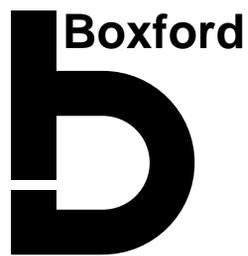


Installation and User Manual

Boxford Duet Turn and Mill CNC Training Machine



Boxford Ltd.,
Wheatley, Halifax, West Yorkshire,
England, HX3 5AF.
(Registered Office)
Telephone: 01422 358311
Fax: 01422 355924
E-Mail: info@boxford.co.uk
Web: www.boxford.co.uk

Contents

Safety

- Working Practice
- Stopping the Machine
- Guard Switches

1 Introduction

2 Packing List

3 Specifications

4 Computer Requirements

5 Installation

- 5.1 Installing the DUET Machine Tool
- 5.2 Installing a Robot for FMS Operation
- 5.3 Installing the DUET Software
- 5.4 Updating Existing V5 DUET Software
- 5.5 Network Installations
- 5.6 Configuring the DUET Lathe and Mill Simulation Software

6 Machine Controls

7 Using the DUET Simulation Software

- 7.1 Running the Software
- 7.2 Sequence of Operation
- 7.3 Catalogues and File Handling

8 Circuit Diagrams and Description

- 8.1 System Schematic
- 8.2 Power Supply PCB
- 8.3 Spindle Drive
- 8.4 Microprocessor PCB
- 8.5 Axis Control

9 Fault Diagnosis and Maintenance

- 9.1 Fault Diagnosis Procedure
- 9.2 LEDs, Test Points and Fuses
- 9.3 Software Fails to Run
- 9.4 Maintenance

Safety

Working Practice

The moving parts of the machine are totally enclosed when both front and drive guards are closed, and interlocks prevent the spindle drive from running when either guard is open. The operator is therefore well protected against the risk of injury; however the following precautions should be observed to promote safe working procedures and to prevent damage to the machine:

Clothing

Do not wear loose clothing or jewellery which can get caught in machinery. Tie back long hair or contain it with a hat.

Cleanliness

Keep the work area tidy. Clean all swarf from the machine after use.

Switching On

Check that the POWER ON switch is set to off before switching on the mains supply.

Securing Tooling and Workpiece

Make sure that tooling clamps and chuck jaws are properly tightened.

Make sure that the chuck key and other securing keys are removed before closing either guard.

Care of Cutting Tools

Keep tools clean and sharp. Use the most suitable tool for the job.

Tool Settings

To avoid running a tool into the workpiece or chuck, make sure that tool offsets and workpiece datum are correctly set, and that the correct tool types and positions have been selected.

Performance and Limitations

Know the capabilities and limitations of the machine. Do not overstress the machine by selecting excessive feed rates and depth of cut.

Stopping the Machine

WARNING:

DO NOT ATTEMPT TO STOP THE MACHINE BY OPENING A GUARD. USE ONE OF THE METHODS GIVEN BELOW, AND WAIT UNTIL THE SPINDLE HAS STOPPED BEFORE OPENING THE GUARD.

When the machine is executing a production cycle, it can be stopped by any of four methods:

Emergency Stop Button (E-STOP)

Pressing the button stops the machine, switches off machine electrics and aborts the production cycle. The button must be turned to release it, and to resume production the machine must be re-initialised and the cycle repeated from the beginning.

Inhibit/Run Switch

Setting the switch to INHIBIT stops the machine and aborts the production cycle in the same way as the E-STOP button.

POWER ON Switch

Setting the switch to OFF removes the power from the DUET machine and the power supply unit. To resume production, the machine must be re-initialised and the cycle repeated from the beginning.

Computer Keyboard

Pressing ESC stops the machine and interrupts the production cycle. Production can be resumed from the point where it was interrupted by re-selecting the file in use.

Guard Switches

For setting tool offsets, and when the Manual Mode option is used, the machine is controlled manually by the computer keyboard or mouse. For these purposes it is necessary to gain access to the chuck, workpiece and tooling. Safety switches detect when the guard is closed and restrict the operation of the machine under manual control as follows:

Spindle drive cannot be started unless guard is closed.

With guard open, toolholder can only be moved at slow speed.

Ensure that swarf tray is in place before starting or resuming machining.

1 Introduction

The Boxford DUET is a machine tool designed for both lathe and mill CNC training on the same machine. The 380w motor permits machining of various plastics.

In lathe mode, the DUET provides 2-axis simultaneous movement and screwcutting capability. In mill mode, the machine provides 3-axis simultaneous movement.

The machine is operated by an IBM-compatible PC on which the DUET software package is installed, allowing control by keyboard or mouse.

The DUET software is an integrated suite of CAD and CAM tools, enabling ISO G and M code programs to be produced by either :-

- a. Automatically processing a drawing created with the integrated CAD package or imported from any major package using the CAM processor.
- b. Manual data inputting using a sophisticated program editor, interactive help and in built error checking.

Screen graphics include 2D and 3D viewing with rotation, cross sections and zooming and simulation of machining for program verification.

This manual contains instructions for installing the DUET machine and software, and general guidance in using the DUET software. After setting up the equipment and becoming proficient in operating the software, refer to the TURNING and MILLING manuals for details of CNC programming and machining.

If required, all aspects of programming, program editing and simulation of machining can be practised without the PC connected to the DUET machine. This enables training to be carried out on a number of PCs simultaneously; completed programs can be transferred to a PC connected to the DUET for machining and program verification.

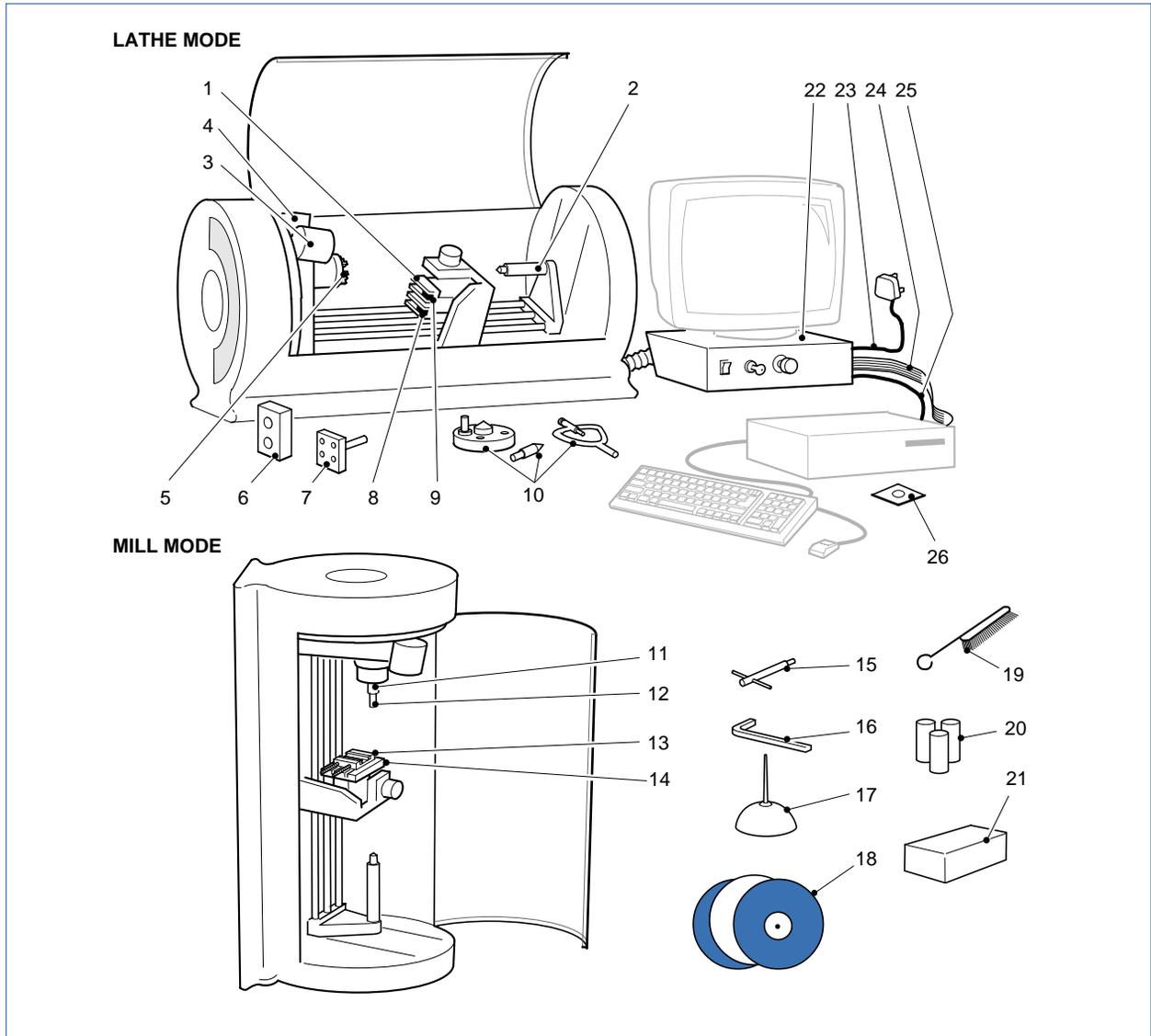


Figure 1.1 Duet Machine Tool and Accessories

2 Packing List

Unpack the case and check that the following items are included, (see Figure 1.1):

**DUET Machine Tool
Fitted with:**

1. 6-position toolholder with six clamps
2. Tailstock and centre
3. Low-voltage light
4. fixed spindle drive with cover
5. 3-jaw chuck
6. Additional speed change cassette

Lathe Mode Tooling:

7. 4-position drilling/boring toolholder with bushes
8. Left-hand turning tool with spare tips
9. Parting-off tool with spare tips
10. Spindle centre, driver and carrier

Mill Mode Tooling:

11. One 10 mm bore cutter holder
Two 5 mm bore cutter holders
12. One 5 mm end mill
13. Milling vice with two reversible jaws
14. Additional Equipment

Accessories

15. Chuck key
16. Camlock key (for securing milling table and drilling/boring toolholder)
17. Oilcan
18. Operating manuals on CD-Rom
19. Swarf brush
20. Turning billets (3)
21. Milling billet (wax)

Control Equipment

22. Control Unit (for 240V or 110V a.c. supply, as appropriate)
23. Mains cable
24. Parallel cable with 25-way connectors
25. Serial cable with 9-way connectors
26. DUET software on 3.5in. disks

3 Specifications

		mm	in
Lathe Mode	Swing over bed (dia)	225	8.86
	Max turned dia. between centres	65	2.60
	Spindle bore	20	0.80
	Distance between centres	330	13.00
	Turning distance between centres	330	13.00
	Tailstock centre adjustment	100	3.90
	Axis travel:		
	X	125	4.92
Y	360	14.00	
Mill Mode Axis Travel	X	125	4.92
	Y	75	3.00
	Z height (chuck to table)	260	10.00
Spindle Speed Range		200-2500 rev/min	
Rapid Traverse Rate		500 mm/min	19.5 in/min
Programmable Feed Rate		0-500 mm/min	0-19.5 in/min
System Resolution		0.01 mm	0.0004 in
Spindle Motor		320W or 450W	
		mm	in
Dimensions	L	900	35.50
	W	455	18.00
	H	480	19.00
Weight		52 kg	115 lb

4 Computer Requirements

The DUET machine tool is designed to be operated by the DUET software running on an IBM-compatible PC. The minimum requirements of the PC are given below, together with guidelines for setting up the computer before connection to the machine and installation of the software.

Processor	The PC should be based on a Pentium 100Mhz processor or higher.
Operating System	Microsoft Windows 95 or Windows 98. The system must have 520K of Conventional Memory available and access to XMS (Extended) memory.
Disk Drives	Disk Drives. A Hard disk with 10 Mbyte free space, and a 3.5in. floppy drive of 1.4 Mbyte capacity are required. It is not possible to run the DUET software from the floppy disk drive.
Memory (Min)	Windows 95 (16Mb), Windows 98 (16 Mb)
Graphics	VGA - 16 Bit (High Color)
Serial Port	The DUET machine must be connected to a serial port on the PC.
RS232 Data Cable	The DUET software enables programs to be exported to another PC. If this facility is required, the second PC is connected to a second free serial port on the PC using a suitable serial data cable. If the PC has only one serial port, then one of the following options should be taken: <ol style="list-style-type: none">1. Interchange the machine and program data export data cable connectors as required.2. Have a second serial port fitted (this can be done at a moderate cost).3. Fit a suitable multi-way switch to the serial cables.
Mouse	The DUET machine must be connected to a serial (COM) port on the PC. If a mouse is to be used, it should be connected either to a dedicated mouse port (PS2 or Bus) or to a second serial port. If necessary, re-configure the PC to use the appropriate port leaving a serial port free for connection to the DUET machine.

5 Installation

5.1 Installing the DUET Machine Tool

Location

The DUET machine requires a firm, level surface. It is not necessary to bolt the machine in position, and the machine can be turned on end for use in mill mode. The control unit and PC require a clean, dry area free from dust, vibration, and risk of splashing with coolant and other liquids.

If the PC has a separate monitor, the monitor can be stood in the recess in the top of the control unit, with the PC, keyboard and mouse arranged conveniently around the unit, (see Figure 1.1).

Connecting DUET to Power Supply Unit (Figure 5.1)

The DUET machine is connected to the control unit by three cables contained in the flexible conduit (4).

1. Remove the securing screws (1) from each side of the cover of the control unit, and take off the cover.
2. Insert the end of the conduit into the slot in the back of the control unit, insert the sealing plate (2) on the inside of the casing, and tighten the nut (3) to secure the conduit and sealing plate.
3. Connect the 25-way ribbon cable and connector to PL3 and the 6-way power connector to PL4 on the printed circuit board.
4. Connect the 2-way connector to the lamp power connector (5) which is wired to the transformer (6).
5. Refit the cover and secure it with the screws (1).

