LINEAR GRAPHICS LIMITED

CONDITIONS OF SERVICING

1. Your Plotmate must be returned in ALL the original packaging as you are liable for any damage incurred in transit. The cost of new packaging will also be payable.

   Please use a reputable carrier.

2. Please return your connection lead with the unit, plus any ROMS supplied or purchased from Linear Graphics Limited. Do not return any software unless you believe it to be faulty.

3. If no fault is found with the unit you are liable for the carriage costs both ways.

4. A letter explaining the exact fault is to be included with the unit.

5. Linear Graphics' products carry a twelve month warranty.

   Units repaired outside this period will be charged, including the carriage costs.

22787

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LINEAR GRAPHICS

LINEAR GRAPHICS LIMITED

CONDITIONS OF SERVICING

PLOTMATE USER GUIDE

Contents Page

1.Introduction

1.1.Why Plot ?

There are two possible methods of displaying graphics.

The first is used for all television displays and for most computer screens and is known as **raster scanning**. Here, images are made up of separate adjacent horizontal lines. This method is used by dot-matrix printers. These may be of impact type (monochrome or coloured), inkjet type (monochrome or coloured) or laser type (monochrome only). Electrostatic 'plotters' are similar.

The second is used for some computer screens (mostly for computer-aided design [CAD]), as well as for pen plotters and is called **vector plotting**, where an image is created by joining individual plotting points on a grid system. Pen plotters may be of flat-bed type (single- or multi-pen) or pinch-roller type (single- or multi-pen).

Raster scanning is particularly good for shapes filled with patterns or colours. However, it requires a great deal of data to achieve a high definition, free of jagged lines. Vector plotting is particularly good for outlines, and for dense block fills. Moreover, it requires much less data to achieve high colour definition.

Comparing the final results of printers and plotters, a typical dot-matrix printer produces up to 640 dots in 200 mm. This gives an absolute resolution of 0.32 mm, with a dot of similar size. A PLOTMATE plotter is capable of 0.1 mm which is more than three times as good (both horizontally and vertically). Plotter pens are available which can draw lines of similar width.

Whereas a standard dot-matrix printer is only capable of printing in a single colour, a single-pen plotter can pause for pen changing, and thus offer multi-colour reproductions. These advantages mean that plotters can produce much sharper, and more attractive images in about the same time. Many uses include business graphics, artists' graphics, and technical drawings.

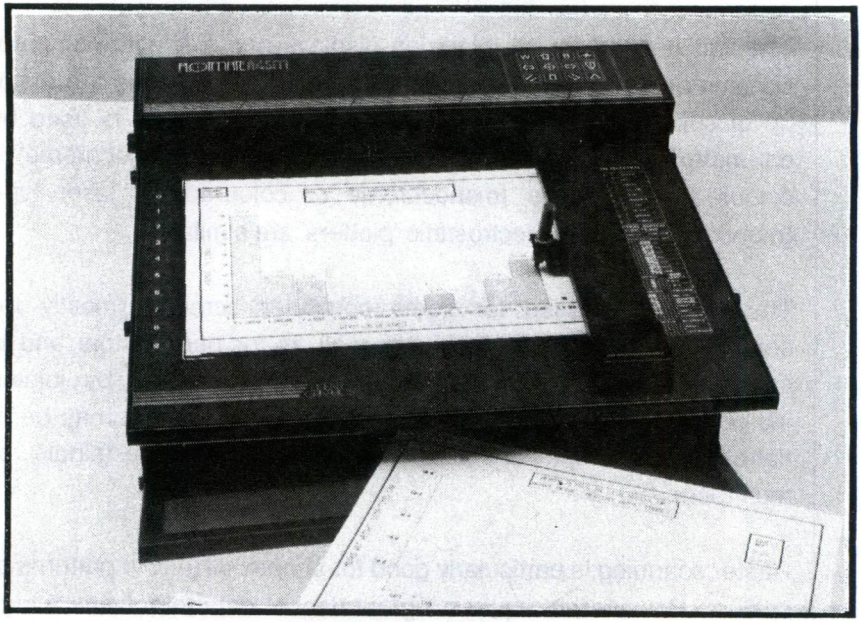


Fig.1. PLOTMATE A4SM.

1.2.Intelligent Plotting

The PLOTMATE M range of plotters are all fitted with an intelligent interface. This interface contains a microprocessor and ROMs which provide all of the necessary plotter control via the Centronics and RS-232-C interfaces. As a result PLOTMATE M is compatible with a wide range of computer systems. There are many special features which help make the plotter easy to use these are :-

- System self-test.
- Direct windowing, bordering and scaling capabilities, to assist initial setting up.
- The plotter may be controlled by a sequence of ASCII control codes, embodied in a text file or a BASIC or other programs.

  (Although this facility can be used with some other computers, it is best used in conjunction with BBC microcomputer based systems which use ASCII **VDU** commands.)

- Emulation of the Graphtec WX4671 and Sweet-P plotters. This allows the PLOTMATE M to be used with software packages already containing plotter drivers for producing hard copy output, for example :-

  When the system is set for Graphtec WX4671 emulation, it can be used for plotting drawings produced with the Robocom Bitstik drawing package.

  When set for Sweet-P emulation, it can be used for plotting graphs and charts produced with the Lotus 1-2-3 package.

- Expansion ROM sockets inside the unit allow further graphics and language emulation capabilities to be added, as they are developed by Linear Graphics Limited. These include the already available Hewlett Packard Graphics Language (HP-GL) emulator ROMs.

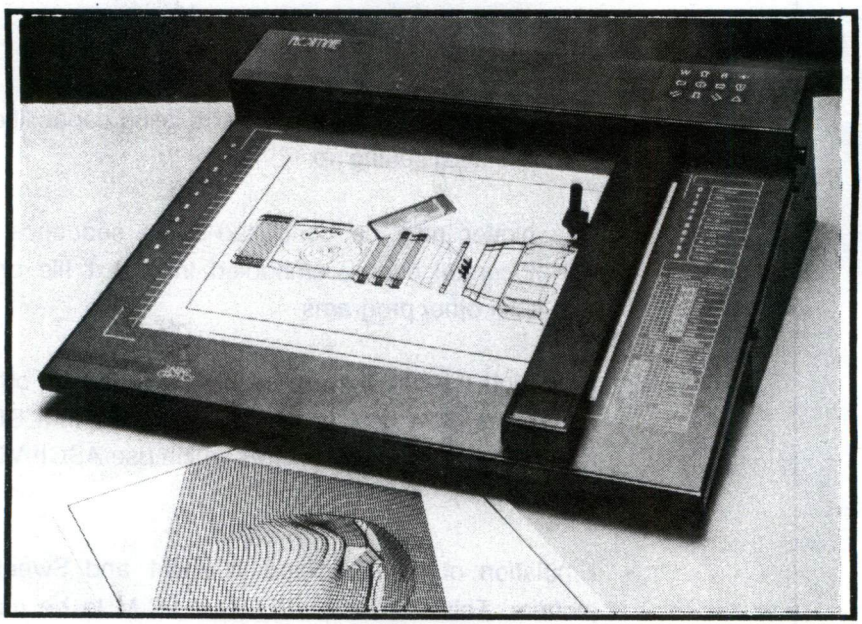


Fig.2. PLOTMATE A3M.

1.3.Before Starting

Before starting to use PLOTMATE M check that the following items have been received in addition to this manual :-

- PLOTMATE M.
- Magnetic Strips (x2 for A4SM, x4 for A3M)
- Two Plastic Tipped Pens.
- Dust Cover.
- Guarantee/Registration Card.

If any of the equipment is damaged, inform the supplier, quoting the number that appears on the delivery note.

Please fill in the Guarantee/Registration Card and send it off promptly. No stamp is necessary, as postage will be paid by Linear Graphics Limited.

To operate PLOTMATE M, other items required are :-

- A microcomputer system fitted with either a Centronics parallel or RS-232-C serial interface.
- Centronics parallel or RS-232-C serial interface lead.

NOTES

2.Operation

2.1.System Setup

The PLOTMATE M is provided with two interfacing standards - 8-bit parallel (Centronics), and 7 or 8-bit serial (RS-232-C).

Before inserting the proper interface lead, selection of the appropriate interface is made by setting the DIP option switches. These are located at the rear of PLOTMATE M next to the data input sockets as shown in Fig.3. The DIP option switches allow different interface standards and control modes to be selected and must be set before power is applied to the plotter. Table 1 shows the various switch settings available. Next connect the interface lead to the appropriate socket on PLOTMATE M, and on the microcomputer system interface.

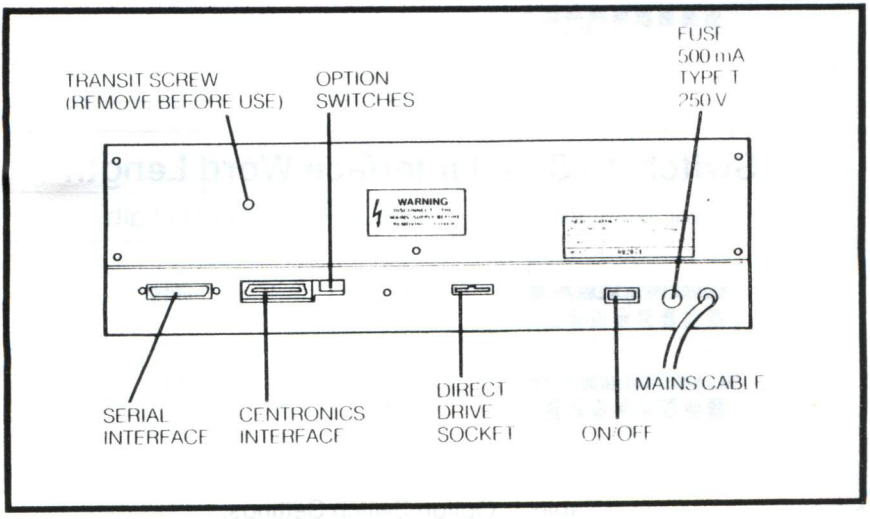
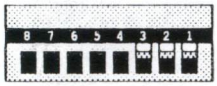
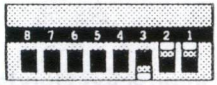
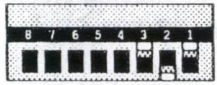
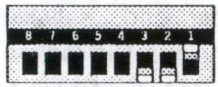
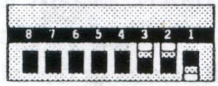
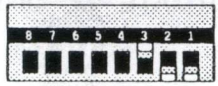
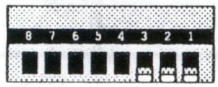


Fig.3. Rear View of PLOTMATE M.

