum facility requires that inductive proximity detectors or alternatively accurate position sensing switches be fitted to the machine axes which have a fixed datum.

The datum detectors recommended are either Bailuff 516-324-E2N-Z or Proxistor 110-002A or equivalent. These detectors are compatible with the SMCU and give a precise repeatable datum position. These detectors act in simple terms as a variable resistor which have a high resistance if a ferrous metal object is above the detector and have low resistance if no ferrous metal is above the detector. The detector should be fitted at one end of the machine's desired movement such that it is operated a short distance before the relevant overtravel switch is operated. The length of this short distance should be sufficient to enable the machine to decelerate from its "datuming" speed between the datum detector operating and the overtravel switch operating point. This distance is determined by the ACCEL/DECEL ramp setting and the datum feedrate (see SMCU Host Computer Software Manual Section 2). The ferrous metal datum target should be fitted such that it passes over the end of the datum detector approximately 0.5mm away. Additionally the metal target should be large enough to ensure that it is above target for the complete distance from the datum position to the mechanical movement limits.

The datum detectors are two wire devices. The +ve (generally black) should be connected to 9VI (pin 2) and the -ve lead (generally blue) should be connected to the relevant axis datum - input (pin 3 to 5). Switches should be fitted (if desired instead of proximity detectors) such that they connect the 9VI to the respective datum input whilst the machine is either +ve w.r.t. datum for systems where datum is at 0, or -ve w.r.t. datum for systems where datum is at the +ve movement limit. Switch short circuit current = 15mA, open circuit voltage = 9vdc.

(b) Overtravels:

The SMCU is fitted with overtravel switch inputs which when operated inhibit further movement in either the +ve or -ve direction. If an overtravel switch operates whilst the machine is moving, the movement is decelerated to stop and an error message is displayed.

Overtravel switches should be fitted such that they operate a short distance before the mechanical movement limit.

Overtravel switches should be connected such that they are normally closed, and only open for the overtravel condition. Overtravel common is OVI (pin 9).

Switch short circuit current = 15mA, open circuit voltage = 15vdc.

NOTE: Unused overtravel inputs should be connected to OVI (pin 9).

vi) Keypad

The SMCU is supplied with an 8 key keypad consisting of 8 individual single pole keys. Each key, when pressed, pulls down on the eight inputs to the keypad port of the SMCU. Contacts are rated at 5v-1ma.

vii) Analogue Output (Option)

An 8 bit optically isolated analogue output is available. Designed primarily to replace the speed control potentiometer of external motor speed controls, the analogue output requires a supply of approximately 12 v dc at 5 ma and can generate 0 to 10v into 4K7 input impedance of a speed control system.

Three relays operate in conjunction with the analogue output. The first relay is in series with the output and is used to isolate the output until required by the user program. The second and third relays provide volt free contacts for ON/OFF and FWD/REV functions when the spindle control option is selected in Auxiliary setup. (SMCU Host Computer Software section 2.1.6).

Start Out is connected to Start Common when Spindle movement is required and Fwd is connected to Fwd/Rev Common for Forward spindle movement.

Contact ratings of the relays are 110 vdc/ac at 100ma, resistive.

Gain and offset potentiometers are provided to allow adjustment of the analogue output, these are factory preset. (Sheet 2 of the circuit diagrams).

viii) Spindle Output (Option)

Instead of using an external spindle motor drive, the SMCU can be equipped with two contactors to give spindle ON/OFF and FWD/REV control directly by switching the 240v supply to the spindle motor.

The spindle connector pins are as follows:-

- (A) Earth
- (B) Switched line - 240 v ac Live when spindle drive is selected.
- (C) Switched Neutral - supply neutral when spindle drive is selected.
- (D) Forward Live - supply Live when spindle forward is selected  
supply Neutral when spindle reverse is selected.
- (E) Forward Neutral - supply Neutral when Spindle forward is selected  
supply Live when spindle reverse is selected.

Maximum spindle motor power must be restricted to 1KVA and 240va operation.



### 1.3 Cabling Requirements

- a) The connection leads to all input, datum and overtravel switches should be of a screened type, the screen being only grounded at the SMCU end.

The input and overtravel switches must be volt free contacts and electrically isolated from all external circuits.

The datum switches should be 2 wire inductive proximity switches. the recommended type being Balluff 516-324-E2N-2 or equivalent. Volt free contacts can be used as an alternative but inferior datum repeatability will be experienced. The arrangement for these contacts should be open circuit at datum, short circuit remote from datum and as with other switches electrically isolated from all external circuits.

- b) Motor leads should be run separately from all the control leads mentioned in a), particularly the datum switch/leads.
- c) Where the auxiliary relays of the SMCU are switching inductive loads it is recommended that suppression components be fitted across the coils to reduce electrical interference and prolong the life of the conventional relays used in the SMCU.
- d) When the drives are switched on the current surge can exceed 50 amps for a few milli seconds consequently anti surge fuses must be used to fuse the input power. A 3.15Amp anti surge fuse is fitted to the rear of the SMCU or a 10 Amp HBC fuse when spindle contactors are fitted.

## 2. System Tests

### SMCU Test Mode

Included in the NEE Software are a comprehensive range of SMCU test features enabling the following to be tested:-

RS232 Serial Link.

Datum detectors, Spindle Speed and inputs 1 to 4.

Overtravel Switches.

SMCU Assign Switches.

SMCU Keypad.

SMCU Program Stop switch and axis drives.

SMCU Auxiliary/Spindle Relays.

SMCU axis control electronics.

Analogue output.

SMCU ROM.

SMCU RAM.

These tests when executed via the personal computer enable system faults to be rapidly and easily located. For further details see section 7 of the SMCU Host Computer Software.

By use of the internal assign switches the SMCU can be made to carry out hardware test routines, for further details see section 5 of this manual.

### 3. Error Indicator

The SMCU unit includes a front panel indicator which has a number of uses.

At initial power up if the SMCU microprocessor is running the indicator repeatedly flashes ON for 1/4 second, then OFF for 1/4 second until the first RS232 command is received or until the optional Keypad is used .

The SMCU indicator changes from ON to OFF or vice-versa for each RS232 character received. In normal operation controlled by a host computer the indicator will glow dimly as RS232 characters are received then will remain OFF or ON for the period between receipt of Characters. Any error conditions detected by the SMCU are transmitted via the RS232 link to the host in a coded form if the RS232 data transmission switch is ON (see section 5). (See Section 7 of SMCU Host Computer Software Manual).

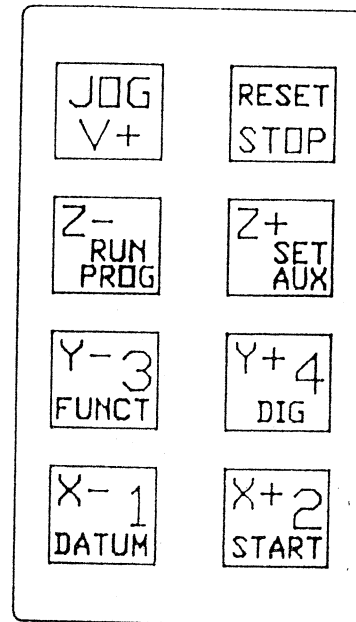
If the SMCU keypad is used the initial flashing stops when the keypad is operated. The indicator then changes from ON to OFF or vice-versa each time the Keypad is operated. Additionally in this mode the indicator is used to indicate a number of error conditions as follows:-

<u>Error</u>	<u>Indicator Operation</u>
Overtravel Error	1 short flash ON then OFF for 2.5 seconds repeated.
Stepper Drive Fault	2 short flashes ON then OFF for 2.5 seconds repeated.
Datum Error	3 short flashes ON then OFF for 2.5 seconds repeated.
EXT.STOP pressed	4 short flashes ON then OFF 2.5 seconds repeated.
ROM.RAM DATA ERROR	5 short flashes ON then OFF 2.5 seconds repeated.
KEYPAD COMMAND ERROR	6 short flashes ON then OFF 2.5 seconds repeated.

Pressing RESET on the keypad, clears the error, additionally receipt of an ascii 'H' via the RS232 link clears the error.

If the SMCU is executing a program from it's EPROM or RAM the indicator is only used as an error indicator or to indicate a 'DWELL' operation by getting dimmer then brighter once per second.

#### 4. Keypad Operation



#### System Full Reset

The SMCU control unit may be given a FULL RESET which clears all internal RAM and sets all parameters to a fixed state by:-

- With the UNIT switched OFF press and hold the JOG, RESET and START keys simultaneously.
- Switch on the SMCU.
- Hold the keys for 2 seconds.
- Release all the keys.
- Press the RESET key.

At this point the SMCU front panel indicator will flash regularly twice per second. On early SMCU's the RS232 port will now operate as defined by the internal assign switches (see section 5). On later SMCU's the RS232 port operates after a full reset at 300 baud, odd parity with 7 data bits. The SMCU set up sequence enables the RS232 port parameters to be redefined.

N.B. A FULL RESET erases all the information from the SMCU RAM including machine set up parameters and all stored programs.