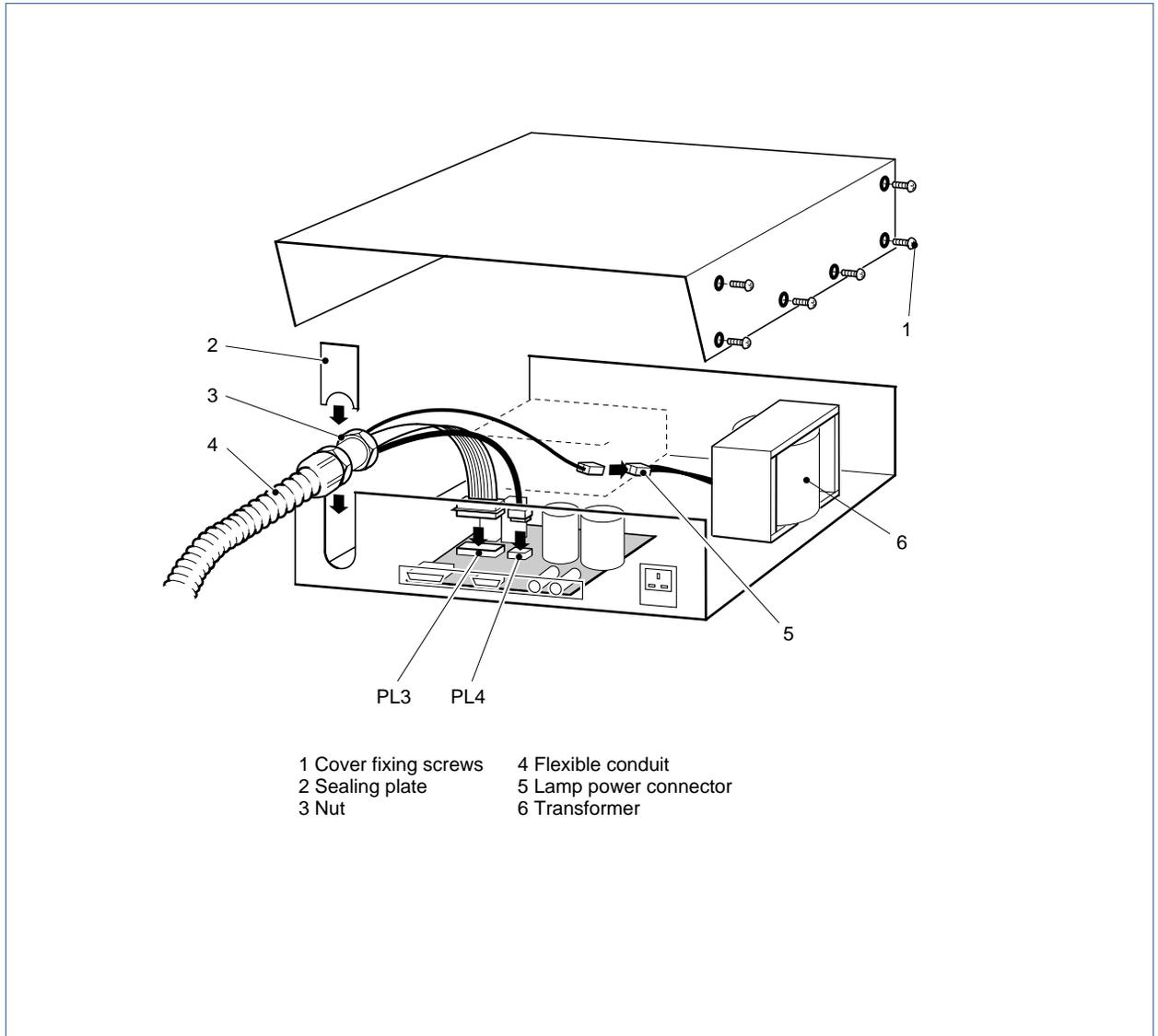


Figure 5.1 Connecting DUET to Control Unit

Connecting PC (Figure 5.2)

Make the connections to the back of the control unit as follows:

1. Connect PL1 to the parallel port on the PC with the 25-way parallel cable. (If a switch is to be used for connecting the printer, connect the switch to the parallel port on the PC and connect the parallel cable to the switch). If the PC has two parallel ports, use LPT2 to avoid conflict with any other software installed which may use LPT1.
2. Connect PL2 to the serial port on the PC with the serial cable.
3. Connect the printer to the second parallel port or switch, or place the cable connector close to the first parallel port to allow easy connection, as appropriate.

Connecting Mains Supply (Figure 5.2)

The mains lead must be terminated with an earthed (grounded) three-pin plug and connected to an earthed (grounded) a.c. power supply socket of the correct voltage (110 or 240V).

The wires are colour-coded as follows:

Black	:	Live
Brown	:	Neutral
Green/White	:	Earth (ground)

WARNING:

BEFORE CONNECTING AND SWITCHING ON THE MAINS SUPPLY, CHECK THAT THE 'POWER ON' SWITCH ON THE POWER SOCKET IS SET TO 'OFF'.

Connect the mains lead to the power socket at the back of the control unit, and to an a.c. power socket.

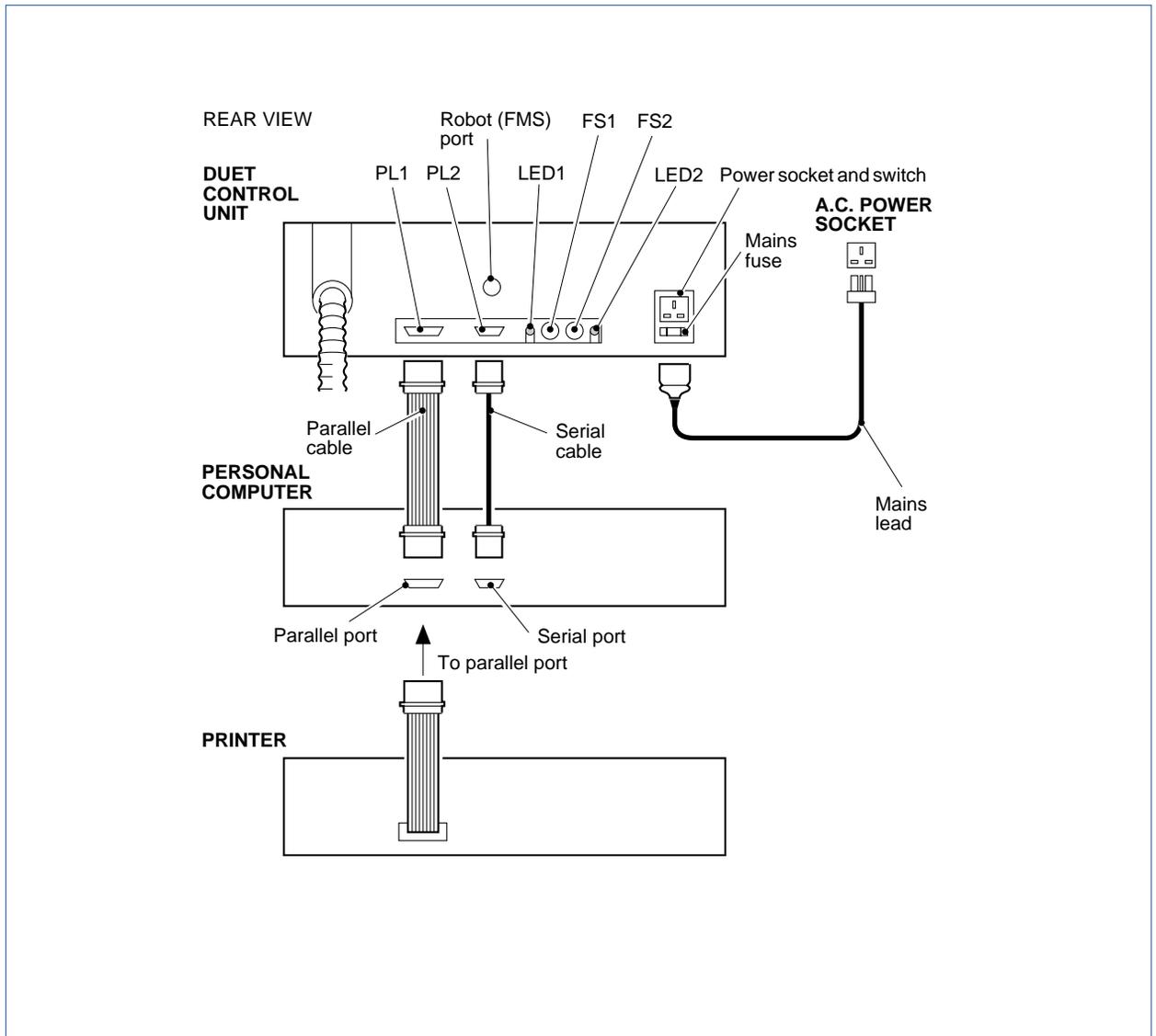


Figure 5.2 Connecting PC and Power Supply

5.2 Installing a Robot for FMS Operation (Figure 5.3)

A robot can be connected to the port at the back of the control unit (see Figure 5.2). The port accepts an input (CYCLE START) signal and provides an output (CYCLE COMPLETED) signal.

The port must be activated by using the CONFIG menu in the DUET software, (see 5.4 Configuring the DUET software).

When the port is activated, the input and output signals operate as follows:

Input Signal

Signal from robot to start machine cycle. Remote switch must be capable of handling 10mA at 5V.

Output Signal

Signal from DUET that machine cycle has been completed. Output will handle 100mA at up to 12V.

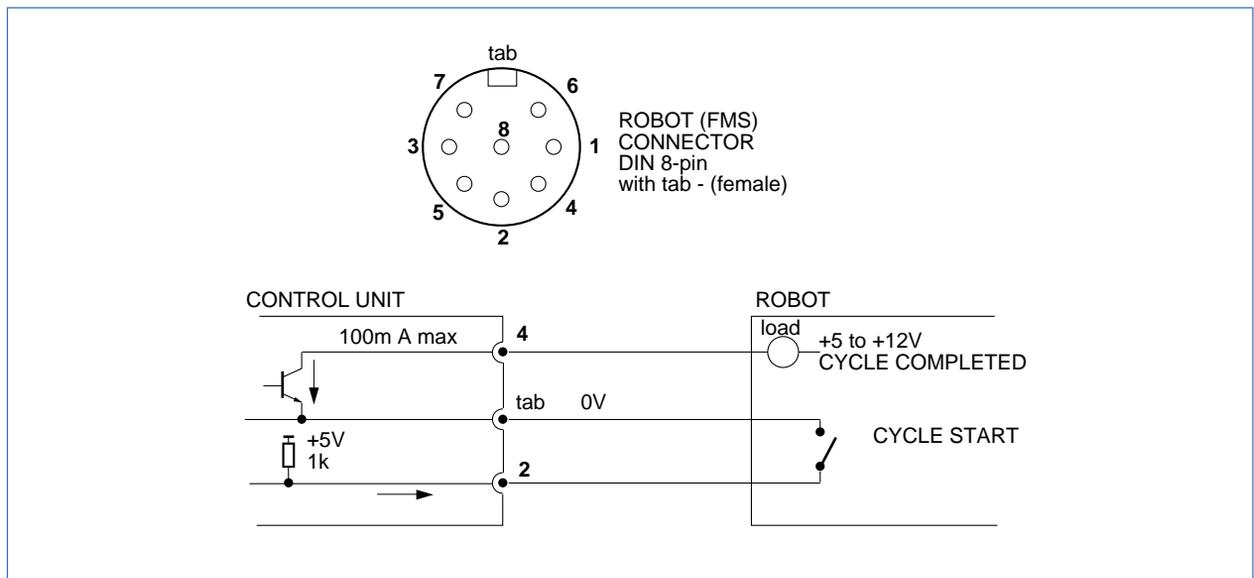


Figure 5.3 Robot (FMS) Connections

5.3 Installing the DUET Software

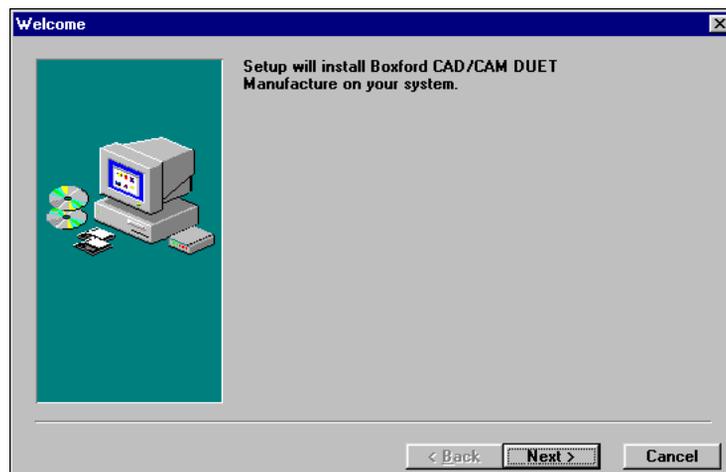
Note: In these instructions it is assumed that the DUET software will be copied from the floppy disk (in drive A) to the hard disk (drive C). If you are using different drive letters from these, make the appropriate substitutions.