Switches 1 to 3 - Serial Interface Baud Rate

Switch Setting	Baud Rate Selected
	110
	150
	300
	600
	1200
	2400
	4800
	9600

Switch 4 - Serial interface Word Length

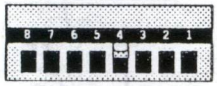
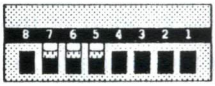
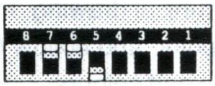
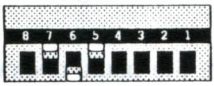
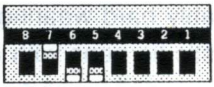
Switch Setting	Word Length
	7-Bits
	8-Bits

Table.1. Option Switch Settings.

Switches 5 to 7 - Plotter Language/Control

Switch Setting	Language/Control Selected
	Acorn BBC (VDU) Commands
	Graphtec WX4671 Emulation
	Sweet-P Emulation
	Direct-Drive Mode
	Expansion Language

! Direct-Drive mode bypasses the on board intelligence and makes the operation of PLOTMATE M the same as the PLOTMATE basic model.

Switch 8 - Interface Selection

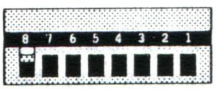
Switch Setting	Interface Selected
	Serial RS-232-C
	Parallel Centronics

Table.1. Option Switch Settings.

2.2.Pens and Papers

2.2.1.Choosing Pens

The choice of pens is dictated by the specification of the finished article - paper or film - and the nature of the image to be plotted - business graphics, artists' graphics, or technical drawing. Pen types available include plastic-tip, fibre-tip, ball point, and hollow tip, these are available in a range of various tip sizes and colours.

Plastic-tip pens with water-based inks are the usual choice for fast plotting on matt paper. They are reasonably hard wearing and are available in a wide range of colours. Plastic-tip pens with oil-based inks give better results, both on glossy paper and overhead projection (OHP) film, but the writing speed must be much slower.

Fibre-tip pens are good for shading large areas of paper but are subject to progressive widening of the lines with wear and impact, well before the ink is exhausted.

Ball-point pens are very good for fine lines, but the line width depends on paper thickness. Towards the end of their life they tend to leave gaps especially on certain paper types.

Metal and ceramic hollow-tipped pens (Rotring & Staedler) are excellent for lines of constant width without unwanted gaps, but the writing speed and pen drop characteristics must be chosen carefully to match the paper or film. Ceramic tips have a longer life than those of metal but are generally more expensive. A wide range of colours and sizes are available.

A multi-purpose pen holder is available which can hold all of the above types of pens as well as biro's, pencils and the LinSCAN scanning head.

2.2.2.Fitting Pen and Paper

Position paper on PLOTMATE as shown in Fig.4. Locate the top left corner of the paper into the corresponding corner of the boundary marks. Ensure the paper is perfectly flat, with no ripples. Place the magnetic strips in the position shown, making sure that the lower strip is clear of the track of the wheel at the end of the plotter arm.

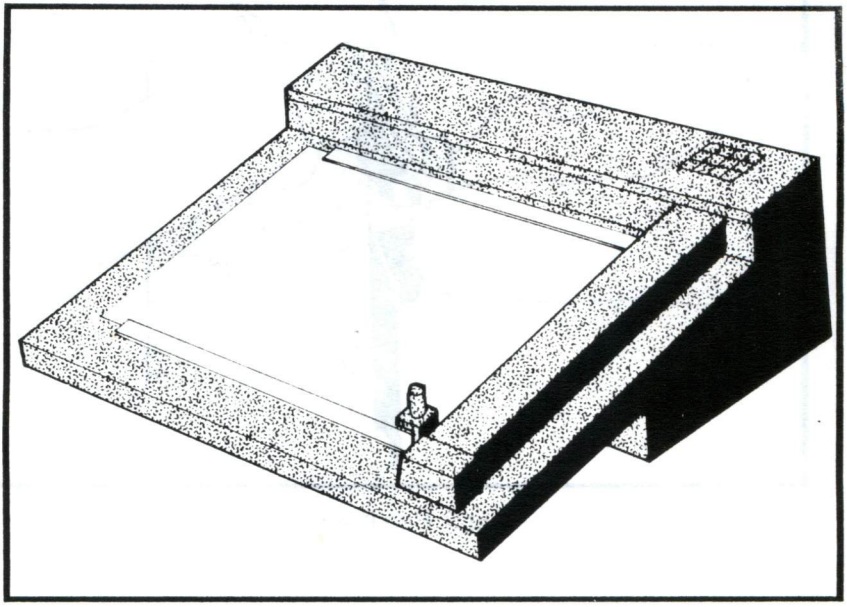


Fig.4. Positioning Paper.

Select a plotter pen and remove the cap. Support the pen holder and insert pen. The locating pips on the pen align with the two slots in the pen holder. Twist the pen a quarter-turn to fix it firmly in position, see Fig.5.

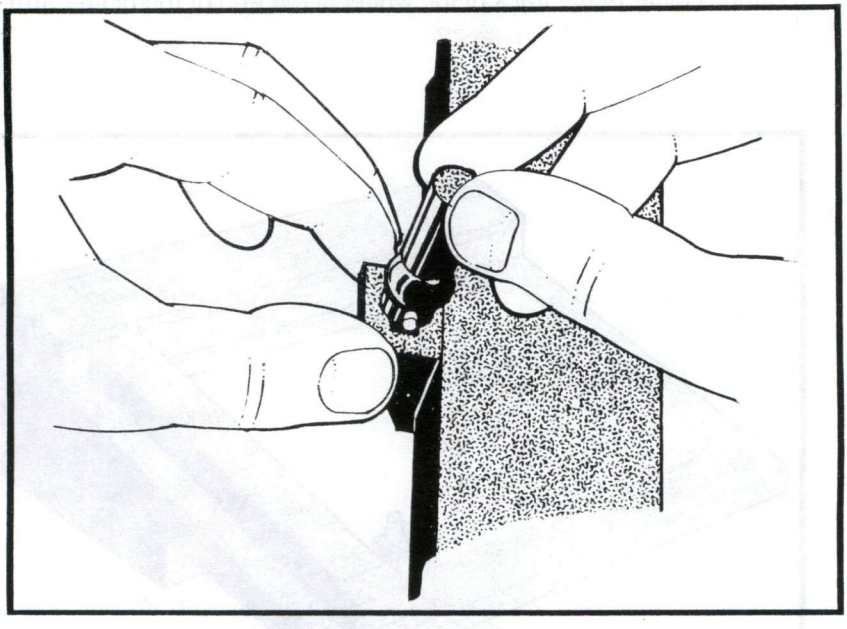


Fig.5. Pen Insertion.

2.3.Switching on PLOTMATE M

Plug PLOTMATE M into a 240 V ac power supply then switch on using the rocker switch at the rear of the unit. It should perform a reset operation by moving the pen to a set position. This sets the default values of all the plotting commands in the currently selected command set. It thus sets up a known initial condition for susequent operations, controlled either from the computer keyboard, or from a plotting program.

If reset does not occur, switch off the unit and repeat the switch-on. If the reset still fails to occur, refer to chapter **6.Troubleshooting**.

The system is now ready for use.

2.4.Front Panel

2.4.1.Using the Keypad

On the top cover of PLOTMATE M, is an LED indicator and a twelve switch, membrane-type keypad, see Fig.6. These keys allow various control operations to be carried out, as described later in this section.

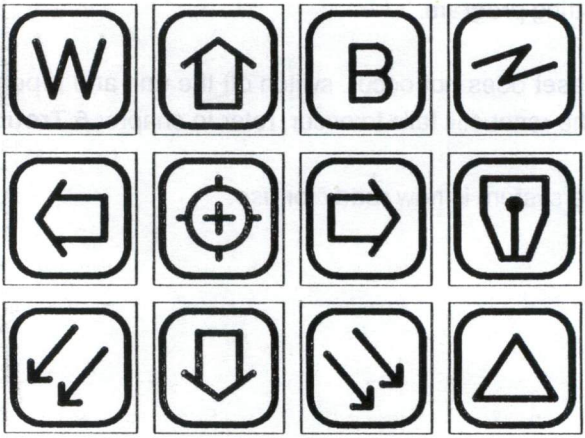


Fig.6. PLOTMATE M Keypad.

Before any keypad operations can be performed the unit must be taken '**off-line**'. The on/off-line status is shown by the LED indicator next to the keypad. When this indicator is lit, PLOTMATE M is '**on-line**' and ready to receive data from the host computer.

To take the unit **off-line**, press the [Z] key once. This will cause the LED indicator to go out, showing an off-line status. All data sent by the host computer will then be halted until an on-line status is resumed. To put the unit back **on-line**, the [Z] key must be pressed once again, so that the LED indicator is illuminated.

2.4.2.Keypad Controls

When two keys are shown in the descriptions below, hold down the key shown on the left then press the other key to perform the required function.

 — On/off line.

Pressing once, if the unit is **on-line** (LED lit), will cause the unit to go **off-line**. Pressing once if the unit is **off-line** (LED off) will cause the unit to go **on-line**.

 — Pen up/down.

Pressing once when pen is up will cause the pen to be lowered onto the paper. Pressing once when pen is on the paper will cause the pen to be lifted.

 — Moves pen slowly upward along Y-axis.

 — Moves pen slowly downward along Y-axis.

 — Moves pen slowly to the left along X-axis.

 — Moves pen slowly to the right along X-axis.


— Moves pen upward along Y-axis fast.


— Moves pen downward along Y-axis fast.


— Moves pen to the left along X-axis fast.


— Moves pen to the right along X-axis fast.


— Moves pen to the lower left location of current plotting window (**home position**).


— Moves pen to the lower right location of current plotting window (**park position**).

— Border function.

If the pen is up, it will move around the border of the current plotting window. If the pen is down, a border will be drawn around the current plotting window.

— Move Origin and Plotting Window.

Moves the bottom left corner of the current plotting window to the current pen position.

— Plotting Window Size.

Sets the plotting window size. To set up the window size it is best to first home the pen by pressing  . Next move the pen to a position, above or to the right of home, which marks the new limit of the X or Y axis. Only one of the axes should be set. If both axes are set, the second overrides the first. Pressing  will now set the new plotting window size, keeping the aspect ratio the same as that of the default plotting window.

— Pen speed fast/slow.

Pressing once when fast pen speed is in operation will select slow pen speed. Pressing once when slow pen speed is in operation will select fast pen speed. This control can be of use when using pens that have a slow ink flow. The default setting is fast.

— Moves pen to absolute lower left of plotting area (**home absolute**) and returns the plotting window to the default size.

 — Moves pen to absolute lower right of plotting area (**park absolute**) and returns the plotting window to the default size.

 — Enable pen changes.

Will cause the pen to move to the pen indicator, at the left of the drawing platen, each time a pen change command is received.

 — Disable pen changes.

All pen change commands received will be ignored by the plotter.