### Jog Facility

The machine can be jogged into position by using the <JOG/V+> key followed by the axis direction key.

e.g. press <JOG/V+>

<START/X+2>

The instruction causes the X axis to move in a positive direction at a slow feedrate.

If the <JOG/V+> key is pressed twice before the axis direction key is pressed then the machine will start moving at a faster feedrate.

e.g. press <JOG/V+>

<JOG/V+>

<START/X+2>

This instruction causes the X axis to move in a positive direction at a faster feedrate.

If whilst jogging the (JOG/V+) key is held the feedrate will gradually ramp up.

Note. The SMCU does not permit jogging beyond either the preset +ve or -ve machine limits as defined by section 2 of the SMCU Host Computer Software manual.

### Auxiliary functions

To select one of the four integral SMCU auxiliary relays press the <SET AUX> key followed by keys <1>-<4> which change the current state of auxiliaries 1-4 respectively.

e.g. press <SET AUX>

<START/X+2>

This instruction will invert auxiliary two's setting.

### RUN Program

To execute a program stored in the battery backup memory of the SMCU, press the <RUN Prog> key followed by keys <1>-<4> which will execute from block 1, the program number selected. (Programs numbered in the range 5-15 have to be selected from the host computer)

e.g. press <RUN Prog>

<DATUM/X-1>

This instruction will execute program one. When the program has finished the program may be executed again either by pressing the <START> key, or by repeating the sequence above.

A program that is being executed can be stopped by pressing the (STOP/RESET) key, it can be resumed using the (START/X+2) key.

### Datum key

Pressing the <DATUM/X-1> key will cause all the defined axis to go to their datum positions as defined in the set up procedure, (see section 2 Host Computer Software Manual).

Each axis can have the following attributes for datum.

1. Datum position either 0 or its maximum +ve limit.
2. Fixed datums or not - if not fixed then that axis will simply take its present position as its new datum point. If fixed then it will actively seek datum markers.

The order in which each axis takes up its datum position can be specified by the set up procedure.

### Reset key

The <reset> key will cause the SMCU to stop whatever it is doing.

If an error has occurred, for example an overtravel has been hit, the <RESET> key must be pressed before the SMCU can continue to do anything else.

### START key

Pressing the <START> key will cause the SMCU to continue to execute the program previously selected by the <RUNPROG> key.

If this key is pressed and the <RUNPROG> key has not been used previously to execute a program a command error will occur. The error will be indicated by the red LED on the front panel of the SMCU.

### DIG key

This key is used in conjunction with edit to allow the operator to digitize machine positions.

e.g. Whilst in input mode of edit, enter a linear block.

Press the <DIG> key on the SMCU keypad.

The current machine positions will now be displayed in the block.

### FUNC key

Facility not available at the moment.

## 6. Circuit Diagrams

<u>Sheet</u>	<u>Contents</u>
1	Processor
2	Auxiliaries/Spindle
3	Datums/Overtravels/Inputs
4	Power Supply

7. Maintenance and care of your SMCU

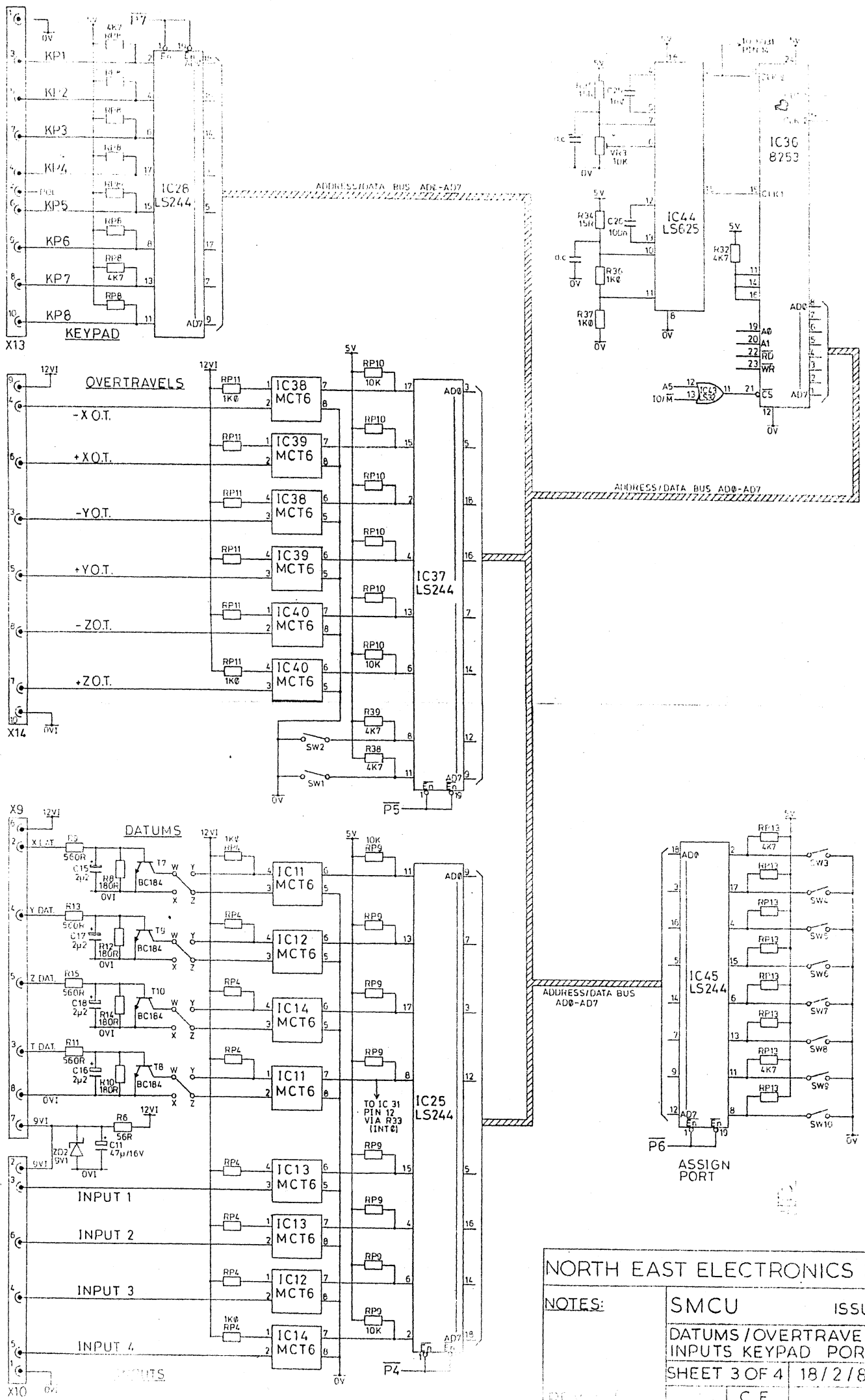
If your SMCU has been supplied with CD20 drives or larger, then a cooling fan will be fitted to the rear panel. To ensure the continued effectiveness of the fan, the filter should be cleaned regularly by removing the filter material and using a domestic vacuum cleaner to remove any dust.