For Update of existing V6 software, see section 5.4

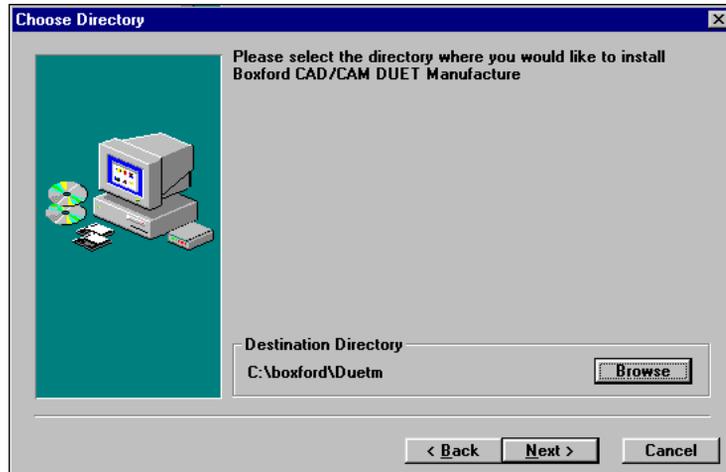
For Software Installation on a Network, see Section 5.5

Microsoft Windows 95 & 98

1. Start Microsoft Windows
2. Insert the Boxford CAD/CAM Installation disk 1 into the floppy disk drive.
3. Select **Start > Run**.
4. Type `a:\setup` and press ENTER.
5. After a pause the Welcome screen below is shown **Next** is selected



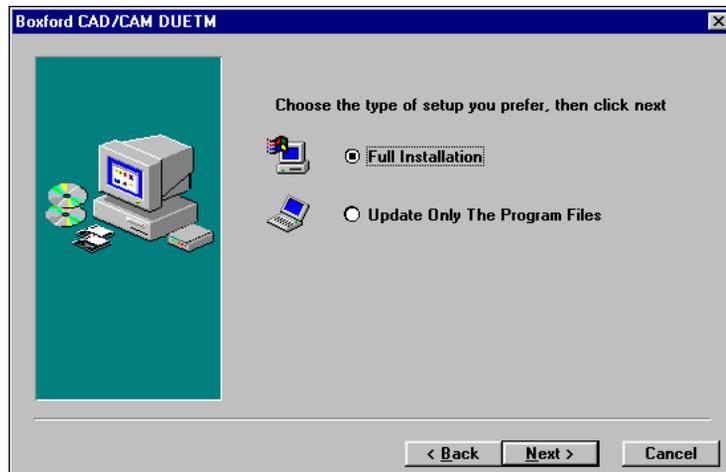
6. The screen below is shown.



The CAD/CAM software install default directory is *C:\Boxford\DUETmv6*. To modify, **Browse** is selected and a new directory specified. It is recommended that a similar directory structure is maintained. **i.e.** a main directory with the machine directory a subdirectory of it.

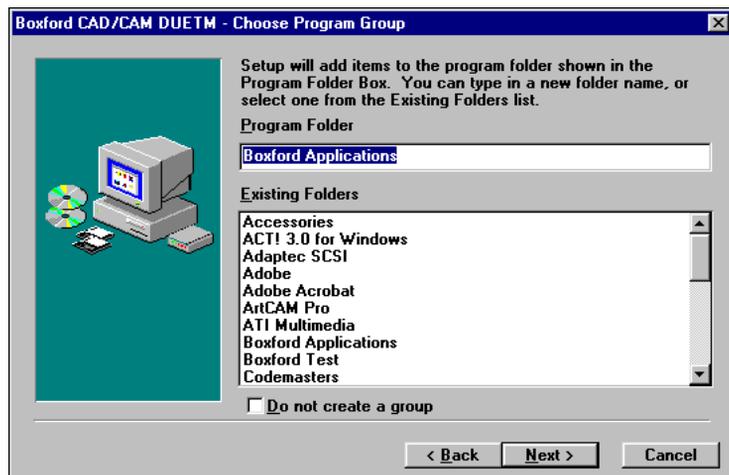
Next is selected when the directory is specified.

7. The screen below is shown.



Full Installation is selected for a new installation (see 8 below).
Update Program Files Only is selected to update an existing copy of V6 CAD/CAM software (see section 5.4 for further details).

8. The screen below is shown



The CAD/CAM software installation default folder is *Boxford Applications*.

To modify, either a new folder name is input or one selected from the existing folder list.

Next is selected when the folder is specified. File copying begins. When prompted, the user inserts Disc 2 and 3. **OK** is selected.

9. A successful Installation is confirmed. **OK** is selected.

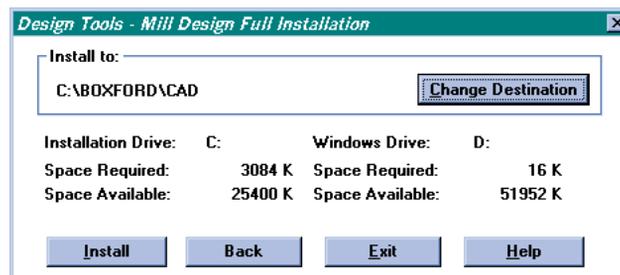


Microsoft Windows 95 & 98

10. Insert the DESIGN TOOLS Mill Design Installation disk 1 into the floppy disk drive.
11. Select *Start > Run*.
12. Type *a:\setup* and press ENTER.
13. The screen below is shown.



14. The screen below is shown.



The CAD software installation default directory is *C:\Boxford\CAD*

To modify, *Change Destination* is selected and a new directory specified.

It is highly recommended that the CAD software is installed in the same main directory as the machine software

Install is selected when the directory is specified.

15. After a short while, the message below is displayed



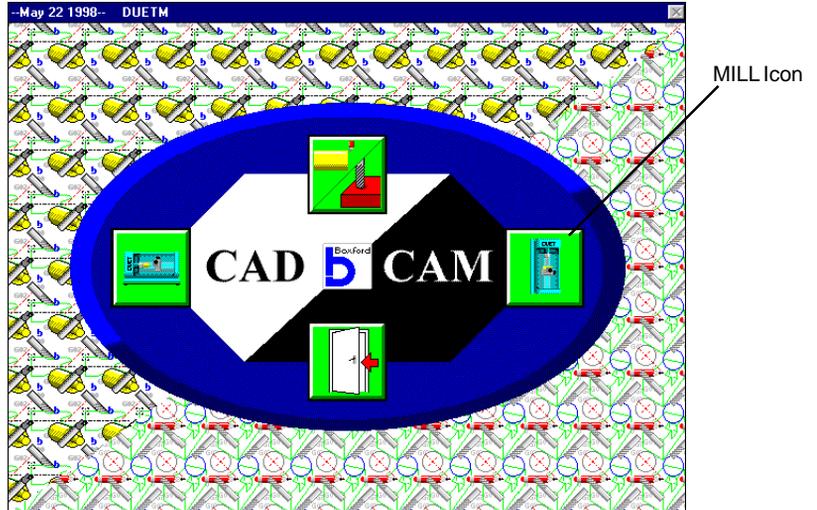
The required disk is inserted and **OK** selected.

16. A successful Installation is confirmed. **OK** is selected.



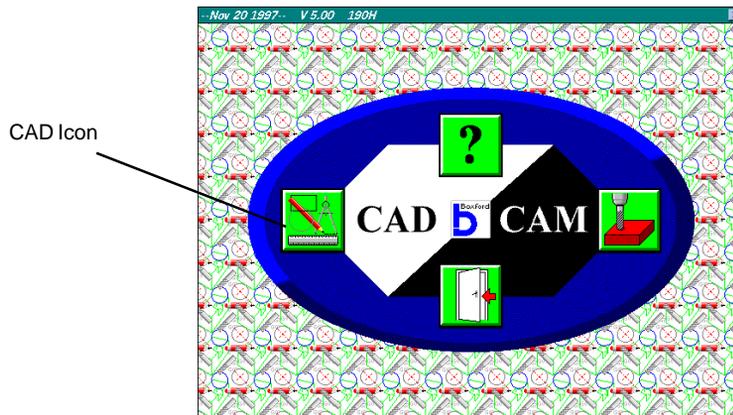
17. The CAD/CAM software is started from the relevant Icon within the relevant Windows program group.

18. The main front end menu screen below is shown.



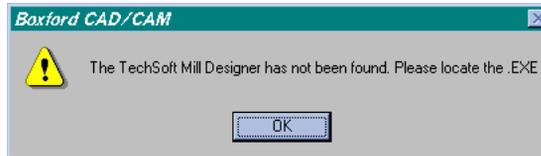
The Mill Icon is selected

19. The Main Front End Menu Screen below is shown.



The *CAD* Icon is selected.

20. The message below is displayed. **OK** is selected.



Microsoft Windows 95 & 98

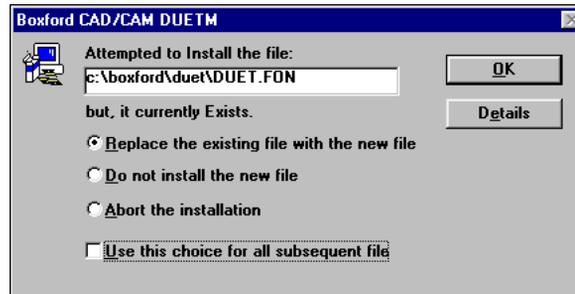
21. The file Mileds32.exe is located and **OK** selected. This is in the directory where the CAD package is installed
22. Configure the DUET machine software before attempting to use it, as detailed in section 5.6 of this manual.

5.4 Updating Existing DUET V6 Software

7. **Update Program Files Only** is selected to update an existing copy of V6 CAD/CAM software.

This option will only update the main application files and DOES NOT overwrite or delete any Configurations, Drawings, programs etc.

8. The dialogue box below is shown.



As files are about to be overwritten (updated), the user is warned about the impending overwrite.

To Update the file, '**Replace the existing file with the new file**' is selected.

To perform a complete Update of all files, '**Use this choice for all subsequent files**' is also selected,

OK is selected and the file(s) updated.

5.5 Network Installations

Overview

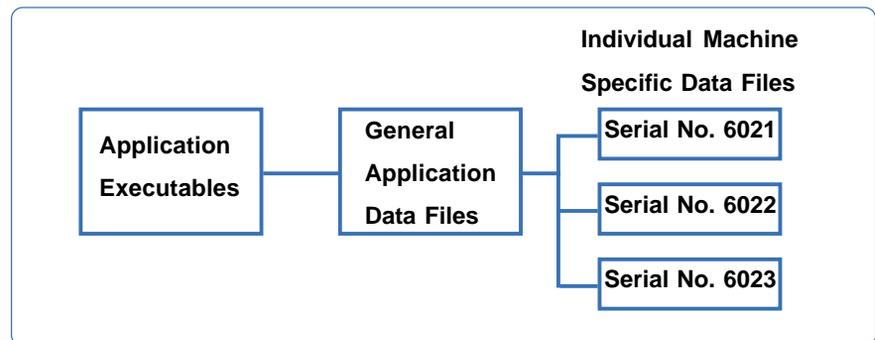
Network software differs from standalone software in that the application loads from one Drive (Public Drive) and the users programme data (work) is saved on another drive (User Drive).

Machine Specific Data

Important:- Boxford CAD/CAM software differs from most packages (word processors, spreadsheets etc.) in that a number of software data files are specific to each separate Boxford CNC Machine Tool. This applies even if they are the same model of machine tool.

These data files are held in sub-directories off the main application directory and are named to correspond to each individual CNC Machine Tools serial number.

A map of the application directory on the Public drive is shown below (the serial numbers shown are examples and will be different for customer machines).



Server Installation

The software installation set consists of Three Boxford disks (Installation, Offsets, and Tutorials), and a set of TechSoft CAD disks.

Installation Disk and Techsoft CAD disks

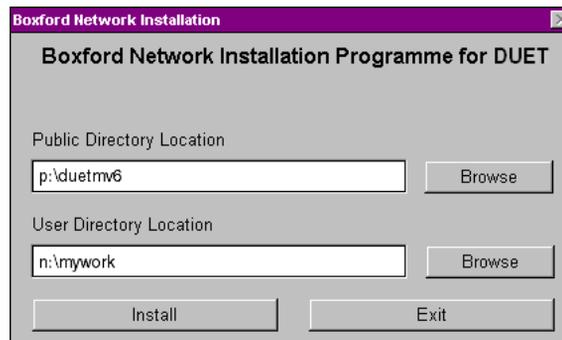
Follow the installation procedure described in section 5.3 of this manual for the Installation Discs and CAD Discs.

After installation of the main software, machine specific data is installed by following the procedures outlined below:

Offsets disk

Microsoft Windows 95 & 98

1. Start Microsoft Windows
2. Insert the Boxford CAD/CAM Installation disk 1 into the floppy disk drive.
3. Select **Start > Run**.
4. Type `a:\setup` and press ENTER.
5. The screen below is shown.



The location of the Public and User drives must now be specified by the user. The Public path is where the V6 CAD/CAM software is installed. The user path is where the user files (their work) will be stored.

Both the public, and user paths MUST BE network drives.

6. Install is selected and the machine data files are installed into the correct location on the public Drive.

The set-up programme also creates a file called network.dat which holds the path information in it.

Tutorials disk:

If access to the Tutorial programs is required, copy the contents of the disk to the user areas which require access.

The software should now have been successfully installed on the server.

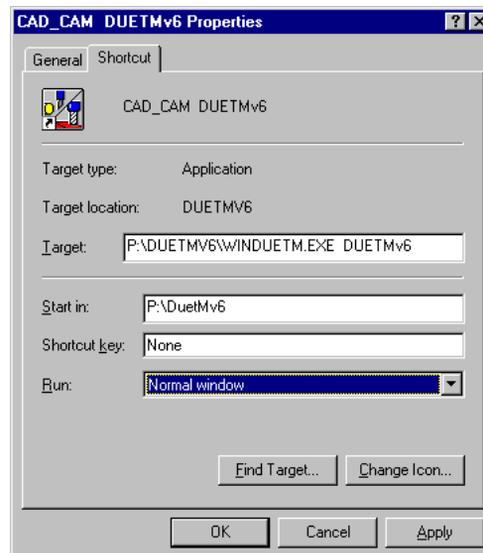
For workstation installation, see the following page.

Installing and Running the software on workstations:

A shortcut should be made on the user machines that points to the winduetm.exe on the server.

The command line prompt of the Winduetm.exe should be the machine name i.e. DUETMv6.

Please note this IS CASE sensitive and hence the "H" is in capitals and the "v" in lower case.

Microsoft Windows 95 & 98

All Operating Systems

In order for the software to run correctly the following files **MUST** be included on the user machine in the directory shown:

Windows directory:

Fontmap.ini
Ro.ini

Windows system directory.