 — Reset system.

Resets PLOTMATE and returns plotting window and all other parameters to default values.

 — Self-test mode.

Tests PLOTMATE M by running a test plot, see chapter **6.Troubleshooting**. The test plot also displays the current option switch setting.

3.Control

3.1.Plotting and programs

Before the PLOTMATE M can plot anything (other than the self-test pattern or a border) it must be sent commands from the host computer. A **PRINT** statement, identical to those used with a printer, must precede all plotter commands. **PRINT** statement formats vary from one computer to another, and may be found in the host computer manual. The commands sent can be organised either as a text file or within a program held in the host computer. Such a program can be written in a computer language, such as BASIC or Pascal.

PLOTMATE M intelligent interface, interprets the commands received and then makes it move and operate the pen in the appropriate manner. Various command sets can be selected by using different option switch settings, see section **2.1.-System setup.**

Three graphics command sets are available. These are the ASCII control codes (equivalent to the **VDU** commands of the Acorn BBC microcomputer), and the Graphtec WX4671 and Sweet-P plotter commands.

ASCII control codes may be sent from suitable application packages, as well as from user-written text files or programs. For example, in the case of the Acorn BBC Microcomputer, packages such as Linear Graphics Linchart and Lincad, may be used to create the required images on screen, which can then be output to PLOTMATE. This is possible because these packages - like BBC BASIC - send a sequence of ASCII control (**VDU**) commands to

draw on the screen, via the OSWRCH vector. These may be intercepted, and used to drive PLOTMATE M.

When the system is configured for Graphtec WX4671 emulation, it can be used for plotting drawings produced with the Robocom Bitstik drawing package.

When the system is configured for Sweet-P emulation, it can be used for plotting graphs and charts produced by the LOTUS 1-2-3 package.

In the PLOTMATE implementations, the ASCII control code (**VDU**) graphics language has the most facilities. These are also available, as extensions, to the Graphtec WX4671 and Sweet-P emulatiors.

All three command sets are described later in this section. Other command sets, such as the HP-GL (Hewlett Packard Graphics Language) emulator, are supplied on ROMs. These can be plugged into spare ROM sockets located inside the plotter as they become available from Linear Graphics Limited.

3.2.Pen Movement

The PLOTMATE plotting area should be regarded as a Cartesian Co-ordinate System, extending over thousands of plotter units. Plotter units are used to define distances along the horizontal (X) and vertical (Y) axes. Individual plotting points are located, using both X and Y co-ordinates to express the distance in plotter units from the '**home**' position. See Fig.7.

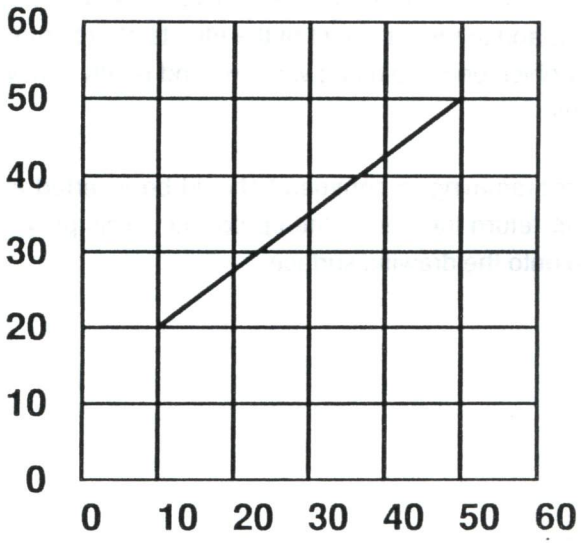


Fig.7. Cartesian Co-ordinate System.

When referring to the co-ordinates, the convention is that the X- axis value is given first, then the Y-axis value. Lines of any length and angle can be drawn by defining the start and end co- ordinates of each line. These co-ordinates can be defined by using commands available in the selected command set. The absolute magnitude of each plotter unit, and hence the size of the plotting area, depends on the command set selected and on the global scaling factor or the size of the current plotting window.

Should co-ordinates be sent that are outside the plotting area, the pen will lift upon reaching the boundaries. PLOTMATE will keep track of the plotting data and resume pen operation (i.e. moving and drawing) once the co-ordinates return within the plotting area.

As well as operating from a text file or program, PLOTMATE may be driven by individual commands entered from the computer keyboard. This is particularly useful during program development.

It is, of course, necessary to enter commands which will be understood by the currently selected command set (or graphics language), and to take account of the effects of previous changes of scale, graphics origin, plotting window, and relative move and draw operations.

When programming, a command should be inserted at the end of plotting to return the pen to the up position. This prevents ink from bleeding onto the drawing surface.

3.3.ASCII Control (VDU) Commands

All thirty-two ASCII control codes are recognized by PLOTMATE M and many of them are interpreted as graphics commands. Many of the codes are followed by a number of bytes which repres parameters or arguments (X,Y co-ordinates). The number of bytes depends on the function being performed. All X and Y co-ordinates must be sent as two bytes since the values may well be greater than 255. Each byte pair must be sent with low byte first followed by the high byte. Even though the co-ordinates may be far outside the plotting window, the values should be within the range of +/- 32,767.

The BBC microcomputer uses many of these ASCII control (**VDU**) codes for screen graphics. Every effort has been made to make PLOTMATE directly compatible with the BBC graphics commands, however there are certain commands where this is difficult.

Most computers can send ASCII control codes. Single codes can be sent by using **PRINT CHR$(X);** commands from most BASIC interpreters. Multiple codes can be sent by using **PRINT CHR$(X);CHR$(Y);CHR$(Z);**. Below is an example of how to send a pen move command :-

> To move the pen absolute to position X=100, Y=500 the ASCII command **25,K,Xl,Xh,Yl,Yh** must be used. For the command to be an absolute move **K** must be given a value of 4. **Xl** and **Xh** give the low and high byte values of the X co-ordinate (**Xl=X MOD 256**, **Xh=X DIV 256**). **Yl** and **Yh** give the low and high byte values of the Y co-ordinate (**Yl=Y MOD 256**, **Yh=Y DIV 256**). Thus the codes :-
>
> **25,4,100,0,244,1**
>
> would move the pen to absolute position 100,500.

This command can be represented in Microsoft BASIC by the lines :-

```
10 PRINT CHR$(25); CHR$(4); CHR$(100);
20 PRINT CHR$(0); CHR$(244); CHR$(1)
```

On some computers these control codes may not be easily used as they may be reserved for machine operating system functions. If this is the case, one of the plotter emulators should be used. Both the Graphtec WX4671 and Sweet-P emulators contain commands (**V** and **VU**) which provide access to all the ASCII control command functions. When the BBC microcomputer is being used, provided the appropriate interface is enabled, ASCII control code (**VDU**) commands will be sent automatically to the plotter.

Table 2 summarises all the ASCII control codes, the number of bytes which follow them, and the action on PLOTMATE.

ASCII Control Code			Bytes Extra	Action on PLOTMATE
Dec	**Hex**	**Abbrev.**		
0	0	NUL	0	•
1	1	SOH	1	System functions
2	2	STX	0	•
3	3	ETX	0	•
4	4	EOT	0	No text at graphics cursor position
5	5	ENQ	0	Write text at graphics cursor
6	6	ACK	0	•
7	7	BEL	0	•
8	8	BS	0	Backspace if text is enabled
9	9	HT	0	•
10	A	LF	0	•
11	B	VT	0	•
12	C	FF	0	•
13	D	CR	0	Line-Feed and Carriage Return
14	E	SO	0	•
15	F	SI	0	•
16	10	DLE	0	•
17	11	DC1	1	•
18	12	DC2	2	Pause to change pen (e.g. colour)
19	13	DC3	3	•
20	14	DC4	4	•
21	15	NAK	0	•
22	16	SYN	1	•
23	17	ETB	9	Change parameters
24	18	CAN	8	Block fill or plotting window
25	19	EM	5	Plotting command
26	1A	SUB	0	Reset plotting window
27	1B	ESC	0	•
28	1C	FS	4	•
29	1D	GS	4	Define graphics origin
30	1E	RS	0	•
31	1F	US	2	•
127	7F	DEL	0	•
• - Indicates **VDU** code recognised but no action taken.				

Table.2. ASCII Control (VDU) Codes.

1,2

— Take PLOTMATE M **'off-line'**.

Halts all data being sent by the host computer and turns out the on/off line indicator. Control is then given to the front panel see section **2.4.2-Keypad Controls.**

1,6

— Pen up.

Lifts pen from the paper.

1,7

— Pen down.

Lowers pen onto the paper.

1,11

— Reset system.

Resets PLOTMATE and returns plotting window and all other parameters to default values.

1,16

— Pen home.

Moves pen to the lower left location of current plotting window (**home position**).

1,17

— Pen park.

Moves pen to lower right location of current plotting window (**park position**).

1,18

— Self-test.

Draws the self-test plot.

1,19

— Border function.

If the pen is up, it will move around the border of the current plotting window. If the pen is on the paper, a border will be drawn around the current plotting window.

1,20

— Give control to expansion language.

This command will only function if PLOTMATE M has been fitted with some expansion language ROMs. If a language has been fitted then all further commands will have to be sent in the expansion language syntax.

1,N

— Shading and pen response.

N=32 to 63 - Changes vertical line spacing on GXR shape fills. 32=Most dense fill. 63=No fill.

N=64 to 95 - Changes horizontal line spacing on GXR shape fills. 64=Most dense fill. 95=No fill.

N=128 to 255 - Change pen response time. 128=Shortest delay. 255=Longest delay.

4

— Disable text plotting.

Stops text output appearing on PLOTMATE

5

— Enable text plotting.

Any ASCII character above the value of 32 sent after this command will be plotted at the current pen position.

If an attempt is made to print characters with the pen position near the plotting boundary, whole characters or parts of characters may not be plotted. This will depend on the values of parameters affecting character size and orientation (see **VDU 23,255,...** command).

8

— Backspace one character.

This command is equivalent to backspace and moves the pen one character space in the opposite direction to which characters are currently being plotted.

The function will only be carried out if text has been enabled by a **VDU 5** code.

If the pen is at the start of a line, it does not move to the end of the previous line, but instead backspaces further along the current line.

13

— Line-Feed and Carriage Return.

This command simulates a line feed and carriage return on PLOTMATE if text has been enabled by a **VDU 5** code. The orientation, height and width of the characters (set by a **VDU 23,255,...** command) are automatically taken into account.

The pen moves to a margin, the position of which is set by the last **MOVE** command.

18,N,C

— This command, when enabled, halts PLOTMATE operation and moves the raised pen to the pen indicator strip marked on the left edge of the drawing plate. The pen will stop adjacent to the next colour name/number to be used and the front panel LED indicator will flash while it is waiting for the pen to be changed. To continue plotting press any key on the PLOTMATE keypad.