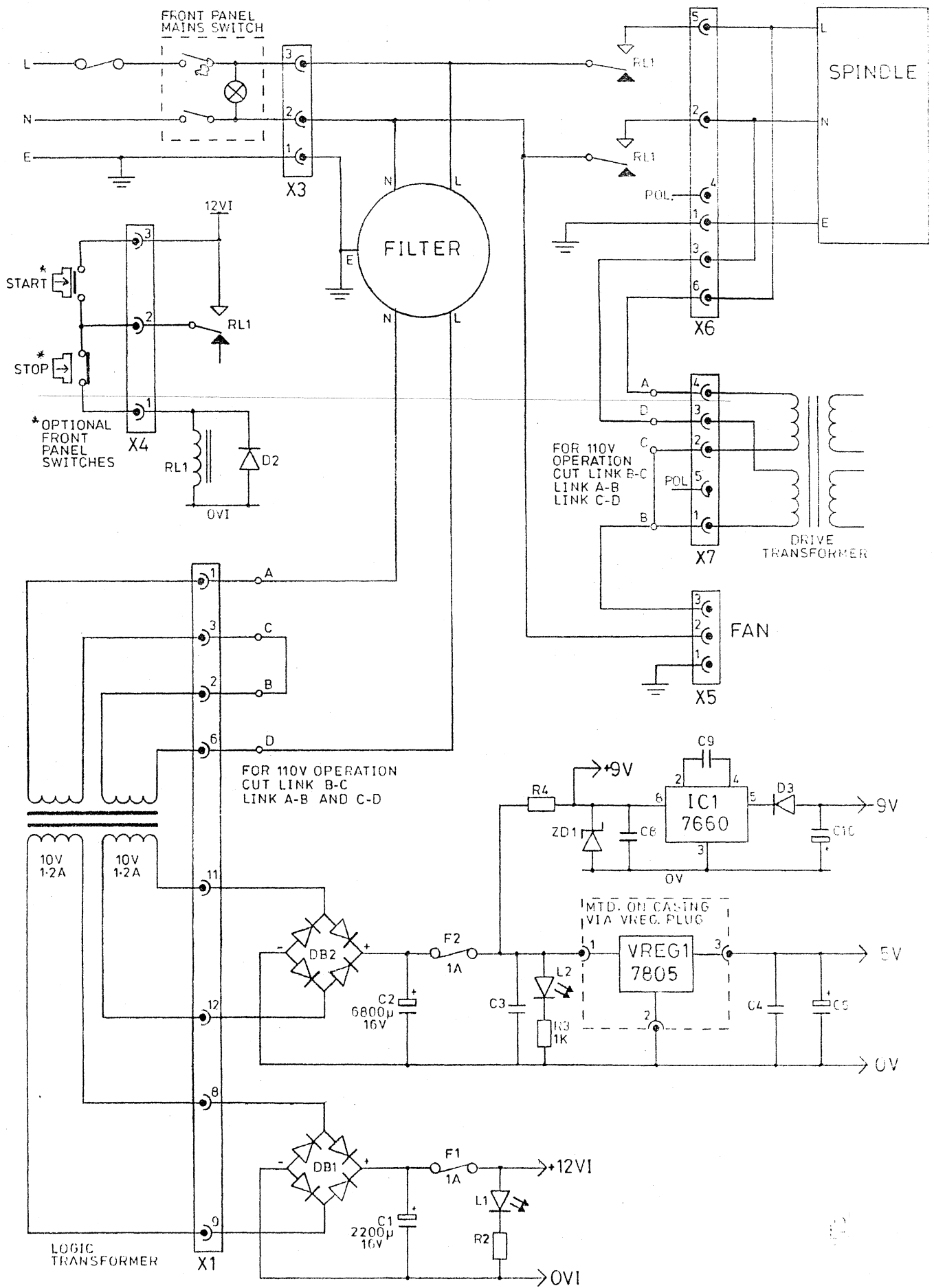
Failure to keep the filter clear could cause the drives to overheat and will additionally reduce the system reliability.



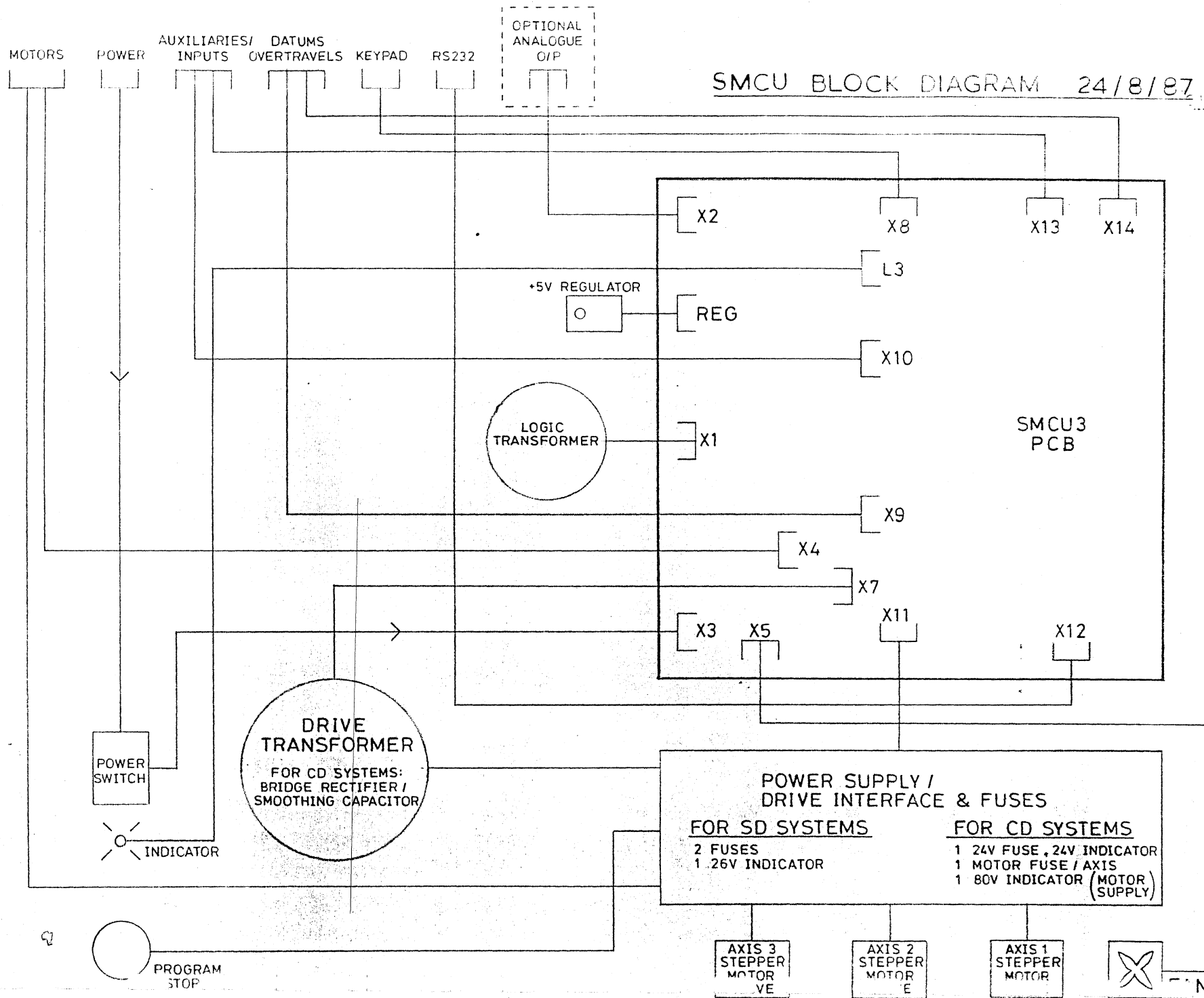








NORTH EAST ELECTRONICS LTD.			
NOTES:	SMCU		ISSUE 1
	POWER SUPPLIES		
	SHEET 4 OF 4		20/2/87
	REV. 1	CE	CHKD 18/2/87



ISSUE 3  
REV 1

NORTH EAST ELECTRONICS LTD

SMCU HOST COMPUTER SOFTWARE - (IBM systems and compatibles)

Users Manual (Version 2)

October 1987

## Contents

1. Getting Started
2. Configuring to suit your system
3. Program loading and editing
4. Disc operations
5. Graphical Simulation
6. Program Execution by SMCU
7. SMCU System Tests
8. Printer operation

Appendix A - System Errors

Appendix B - Computer to SMCU interface cable

## 1. Getting Started

This chapter describes the basic philosophy behind the software and also describes the minimum hardware requirements. It is essential reading for first time users.

N.B. This manual in no way replaces your own computer users manual or DOS operating system manual. Make sure that you read and understand those manuals before using the SMCU software!

### 1.1 Hardware requirements

The following items of hardware are essential for correct operation of the software.

- a) IBM PC, XT or AT or compatible with 1 or more floppy disk drives.
- b) DOS 2.0 or above.
- c) Colour Graphics Adaptor (CGA).
- d) RS232 serial interface adapter (configured as COM 1).

If you also have a winchester hard disk then it is advisable to copy the SMCU software onto this as it will greatly improve the speed of response of the system.

### 1.2 Making a security back up copy

The first thing you should do is make a copy of the SMCU software disk and keep it in a safe place. If you damage the master copy then a replacement copy can be obtained from us at a small charge. To make a copy of the master disk follow these steps:-

- a) First put a write protect sticker onto the master disk.
- b) Put your DOS disk which contains the DISKCOPY program into the disk drive and follow the instructions given for the DISKCOPY utility, given in your DOS manual.

This utility will enable a copy of the master software to be made. You should follow the instructions as they appear on the screen. Remember that the master disk will be referred to as the "source" disk and the "destination" or "target" disk will refer to a blank disk.

- c) When DISKCOPY has finished, you should identify the previously blank disk as the backup copy of the SMCU software. We recommend that you now keep the master disk in a safe place and use the backup copy for everyday use.

### 1.3 Copy onto a winchester

If you have a winchester disk then it is advisable to keep your working copy on the winchester. To do this, put the master disk into drive a: and type:-



SMCUCOPY A: C: <Enter>

This will copy everything from drive A: onto drive C:, the winchester.

#### 1.4 Starting the Software

Make sure that your copy of the SMCU software is in your current working directory and then type:

SMCU <Enter>

This will cause the main menu to be displayed on the screen.

The SMCU software makes extensive use of menus. To make a selection from a menu press the appropriate numeric key. Remember that the numeric keypad on the right hand side of an IBM keyboard only works if the NUM LOCK light is lit. When the light is off the keypad works as cursor control keys. To switch between these two modes of operation, press the NUM LOCK key until the desired mode is set (indicated by the light).

You should also now locate the Escape key. This key is marked "Esc" and is referred to as Esc throughout the rest of this manual. The Escape key is used to reset from error conditions and also to return to previous menu blocks.