Dialdraw.dll
Drawobj.dll
Dssprite.dll
Fileaff.dll
Filewmf.dll
Fontmap.dll
Percent.dll
Txtpath.dll

Also there must be some entries placed in the win.ini file in the windows directory. These lines are added by the installation programme, so they will exist already on the server the software was installed on and can be copied.

Win.ini section:

```
[WINDOWS5]
TECHSOFT_PATH_FILE=P:\BOXFORD\CAD\MILDES32.EXE
TECHSOFT_MODULE_NAME=Mildes32
DRAWMILL_PATH_FILE_DUETM=P:\boxford\duetmv6\DRAWMILL.EXE
DRAWMILL_MODULE_NAME_DUETM=DRAWMILL
BOXFORD_MC_DATA_DUETM=P:\boxford\duetmv6
BOXFORD_USER_DATA_DUETM=P:\boxford\duetmv6\duet
```

More detailed information on the individual ini file lines:

TECHSOFT_PATH_FILE=E:\BOXFORD\CAD\MILDES32.EXE
This line points to the location of the TechSoft CAD package.

TECHSOFT_MODULE_NAME=Mildes32

The module name of the CAD package.

DRAWMILL_PATH_FILE_DUETMv6=p:\boxford\duetm\DRAWMILL.EXE

This line points to the location of the DRAWMILL.EXE processor executable.

DRAWMILL_MODULE_NAME_DUETMv6=DRAWMILL

The module name of the processor.

BOXFORD_MC_DATA_DUETMv6=p:\boxford\duetmv6

This line points to where the main executables are located.

BOXFORD_USER_DATA_DUETMv6=p:\boxford\duetmv6\duet

This line points to a sub-directory off where the main executables are located. Its sub-directory should not be changed

The information above may not be needed as often the copying of files etc. is done by the network management software.

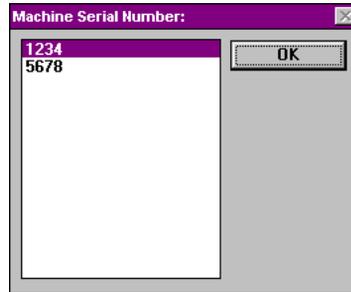
Running the Software

If the software is only used to design and manufacture for one Boxford Machine Tool of the same type (i.e. only one serial numbered directory) then the software will run as described in this manual.

If the software is used to design and manufacture for a number of Boxford Machine Tools of the same type (i.e. there are more than one serial numbered directories), then on running the software the user is presented with a dialogue box asking them to specify which machine they wish to Design and/or Manufacture for.

To make this choice automated, an environment variable must be placed in the autoexec.bat telling the software the machine serial number.

e.g.. SET ID_DUETMv6= 1234



Where the DUET is the machine name, and 1234 is the serial number of the machine required.

When the software is running, the machine serial number is displayed in the program window caption bar as shown below.



Very Important Notes

It is strongly recommended that each machine tool of the same type has exactly the same tooling configuration so that at the design stage any serial number can be selected allowing the user to manufacture at a later date on any one of the machine tools of same type.

Wherever possible, the computer connected to the Machine Tool should have the environment variable placed in the autoexec.bat file. If this is not included and the decision is left to the user, error in selection will cause the Machine Tool to use inappropriate data files which invariably will cause costly damage to the Boxford Machine Tool.

If this software has NOT been supplied with a NEW Machine Tool, and is an upgrade for existing machines, the Tool Offsets MUST BE reset. This can be done by logging onto the software as an administrator and setting the tool offsets as normal. If you have your offsets written down, the values can be directly entered into the tool library. This must be done for each machine serial number to complete the installation

5.6 Configuring the Lathe and Mill Simulation Software

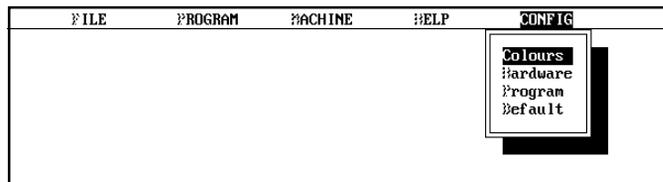
Before the DUET machine is used, the software must be configured to suit your computer system and programming preferences. The **Lathe** and **Mill** modules of the software must be configured independently; the procedure is the same for each module.

Refer to Section 7 - Using the DUET Software for details of how to run the software. Each module is configured by means of the CONFIG option on the main menu.

Run the **Lathe** Simulation module, and carry out the procedure given below. Repeat the procedure for the **Mill** Simulation module.

CONFIG Menu

1. From the main menu, select **CONFIG** to display the **CONFIG** menu:



The **Colours** option sets the colours for the screen display on a colour monitor, and the grey tones for a monochrome monitor.

The **Hardware** option sets the ports and disk drive which the software will use. The system will not operate correctly unless the appropriate settings are made.

The **Program** option sets the units of measurement and other parameters associated with CNC programming and graphics.

The **Default** option sets all parameters to their default settings, which may not be suitable for your system.

Using a Mouse

Click on the required colour box to select the colour to be set.

Set the slider in the required position by clicking on  or  or by dragging the slider with the cursor.

**Using the Keyboard**

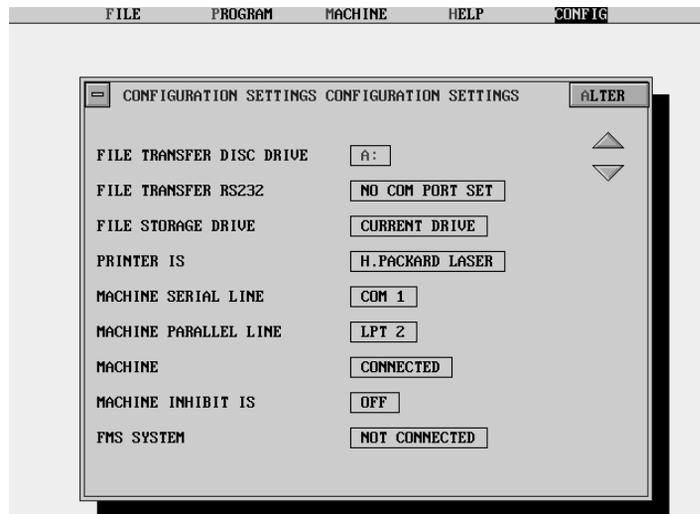
Use the cursor keys: press  or  to select the colour to be set.

Press  or  to set the slider in the required position.

3. Select **MENU**, and **Save Settings**.
4. Return to the main menu.

Hardware

5. Select **Hardware** from the **CONFIG** menu. The screen shows the CONFIGURATION SETTINGS OUTPUT display with typical settings as shown:



Select the settings as follows:

FILE TRANSFER DISK DRIVE:

The drive letter of the 3.5 in floppy disk drive to be used for exporting and importing programs (usually A:).

FILE TRANSFER RS232:

The COM port to be used for transferring files direct to another PC by data cable, if required. If your PC has only one COM port, set **COM1**. If there is a second COM port, set **COM2**. One COM port must be reserved for the machine serial line.

PRINTER ON:

The port setting will depend on the arrangements made for connecting a printer, (see Section 4 - Computer Requirements). Set **LPT1** or **LPT2** as appropriate.

MACHINE SERIAL LINE:

Set the COM port to which the machine serial cable is connected, (usually **COM1**).

MACHINE PARALLEL LINE:

Set the LPT port to which the machine parallel cable is connected.

MACHINE :

The options are **CONNECTED** and **NOT CONNECTED**. Set **CONNECTED** to enable the PC to communicate with the machine.

SPECIAL OPTION IS:

This option is reserved for future use, and the options are **ENABLED** and **DISABLED**. Set **DISABLED**.

FMS SYSTEM IS:

This option is used to activate the robot port when the DUET machine is used with an FMS system, and the options are **CONNECTED** and **DISCONNECTED**. Set **DISCONNECTED** initially; the setting can be altered to **CONNECTED** if a robot is to be used.

Using a Mouse:

To select the parameter to be set, either click on the required box or click on ▲ or ▼ .

Click on to display the options, and click on the required option.

Using the Keyboard:

Press or to select the parameter to be set.

Press to select and display the options.

Press or to select the required option

6. Display the SAVE SETTINGS box:



Using a Mouse:

Click on:



Using the Keyboard:

Press

7. Save the settings.

Using a Mouse:

Click on

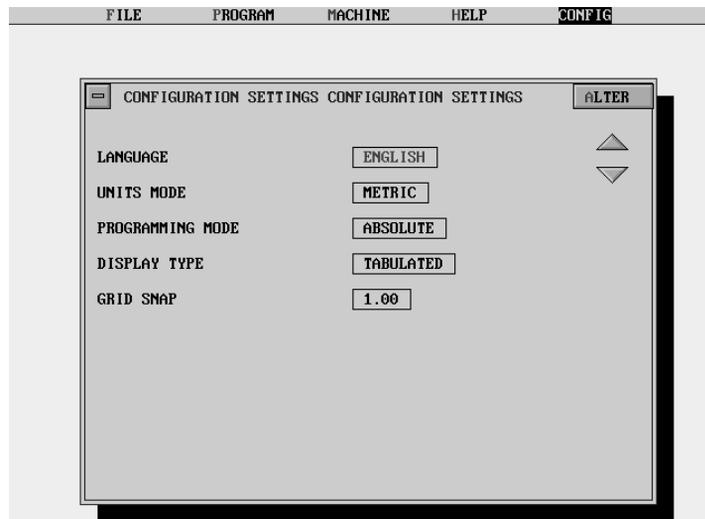
Using a Keyboard:

Press Return

The screen shows the main menu.

Program

8. Select **Program** from the **CONFIG** menu. The screen shows the CONFIGURATION SETTINGS PROGRAM display with typical settings as shown:



Make the initial settings in the same way as for the **Hardware** option. It will probably be necessary to change the settings later when producing a program as detailed in the TURNING and MILLING manuals.

UNITS MODE:

Sets the units of measurement to be used by the software in CNC and CAM programming and in displaying the workpiece graphically. The options are **Imperial** (inch), **Metric**, and **Met/Imp** which uses a combination of the other two.

PROGRAMMING MODE:

The options are **Absolute** and **Incremental**, which determine the system of co-ordinates used in CNC programs. Accept the current setting initially; further details of absolute and incremental co-ordinates are given in the TURNING and MILLING manuals.

DISPLAY TYPE:

This parameter sets the format in which manual programs are displayed; the options are **Tabulated** and **Compact**. Set **Tabulated** for the initial setting, as this format will be more easily understood in the early stages of training.

GRID SNAP:

Sets the fineness of the graphics grid to which lines drawn on the screen will 'snap'. Accept the default setting initially; it can be changed later during programming.

9. Display the SAVE SETTINGS box and save the settings as for the **Program** option.

The DUET machine and software should now be correctly configured and ready for use. Take some time to explore the options of the **Lathe** and **Mill** modules of the software by referring to Section 7 - Using the DUET Software, until you are familiar with the menus, options and displays. This will save time when using the TURNING and MILLING manuals in which the accent is on producing CNC and CAM programs and machining components.

6 Machine Controls (Figure 6.1)

POWER ON Indicator

The switch lights up when the mains power supply is turned on. See section 5 - fig 5.2, for power socket and switch details.

RUN/INHIBIT Switch

With the switch set to RUN, the machine operates normally. When the switch is set to INHIBIT, the PC is prevented from operating the machine. Set the switch to INHIBIT and remove and retain the key to prevent unintentional operation of the machine when an untested program is being produced.

E-STOP (Emergency Stop Pushbutton)

Pressing this pushbutton stops all machine movement, and the button locks in the depressed position. If the machine is in production, an appropriate message is displayed on the PC screen. The button must be turned to release it and to enable the machine to be started. If the machine was performing a production cycle, the cycle must be repeated from the beginning.

Low Voltage Light

The lamp is operated by the switch at the back of the lamp housing, and is pivoted to allow adjustment.

Guard

With the guard closed, the moving parts of the machine are totally enclosed. Safety switches detect when the guard is closed and provide the protection described in Safety. If the guard is open and an attempt is made to machine a component, an appropriate message is displayed on the PC screen.

LEDs

A red and green LED on a printed circuit board are visible through the window in the end cover. The LEDs flicker when the DUET software is communicating with the DUET machine.