Initially this command does not interrupt PLOTMATE operation. It has to be enabled by setting **SF**=4 in the **VDU 23,255,...** command.

The first parameter (**N**) has no effect on the operation of PLOTMATE, the second (**C**) represents the number of the new pen colour. This can be a value between 1 and 10 depending on the colour to be selected. The following table gives pen colour suggestions for different values of **C** :-

Value of **C**.	Pen Colour.
0	Orange
1	Red
2	Green
3	Yellow
4	Blue
5	Magenta
6	Cyan
7	Black
8	Brown
9	Purple

Table.3. Pen Colour Suggestions.

23,255,CH,CW,CS,CO,PS,SF,SH,SC

— This command allows various parameters to be changed within the range shown. They are set initially to the default values given in the table below :-

Parameter	Description	Default Value	Range
CH	Character Height	3	1-255
CW	Character Width	5	1-255
CS	Character Slant	1	1-4
CO	Character Orientation	1	1-4
PS	Pen Speed	10	1-10
SF	Special Function	7	1-9
SH	Shading/Broken Lines	1	1-255
SC	Scaling	120	1-255

Table.4. VDU 23,255,... Parameters.

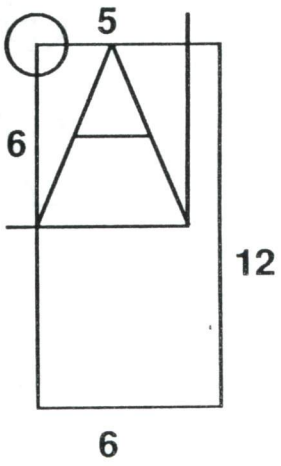
The parameters may be changed by altering the value in the appropriate byte, as detailed below. A zero placed in a byte maintains the current parameter value.

23,255,CH,-,-,-,-,-,-,- Character Height

— This parameter controls the height of the characters. The value of **CH** can be between 1 and 255. The default value is 3.

All characters are fitted within a lattice of height twelve and width six plotter units. The vertical height of each is altered by **CH**, and also by **SC** the global scaling parameter.

The height of the lattice is given by the expression (12 x **CH** x **SC** x 0.1016)/64 mm. Using the default values for A4, the character cell height (line spacing) is 6.86 mm. Capital letters measure six elements high giving rise to a default height of 3.43mm.

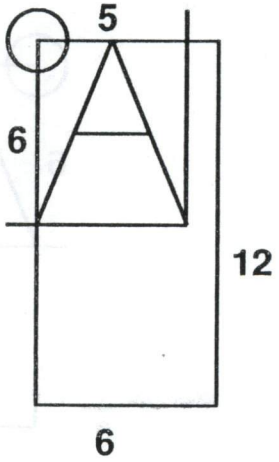


23,255,-,CW,-,-,-,-,-,- Character Width

— This parameter controls the width of the characters. The value of **CW** can be between 1 and 255. The default value is 5.

All characters are fitted within a lattice of height twelve and of width six plotter units. The width of each is altered by **CW**, and also by **SC** the global scaling parameter.

The width of the lattice is given by the expression (6 x **CW** x **SC** x 0.1016)/64 mm. Using the default values, the character cell width is 5.72 mm, and the character width is 4.76 mm.

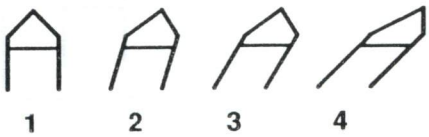


23,255,-,-,CS,-,-,-,-,- Character Slant

— This parameter controls the slant of the characters. The default value is 1 which gives upright text. A value between 1 and 4 may be selected to give the following character slants :-

Value of **CS**	Character Slant
1	Upright
2	Slant Angle 14.0°
3	Slant Angle 25.5°
4	Slant Angle 45.0°

Table.5. Character Slant Settings

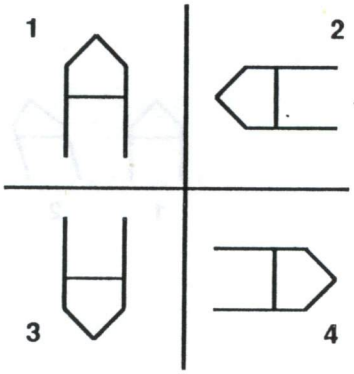


23,255,-,-,-,CO,-,-,-,- Char Orientation

— This parameter controls the text character orientation. The default value is 1 in which case characters read along the X-axis. A value between 1 and 4 may be selected to give the following character orientations :-

Value of **CO**	Character Orientation
1	Characters read along X-Axis
2	Characters read along Y-Axis
3	Characters read upside-down along X-Axis
4	Characters read upside-down along Y-Axis

Table.6. Character Orientation.



23,255,-,-,-,-,PS,-,-,- Pen Speed

— This parameter controls the speed at which the pen plots. The value can be between 1 and 10 (where 1 is the slowest, and 10 is the fastest).

The default value is 10.

The pen always moves at the fastest speed when raised, and when performing filling functions.

23,255,-,-,-,-,-,SF,-,- Special Functions

— This parameter can be given a value between 1 and 9 which selects a number of special functions described below. The default value is 7.

Value of SF	Function Performed
0	No change to special function selected.
1	Reorigin plotter at present pen position. (*Equivalent to* **VDU 29,...** *where the co-ordinates are the present pen position*)
2	Reset parameters to default values.
3	Reorigin plotter and reset parameters to default.
4	Enable pen pause/change. (*See* **VDU 18**)
5	Disable pen pause/change. (*See* **VDU 18**)
6	Subsequent plotting will be drawn upside down. (*Further explanation given below* •)
7	Subsequent plotting will be drawn correct way up.
8	Enable block filling. (*See* **VDU 24**)
9	Enable setting of plotting window. (*See* **VDU 24**)

Table.7. Special Functions.

- **SF**=6 Further explanation.

  PLOTMATE is reset as normal (as **SF**=3) except that pen home position is now at the top right corner of the plotting area. All plotting will now be performed upside-down and in reverse, using the top right corner of the plotting area as the origin. The four direction keys will now operate in the reverse sense.

  Plotting can be returned to normal by either setting **SF**=7 or resetting the system with **SF**=3.

23,255,-,-,-,-,-,-,SH,- Shading Parameter

— This parameter alters the type of shading pattern that is used in triangle and block filling operations. It also alters the type of broken line pattern in dotted line drawing operations.

SH=L+(M*16) where **L** is a value between 0 and 15 that determines the shading pattern, and **M** is a value between 0 and 15 that determines the broken line pattern. The effect of different values of **L** and **M** is shown below :-

Value of **L**	Effect on Shading Pattern
0	No Change.
1	Solid fill. (Default Value)
2-3	Half fill.
4-15	Less Dense Shading.
Value of **M**	Effect on Line Pattern
0	Dotted Line Pattern. (Default Value)
1-15	Other Dotted Line Patterns.

Table.8. Shading & Line Parameters.

23,255,-,-,-,-,-,-,-,SC Scaling

— This parameter, which sets the plotting scale, can be between 1 and 255. The default value is 120, which gives a **full size** plot on an A4 sheet with maximum X and Y co-ordinates (in plotter units) of Xmax = 1522 and Ymax = 1039. This value should be changed to 164 if a **full size** plot on an A3 sheet is required on PLOTMATE A3M.

Generally, one plotting unit corresponds to (SC*0.1016)/64 mm on PLOTMATE. This means that, with the default scaling parameter values, one plotter unit equals 0.1905 mm.

The table below shows how different scaling values affect the size of plotter units and the maximum X,Y plotting co-ordinates :-

Value of SC	Plotter Unit (mm)	Xmax (A4)	Ymax (A4)	Xmax (A3)	Ymax (A3)
64	0.1016	2854	1988	3937	2657
120	0.1905	1522	1039	2100	1417
164	0.2604	1114	776	1536	1037
255	0.4048	716	499	988	667

Table.9. Scaling.

Although the plotter unit size varies depending on the scaling selected, the point accuracy always remains at 0.1016 mm.

24,Xmini,Xminh,Ymini,Yminh,Xmaxi,Xmaxh,Ymaxi,Ymaxh

— This command can be used either for filling rectangular blocks or defining the plotting window size.

Block filling can be performed provided the facility has been enabled by a **VDU 23,255,...** command, with **SF**=8. The co-ordinates of the bottom left and top right corners of the block are given by the parameters following **VDU 24**. These are described in the table below :-

Parameter	Description	Value
Xmini	Bottom left X co-ordinate low byte	Xmin DIV 256
Xminh	Bottom left X co-ordinate high byte	Xmin MOD 256
Ymini	Bottom left Y co-ordinate low byte	Ymin DIV 256
Yminh	Bottom left Y co-ordinate high byte	Ymin MOD 256
Xmaxi	Top right X co-ordinate low byte	Xmax DIV 256
Xmaxh	Top right X co-ordinate high byte	Xmax MOD 256
Ymaxi	Top right Y co-ordinate low byte	Ymax DIV 256
Ymaxh	Top right Y co-ordinate high byte	Ymax MOD 256

Table.10. VDU 24 Parameters.

To define a new plotting window, the block filling facility must first be disabled by use of a **VDU 23,255,...** command, with **SF**=9. The co-ordinates of the bottom left and top right corners of the new plotting window are given by the parameters following **VDU 24**.

25,K,Xl,Xh,Yl,Yh

— This is a multi-purpose point, line and triangle drawing command.

The value of **K** determines what kind of point, line or triangle is going to be drawn and is described in the table below. The other parameters are used to specify the X and Y co-ordinate low and high bytes used in plotting the point or drawing the line or triangle.

Value of K	Function
0	Move relative to last point.
1	Draw line relative to last point.
2	Same as 1 above.
3	Same as 1 above.
4	Move to absolute position.
5	Draw line to absolute position from last point.
6	Same as 5 above.
7	Same as 5 above.
8-15	Same as 0-7 above.
16-23	Same as 0-7 but with a dotted line pattern defined
24-31	in the **SF** parameter as set by **VDU 23,255,...**
64-71	As 0-7 but a single point is plotted.
80-87	As 0-7 but plots and fills a triangle between the co-ordinates given and the last two points visited. The fill pattern is dependent on the **SF** parameter set by the **VDU 23,255,...** command.
96-103	GXR Rectangle fill.
112-119	GXR Parallelogram fill.
144-151	GXR Circle outline.
152-159	GXR Circle fill.
160-167	GXR Circular arc.
168-175	GXR Circular segement.
176-183	GXR Circular sector.

See section - 3.4-The GXR Commands.

Table.11. VDU 25,K Parameters.

26

— This command returns the plotting window to its initial size, where it occupies the whole plotting area.

29,Xl,Xh,Yl,Yh

— This command is used to move the graphics origin of the computer screen to a new position. The parameters following the command specify the X and Y co-ordinate low and high bytes of the new origin. These are expressed in the plotter units of the current plotting window.