#### 1.5 Know the SMCU

To get the best out of this software package you should know as much as possible about your SMCU. To do this read the SMCU manual and also make notes about how it is configured for your particular application.

#### 1.6 The rest of this manual

The manual has been laid out so that you can read through it from start to finish, preferably whilst also running the software. Once you are familiar with the basic operation of the software then this manual can be used as a reference guide. You should only need to refer to it for clarification of certain points.

## 2. Configuring to suit your system

The SMCU has been designed to work in a wide range of configurations depending on the mechanics of the system to which it is connected. However, it needs to be set up with the correct parameters to suit each particular system. This chapter of the manual describes the various parameters and how to change them. If they have already been set for your system then you can skip this chapter and move on to chapter 3. To alter the configuration, follow the steps described in section 1 to obtain the main menu, then select option 7 - Machine Set Up.

The screen will now show a further menu:-

- 1) Edit
- 2) Disk handling
- 3) Defaults
- 4) Exit

These options are described in the following sections.

### 2.1 Set-Up Edit

This option allows all the configuration parameters to be displayed and altered. When selected, the following menu appears.

- 1) Axes
- 2) Datum
- 3) Accel/decel ramp
- 4) Feedrate
- 5) Repeat type
- 6) Inputs and Outputs
- 7) SMCU Options
- 8) D to A input
- 9) RS232c Interface

#### 2.1.1 Axes

Choose this option and the display will prompt you to enter the number of axes. This is the number of motors that the SMCU will be driving. Enter a number in the range 1 to 3.

The display will then show the current settings for axis 1. Use the left/right cursor control keys to show the settings for axis 2 and axis 3. The up/down cursor keys control the position of the cursor on the current page. (Press Esc to return to the previous menu). As you move the cursor up or down you will notice that the prompt line at the bottom of the screen changes. Within each page the following parameters can be set.

- a) Axis name - this must be a single character in the range A to Z but not A, C, F, G, I, M, P, R, S, T or J. To select a new name, simply press the appropriate key.
- b) Units - 4 choices of units are available - millimetres, inches, degrees or mils. This is used in conjunction with the next option to define the basic step size of the machine. Also if mm or inch is selected then the axis position can be displayed in mm or inch (using G71 or G70).

- c) Step per unit - This value is the number of motor steps required to produce a movement of 1 unit on the machine. E.g. assuming a 400 steps per revolution motor driving a 5 mm pitch leadscrew, then 400 steps = 5mm so 80 steps = 1mm. In this example you would set "units" to mm and "steps per unit" to 80. To enter a new value, simply key in the new number and press enter.
- d) +ve limit - This is the maximum number of units that can be moved by this axis safely. E.g. if the leadscrew length is 1000 mm and allowing 50 mm at each end for end stops, bearings and limit switches then you should enter the number 900 here. The software will check all programmed moves and give an error if any would result in a move greater than this limit.

To enter a new value, simply key in the required dimension and press enter.

- e) Position After Datum - this is an absolute position to which the axis will move after it has found its datum position in all axes, from the datum detector. It will move to this position at the datum feed. If the axis is defined as Not fixed datum then no movements are made. The datum offset is displayed as the axis position after datuming. New values of offset can be entered in the same way as the +ve limit. If the datum position is either at 0 or at the positive limit then position the cursor over this option and press enter, in which case the word "disabled" will appear.
- f) backlash -
- g) rotary - describes the type of axis as rotary or not.

On version 2.\*\* and subsequent software, selecting this function results in the software treating 360° as 0° and also results in the software selecting the shortest route to the next position, e.g. if the present position is 25° and the next position is 300° the movement will be made through 360°.

- h) fixed datum - this defines whether the axis will seek a detector when being datumed. The option can be set as NO or YES by pressing 1 or 2.
- i) datum at +ve limit - this defines whether or not the datum position is at the +ve limit (if not then it is at zero).

You can use the left/right cursor control keys to display and alter the settings for the other axes. When they are all correct press Esc to return to the previous menu.

### 2.1.2 Datum

Choose this option and the following menu will be displayed. (Press Esc to return to previous menu).

- 1) Datum Order
- 2) Datum Feedrate
- 3) Datum Inaccuracy
- 4) Datum Detectors
- 5) Automatic Datum

Taking each option in turn:-

- a) Datum Order - this allows you to specify which axis will datum first, which axis second, and which axis last. Use the cursor keys and enter the axis number until the display shows the desired order (reading top to bottom). Press Esc to return to the previous menu. If you leave the display showing any axis number in more than 1 position then an error "Axis name duplicated" will be shown. In this case you must set the datum order again, making sure that each axis number appears once only.

If the machine is a single axis then access to this option is not available.

- b) Datum Feedrate - this allows you to specify the maximum feedrate (for all axes) to be used when seeking the datum detectors. To change this value, simply enter a new number and press Enter. Press Esc to return to the previous menu.
- c) Datum Inaccuracy - this allows you to set the permitted datum inaccuracy. This is the number of steps tolerance that the SMCU will allow when re-seeking its datum position. (It only has effect on axes set as Fixed datum). When the SMCU is first powered up and finds its first datum position, it is remembered and used as the reference for all subsequent datum operations. Any further datum not within the tolerance will generate an error.

To set the datum inaccuracy tolerance, enter a number in the range 0 to 255. Press Esc to return to the previous menu.

Note. All systems have mechanical/electrical tolerances, we do not recommend that this figure is set to less than 5. The value set here will depend on the quality of the mechanical system, the repeatability of the datum detector, and the degree of screening on the cables connecting the detector to the SMCU.

- d) Datum Detectors - this choice allows you to use the axis overtravel switches as the datum detectors. Overtravel (or limit) switches are generally fitted to systems controlled by SMCU's and so some savings can be made by also using these switches as datum detectors. Note however the mechanical switches do not generally give good repeatability. Press Esc to return to the previous menu.
- e) Automatic Datum - this allows you to define whether or not the SMCU will execute a datum procedure at power up. Select NO or YES by pressing 1 or 2. Press Esc to return to the previous menu.

### 2.1.3 Accel/Decel Ramp

Choose this option and the display shows a list of all the possible ramp settings. Use the cursor up/down keys to select a new setting. The value selected is the number of steps that the motor needs to achieve full speed (100%). E.g. if the ramp distance is set to 1000 then any moves programmed to run at 100% feed will take 1000 steps to accelerate/decelerate from/to stopped. (It also follows that the move length must be 2000 steps or more for the SMCU to achieve 100% feed !).

Press Esc to return to the previous menu.

#### 2.1.4 Feedrate

Choose this option and the following menu will be displayed. (Press Esc to return to previous menu).

- 1) Maximum feedrate displayed
- 2) Default feedrate
- 3) Feedrate units
- 4) Maximum interpolation feedrate (version 2.\*\*).

Taking each option in turn.

- a) Maximum feedrate displayed - this allows you to set the actual speed value which corresponds to the SMCU maximum speed. When the SMCU has been finally set up and the speed potentiometer adjusted to its optimum position, then you can measure the speed of the axes and enter that value here. E.g. if the SMCU maximum speed corresponds to 1000 mm per minute then enter 1000 here (mm per min is set later). Press Esc to return to the previous menu.

- b) Default feedrate - this allows you to set the feedrate at which axis motion will occur when no feedrate is specified. This is a safety feature - if the SMCU is controlling a large machine then you would typically set the value to something quite small e.g. 10%. Then if anyone commands the SMCU to move, but forgets to specify a feedrate, the SMCU will use the default value of 10%. For a small point-to-point positioning system you may want to set the value at 100% so that the machine always positions as fast as possible.

Press Esc to return to the previous menu.

- c) Feedrate units - this allows you to specify the feedrate units as either mm (or inch) per minute or percentage. The choice of mm or inch is defined by the units of the first axis (set in 2.1.1 b) earlier).

Press Esc to return to the previous menu.

- d) Maximum Interpolation feedrate - During multiple axis moves the SMCU 'interpolates' resulting in unsmooth pulses being fed to the motors. In certain applications high step rates can cause stepper motors to de-synchronise resulting in position inaccuracies! This feature permits the maximum interpolated feedrate to be set.

Press Esc to return to the main menu.

#### 2.1.5 Repeat type

This option allows you to set the type of repeat block. Either Repeat-divide or Repeat is possible. The difference is in the way the repeat offset is used. With Repeat-divide the offset is taken to be the total offset and each time round the repeat loop a portion of the total offset is added until on the final loop the total offset distance is achieved. With Repeat the offset is added each time round the loop, so that the final offset is the product of the offset and the number of repeat loops.

Press Esc to return to the previous menu.

### 2.1.6 Inputs and Outputs

Choose this option and the following menu will appear. (Press Esc to return to the previous menu).

- 1) Auxiliary outputs
- 2) Auxiliaries controlling spindle
- 3) Power up state of auxiliaries
- 4) Set top auxiliary on an error
- 5) Programmable Inputs

Taking each option in turn:-

- a) Auxiliary outputs - select this option and the display shows the total number of possible auxiliary outputs fitted to a SMCU. Use the cursor control keys to select a new setting.