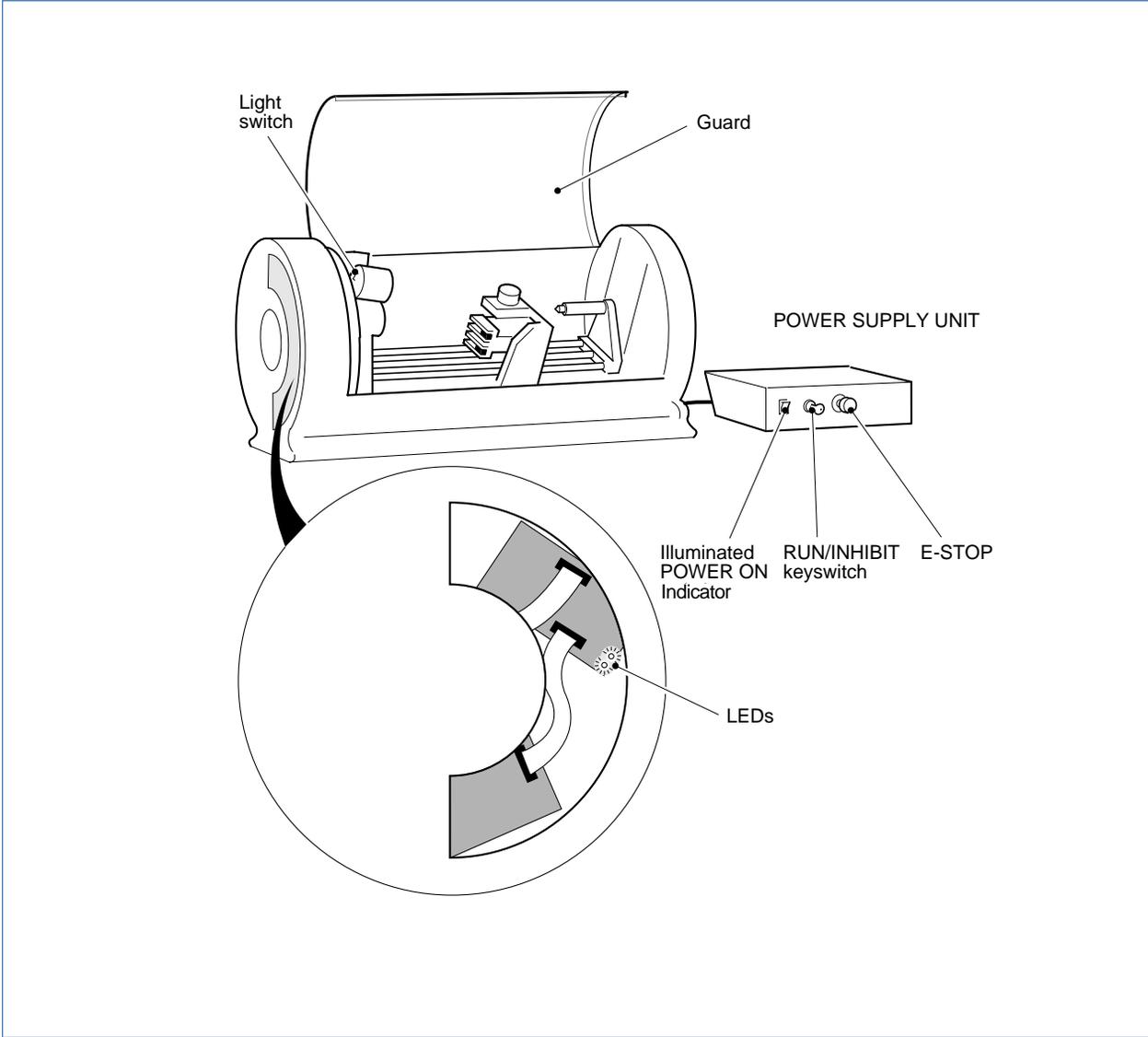


Figure 6.1 Machine Controls

7 Using the DUET Simulation Software

7.1 Running the Software

Switch on the power supply to the PC and to the power supply unit.

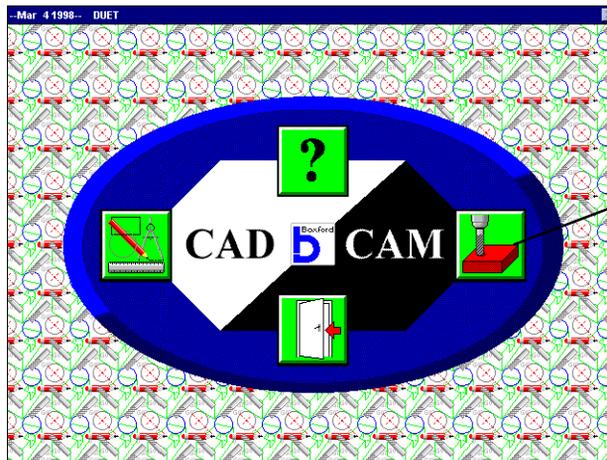
On the power supply unit, set the POWER ON switch to ON, and set the RUN/INHIBIT switch to INHIBIT to avoid unintentional operation of the machine.

The Duet CADCAM Software is started from the relevant icon within the relevant Windows program group.

From the DUET main front end menu, the Lathe or Mill menu module can be run.

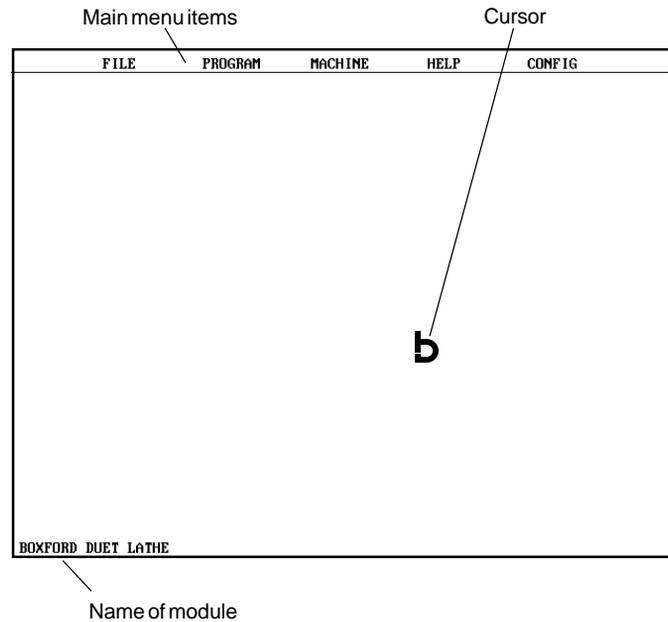


From the Lathe or Mill Module front end, the Simulation icon is selected.



Main Menu

The screen shows the main menu, which is the same for both modules:



The items on the main menu provide the following facilities:

FILE

Transferring files (programs) into and out of the **Lathe** or **Mill** module, deleting files, and quitting the module. For further details, refer to 7.3 Catalogues and File Handling.

PROGRAM

Creating a new CNC or CAM program, and selecting existing programs stored in a catalogue. For further details of catalogues, refer to 7.3 Catalogues and File Handling. For guidance in creating programs, refer to the TURNING or MILLING manual as required.

MACHINE

Control of the DUET machine tool. For further details, consult the TURNING or MILLING manual as required.

HELP

Reference information about the software and the machine, and lists of the G codes and M codes used in CNC programming. The use of the codes is dealt with in the TURNING and MILLING manuals.

CONFIG

Configuration of the software to suit your computer system and programming preferences. If you are configuring your system for the first time, refer to Pull-Down Menus below to select the required options.

Note:

To modify the configuration options, the user must be logged on as an administrator - see programming manuals for details.

Pull-Down Menus

Selecting any of the items on the Main menu produces a pull-down menu containing the menu options.

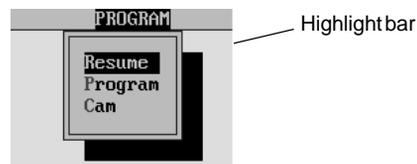
Using a Mouse:

'Click on' the required item - (move the mouse to place the cursor on the required item, and briefly press the mouse button once. On a mouse with two buttons, press the left hand button).

Using the Keyboard:

The first letter of each item is highlighted - (is in a different colour or shade from the other letters). Press + the highlighted letter of the required option.

For example, selecting **PROGRAM** produces the following pull-down menu:



Options

To select an option, place the highlight bar over the required option:

Using a Mouse

Click on the required option.

Using a Keyboard

Press or to place the highlight bar over the required option and press Return, or type the letter which is highlighted in the name of the option.

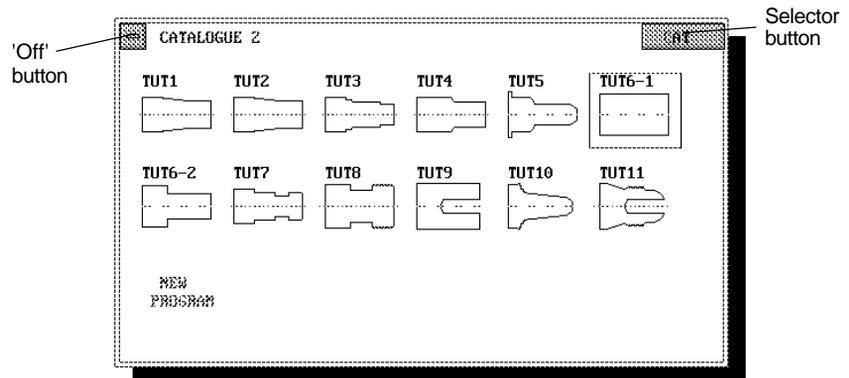
The screen will show either a further pull-down menu, or a display.

Practice selecting pull-down menus, options and displays from the other items on the main menu.

Displays

A display consists of a rectangle containing 'buttons' for activating and turning off the display, together with graphics or boxes for selecting items or entering data.

For example, selecting the **Program** option from the **PROGRAM** menu gives the CATALOGUE display. (The CATALOGUE display for the Lathe and Mill modules are similar, and show graphics of the files stored). A CATALOGUE display looks like this:



To activate a selector button:

Using a Mouse

Click on the button.

Using the Keyboard

Type the letter which is highlighted in the name on the button.

To turn off the display:

Using a Mouse

Click on the 'Off' button.

If the display has no 'Off' button, 'click off' the display - (place the cursor outside the display and click the mouse button).

Using the Keyboard

Press

If the display has no 'Off' button, press Return.

Quitting the Lathe or Mill Module

From the **FILE** menu, select **Quit**. The screen will show the start-up display.

To exit from the DUET software:

Using a Mouse

Click on the right-hand (Exit) symbol.

Using the Keyboard

Press

7.2 Sequence of Operation

Programs are stored in the DUET software in program catalogues. (For further details, see Catalogues and File Handling). In order to machine a component, a program or file must be stored in a Catalogue, and the TURNING and MILLING manuals deal with the creation, editing and saving of new programs.

When the software is first installed, several programs are included in a Catalogue for demonstration and tutorial purposes.

Note:

A demonstration Turning and a demonstration Milling program are included, together with workpiece billets to enable an example of each type of component to be machined, (see Section 2 - Running the Demonstration Program in the Turning and Milling manuals).

The procedure for selecting a program and producing the finished component consists of two stages:

1. **Programming** - initiated from the PROGRAM option on the main menu.
2. **Machining** - initiated from the MACHINE option on the DUET main Front End menu.

Figures 7.1 and 7.2 show the two stages, each consisting of a number of steps, together with brief details of the menu options and selections required for each step. (Full details are given in the TURNING and MILLING manuals). To become familiar with the software, practice selecting a program and carrying out each step of the procedure as follows:

1. **Programming**
This stage can be practised without the machine connected.
2. **Machining**

CAUTION:

TOOL OFFSETS MUST BE SET CORRECTLY BEFORE MACHINING, TO PREVENT THE RISK OF RUNNING THE TOOL INTO THE CHUCK OR WORKPIECE.

THE OFFSETS FOR THE TURNING TOOLING FITTED TO THE MACHINE ON DELIVERY ARE FACTORY-SET. IT IS RECOMMENDED THAT THESE SETTINGS ARE CHECKED BEFORE RUNNING THE DEMONSTRATION AND TUTORIAL PROGRAMS.

IF YOU CHANGE THE TOOLING, DO NOT ATTEMPT TO MACHINE A COMPONENT UNLESS YOU HAVE CORRECTLY SET THE OFFSETS AS DETAILED IN THE TURNING OR MILLING MANUAL.

The MACHINE option also provides direct manual control of the machine with a mouse or the keyboard, by means of the **Manual Mode** option. The use of this option can be practised provided that care is taken not to run the tool into the chuck or workpiece.