The new origin position can only be placed within the current plotting window. This position will also be determined by the value of the scaling parameter, **SC**, set by the **VDU 23,255,...** command.

3.4.The GXR Commands

3.4.1.Drawing GXR Shapes

The GXR (Graphics Extension ROM) provides extra graphics functions which can be accessed by use of the ASCII control (**VDU**) commands (see section **3.3-ASCII Control (VDU) commands**). By using these extra commands complex graphics output such as circles, arcs, segements and sectors can be drawn with minimum programming effort. A number of shape fill commands are also available which allow easy fills of rectangles, parallelograms, circles, segments and sectors. The style of fill can be varied, to produce many different shading patterns, by changing the shading parameters.

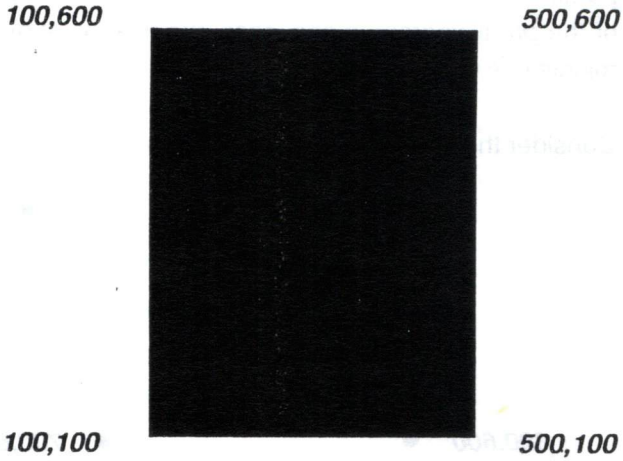
To access these commands the **VDU 25,K,Xl,Xh,Yl,Yh** must be used. The values of **K** are divided into groups of eight **PLOT** codes which have the following effects on PLOTMATE :-

PLOT Code	Function
96-103	Rectangle fill.
112-119	Parallelogram fill.
144-151	Circle outline.
152-159	Circle fill.
160-167	Circular arc.
168-175	Circular segment.
176-183	Circular sector.

Table.12. PLOT Codes.

Plot Code 96-103 - Rectangle Fill.

Consider the following solid rectangle :-



This rectangle can be plotted by use of the following **VDU** commands :-

25,4,0,100,0,100 {Bottom left corner}
25,101,245,1,90,2 {Top right corner}

or:-

25,4,100,0,90,2 {Top left corner}
25,101,245,1,100,0 {Bottom right corner}

Plot Code 112-119 - Parallelogram Fill.

To plot a parallelogram three corner points must be defined. The order in which these are given affects which way round the parallelogram appears. Points are taken as moving around the edge of the parallelogram in sequence, the final point being opposite the middle one defined.

Consider the three points given below :-

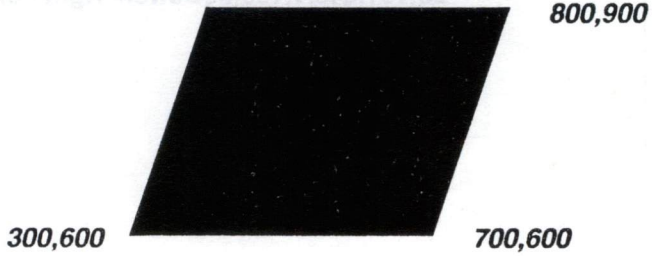
Using the following commands different parallelograms can be drawn around the three points :-

1)

25,4,45,1,90,2 {Bottom left corner}
25,4,190,2,90,2 {Bottom right corner}
25,117,35,3,135,3 {Top right corner}

or:-

25,4,35,3,135,3 {Top right corner}
25,4.190,2,90,2 {Bottom right corner}
25,117,45,1,90,2 {Bottom left corner}

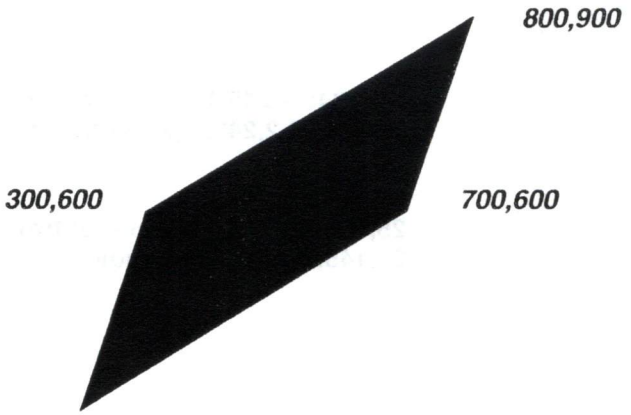


2)

```
25,4,45,1,90,2 {Top left corner}
25,4,35,3,135,3 {Top right corner}
25,117,190,2,90,2 {REM Bottom right}
```

or:-

```
25,4,190,2,90,2 {Bottom right corner}
25,4,35,3,135,3 {Top right corner}
25,117,45,1,90,2 {Top left corner}
```

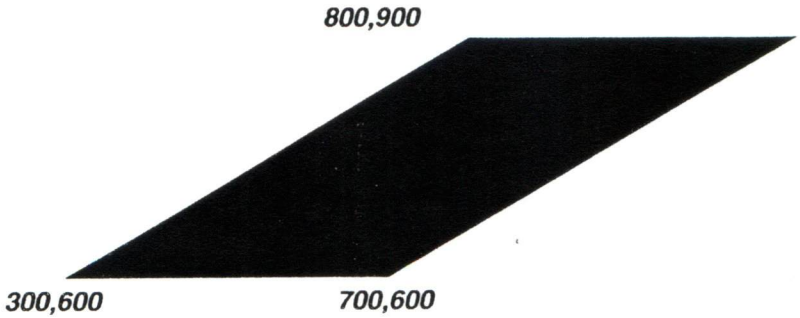


3)

```
25,4,190,2,90,2 {Top left corner}
25,4,45,1,90,2 {Bottom left corner}
25,117,35,3,135,3 {Top left corner}
```

or:-

```
25,4,35,3,135,3 {Top left corner}
25,4,45,1,90,2 {Bottom left corner}
25,117,190,2,90,2 {Bottom right corner}
```



Plot Code 144-151 - Circle Outline.

Circles can be defined by two points, its centre and a point on the X-axis which represents the radius.

To plot a circle centred at point 500,500 with a radius of 100, the following commands can be used :-

25,4,245,1,245,1 {Circle centre}
25,149,90,2,245,1 {X-centre + radius, Arbitrary Y co-ord}

or:-

25,4,245,1,245,1 {Circle centre}
25,145,100,0,245,1 {Radius, Arbitrary Y co-ord}

Plot Code 152-159 - Circle Fill.

Circle fills can be drawn in a similar way to circle outlines. To draw a filled circle centred at 500,500 and with a radius of 100, the following commands can be used :-

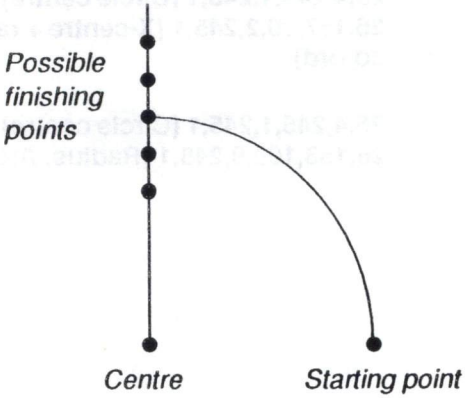
25,4,245,1,245,1 {Circle centre}
25,157,90,2,245,1 {X-centre + radius, Arbitrary Y co-ord}

or:-

25,4,245,1,245,1 {Circle centre}
25,153,100,0,245,1 {Radius, Arbitrary Y co-ord}

Plot Code 160-167 - Circular Arc.

To draw a circular arc three points need to be defined. These are the centre of the circle and two points indicating the starting and finishing points of the arc. The starting point must be somewhere on the circumference, the finishing point is used just to indicate the angle of the arc.



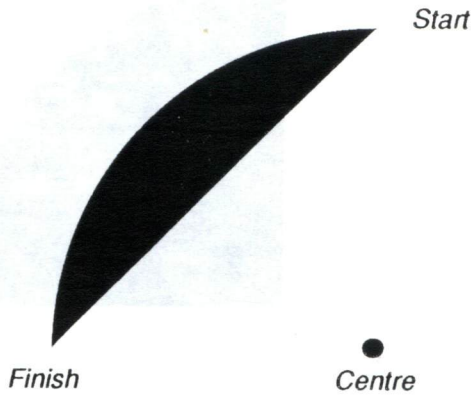
All arcs are drawn in an anti-clockwise direction.

The following commands will draw an arc based on a circle centre which is at 500,500 whose radius is 100. A portion of the arc from 0 to 90 degrees will be drawn :-

```
25,4,245,1,245,1 {Circle centre}
25,4,90,2,245,1 {Starting point}
25,165,245,1,235,3 {Finishing point}
```

Plot Code 168 - 175 Circular Segment.

Segments are defined in the same way as arcs.

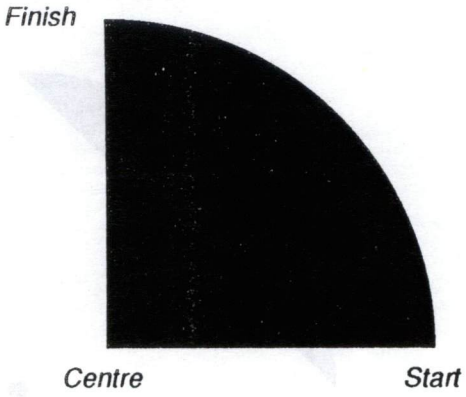


The following example will draw a segment centred at 500,500 with a radius of 100 and has an arc portion between 90 to 180 degrees :-

25,4,245,1,245,1 {Circle centre}
25,4,245,1,90,2 {Starting point}
25,173,0,0,245,1 {Finishing point}

Plot Code 176-183 - Circular Sector.

Sectors are defined in the same way as arcs.



The following commands will plot a 90 degree sector centred at 500,500 with a radius of 100 :-

25,4,245,1245,1 {Circle centre}
25,4,90, 2,245,1 {Starting point}
25,181,245,1,235,3 {Finishing point}

3.4.2.GXR Shading

Shading patterns are made up of two sets of parallel lines that intersect each other. Line spacing can be defined using **VDU 1,32+n** and **VDU 1,64+n** commands where **n** lies in the range 0-31. The table below shows how **n** changes the spacing :-

Value of **n**	Line Spacing
0	Solid fill .3mm spacing
1	.3+(1*.3)mm=.6mm
2	.3+(2*.3)mm=.9mm
.	.
.	.
.	.
n	.3+(**n***.3)mm
.	.
.	.
.	.
31	No fill

Table.13. GXR Shading Parameters.