Press Esc to return to the previous menu.

- b) Auxiliaries controlling spindle - this is a Yes/No choice. It allows you to set the SMCU auxiliaries 3 and 4 to control a spindle. Press 1 for No or 2 for Yes. If YES is selected then the SMCU will reserve auxiliaries 3 and 4 for use as spindle on/off and spindle forward/reverse controls.

Press Esc to return to the previous menu.

- c) Power up state of auxiliaries - this option allows you to define the state of all the auxiliaries at power on and after the initialize command. The display will show the current definition and the prompt line will be asking you to "Enter auxiliary to be OFF". If you again just press Enter then the prompt will change to "Enter auxiliary to be ON". Press enter again and the prompt will change to "Enter auxiliary to be IGNORED". So you should press Enter until the desired prompt appears, then key in an auxiliary number and press Enter. In this way the state of all the auxiliaries can be defined.

Press Esc to return to the previous menu,

- d) Set top auxiliary on an error - this allows you to set the SMCU so that it will set the top auxiliary if an error occurs. Press 1 for NO or 2 for YES.

Press Esc to return to previous menu.

- e) Inputs

Choose this option and the display will show the total number of possible inputs fitted to a SMCU. Use the up/down cursor control keys to select a new setting.

Press Esc to return to the previous menu.

### 2.1.7 SMCU Options

With continuous program execution selected this will cause the SMCU to continually execute the ROM/RAM program selected.

### 2.1.8 D to A output

Choose the option and the following menu will appear:-

- 1) Programmable Spindle
- 2) Initialise D to A output
- 3) Select Ramp

Press Esc to return to previous menu.

- a) Programmable Spindle - this is a YES/NO choice. It allows you to set the spindle to be programmable allowing the operator to specify the speed the spindle will be running at, in the range 1% to 100%.

Press Esc to return to main menu.

- b) Initialise D to A output - this allows you to define the D to A output value that the SMCU will set at power up and after the initialize command. To enter a new value, key in the desired number and press Enter.

Press Esc to return to the previous menu.

- c) Select Ramp - this allows you to set the D to A maximum ramp time. The display will show a list of available values. Use the cursor control keys to select a new value. The value selected is the time (in seconds) that the SMCU will take to ramp the D to A output from 0 to 100%.

Press Esc to return to previous menu.

### 2.1.9 RS232c Interface

Choose this option and the current serial interface settings will be displayed. Press Esc to return to the previous menu, or use the cursor keys to position the cursor over the value to be changed. Notice that as the cursor moves the display prompts you with all the available options for each setting. Press the appropriate number key to enter a new value.

### 2.2 Setup Disk

This is the second option in the MACHINE SET-UP menu. It allows you to save or restore machine settings to the disk. This is particularly useful if you have more than 1 SMCU with different configurations. If you choose this option the following menu will be displayed.

- 1) Store Set-up parameters
- 2) Load Set-Up parameters
- 3) Erase Set-up parameters
- 4) Catalogue
- 5) Assign drive

### 2.2.1 Store Set-up parameters

Select this option and the display will show a catalogue of all the names of any parameter files that are already on the disk. The prompt line will invite you to enter a name. This name will be used as a filename for the file which will contain your settings. As such the name you give must conform to the restrictions of DOS (E.g. up to 8 characters followed by an optional full stop followed by up to 3 characters). Press Esc to abort this operation or key in a file name and press Enter. If you use a name that already exists in the catalogue then your current settings will overwrite the previous settings. Once the operation is complete the previous menu will be re-displayed.

### 2.2.2 Load Set-up parameters

Select this option and the display will show a catalogue of all the names of any parameter files that are already on the disk. The prompt line will then invite you to enter a name (as in 2.2.1 above). The name you key in must correspond exactly to one of the names in the catalogue otherwise an error message will appear. When you key in a name and press Enter the set up parameters will be loaded from disk. You can then use the Edit option (section 2.1 of this manual) to view these parameters. If the "Invalid filename" error occurs press Esc to reset from the error and, key in another filename or press Esc to return to the previous menu.

### 2.2.3 Erase Set-up parameters

Select this option and the display will show a catalogue of all the names of any parameter files that are already on the disk. The prompt line will then invite you to enter a name (as in 2.2.1 above). The name you key in must correspond exactly to one of the names in the catalogue otherwise an "Invalid file name" will occur. When you key in a valid name and press Enter then that file of set-up parameters will be erased from the disk.

### 2.2.4 Catalogue

Select this option and the display will show a catalogue of all the names of any parameter files that are already on the disk. Press any key to return to the previous menu.

### 2.2.5 Assign Drive

This option allows you to keep parameter files on a different disk from your main software disk. When you select this option, the current disk drive letter is displayed. To set a new drive simply press the appropriate letter. The prompt line will show the range of allowable letters. Having set the desired disk drive, if you now select the Catalogue option you will notice that the catalogue of parameter files will be obtained from the newly set disk drive.

Press Esc to return to the previous menu.



### 2.3 Setup - Defaults

This is the third option in the MACHINE SET-UP menu. It enables you to rapidly set the parameter settings to the default state. To do this select this option, then press 1. The display will show the message "Default Parameters loaded" for about a second and then return to the previous menu.

The default parameters are such that the SMCU will be in a "safe" state. No axes will be capable of movement, neither by jogging nor by datum.

### 2.4 Setup - Exit

This option will return to the main menu, but first it gives you the choice of accepting or ignoring any changes you might have made. Press 1 to accept the changes or 2 to ignore them. If you press 1 then the current set-up parameters will be saved in a special area of your work disk. When you next load and run the SMCU software these parameters will be loaded from the special area automatically.

You have now completed system configuration. Read chapter 3 for SMCU programming details.

### 3. Program loading and editing

#### 3.1 Programs

A program consists of a series of blocks, each block contains a G, M or P code. To make the SMCU perform a sequence of operations, you must first create a program. The program you create will contain the commands which will cause the SMCU to perform the requested operation. Chapter 6 describes how to make the SMCU execute the blocks in your program. This chapter explains how to input and edit the blocks needed for your program.

The options Enter New Program and Edit Program allow programs to be created or altered. (From version 2.\*\* Enter New Program option does not exist).

#### 3.2 Edit

Select Edit Program from the main menu and the display will show its first block in the program, if no program is loaded a M02 'End of program' block will be on the display. In the top of the screen is the current mode, the program name, the number of blocks in the program and the memory used by the program as a percentage of the total memory available are displayed. The program name will be "NEW" until you store it to disk when you can give it a name of your choosing. The number of blocks will increment or decrement as you insert new blocks or delete old blocks. The memory used value gives a useful measure of how much of the memory available has been used by the program. You will notice that one block is already in the program. This is an M02 "End of Program" block. There must always be at least one M02 block, so the software automatically inserts it for you. To the left of the block is "N1", this is the block number. You will see this number incrementing as you insert new blocks. Also, later on, you will find that the block number is used to refer to particular blocks for the Search and Delete functions.

At the bottom of the screen is a menu of 7 choices. To select an option from this menu, simply press the key corresponding to the initial letter, e.g. for Input press I. The options are described in the following sections.

#### 3.3 Input

This option allows you to input several blocks one after the other. When you press the I key the block at the bottom of the screen will be cleared and the display will prompt you to enter a G, M or P code. At this point you can press G, M or P then Enter, and a list of all the possible codes will be displayed. The meaning of each code is given in more detail in section 3.10.

#### 3.4 Alter

To save time in inputting full blocks of data where only a portion of a block is to be amended this option will prove useful.

#### 3.5 Replace

If the current block is to be replaced completely then this option is selected, the display will clear and prompt will request the new block and new data to be input. At the end of the new input, key E must be pressed to signify the data is correct and then the edit menu in the prompt line will reappear to allow further editing.

### 3.6 Delete

This will give 3 options 1) deleting the line shown on the action line or 2) deletion of a batch of lines by specifying start block and the end block, entering these selections will automatically remove them from memory. All the remaining blocks will be automatically renumbered or 3) provides a convenient way of deleting the entire program.

### 3.7 Previous

This will move the previous block into position to allow editing to take place. Assuming <NUM LOCK> is released this function can be achieved by pressing the up arrow, also the <page up> key can be used to move one full page and, the <home> key can be used to move back to block 1.

### 3.8 Next

This will move the next block in the program into position to allow editing to take place. Assuming the <NUM LOCK> is released this function can be achieved by pressing the down arrow, also the <page down> key can be used to move forward one full page, and the <end> key may be used to move to the last block in the program.

### 3.9 Search

This is to bring the user quickly to the block required. This option is particularly useful when large programs are being edited. On keying in the desired number (and pressing return) the block will be displayed.

### 3.10 Block details

#### (i) G00 Rapid

Up to 3 axis positions may be defined. The axes required will be moved at 100% feedrate except that if more than 1 axis is being moved the feedrate will be set by the maximum interpolation feedrate set in section 2. The movement will be linear with all axes arriving at their end points simultaneously. On versions 2.\*\* pressing <DIG> on the SMCU keypad will load first, second and third axis values in this block.