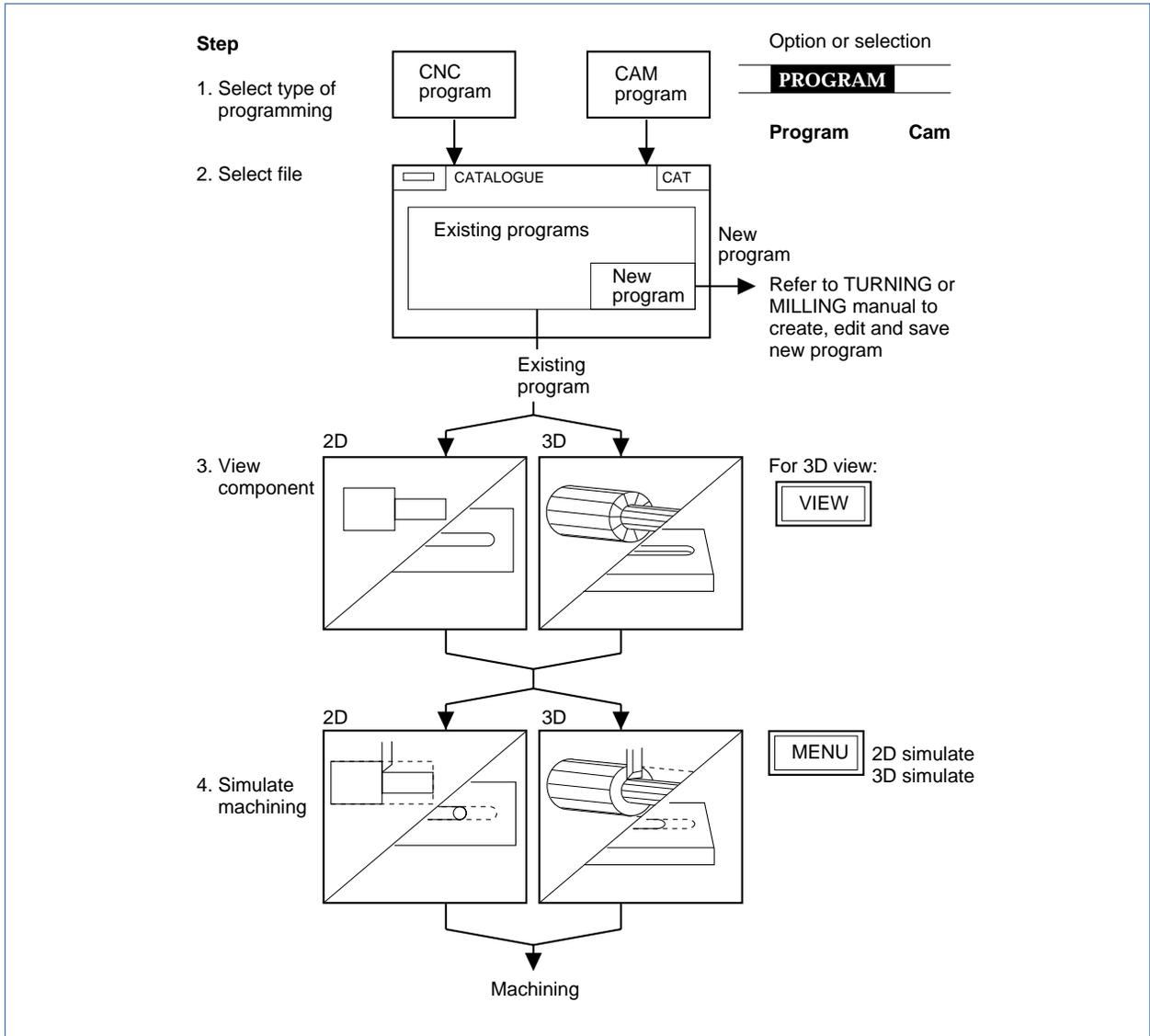


Figure 7.1 Programming

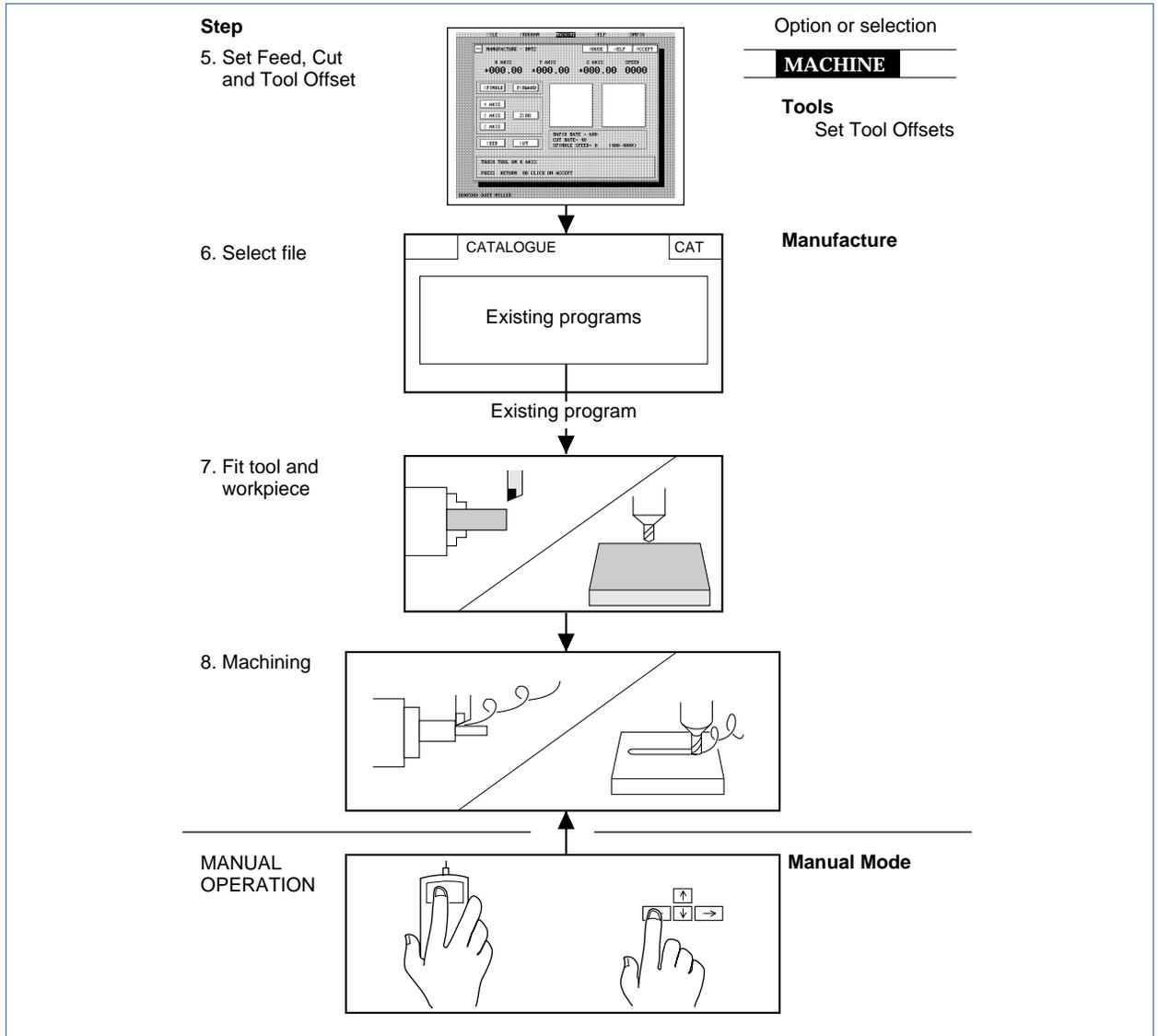


Figure 7.2 Machining

7.3 Catalogues and File Handling (Figure 7.3)

Nine CNC program catalogues and nine CAM catalogues are available, and each can store 18 programs.

The **FILE** option on the main menu enables programs to be imported into the catalogues from disk, and to be exported to disk, exchanged between catalogues, sent to a printer or another PC, or deleted, as shown.

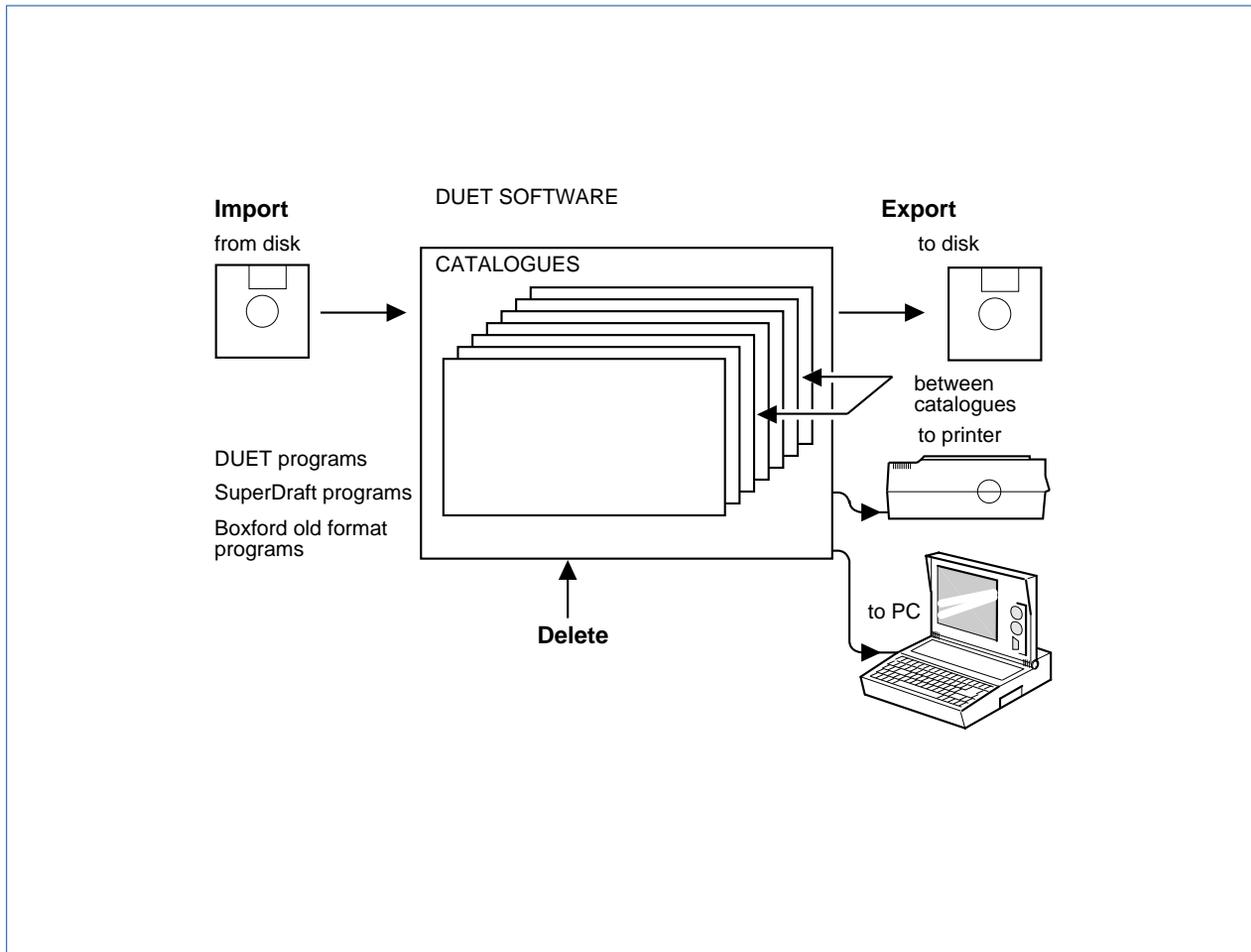
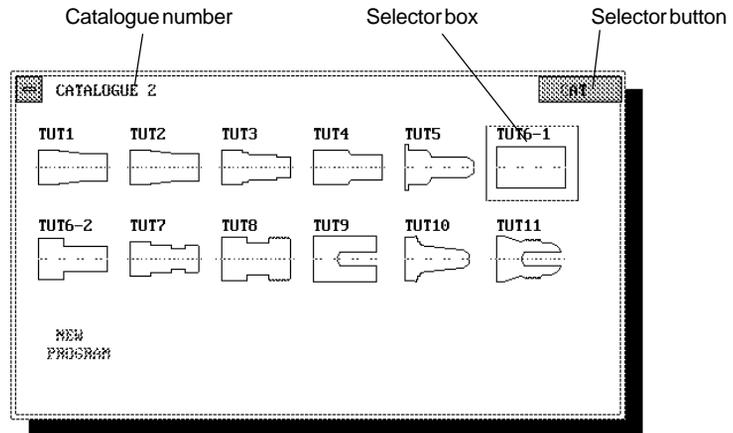


Figure 7.3 File Import and Export

To Examine the Catalogues:

From the main menu of the **Lathe** or **Mill** module, select **PROGRAM**. From the **PROGRAM** menu, select either **Program** or **Cam**; the screen will show the appropriate CNC or CAM CATALOGUE display. A typical Lathe catalogue display looks like this:



Each program is shown as an image of the component together with the program name. On the Lathe display, the images are in outline; on the Mill display they are 3D images.

If the catalogue is full, the catalogue number will be followed by the message: (FULL).

To view another catalogue, select **CAT** to display the catalogue menu, which lists the available catalogues.

Select the required catalogue with the highlight bar.

To Export a Program to Disk:

Place a formatted disk in the disk drive.

Select **CONFIG** and then **Hardware** to check that the correct disk drive is selected.

Select **FILE** and then **Export program**. A sub-menu will appear; select **To disc**.

The screen will show the CATALOGUE display. Select the required catalogue, and select the required program by placing the selector box with the mouse or the arrow keys. Click the mouse button or press Return.

The display will show the message:

COPYING '(filename)' . . .

- which will disappear when the file has been copied to the disk.

If the file already exists on the disk, a message will appear giving the choice of overwriting the program or quitting the transfer.

To Transfer a File Between Catalogues:

Select **FILE** and then **Export Program**. From the sub-menu select **Between Catalogues**.

The screen will show the COPY FROM CATALOGUE display followed by the number of the catalogue from which the program will be copied. If required, change the catalogue number by selecting and then the required catalogue.

Select the required program. The screen will show the message:

Copy '(filename)' to Catalogue ■

Type the number of the catalogue to which the program is to be copied; the number will appear in the box at the end of the message.

Press Return; the screen will show the message:

Copying '(filename)' . . .

- which will disappear when the program has been copied.

To Print a Program:

Select **CONFIG** and then **Hardware** to check that the correct parallel port (LPT) is selected for the printer.

Check that the printer is connected to the parallel port.

Select **FILE** and then **Export Program**. From the sub-menu select **Printer**.

The screen will show the PRINTER CATALOGUE display followed by the number of the catalogue from which the program is to be printed. If required, change the catalogue number by selecting and then the required catalogue.

Select the required program. The screen will briefly show the message:

READING FILE
'(filename)'

- followed by the message:

READY TO PRINT (filename)
IS PRINTER CONNECTED?

YES

NO

Check that the printer is connected and switched on, and check the paper. Select YES by clicking on YES with the mouse or typing . The screen will show the message:

PRINTING (filename)

- which will disappear when the file has been sent to the printer.

To Transfer a Program to another PC:

Check the port setting and connections to the PC as for a printer.

Select **FILE** and then **Export Program**. From the sub-menu select **RS232**, and proceed in the same way as for printing a file.

To Import a DUET Program from Disk:

Insert the disk containing the program into the disk drive.

Select **FILE** and then **Import Program**. From the sub-menu select **Copy from disk**.

The software will read the disk, and the screen will show the catalogue display of the files on disk, with the title: COPY FROM DRIVE A:

If there is more than one catalogue on the disk, change the catalogue by selecting **CAT** and then the catalogue number.

Select the required program. The screen will show the message:

COPYING '(filename)' . . .

- which will disappear when the program has been copied.

The program will be copied into the next free space in the first available catalogue.

To Input a SuperDraft Program from Disk:

Make a note of the source drive, path and name of the required file, for example:

(Floppy disk) - A:\filename

(Hard disk) - C:\SDPROGS\filename

If the file is on floppy disk, insert the disk into the disk drive.

Select **CONFIG** and then **Hardware** to check that the correct drive is selected.
Select **FILE** and then **Import Program**. From the sub-menu select **SuperDraft file**.
The screen will show the message:

Enter file name to be read in

Type in the source, path and name of the file and press Return. The screen will show the message:

COPYING '(filename)' . . .

- which will disappear when the program has been copied.

The program will be copied into the next free space on the first available program, and will be converted to the same format as a DUET program.

To Import a Boxford Old Format File from Disk:

Note:

Boxford old format software has nine catalogues. Note the number of the catalogue in which the required file is stored.

Proceed in the same way as for importing a SuperDraft file, selecting **Boxford old format** from the **FILE** sub-menu.

The screen will display the message:

Enter file name to be read in

Catalogue

Type in the source drive, path and name of the required file, for example:

(Floppy disk) - A:\filename

(Hard disk) - C:\BOXPROGS\filename

Press Return and type in the number of the catalogue from which the file is to be copied.