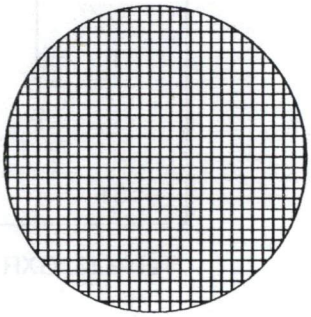
Circular Shading

When a circle fill, circular segment or circular sector is plotted, the commands **VDU 1,32+n** changes the vertical line spacing and **VDU 1,64+n** the horizontal line spacing.

Examples :-

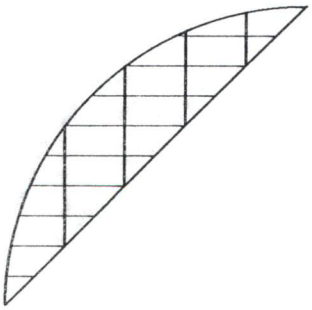
1)

```
1,35 { Vertical line spacing = 1.2mm}
1,67 {Horzontal line spacing = 1.2mm}
25,4,245,1,245,1 {Circle centre}
25,157,90,2,245,1 {X-centre + radius, Arbitrary Y
co-ord}
```



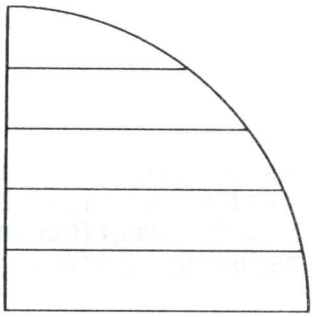
2)

```
1,52 {Vertical line spacing = 6.3mm}
1,74 {Horizontal line spacing = 3.3mm}
25,4,245,1,245,1 {Centre}
25,4,245,1,140,2 {Starting point}
25,173,0,0,245,1 {Finishing point of segment}
```



3)

1,63 {No vertical fill}
1,82 {Horzontal spacing = 5.7mm}
25,4,245,1,245,1 {Centre}
25,4,140,2,245,1 {Starting point}
25,181,245,1,235,3 {Finishing point of sector}



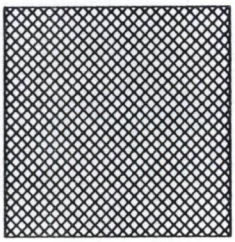
Rectangle Shading.

Rectangles are filled by parallel 45 degree lines. **VDU 1,32+n** defines the vertical line spacing of lines sloping upwards to the right. **VDU 1,64+n** defines spacing of lines sloping upwards to the left.

Examples :-

1)

1,35 {Line spacing = 1.2mm}
1,67 {Line spacing = 1.2mm}
25,4,245,1,245,1 {Bottom left corner}
25,101,90,2,90,2 {Top right corner of rectangle}

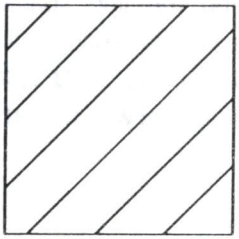


2)

1,46 {Line spacing = 4.5mm}
1,71 {Line spacing = 2.4mm}
25,4,245,1,245,1 {Bottom left corner}
25,101,90,2,90,2 {Top right corner of rectangle}

3)

1,50 {Line spacing = 5.7mm}
1,95 {No fill}
25,4,245,1,245,1 {Bottom left corner}
25,101,90,2,90,2 {Top right corner of rectangle}



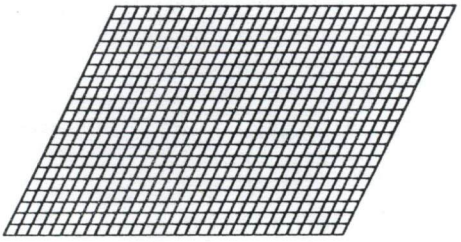
Parallelogram Shading.

Parallelograms are filled by lines running parallel to the edges. The type of shading pattern depends on the way in which the parallelogram and the line spacing parameters are used. **VDU 1,32+n** sets the vertical spacing for lines running parallel with the edge that is defined first. **VDU 1,64+n** defines the vertical spacing for lines running parallel with the other edge.

Examples :-

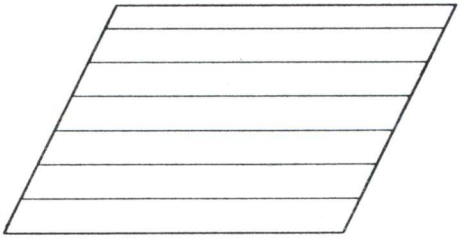
1)

```
1,35 {Line spacing = 1.2mm}
1,67 {Line spacing = 1.2mm}
25,4,45,1,90,2 {Bottom left corner}
25,4,190,2,90,2 {Bottom right corner}
25,117,35,3,135,3 {Top right corner}
```



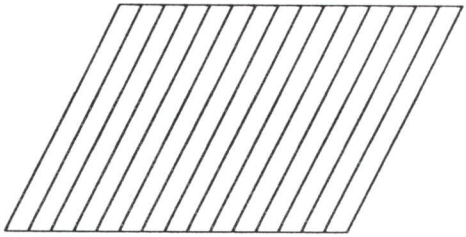
2)

```
1,40 {Line spacing = 2.7mm}
1,95 {No fill}
25,4,45,1,90,2 {Bottom left corner}
25,4,190,2,90,2 {Bottom right corner}
25,117,35,3,135,3 {Top right corner}
```



3)

1,40 {Line spacing = 2.7mm}
1,95 {No fill}
25,4,35,3,135,3 {Top right corner}
25,4,190,2,90,2 {Bottom right corner}
25,117,45,1,90,2 {Bottom left corner}



NOTES

4.The Plotter Emulators

4.1.Installing Emulators

The PLOTMATE M plotter comes with two plotter emulators already installed which allow the commands and functions of the Graphtec WX4671 and Sweet-P plotters to be imitated. These emulators can be used to make interfacing with many available graphics software packages.

Hewlett Packard HP7470A and HP7475A (HP-GL) emulators are available from Linear Graphics Limited. These are supplied on ROMs which can be fitted into spare sockets inside PLOTMATE.

To access the emulators they must be selected by setting option switches 5,6 and 7 to one of the settings shown below :-

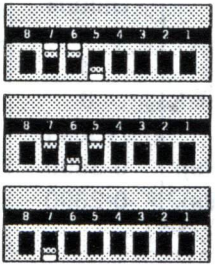
Switch Setting	Emulator Selected
	Graphtec WX4671 Sweet-P Expansion (e.g. HP-GL)

Table.14. Emulator Switch Settings.

4.2. The Graphtec WX4671 Emulator

The Graphtec WX4671 plotter emulator has eight commands relating to vectors, and four relating to characters. Each command is identified by a command code, which is a single uppercase letter. The command code is followed by optional parameters; these are numerical values, except when specifying a character string to be plotted with a **PRINT** command.

Even if they lay far outside the current plotting window, all X,Y co-ordinates should be less than +/- 32,767.

All parameters are separated by commas, and the terminator for each command may be any of ASCII codes 0 to 13, including **Line-Feed** (10) and **Carriage Return** (13).

After a reset function, the emulator is pre-programmed with default values for certain commands. These default values are given below and can be changed by using the commands provided.

Parameter Type	Default	Range
Character Size.	3	0-15
Character orientation.	0	0-3
Line Type.	0 (Solid)	0-1
X-Axis Range (Plotter Units).	0-3600	-
Y-Axis Range (Plotter Units).	0-2600	-

Table.15. Graphtec Default Values.

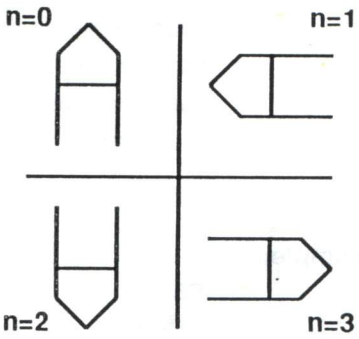
ALPHA ROTATE (Q)

Syntax:

Qn(Terminator)

Function:

The orientation of characters is specified by **n**, which must be an integer in the range 0 to 3.



Once specified the character orientation is constant until reset. After reset the setting **n**=0 is always assumed.

Example:

Q1
PHello

The text, **Hello**, is drawn along the Y-axis.

ALPHA SCALE (S)

Syntax:

Sn(Terminator)

Function:

Specifies the size of plotted characters and marks. **n** is an integer in the range 0 to 15 which sets the new size. Once specified, the character size remains the same until reset. Initially, after reset, the setting **n**=3 is assumed.

Example:

```
S5
PHello
```

The text, **Hello**, is drawn at 4 times the basic size.

AXIS (X)

Syntax:

Xp,q,r(Terminator)

Function:

Draws an X or Y-axis with tick marks.

p=0 specifies a Y-axis, and **p**=1 specifies an X-axis. A segment of length **q** is drawn, and then a tick mark; this is repeated **r** times.

Example:

X1,50,5

Draws a line 250 units in length along the positive X-axis from the current pen position. Tick marks are drawn at 50 unit intervals along this line.

DRAW (D)

Syntax:

Dx1,y1,x2,y2...xn,yn(Terminator)

Function:

If (x0,y0) is the present position, draws a series of vectors :-

(x0,y0) » **(x1,y1)** » **(x2,y2)** » ... » **(xn,yn)**

All points are specified in absolute co-ordinates by up to 4-digit (decimal) integers.

Example:

D500,500

Lowered pen draws a straight line from its current position to point (500,500).

HOME (H)

Syntax:

H(Terminator)

Function:

Moves the pen to the **home** position (bottom left corner of plotting area).

LINE SCALE (B)

Syntax:

BI(Terminator)

Function:

Specifies the pitch of a broken line.

Different types of broken line will be selected for different values of **I**, which must not be greater than 127. Once specified the setting holds until reset. Default value =1.

LINE TYPE (L)

Syntax:

Lp(Terminator)

Function:

Sets type of line for drawing vectors.

p=0 indicates a solid line, and **p**=1 indicates a broken line. Once specified, the same line type is maintained until reset. After a system reset, the solid line setting is always assumed. This setting affects the **DRAW (D)** and **RELATIVE DRAW (I)** commands.

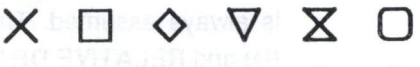
MARK (N)

Syntax:

Nn(Terminator)

Function:

Draws the special symbol (mark) specified by **n**, which is an integer from 1 to 6.



Example:

N3

Draws symbol ◇ around the current pen position.

MOVE (M)

Syntax:

Mx,y(Terminator)

Function:

Moves with the pen lifted off the paper to position (**x**,**y**) in absolute co-ordinates. If a series of points **x1,y1,x2,y2,...xn,yn** are specified as for the DRAW command, the pen performs the same movement with the pen raised.