#### (ii) G01 Linear

Up to 3 axis position may be defined together with a feedrate in the range 0.1 to 100% dependant on the maximum interpolation feedrate set in section 2. The movement will be linear with all axes arriving at their end points simultaneously. Pressing <DIG> on the SMCU keypad will load first, second and third axis values in this block.

#### (iii) G02/G03 Circular Clockwise and Counter Clockwise

On software version 1.\*\* only option (c) is available.

Circular movement blocks may be defined in any one of the three following methods:-

- (a) End point and centre
- (b) Centre and angle
- (c) End point and radius

Because of the ambiguity of method (c), only arcs up to 180° and full circles can be defined. To define a full circle the start and end points must be equal, and the centre will be calculated as the start point plus the radius.

The Z axis may also be specified to move in this block. All axes will arrive at their end points simultaneously. Movements are made at the current or specified feedrate. Pressing <DIG> on the SMCU keypad will load first, second and third axis values in this block.

On version 2.\*\* or later systems circular movement may be defined in any two axes out of the three, i.e. circular movements can be made in either the XY or the XZ or the YZ axes, the G02/G03 blocks enable this selection to be made.

(iv) G04 Dwell

This block will cause a delay of a specified amount of seconds. A delay of up to 650 seconds is possible in 0.01 second increments.

(v) G10 Mirror axis 1

This block uses the current axis 1 position as a point about which all further axis 1 movements will be reflected.

(vi) G11 Cancel G10

This block cancels the effect of G10. At the start of the program this block will automatically be executed.

(vii) G12 Mirror Axis 2

This block uses the current axis 2 position as a point about which all further axis 2 movements will be reflected.

(viii) G13 Cancel G12

This block cancels the effect of G12. At the start of the program this block will automatically be executed.

(ix) G20 Program Scale

This block will cause all subsequent moves to be scaled by the percentage given in the block. Values in the range 0.1 to 6500.0% are allowed, however if the input mode is incremental then the scale value will be also, and therefore negative scales are allowed to reduce the scale.

The natural status condition for program scale is 100%.

(x) G54 Program offset

Offsets for up to 3 axes may be defined in this block. All further programmed positions will be offset by the amount specified in the block. The values are incremental and set to zero on all axes at the start of the program. Pressing <DIG> on the SMCU keypad will load first, second and third axis values in this block.

(xi) G70 Imperial Units

Following this block all program dimensions will be in inches.

(xii) G71 Metric Units

Following this block all program dimensions will be in millimetres.

(xiii) G81 Repeat/Repeat-divide

This block provides a simple way of repeating sections of current program. The block will require the following:-

- a) The repeat start label number.
- b) The repeat end label number.
- c) The number of repeats.
- d) The amount of offset in each axis, which will be added to values within the loop.

If Repeat-divide option is selected then the offset value specified in d) represents the total offset and only the required portion will be added each time through the loop. Repeat or Repeat-divide can be selected when setting up the system parameters. Pressing <DIG> on the SMCU keypad will load first, second and third axis values in this block.

(xiv) G90 Absolute Units

Following this block all dimensions will be taken to be absolute values.

(xv) G91 Incremental Units

Following this block all dimensions will be taken as incremental values which will be added to the previous values.

(xvi) G98 Absolute datum

This block will cause the machine to seek datum in up to 3 axes as defined by the datum sequence in the Machine Configuration section, section 2.

(xvii) M00 Program Stop

This block will cause program execution to pause, and only continue to the next block on the press of a key by the machine operator.

(xviii) M02 Program End

This block will cause program execution to stop.

(xviv) M03 Spindle FWD

This block will control the relays required for forward spindle operations. If the programmable spindle option is selected in the machine configuration section then a vlaue in the range 1 to 100% will also be required for the D to A converter which will control the analogue output, driving the spindle.

(xx) M04 Spindle REV

This block is the same as M03 except the direction will be reverse.

(xxi) M05 Spindle Stop

If the programmable spindle option is selected in the machine configuration section then the analogue output will be ramped down to zero. The spindle relays will then be reset.

(xxii) M06 Tool Change

This block will pause program execution and allow machine operator intervention to change the tool. On pressing a key the program will continue and the tool length offset for the tool whose number was in the block is used in subsequent program blocks.

(xxiii) M17 Label

This block defines a label number in the range 1-99999. Labels will be referenced by M32 and G81 blocks.

(xxiv) M20 Auxiliaries

This block defines which auxiliary contacts are to change state and what their new state will be. Up to seven auxiliaries will be controlled although if more than 4 are selected the spindle relays are used and blocks M03, M04, and M05 will become invalid.

(xxv) M21 Inputs

This block defines the state of the inputs that must be set before execution continues with the next block. The state of any combination of the 4 inputs can be defined as on, off, or ignored.

(xxvi) M32 Goto label

This block can be used to cause the controller to continue program execution from the label number defined in the block. The block may also be used to test for certain conditions and only transfer execution to the label if the condition is true. The conditions will be the state of the inputs (similar to M21). This block will not load into a SMCU program (see 6.3).

(xxvii) P00 Wait for proceed

This block will cause the program to pause and wait for a proceed command from an external device. The proceed command consists of the external device sending an ascii p via the serial link to the SMCU, or an operator pressing the START key on the SMCU keypad. (Only used in programs which will be loaded into the SMCU RAM.)

(xxviii) P01 Call ROM program

This block will cause execution of a program in the SMCU ROM. The number specified in the block is the program selection. The host computer will wait for completion of the ROM program. This block will not load into an SMCU program (see 1.4.5).

(xxix) P02 Call RAM program <sup>2</sup>

This block will cause execution of a program in the SMCU RAM. The number specified in the block is the program selection. The host computer will wait for completion of the RAM program. This block will not load into an SMCU program ( see 1.4.5).

(xxx) P03 Move until input

This block can only contain one of the three axes available. A linear move in the axes specified at a defined feedrate will be produced. Movement will end at the end of the move or when the state of the input specified in the block becomes closed.

(xxxi) P04 Program reference

This block can contain up to 3 axis positions and a feedrate value. The movement produced is in single axis form and therefore up to 3 single axis moves can be made by a single block. The order of axis movement is 1st, 2nd, and then 3rd. Movement will always be made to an absolute machine position.

We strongly recommend that programs which are to be downloaded to the SMCU include, as the 1st movement block in each program, a P04 block. This will ensure that the SMCU can position the axes correctly at the start of each program. Pressing <DIG> on the SMCU keypad will load first, second and third axis values in this block.

### 3.11 Block Code Summary

#### (i) G Codes

G00 Rapid  
G01 Linear  
G02 Circular clockwise  
G03 Circular counter clockwise  
G04 Dwell  
G10 Mirror axis 1  
G11 Cancel G10  
G12 Mirror axis 2  
G13 Cancel G12  
G20 Program Scale  
G54 Program Offset  
G70 Imperial Units  
G71 Metric Units  
G81 Repeat/Repeat-divide  
G90 Absolute input  
G91 Incremental input  
G98 Absolute datum

#### (ii) M Codes

M00 Program Stop  
M02 End of Program  
M03 Spindle FWD  
M04 Spindle REV  
M05 Spindle Stop  
M06 Tool change  
M17 Label  
M20 Auxiliaries  
M21 Inputs  
M32 Goto Label

#### (iii) P Codes

P00 Wait for Proceed  
P01 Call ROM Program  
P02 Call RAM Program  
P03 Move until input  
P04 Program Reference



#### 4. Disk Handling Facilities

This function allows the operator to load, store and erase programs on disk. When selecting this option from the main menu you will be prompted with the following.

- <1> Store program
- <2> Load program
- <3> Erase program
- <4> Catalogue
- <5> Assign drive
- <6> Merge program

##### 4.1 Store Program

On selection of this option a catalogue of the program data on the current disk drive is displayed, if none are found, a "no program data on disk" error is displayed, the operator is then prompted to "Enter program name" which can be up to 8 alphanumeric characters, a further three can be added if a decimal point is inserted into the program name, this can then be terminated by the enter key.

##### Valid Program Names

12345678  
FG4  
TEST1.PRG  
12345678.BAK

If a file already exists of the same name, then the new file will overwrite the old one.

##### 4.2 Load Program

On selection of this option a program catalogue is given in the same way as described in section 4.1, and again you are prompted to enter the program name, if the program you have entered does not exist then an "Invalid file name" error is displayed.

##### 4.3 Erase Program

This selection is identical to the load program option only instead of the program being loaded into the computer memory, it is erased from the disk.

##### 4.4 Catalogue

This selection gives a catalogue of the programs in the currently selected disk drive as described in section 4.1

#### 4.5 Assign Drive

On selection of this option the currently selected disk drive is displayed and the operator is then prompted to select a new disk drive to which programs can be loaded and stored. The range from which he can select the new disk drive will depend on the number of disk drives the computer has available.

#### 4.6 Merge Program

This selection is identical to the load program option only the program is added to the end of the program currently in memory. If the size of the new program will exceed the memory limit then the error "Memory limit exceeded" will be displayed, and the program currently in memory will remain unchanged.