The screen will show the message:

COPYING '(filename)' . . .

- which will disappear when the program has been copied.

To Delete a Program:

Select **FILE** and then **Delete file**.

The screen will show a catalogue display with the title: DELETE FROM CATALOGUE.

Select the catalogue and program:

Using a Mouse

Click on and select the required catalogue.

Place the selector box over the name of the required program and click the mouse button.

Using the Keyboard

Type to display the catalogue and select the required catalogue.

Use the cursor keys to place the selector box over the name of the required program and press Return

The screen shows the message:



To delete the program:

Using a Mouse

Click on

Using the Keyboard

Press Return

If you do not want to delete the program:

Using a Mouse

Click on

Using the Keyboard

Press

8 Circuit Diagrams and Description

8.1 System Schematic (Figure 8.1)

Figure 8.1 shows the identity and location of the units comprising the control system of the DUET machine.

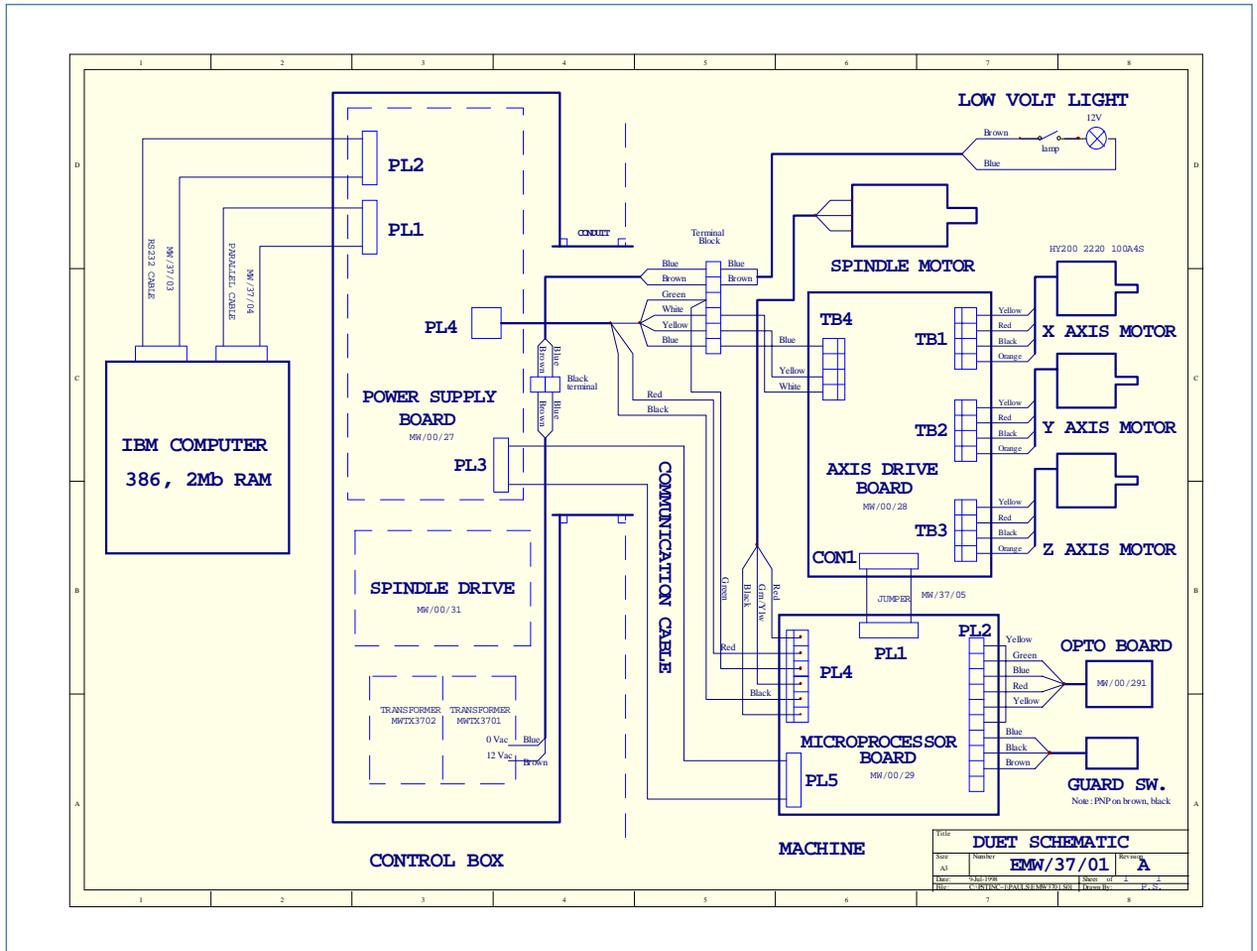


Figure 8.1 System Schematic

This PCB produces the +12V and +24V d.c. supplies.

Transformer Tx1 supplies the a.c. voltage for all the control supplies and for the low voltage light.

Tx2 provides the 110V d.c. supply for the spindle drive.

All supplies are fused on the PCB and LED indicators are fitted.

Note:

The +5V d.c. supply is produced from the +12V supply on the spindle drive PCB, using a regulator.

A 380W permanent magnet motor is fitted and is controlled by the pulse width modulated spindle drive PCB. The motor supply is taken from Tx2 on the power supply PCB and is rectified and smoothed by a rectifier and capacitor in the control unit. No choke is required.

Full voltage is supplied to the motor, and speed control is provided by varying the period for which the supply is connected. This enables maximum torque to be applied throughout the speed range. The supply is chopped at 10kHz, with a mark/space ratio variable from 10% to 90%. Motor current is sensed across R5 and the limiting value is set by VR1.

8.4 Microprocessor PCB (Figure 8.4)

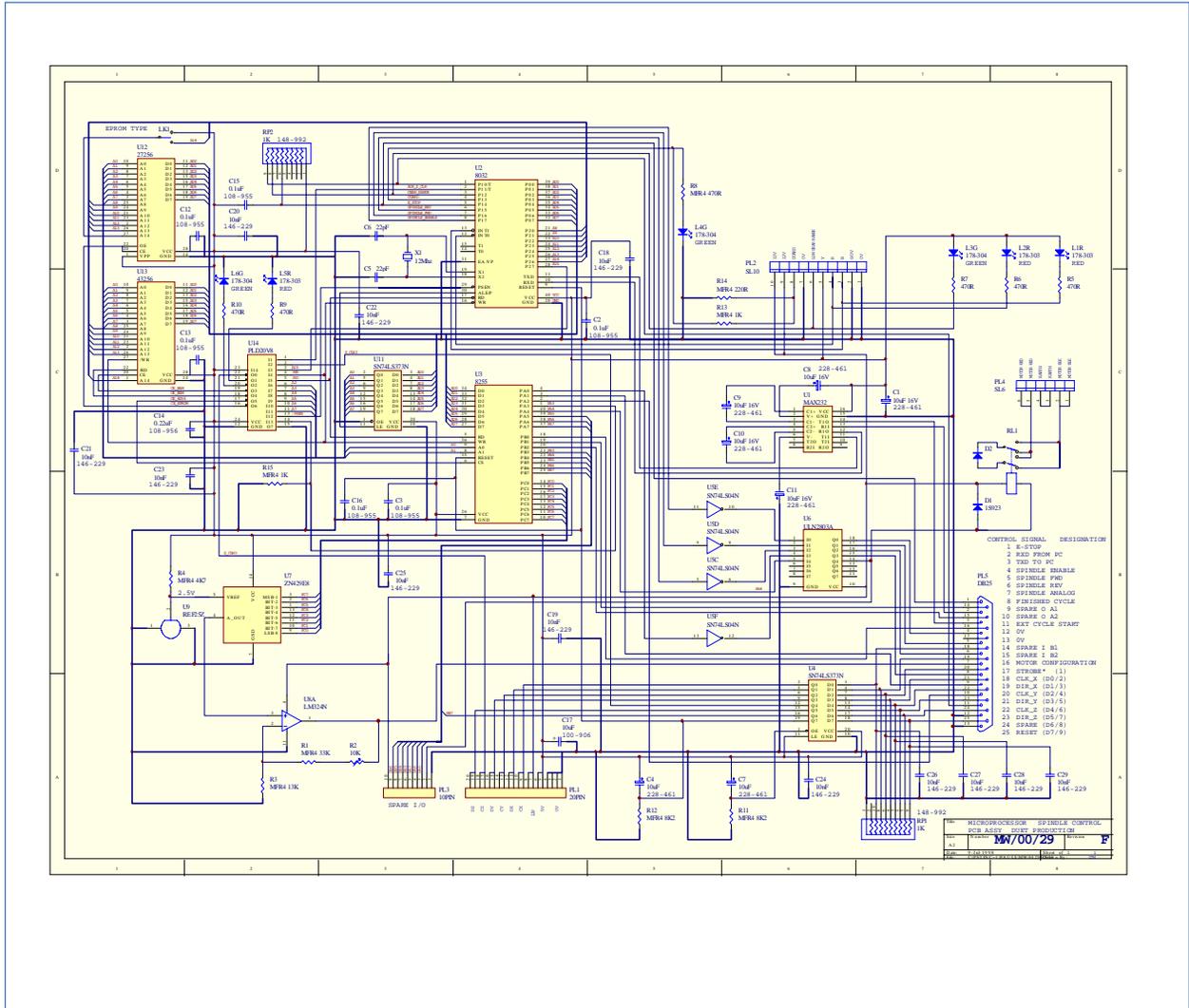


Figure 8.4 Microprocessor PCB

8.4.1 Functions of Software

The DUET software loaded on the PC generates the clock and direction outputs which control the axis movements. Serial communication is made with the microprocessor PCB to run the spindle motor and to obtain feedback.

The control software that runs the microprocessor PCB is downloaded to the PCB when the software initialises the machine. The DUET software can be run off-line, but for the functions requiring feedback (selected from the MACHINE option on the main menu), the machine must be connected.

8.4.2 Description

The microprocessor PCB receives its supplies from the axis control PCB and issues the clock and direction signals to the axis control PCB.

All data sent through the serial and parallel cables is decoded and actioned by the microprocessor PCB. This data includes spindle speed control and full axis control during a threading cycle. (During normal operation, clock and direction pulses are gated directly to the axis control PCB).

8.4.3 Connectors

- PL 1 Accepts 20-way IDC type connector from axis control PCB, which supplies 0V, +5V and +12V d.c. to the microprocessor PCB, and clock and direction signals to the axis control PCB.
- PL 2 8-way discrete wire cage clamp-type connector. Accepts inputs from spindle encoder, guard switch.
- PL 3 Not fitted.
- PL 5 Accepts 25-way D-type male connector from power supply PCB via conduit. Supplies all signals from PC and for spindle control.

8.5 Axis Control

8.5.1 Stepper Motors

The three axis drive stepper motors are identical and have identical control circuits.

Each motor drives a 2.0mm ballscrew directly and has a resolution of 400 half steps/rev, giving an axis resolution of 0.005mm:

$$400 \text{ steps} = 2.0\text{mm}$$

$$\text{Axis resolution} = \frac{2.0}{400} = 0.005\text{mm}$$

8.5.2 Axis Control PCB (Figure 8.5)

The stepper motors are driven by an L297 controller with L293E output stage. The output is chopped at 17kHz and the maximum current is programmed to 0.7A.

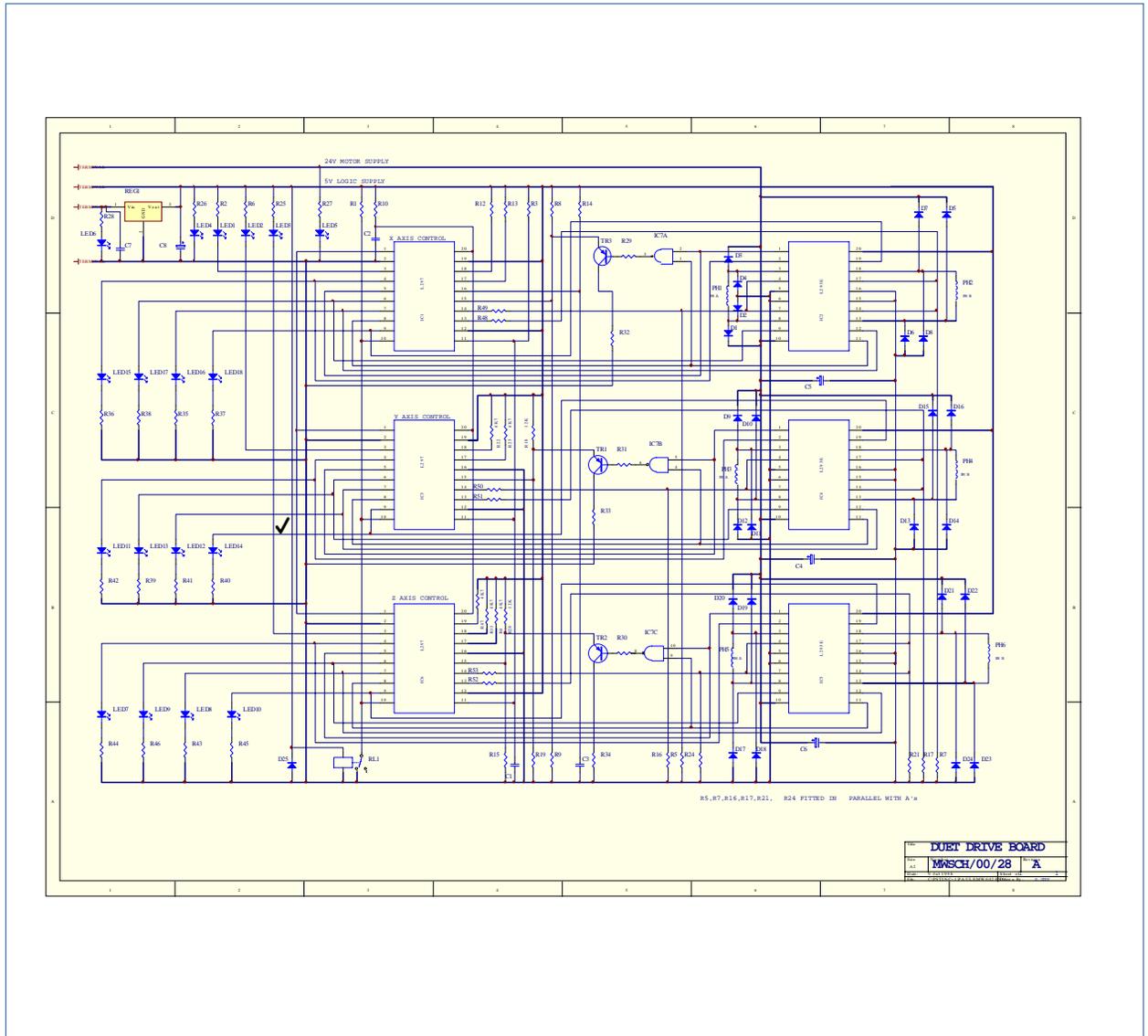


Figure 8.5 Axis Control PCB

9 Fault Diagnosis

WARNING:

THE MAINS SMOOTHING CAPACITOR IN THE CONTROL UNIT WILL HOLD A CHARGE FOR SOME TIME AFTER THE SUPPLY IS DISCONNECTED. ALWAYS CHECK THAT THE CAPACITOR HAS DISCHARGED BEFORE WORKING ON THE CIRCUITRY.