Example:

M500,500

Raised pen moves from its current position to point (500,500).

PRINT (P)

Syntax:

P,c1 c2 c3...cn(Terminator)

Function:

The character string **c1 c2 c3...cn** is drawn.

ASCII codes, other than 0 to 13, which do not plot into printable characters are ignored. Spaces, however, are left blank in the normal way.

Example:

PHello

Draws text, **Hello**, starting at the current pen position.

RELATIVE DRAW (I)

Syntax:

Ix1,y1,x2,y2...xn,yn(Terminator)

Function:

If (x0,y0) is the present position, draws a series of vectors :-

(x0,y0) » (x0+**x1**,y0+**y1**) » (x0+**x1**+**x2**,y0+**y1**+**y2**) » (x0+**x1**+**x2**+...**xn**,y0+**y1**+**y2**+...**yn**)

In other words, the parameters specify the increments for each vector rather than absolute co-ordinates.

Example:

I20,-20

Lowered pen draws a line from its current position to a point that is 20 units to the right and 20 units down.

RELATIVE MOVE (R)

Syntax:

Rx,y(Terminator)

Function:

Moves with pen lifted off the paper from present position (x0,y0) to (x0+**x**,y0+**y**). As for **RELATIVE DRAW**, a series of increments may be specified.

Example:

R20,-20

Raised pen moves from its current position to point that is 20 units to the right and 20 units down.

VDU FUNCTION (V)

Syntax:

Va,b....(Terminator)

Function:

Provides access to ASCII control codes graphics commands, as implemented by Acorn and Linear Graphics Limited. (See Section **3.3-ASCII Control Code (VDU) Commands**).

Example:

V1,11

PLOTMATE will perform a reset function.

Graphtec WX4671 Example Program.

The following example, which is written in BASIC, assumes that the PLOTMATE system is connected to an IBM Personal Computer parallel Centronics printer interface. The **LPRINT** statement is the same as that required for sending data to a printer.

```
10 REM * DRAW X AND Y AXIS *
20 LPRINT "M500,500"
30 LPRINT "X1,250,4"
40 LPRINT "M500,500"
50 LPRINT "X0,250,4"
60 REM * LABEL X AXIS *
70 LPRINT "Q0"
80 LPRINT "S4"
90 LPRINT "M730,420"
100 LPRINT "P83"
110 LPRINT "M980,420"
120 LPRINT "P84"
130 LPRINT "M1230,420"
140 LPRINT "P85"
150 LPRINT "M1480,420"
160 LPRINT "P86"
170 LPRINT "M910,350"
180 LPRINT "S5"
190 LPRINT "PYEAR"
200 REM * LABEL Y AXIS *
210 LPRINT "S4"
220 LPRINT "M420,760"
230 LPRINT "P1"
240 LPRINT "M420,1010"
250 LPRINT "P2"
260 LPRINT "M420 1260"
270 LPRINT "P3"
280 LPRINT "M420,1510"
290 LPRINT "P4"
300 LPRINT "M330,690"
310 LPRINT "Q1"
320 LPRINT "S5"
330 LPRINT "PPOUNDS (100,000)"
```

```
40 REM * STARTING POINT OF GRAPH *
350 LPRINT "M500,500"
360 YR=1983:SO=0
370 CLS:REM * CLEARS SCREEN *
380 FOR X=350 TO 1100 STEP 250
390 PRINT "ENTER SALES FOR";YR;"(I.e.12500)"
400 INPUT S1
410 IF S1=0 AND S1=400000 THEN GOTO 450
420 PRINT "ANSWER MUST BE BETWEEN 0
AND 400000"
430 PRINT "FOR NEGATIVE NUMBERS INPUT 0"
440 GOTO 390
450 REM * CONVERT SALES FIGURES TO *
460 REM * POINTS ON GRAPH *
470 S1=(S1/100000)*250
480 REM * MAKE SURE THAT PARAMETERS *
490 REM * ARE OF TYPE INTEGER *
500 S1=INT(S1)
510 REM * FIND DIFFERENCE IN THE Y AXIS *
520 REM * FROM LAST POINT AND CURRENT
POINT *
530 S=S1-SO
540 YR=YR+1:SO=S1
550 LPRINT "I";250;",";S
560 NEXT X
570 LPRINT "M0,0"
580 END
```

4.3.The Sweet-P Plotter Emulator

The Sweet-P emulator commands are entered by typing two-letter command symbols, followed either by lengths or X,Y co-ordinates (in plotter units) or by text (e.g. alphanumeric characters).mand is finished. For example, in making the **Move Absolute** command, type :-

MA x,y; (e.g. MA 500,500;)

When carrying out a series of similar operations, (e.g. **Draw Absolute**, **Move Absolute**, **Draw Relative**, **Move Relative**, **Point** and **Line**), there is no need to enter separate command lines. Just one command need be entered, followed by the plotter co-ordinates in the order required. Each set of numbers should be separated with a comma and a semi-colon entered when the series is complete. For example, in drawing a series of lines from point to point using the **Draw Absolute** command, type :-

DA x1,y1,x2,y2,x3,y3...xn,yn;

The Sweet-P emulator is pre-programmed with default values for certain commands. These default values are shown in the table below and can be changed by using various commands provided :-

Parameter Type	Default	Range
Character Size	1 (20 plotter units high)	1-255
Character Rotation	0 (characters upright)	0,90,180,270
Pen Speed	15	0-15
Text Delimiter	;	-
X-Range	0-2500 plotter units	-
Y-Range	0-1838 plotter units	-

Table.16. Sweet-P Default Values.

AXIS X (AX)

Syntax:

AX n,ts,t1;

Function:

Draws a line along the positive X-axis with ticks spaced at a specified distance. Since the line is drawn from the current pen position, the pen should first be moved to the start point using the proper command (e.g. **Home** or **Move Absolute**).

n — The length of the X-axis in plotter units. (Min=1, Max=32,767)

ts — The distance between ticks in plotter units. (Min=1, Max=32,767)

t1 — Length of ticks in plotter units. (Min=1, Max=255)

Example:

AX 1000,100,20;

Draws a line 1000 units in length along the positive X-axis from the current pen position. Ticks are at 100 unit intervals and are 20 units long.

AXIS Y (AY)

Syntax:

AY n,ts,t1;

Function:

Draws a line along the positive Y-axis with ticks spaced at a specified distance. Since the line is drawn from the current pen position, the pen should first be moved to the start point using the proper command (e.g. **Home** or **Move Absolute**).

n — The length of the X-axis in plotter units. (Min=1, Max=32,767)

ts — The distance between ticks in plotter units. (Min=1, Max=32,767)

t1 — Length of ticks in plotter units. (Min=1, Max=255)

Example:

AY 1000,100,20;

Draws a line along the positive Y-axis from the current pen position. Line is 1000 units long with ticks at 100 unit intervals that are 20 units long.

CHARACTER SIZE (CS)

Syntax:

CS n;

Function:

Specifies the size of the alphanumeric characters to be drawn. The basic size is 1 (20 plotter units high and 12 to 16 units wide). Spaces between characters vary from 10 to 6 units, depending on the character width (i.e. to produce a total character cell width of 22 units). The maximum character height is 255 (5100 plotter units high). A character this size would exceed the plotting range and lay partly outside the current plotting window.

Example:

```
CS5;
TX 'Sweet-P';
```

The text, **Sweet-P**, is drawn at a height 5 times the basic character size.

DRAW ABSOLUTE (DA)

Syntax:

DA x,y;

Function:

Draws a straight line to a specified point.

Example:

DA 500,500;

Lowered pen draws a straight line from its current position to point (500,500).

DRAW RELATIVE (DR)

Syntax:

DR x,y;

Function:

Moves the lowered pen from its current position to another point in a straight line, according to the number of units specified. Positive numbers will move the pen to the right along the X-axis and up the Y-axis. Negative numbers will move the pen left along the X-axis and down the Y-axis.

Example:

DR 20,-20;

Lowered pen draws a line from its current position to a point that is 20 units to the right and 20 units down.

HOME (HO)

Syntax:

HO;

Function:

Returns pen to home position (0,0) at lower left corner of the plotting area.

LINE (LN)

Syntax:

LN x1,y1,x2,y2;

Function:

Draws a straight line between two sets of co-ordinates.

Examples:

LN 20,30,200,300;

A line is drawn from point (20,30) to point (200,300).

LN 20,30,200,300,44,80,76,503;

A line is drawn from point (20,30) to point (200,300) and another is drawn from point (44,80) to point (76,503).

MARK (MK)

Syntax:

MK '<Character>';

Function:

Draws a specified character around the current pen position. Similar to the **TX** command, except that the pen return to the original co-ordinate position after drawing the character. This command is useful for labelling points on a graph. Like **TX**, **MK** uses text delimiters to indicate the character to be drawn.

Example:

MK 'A';

Draws the character **A** around the current pen position.

MOVE ABSOLUTE (MA)

Syntax:

MA x,y;

Function:

Moves raised pen to the specified X,Y co-ordinates.

Example:

MA 500,500;

Raised pen moves from its current position to point (500,500).

MOVE RELATIVE (MR)

Syntax:

MR x,y;

Function:

Moves raised pen from its current position to another point according to the amount of units specified. Positive numbers will move the pen to the right along the X-axis and up the Y-axis. Negative numbers will move the pen to the left along the X-axis and down the Y-axis.

Example:

MR 20,-20;

Raised pen moves from its current position to a point that is 20 units to the right and 20 units down.

PEN DOWN (PD)

Syntax:

PD;

Function:

Lowers pen onto paper.

PEN UP (PU)

Syntax:

PU;

Function:

Raises pen from paper.

POINT (PT)

Syntax:

PT x,y;

Function:

Moves the pen to a specified position and marks the point with a single dot.

Example:

PT 600,600;

Pen moves to (600,600) and makes a dot.

RESET (RE)

Syntax:

RE;

Function:

Resets plotter and returns all command settings to default values.

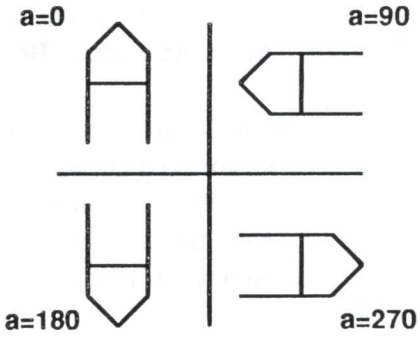
ROTATION (RO)

Syntax:

RO a;

Function:

Sets the angle at which the alphanumeric characters are to be drawn. There are four settings which correspond to four values of **a** :-



Example:

```
RO 90;
TX 'Sweet-P';
```

The text, **Sweet-P**, is drawn upright on the Y-axis.