## 5. Graphical simulation

After selecting graphical simulation from the main menu you will be presented with a screen similar to that in figure 1 which is at the rear of the manual. The box at the top of the screen reading from left to right displays the name of the program currently held in memory and the number of blocks in the program. The magnify value is the current magnification factor of the graphics box. The current graphics view is displayed. The units are updated by the execution of the relevant blocks, G70 Imperial units, G71 Metric units, G90 Absolute input and G91 Incremental input. The tool display is updated on the execution of the M06 Tool change block. At the top right of the screen is the spindle status area which is updated on the execution of M03 Spindle Fwd, M04 Spindle Rev and M05 Spindle Stop. Below that is the auxiliaries status box which is updated when an M20 Auxiliary block is executed.

The main box in the centre gives a graphical representation of axis movement blocks in a line plot.

The box at the bottom of the screen is the prompt area and displays the options available to the operator, which are as follows:-

### 5.1 Initialise

This option returns the cursor to the centre of the graphics display and resets the magnification factor to 1, which allows all of the table area to be displayed within the graphics screen.

### 5.2 Magnify

Magnify allows parts of the plotted program to be enlarged by a factor within the range of 1 to 100. To select an area to be enlarged the cursor must be placed in the centre of this area. Then by selecting the magnify option and entering the required factor of enlargement the new magnification factor will be displayed at the top of the graphics screen. Simply pressing <ENTER> will not alter the current factor, pressing <ESC> will return back to the graphics main menu. After entering a factor the screen is firstly centralized around the cursor and magnified about the centre of the display area. The program currently held in memory will now be plotted to the graphics display in the current view.

### 5.3 View

View displays a menu of viewing directions of the programmed profile.

- <1> Plan View
- <2> Side View
- <3> Front View
- <4> Isometric

Pressing <ESC> will pass control back to the graphics main menu. Upon selecting a view the box at the top of the screen will be updated.

#### 5.4 Cursor

The graphics display has a cursor which is moved around the screen using the cursor keys whilst the <NUM LOCK> is switched off. The cursor keys are used in connection with the magnify function. When the screen is magnified it is done so from the centre. When entering a magnification factor, if the cursor has been moved, then the centre of the screen is moved to the current cursor position and then magnified from that point.

#### 5.5 Single Step

The first block in the program is displayed and graphically executed, the next block will not be executed and displayed until the operator has pressed the <SPACE BAR> on the host computer keyboard. This operation will continue until the <ESC> key is pressed or the end of the program block is reached.

#### 5.6 Continuous

Continuous program execution works in the same way as single step except that the wait for the operator to press the <SPACE BAR> is replaced by a short delay of approximately two seconds between blocks.

#### 5.7 Rapid

Selecting this option causes the program blocks not to be displayed and there is no delay between execution of blocks. This enables a graphical execution to continue as quickly as possible.

#### 5.8 Set up

Upon selecting this option the current settings will be displayed in the centre of the graphics window. The left and right cursor arrows will show which set of parameters are being edited. The arrows may be moved up and down using the cursor keys. Make sure that <NUM LOCK> is switched off.

When first entering graphics set-up the prompt line will read as follows:-

- <1> Solid lines and dotted lines
- <2> Solid lines and hidden lines

By pressing keys <1> or <2> the current setting will be updated. By moving the cursor down by pressing the down cursor key the following prompt will be displayed if the machine set-up has been configured as a three axis system.

Solid line defined by:-

- <1> Auxiliary condition
- <2> Position of Z axis

Selecting option 1 or if the machine set-up has been configured as a one or two axes system, then the following prompt will be displayed:-

Select auxiliary number (1 to 4)

Upon entering a valid auxiliary number it will be displayed in with the current settings.

The following prompt will now be displayed to allow the operator to select the condition of the auxiliary.

Select condition of Auxiliary

<1> ON            <2> OFF

Pressing <1> or <2> will select the condition of the auxiliary and the current setting will be updated. After doing this the operator has defined the condition for when a solid line will be drawn.

e.g.

Solid lines and dotted lines.  
Solid line defined by Aux 1 On.

The above example means a solid line will be drawn when auxiliary one is on, otherwise a dotted line will be drawn. Selecting option 2, position the Z axis allows the operator to define a condition around the third axis as to when solid lines will be drawn. The following prompt will be displayed after selecting this option:-

Select Sign

<1> "=" <2> "<" <3> ">" <4> ">"

This allows the operator to select the sign. After entering the sign the following prompt will be displayed.

Enter position of Z axis.

This allows the operator to enter the position of the Z axis at which the solid line will be drawn.

After doing this the solid line will now be defined by the position of the Z axis.

e.g.

Solid lines and hidden lines.  
Solid lines defined by Z axis < 0.000

The above example means a solid line will be drawn when the Z is less than zero, otherwise the line will not be displayed.

<ESC> at any point will take the operator back through the levels. Pressing <ESC> after moving the cursor arrows the following prompt will be displayed:-

<1> Accept changes            <2> Ignore changes

If the changes are accepted by selecting option one then the graphics set-up is stored to disk and control will then be pressed back to the graphics main menu. If option two is chosen then control is passed back to the graphics main menu. Pressing <ESC> will return control back to the graphics set-up menu.

## 6. Execute Program

When first entering execute program for the first time you are forced to datum the SMCU. Once the SMCU has been datumed the operator is prompted with the following options:-

<E> Execute program

<M> Manual control

<P> Program SMCU

<D> Datum

<T> Tool offsets (3 axis only)

### 6.1 Execute program

This option selects the main execution section and two modes of operation will be available.

#### (i) Single Step

The user program currently in memory will be displayed and executed a block at a time starting at block 1. On completion of each block the user will be prompted to press a key to continue, and execution will be halted until such a key press is supplied. During execution, current machine positions, auxiliary status, spindle status and tool number will be continually updated on the display, in order to follow the machine's movements.

Execution may be aborted at any time by pressing the escape key, and restarted again from the block where it stopped or from the beginning.

#### (ii) Continuous

Unlike single step, block execution will be continuous with no pause between blocks. Also, if the block following the current block is a movement block, then the information in the block will be processed for transmission during the execution of the current block. Upon completion of the current block, the next block can be sent immediately and therefore allow for the fastest possible execution sequence.

If during the execution sequence an error occurs, then an error message will be displayed explaining the error condition.

### 6.2 Manual Control

The following facilities will be available in this mode of operation.

#### (i) Move X Axis

Allows a single axis absolute move in the X axis to be executed, at the current feedrate.

(ii) Move Y Axis

As section (i) above.

(iii) Move Z Axis

As section (i) above.

(iv) Spindle

This will allow control of the spindle relays and the analogue output. Spindle direction and speed (option dependant) can be specified.

(v) Feed rate

This will allow the changing of the current feedrate at which all movements in manual mode will take place.

(vi) Tool number

This will allow the changing of the current tool of which the amount of length offset will be used. Values in the range 1 to 8 will be allowed.

(vii) Run SMCU program

This will allow any one of the 15 SMCU RAM programs to be executed. The display of all variable data will be cleared and the host will wait for completion of the SMCU program. Upon completion the display will be regenerated using current and correct data. If an attempt is made to execute a program which is not in memory then a suitable error will be reported. Also the pressing of the <ESC> key during the execution of a SMCU program will halt execution and control will return to the host.

### 6.3 Program SMCU

The following facilities will be available from within this selection.

(i) Directory of SMCU programs

This will produce a list of the SMCU RAM program numbers which have been loaded.

(ii) Create SMCU program

This option will require a number in the range 1 to 15 to identify the program. The SMCU is informed to store the program in its own battery backed RAM and execution is entered in continuous mode. The blocks are executed as normal but also stored, to be re-executed via the external keypad or from manual operation mode.

(iii) Erase SMCU program

There will be 2 options for erasing SMCU programs.

a) All - All programs currently in memory will be erased.



- 2 b) Single - A number in the range 1 to 15 to identify the single program to be erased. An attempt to erase programs which are not in memory will result in an appropriate error message.

#### 6.4 Datum

This will be required before any of the other menu selections become available. When selected the machine will proceed to move to its datum position as dictated by the datum sequence in the Machine Configuration section. Any datum inaccuracies which may occur will be displayed if they are greater than the permitted level, as defined in the Machine Configuration section.

#### 6.5 Tool offsets

Tool length offsets are described as a measured distance from the machine fixed zero plane at which the part is programmed, usually the top of the workpiece.

The ability exists to use several tools with independant lengths in one program. To program the Z axis we must know where the tip of the tool is at all times. This is done by the current tool number and using the tool length offsets stored in the tool library. The control automatically adds 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 Z 0.

This feature eliminates the need for preset tooling.

The following facilities will be available from within this section.

##### (i) Edit

The 8 tool length offsets allowed can be entered or altered simply by selecting the tool number, from 1 to 8 then either entering the amount of length offset that the tool requires or jogging the Z to position and then pressing the DIG on the SMCU keypad.