9.1 Fault Diagnosis Procedure

If the software will not run, refer to 9.3 - Software Fails to Run.

In the event of a fault which occurs while the software is running, first carry out the initial checks given in 9.1.1. below before turning off the power supply, referring to other parts of the manual as indicated. If the initial checks do not reveal the fault, refer to 9.1.2 - Control Unit Checks and 9.1.3 - Power-Up Checks, in the sequence given.

If any of the test conditions are not met, refer to 9.2 - LEDs, Test Points and Fuses to trace the fault and identify the faulty component.

9.1.1. Initial Checks	Reference
(With system powered up and software running)	
1. On the Control Unit, check:	
Mains lead connected to a.c. power socket and supply switched on	Figure 5.2
POWER ON switch set to ON and illuminated	Figure 6.1
E-STOP button released	Figure 6.1
RUN/INHIBIT keyswitch set to RUN	Figure 6.1
LEDs 1 and 2 ON	Figure 5.2
2. On the PC, check:	
CONFIG settings correct	Section 5, 5.6- Configuring the DUET Software
3. On the DUET machine, check:	
Guard closed	

9.1.2. Control Unit Checks	Reference
1. Switch off mains supply, and set POWER ON switch to OFF	Figure 6.1
2. Check cables and connectors: Control Unit to PC - serial and parallel cables	Figure 5.2
Control Unit to Duet - cables in conduit	Figure 5.1
3. Check fuses: Mains fuse, FS1, FS2	Figure 5.2

9.1.3. Power-Up Checks

1. On the Control Unit:
 - Connect mains lead to a.c. power supply and switch on supply Figure 5.2
 - Set POWER ON switch to ON and check that switch is illuminated Figure 6.1

2. On the PC:
 - Run DUET software, but do not initialise the machine Section 7,
7.1-Running
the Software

3. On the Axis Control PCB, check: Figure 9.1
 - LEDs 4 and 6 ON
 - LED 3 ON (E-STOP button released)
 - LED groups 7-10, 11-14, 15-18 - even number of LEDs ON

4. On the Microprocessor PCB, check: Figure 9.1
 - L5R ON and L6G OFF
 - If this condition is not met, switch off the power, wait for 2-3 seconds, and switch on again.

5. Initialise the machine:
 - On the PC, from the main menu select **MACHINE** and then **Reset Machine**
 - Check that LEDs L5R and L6R flash alternately until the program is downloaded, then check that L5R is OFF and L6R is ON. Figure 9.1

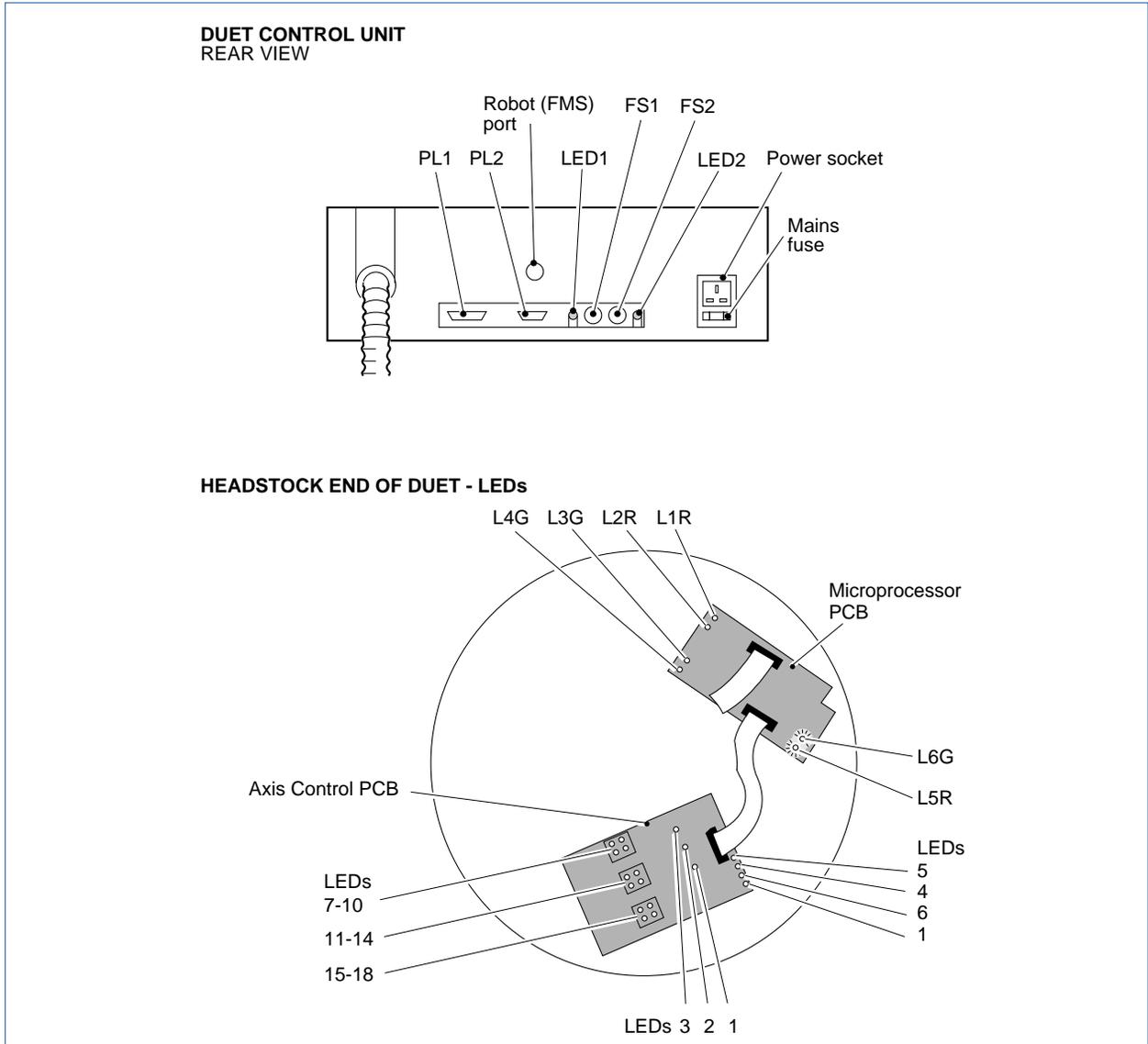


Figure 9.1 LEDs and Fuses

9.2 LEDs, Test Points and Fuses (Figure 9.1)

9.2.1 Power Supply PCB

The LEDs can be seen from the back of the Control Unit and the fuses can be checked and renewed without opening the unit:

Supply	Indication	Fuse
+12V d.c.	LED 1	FS 1 3.15A
+24V d.c.	LED 2	FS 2 3.15A
Mains input	—	Drawer type 10A

10A fuse fitted on spindle drive PCB to protect the PCB in the event of a motor fault.

9.2.2 Spindle Drive PCB

No LED indicators are fitted, but the following readings can be taken with an oscilloscope:

Test Point	Signal	Reading	Adjustment
IC 1, pin 8	Chop Frequency	10kHz	VR3
TP 1	Mark/space	Changes with speed demand	VR2
TP 2	Motor current limit	1.5V (=3A)	VR1

LEDs**9.2.3 Microprocessor PCB**

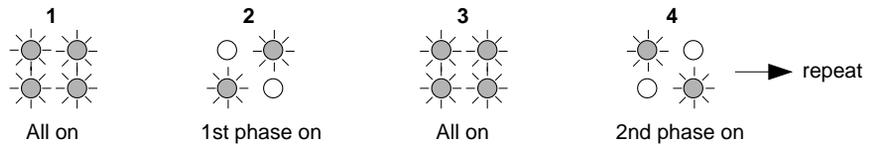
- L1R Driven by signal from spindle encoder - (sensor and disc with 32 holes). Signal used to measure spindle speed.
ON (red) when sensor sees a hole.
OFF when sensor sees metal of disc.
- L2R Driven by signal from sensor viewing single marker slot in encoder disc. Signal used to produce consistent starting point for each threading pass.
ON (red) when sensor sees slot.
OFF when sensor sees metal of disc.
- L3G Always OFF.
- L4G Driven by signal from guard switch.
ON (green) when guard is closed.
OFF when guard is open.
- *L5R Indicates control program status.
ON (red) when machine is powered up but not initialised from PC.
OFF when machine is initialised (control program loaded from PC and running).
- *L6G Indicates control program status.
OFF when machine is powered up but not initialised from PC.
ON (green) when machine is initialised (control program loaded from PC and running).

*L5R and L6G:	<p>While the control program is being downloaded from the PC to the machine (using the Reset Machine option), LEDs L5R and L6G flash rapidly and alternately. If, when downloading is complete:</p> <p>L5R is OFF and L6G is ON - the control program is running satisfactorily.</p> <p>L5R stays ON and L6G stays OFF - the control program is not running. Suspect a hardware fault on the microprocessor PCB.</p>
Test Points	<p>GND Used as a reference for the following test points:</p> <p>+5V Logic supply rail +5V d.c.</p> <p>+12V Auxiliary supply rail +12V d.c.</p> <p>ANLG Spindle drive analogue voltage - proportional to speed, 0-10V d.c.</p> <p>EPROM Control software status. This test point requires the use of an oscilloscope:</p> <p>With the machine powered up, but control software not loaded (L5R ON and L6G OFF), an even mark/space ratio should be seen.</p> <p>With the software downloaded, (L5R OFF and L6G ON), the waveform should change to short sections of even mark/space ratio periodically separated by a long mark time.</p>
Software Loader EPROM	<p>The software for downloading the control program resides in EPROM U12, which is labelled with the version number.</p>

9.2.4 Axis Control PCB

LEDs	<p>LED 1 X-axis motor. OFF when motor is in home phase condition (one pulse in eight).</p> <p>LED 2 Y-axis motor. (As LED 1).</p> <p>LED 3 Z-axis motor. (As LED 1).</p> <p>LED 4 +5V supply. (Will be OFF if LED 6 is OFF, as +5V supply is derived from +12V supply).</p> <p>LED 5 Motor supply (24V d.c.). OFF when E-stop is operated.</p> <p>LED 6 +12V supply.</p>
-------------	--

LEDs 7-10 Z-axis motor. Indicate phase outputs which are ON, and should cycle as steps are output. While the motor is energised at least one pair of diagonally opposed LEDs should be ON, alternating with both pairs ON together:



An odd number of LEDs ON would indicate a fault in the motor or output stage.

LEDs 11-14 Y-axis motor. (As LEDs 7-10).

LEDs 15-18 X-axis motor. (As LEDs 7-10).

9.3 Software Fails to Run

Most problems will be caused by lack of available conventional memory.

Make the following checks, referring to Section 4 - Computer Requirements where indicated:

1. Does your computer support XMS (Extended Memory)?
2. Does your computer have sufficient available memory?

It may be that your computer has sufficient memory, but that much of this is being used by other memory-resident programs, leaving little memory free to run the DUET Software. If you think that this may be the cause of the problem, refer to the your Operating System manual for guidance in limiting the amount of memory that other programs are allowed to use. Such programs are typically RAM disks or disk caches.

CAD Software

If the Lathe CAD software (See section 5.1 - Turning Manual) causes a General Protection Fault or crashes in any other way when it is initially started, the problem is caused by the windows '*common control library*' been out of date.

To solve the problem, complete the following:-

Windows 95A

Copy the files **MFC40.DLL** and **MSVCRT40.DLL** (located in the '**Patches**' directory on the manuals CD ROM) to the **windows\system** directory.

Locate and execute the file '*comctl32.exe*' which is located in the directory where the DUET lathe software is installed. Alternatively a copy can be found on the manuals CD ROM in the '**Patches**' directory.

If COMCTL32.EXE reports an OLE Automation Error, then 'shut down windows and restart in MS-DOS mode'. Copy the file **COMCTL32.DLL** (located in the '**Patches**' directory on the manuals CD ROM) to the **windows\system** directory.

e.g. *copy d:\patches\COMCTL32.DLL c:\windows\system*

Windows 95B

Locate and execute the file '*comctl32.exe*' which is located in the directory where the DUET Lathe software is installed. Alternatively a copy can be found on the manuals CD ROM in the '**Patches**' directory. Follow the prompts to update the library.

3D Renderer

If the '**Launch 3D Renderer**' option (see section 5.8 - Turning Manual) is greyed out it is because the computer system graphics display is not configured to **16 Bit (High Color)** or above.

9.4 Maintenance

Keep the DUET machine free from dirt and swarf.

Lightly oil the slideways at regular intervals.