TEXT (TX)

Syntax:

TX ;a,b,c,d...n;

Function:

Draws alphanumeric characters (numerals, letters, punctuations, Symbols i.e. ASCII codes 32 to 241) at the current pen position. If text is required at a specified position, the pen must first be moved to that position using the proper command. [i.e. **Move Absolute** or **Move Relative**].

The characters to be plotted are indicated by enclosing them within text delimiters. The default text delimiter is a semicolon (;). A different text delimiter can be chosen by using the **Text Delimiter** command (**TD**), which is explained next.

Example:

TX ;Sweet-P;

Draws, **Sweet-P**, starting at the current pen position.

TEXT DELIMITER (TD)

Syntax:

TD c;

Function:

Changes the text delimiter.

When entering this command, the character immediately following **TD** becomes the text delimiter. If a space is placed after **TD**, then a space becomes the text delimiter.

Example:

TD';

The single quote (') becomes the new text delimiter. Using the example from the **Text (TD)** command the following would be entered.

TX 'Sweet-P';

VELOCITY SETTING (VS)

Syntax:

VS n;

Function:

Changes pen speed. Speed settings range from 0 to 15, where 0 is the slowest and 15 is the fastest.

Example:

VS 0;

The slowest pen speed is set.

VDU FUNCTION (VU)

Syntax:

VU a,b....;

Function:

Provides access to the ASCII control code graphics commands, as implemented by Acorn Computers Limited and Linear Graphics Limited. (See **3.3-ASCII Control Code (VDU) Commands**).

Example:

VU 1,11;

will cause PLOTMATE to perform a reset function.

Sweet-P Example Program.

The following example, which is written in BASIC, assumes that the PLOTMATE system is connected to an IBM Personal Computer parallel Centronics printer interface. The **LPRINT** statement is the same as that required for sending data to a printer :-

```
10 REM * DRAW X AND Y AXIS *
20 LPRINT "MA 500,500;AX 1000,250,100;"
30 LPRINT "MA 500,500;AY 1000,250,100;"
40 REM * LABEL X AXIS *
50 LPRINT "RO 0;CS 1; MA 730,420;TX;83;"
55 LPRINT "MA 980,420;TX;84;"
60 LPRINT "MA 1230,420;TX;85;"
65 LPRINT "MA 1480,420;TX;86;"
70 LPRINT "MA 910,350;CS 2;TX;YEAR;"
80 REM * LABEL Y AXIS *
90 LPRINT "CS 1;MA 420,735;TX;1;"
95 LPRINT "MA 420,985;TX;2;"
100 LPRINT "MA 420,1235;TX;3;"
105 LPRINT "MA 420,1485;TX;4;"
110 LPRINT "MA 350,690;"
115 LPRINT "RO 90;CS 2;TX;POUNDS (100,000);"
120 REM * STARTING POINT OF GRAPH *
130 LPRINT "MA 500,500;"
140 YR=1983:SO=0
150 CLS:REM * CLEARS SCREEN *
160 FOR X=350 TO 1100 STEP 250
170 PRINT "ENTER SALES FOR ";YR;" (i.e.
12500)";
180 INPUT S1
190 IF S1=0 AND S1=400000 THEN GOTO 230
200 PRINT "KEEP ANSWER  BETWEEN
0-400000"
210 PRINT "FOR NEGATIVE NUMBERS INPUT 0"
220 GOTO170
230 REM * CONVERT SALES FIGURES TO *
240 REM * POINTS ON GRAPH *
250 S1=(S1/100000)*250
260 REM * MAKE SURE THAT PARAMETERS *
```

```
270 REM * ARE OF TYPE INTEGER *
280 S1=INT(S1)
290 REM * FIND DIFFERENCE IN Y AXIS FROM *
300 REM * LAST POINT AND CURRENT POINT *
310 S=S1-SO
320 YR=YR+1:SO=S1
330 LPRINT "DR";250;",";S;";"
340 LPRINT "MA 0,0;"
350 NEXT X
360 END
```

4.4.Expansion

The PLOTMATE M intelligent interface board contains one spare ROM socket (of 8 K bytes capacity) and one spare RAM socket (of 4K bytes capacity) which allow the language and graphics facilities to be expanded.

Expansion kits can be supplied by Linear Graphics Limited as and when they become available.

5.Care and Maintenance

CAUTION

- **Always make sure that PLOTMATE M is disconnected from the mains supply before carrying out any form of maintenance.**
- **When the system is not in use, it should be stored in a clean dry place, preferably under the dust cover that is supplied.**

5.1.Looking After PLOTMATE

PLOTMATE M requires very little attention. Periodically the outsides of each unit should be cleaned with a slightly damp cloth. A weak detergent solution on the cloth may be used to remove ink and grease marks from the PLOTMATE drawing surface. Never use strong solvents when cleaning as they can sometimes damage, or even remove, the paint. Between cleaning a light dusting is sufficient. It is not necessary to remove any covers when cleaning.

The X and Y axis guides and bearings should not be cleaned or allowed to get wet. These parts are self-lubricating and could malfunction if an attempt is made to clean them.

No other maintenance should be attempted. If the system needs servicing, contact the nearest PLOTMATE service centre.

NOTES

6.Troubleshooting

6.1.System Self-test

Pressing the  keys when the system is off-line initiates a test plot, to confirm that the system is operating correctly. Paper and pen should be loaded before this test is started.

6.2.Common Problems

Should the plotter system not perform correctly check the following table for some possible causes and solutions. If the malfunction is not easily rectified refer faulty unit to a PLOTMATE service centre or dealer.

Symptoms	Probable cause and solution
PLOTMATE pen will not move after system is powered up.	Mains to PLOTMATE not switched on. Connection lead not fully pressed home into sockets. Press connection lead home into sockets and try again. Power fuse blown. The power fuse is located near the mains cable at the rear of PLOTMATE. Check fuse and replace with a 500mA **slo-blow** fuse if neccessary. If the fuse blows again, refer the unit to a PLOTMATE service centre.

Symptoms	Probable cause and solution
PLOTMATE pen will not move after system is powered up.	Check for any transit damage. If the unit is damaged refer it to a PLOTMATE service centre. Check that the transit screw has been removed from the back of the unit. Check that the option switches are **NOT** set for **Direct-Drive**.
PLOTMATE pen vibrates or does not reset correctly after power up.	Connection lead either faulty or not properly located in sockets. Press connection lead home into sockets and try again.
Plots appear to have random shifts in X,Y values.	Check X and Y guides for obstructions.
Pen fails to draw on the paper when it is lowered.	Pen worn or empty. Check pen for worn tip or depleted ink supply and replace if neccessary.
Part of a plot gets drawn but system stops with pen up.	Programming error due to incorrect parameters in a command or plotting out of current window. Check for program error.

Symptoms	Probable cause and solution
Draws random lines and characters.	Programming error due to incorrect parameters in a command. Check program for error.
Plot is complete but wrong size or offset.	Window size and origin positions are incorrectly set. These factors are retained by the system until changed or the system reset: Change window size and origin or reset system and try again.

NOTES

7.Quick Reference Guide

7.1.ASCII Control Code (VDU) Commands

VDU 1,2 . . . . . .Off-line PLOTMATE M.

VDU 1,6 . . . . . .Pen up.

VDU 1,7 . . . . . .Pen down.

VDU 1,11 . . . . . .Reset system to default values.

VDU 1,16 . . . . . .Pen home.

VDU 1,17 . . . . . .Pen park.

VDU 1,18 . . . . . .Self test.

VDU 1,19 . . . . . .Draw or trace border.

VDU 1,20 . . . . . .Give Control to expansion language.

VDU 1,N . . . . . .Pen response and GXR shading.
N=32 to 63 - Vertical shading.
N=64 to 95 - Horizontal shading.
N=128 to 255 - Pen response time.

VDU 4 . . . . . .Disable text output.

VDU 5 . . . . . .Enable text output.

VDU 8 . . . . . .Backspace.

VDU 13 . . . . . .Line-feed and carriage return.

VDU 18,N,C . . . . . Pause to change pen (e.g. colour).

VDU 23,255,CH,CW,CS,CO,PS,SF,SH,SC . . . . . .Change parameters.

		Default	Range
CH	Character height	3	1-255
CW	Character width	5	1-255
CS	Character slant	1	1-4
CO	Character orientation	1	1-4
PS	Pen speed	10	1-10
SF	Special function	7	1-9
SH	Shading and broken line	1	1-255
SC	Scale	120	1-255

VDU 24,Xminl,Xminh,Yminl,Yminh,Xmaxl,Xmaxh,Ymaxl,Ymaxh
- Block fill and plotting window size.

VDU 25,K,Xl,Xh,Yl,Yh . . . . . Multi-purpose plotting command.

VDU 26 . . . . . Reset plotting window size.

VDU 29,Xl,Xh,Yl,Yh . . . . . Re-origin PLOTMATE.

7.2.Graphtec WX4671 Plotter Emulator

B - LINE SCALE . . . . . .Specify broken line type.

D - DRAW . . . . . .Draw line to absolute co-ordinates.

H - HOME . . . . . .Return to origin with the pen up.

I - RELATIVE DRAW . . . . .Draw line to relative co-ordinates.

L - LINE TYPE . . . . . .Specify solid or broken line drawing.

M - MOVE . . . . . .Move pen to absolute co-ordinates.

N - MARK . . . . . .Draw mark character at pen position.

P - PRINT . . . . . .Draws ASCII code characters.

Q - ALPHAROTATE . . . . . .Specify character orientation.

R - RELATIVE MOVE . . . . .Move pen to relative co-ordinates.

S - ALPHA SCALE . . . . . .Specify character size.

V - VDU . . . . . .Access **VDU** graphics commands.

X - AXIS . . . . . .Draw X- or Y-axis.

7.3.Sweet-P Plotter Emulator Commands

AX - Axis-X ..... Draws X-axis.

AY - Axis-Y ..... Draws Y-axis.

CS - Character Size ..... Defines new character size.

DA - Draw Absolute ..... Draws line to absolute co-ordinates.

DR - Draw Relative ..... Draws line to relative co-ordinates.

HO - Home ..... Move pen to **home** position.

LN - Line ..... Draws a line between two co-ordinates.

MK - Mark ..... Plots character at current pen position.

MA - Move Absolute ..... Moves pen to absolute co-ordinate.

MR - Move Relative ..... Moves pen to relative co-ordinate.

PD - Pen Down ..... Lowers pen.

PU - Pen Up ..... Raises pen.

PT - Point ..... Places a dot at specified co-ordinate.

RE - Reset ..... Resets plotter & sets default parameters.

RO - Rotate ..... Rotates character.

TX - Text ..... Draws ASCII characters at pen position.

TD - Text Delimiter ..... Enters new text delimiter.

VS - Velocity Setting ..... Defines new pen speed.

VU - VDU ..... Access **VDU** graphics commands.

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