##### (ii) Disk Handling

###### Save

Will be used to store a set of 8 tool length offsets to the disk in the selected drive and given any name which will be displayed in the catalogue and used in the load option.

###### Load

Will be used to retrieve a set of 8 tool length offsets from the disk in the selected drive, stored using the save option.

###### Erase

Will remove a set of 8 tool length offsets from the disk in the selected drive, stored using the store option.

### Catalogue

A catalogue of the tool offset information stored on the disk in the selected drive will be displayed.

#### (vi) Delete

Will be used to remove a set of 8 tool length offsets from the disk in the selected drive.

The tool length offsets will be entered and displayed in the units indicated at the top of the display.

7. SMCU System tests

Note. Tests iii), iv), v), and vi) should not be executed when the SMCU is connected to a machine! Those tests are fitted for NEE engineers.

(i) RS232 Serial link test

This test causes randomly generated ASCII characters to be transmitted down the RS232 serial link to the SMCU. The SMCU then returns the character and appropriate error checking is done.

(ii) External input port tests

The external ports, monitoring Datum detectors, Inputs, Overtravels etc., are read in from the SMCU and displayed as bit patterns showing the state of the ports. The tests are divided as follows:-

(a) Datum detectors, Spindle and Inputs.

(b) Overtravels and hardware Links 1 and 2.

(c) Assign Switches 1 to 8.

(d) External Keypad.

(e) External Stop and Drive Faults.

(iii) External output port tests

Sets the SMCU sequencing through the auxiliary output ports several times, changing the state of auxiliaries and indicators.

(iv) Auto-test

Not yet implemented.

(v) 3 axis move test

Produces a small 3 axis move and then returns to the original position.

(vi) Digital to Analogue test

This test causes the analogue to digital converter to ramp from 0 to max and then back to 0. The test is repeated three times.

(vii) 8031 ROM checksum error

This allows the 8031 Version number and checksum to be transmitted to the host for display.

(viii) 8031 External RAM test

Causes the 8031 external RAM to be tested and a reply transmitted to the host defining the area of RAM where any errors occurred.

(ix) Dump SMCU Ram Program

This option allows the user to display a program which has been previously downloaded from the host computer to the SMCU. The program displayed is of the format that the SMCU stores its programs in the battery backed Ram.

The operator is prompted to enter a program number in the range of 1 to F. If the program exists it will be displayed in a window at the top of the screen otherwise an error will be displayed.

(x) Dump SMCU Rom Program

This option allows the user to display a program currently held in Rom. It uses the same display and input format as dump ram program.

Tests (iii) to (vi) require the host to wait for completion of test.

## 8. Printer Operations

Selecting option 3 from the main menu allows the operator to print out a hard copy of the program in memory. Any printer having a centronics parallel interface and a minimum of 80 columns can be used. Upon selecting this option, the current date will be displayed. At this point the operator may enter the date in English, followed by the <ENTER> key or press the <ENTER> key only and the date displayed on the screen will be printed on the listing.

After entering the date the display will read:-

```
<1> Complete Program
<2> Part of Program
```

Selecting option <1> will cause all of the blocks currently in memory to be sent to the printer. The blocks are displayed on the screen as they are sent to the printer.

Pressing <ESC> will abort the printer operation.

Selecting option <2> will display a prompt which reads:-

```
Enter start block (1 to 10)
```

From the example the start block could be nominated as '4'.

The prompt will now read:-

```
Enter end block (4 to 10)
```

From the example the end block could be nominated as '8'. Blocks 4 to 8 inclusive will now be displayed on the screen as they are sent to the printer.

Pressing <ESC> will abort the printer operation.

On completion the display reverts back to the printer menu. If at any time the printer is not connected then an error of "Printer not ready" will be displayed.

A useful option of being able to print out the current display is given. By pressing the PrtSc (Print Screen) key, the printer will print out the contents of the screen, this can be done at any time. (This can only be achieved with printers having a specification of Dot Matrix similar to Epson Rx 80 printers). In order for the print screen mode to work the DOS command "GRAPHICS" will first have to be executed. (See your DOS Operating Manual).

N.B. Before doing a print screen check that a printer is connected as the system will lockup if one is not connected.

## Appendix A

### System errors

#### B.1 Host captured errors

Host captured errors are errors generated and then captured by the host computer. A list of these errors is given below:-

##### (i) SYSTEM ERROR

Indicates that a fatal operating system fault has occurred beyond the control of the software.

##### (ii) SMCU not responding

Will occur when the host is expecting a serial reply from the SMCU and a predefined delay has elapsed with no reply.

In order to respond the SMCU must be:-

i) connected and switched ON.

ii) operating at the same baud rate, parity and data bit count as the host.

iii) in a 'ready' condition indicated by its front panel indicator flashing regularly twice per second. (Other flash sequences can be reset by the 'RESET' key on the keypad).

##### (iii) ERROR - Move exceeds machine limits

Will occur when an attempt is made to move any of the 3 axes below zero or above the limit defined in the Machine Configuration section.

##### (iv) ERROR - INVALID SMCU PROGRAM BLOCK

Will indicate that an attempt has been made to load an SMCU RAM program which contains invalid RAM program blocks. See section 1.2.1 for more block details.

##### (v) ERROR - MORE THAN 9 REPEAT LEVELS NESTED.

Will indicate that an attempt has been made to introduce another repeat level within 9 others.

(vi) ERROR - START LABEL NOT FOUND

Will indicate that another block contains a reference to a label which does not exist.

(vii) ERROR - END LABEL NOT FOUND

Will indicate a Repeat block has specified an End Label which does not exist.

(viii) ERROR - END LABEL FOUND BEFORE START LABEL

Will indicate a Repeat block has specified an End Label which occurs earlier in the program than the Start Label.

(ix) ERROR - REPEAT BLOCK WITHIN ITS OWN LABELS

Will indicate the Repeat block is within the part of the program to be repeated.

(x) ERROR - FEEDRATE OUT OF RANGE

Will indicate that an attempt has been made to program a feedrate greater than the maximum feedrate for a single axis move, or greater than the maximum interpolation feedrate for more than one axis move, both defined in the machine configuration section.

(xi) ERROR - INVALID CENTRE FOR END POINTS

Will indicate that the start point and given centre cannot reach the given end point.

(xii) ERROR - INVALID RADIUS

Will indicate that a radius of less than 1 step has been encountered.

(xiii) ERROR - INVALID CENTRE FOR START POINTS

Will indicate that the centre and start point are within one step of each other.

(xiv) ERROR - INVALID END POINTS FOR RADIUS

Will indicate that the radius given cannot reach the given end point from the start point.

(xv) ERROR - SCALE NEGATIVE IN ABS MODE

Will indicate that a G20 SCALE block has been encountered, containing a negative scale when the input mode was absolute.

(xvi) ERROR - SCALE OUT OF RANGE

Will indicate that a G20 scale block in incremental mode, has caused the scale value to exceed its limits.

SMCU captured errors

SMCU captured errors are errors generated by the SMCU and then transmitted via the serial link to the host to be decoded and displayed.

If the SMCU is being operated by it's keypad, errors are indicated by it's front panel indicator (see section 3 - Error Indicator).

(i) DATUM INACCCURACY - X, Y, Z

The machine position after a machine datum is compared to machine position stored from the last datum, if a difference of greater than the permitted datum error is found, then this error will be produced.

(ii) COMMAND ERROR

Will indicate that an unrecognised character in the current mode of operation, has been received by the SMCU.

(iii) SERIAL ERROR

Will indicate that a character received by the SMCU has failed the parity check.

(iv) CHARACTER DELAY ERROR

Will indicate that a predefined delay has elapsed between transmission of characters to the SMCU during a command sequence.

(v) DATA/CHECKSUM ERROR

Will indicate an invalid character within a command sequence has been received by the SMCU or the accompanying checksum was incorrect.

(vi) X Y Z AXIS DRIVE FAULT

Will indicate that the axis or axes on which movement has been attempted has a drive fault.

(vii) EXTERNAL STOP PRESSED

Will indicate that the SMCU External stop has been pressed.

(viii) TURN DRIVES ON

Will occur when movement is attempted on any axis when no drive power is present.

(ix) DATUM DETECTOR NOT FOUND

Will indicate that after a predefined number of steps of movement, no datum detector has been encountered.

(x) LIMIT EXCEEDED IN X+ X- Y+ Y- Z+ Z-

Will indicate that one or more of the machine overtravel switches have been activated.



(xi) SPINDLE CAN'T CHANGE DIRECTION

Will occur if an attempt has been made to reverse the spindle direction without stopping it first.

(xii) SMCU MEMORY FULL

Will indicate that during the loading of an SMCU RAM program the SMCU's memory has all been used.

(xiii) PROGRAM ALREADY LOADED

Will indicate that an attempt has been made to load an SMCU program with the same number as a program already in the SMCU memory.

(xiv) PROGRAM NOT FOUND

Will indicate that an attempt has been made to run or erase an SMCU program which has not yet been loaded.

All SMCU captured errors require the SMCU to be reset from the error condition by the keypad, or program switch on by an 'H' via the serial interface.