



NOVACAD

A Computer Aided Draughting System
for the BBC Microcomputer
User Manual

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In this manual the pronoun "he" has been used to refer to the user. The authors would like to make it clear that this is not intended to denote a male, but is merely for the greater legibility of the text. It is our belief that male and female users are equally well able to operate both this CAD system and computers in general.

Any comments or suggestions regarding this software should be sent to: TECHNOMATIC LTD., 17 Burnley Road, LONDON NW10 1ED.

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1 INTRODUCTION:

What is a CAD draughting system?

The easiest way to describe a draughting system is to compare it to using a drawing board. Think about what happens when you prepare a drawing?

First you draw a rough sketch on the board with a light pencil so that it can be 'edited'. You then edit it by changing details, lengths of lines, angles, perhaps repositioning some sections and adding some refinements. All these functions will be carried out by rubbing out the unwanted sections and redrawing them. If there are too many changes to be made you, might have to start all over again!

After that you will redraw the whole drawing with a heavier pencil or in ink and have your master copy. If you need extra copies of the drawing you will have your original sent for printing. If at any stage the details on the original drawings change, you will have to repeat the whole procedure again!

With a computer aided draughting system, you will prepare your sketch on the screen, edit the details as required and produce a final drawing. If you make a mistake, it can be corrected quite easily by deleting the section concerned, while leaving no trace behind of the error. If you want to see what an amended section of the drawing would look like whilst also retaining the original so that it can be used if the amendment is not quite right, that section can be saved on a disc for later retrieval or deletion.

When you have produced your final drawing, it can be saved on disc and as many copies as required can be produced on a printer or a plotter. If any amendment to the original drawing has to be made that can be done equally easily. Individual drawings with minor changes to details can be produced with ease and accuracy.

All drawings make repeated use of some common shapes (ICONS) like nuts, bolts, pipe joints, transistors etc. In conventional drawings one would normally use 'LETRASET' or some similar draughting aid for implementing such shapes. However, the ready made aid may not be to the correct scale or quite what is required. On a good CAD system, such shapes can be saved as icons and used as many times as required, and their scales, details etc. can be altered at will.

NOVACAD CAD package

The NOVACAD package is designed to do all that is described above and much more.

It will allow both experienced and amateur draughtsman to quickly and simply produce circuit diagrams, design simple pcb's, draw house plans, in fact design and draw almost anything in two dimensions. Some familiarity with the BBC disc system and keyboard will make the use of NOVACAD very simple and enjoyable.

The NOVACAD package comprises of:

- *A 16K byte EPROM containing the main program
- *A disc containing the utilities used by the main program.
- *A User Manual
- *A Registration Card
- *A Rom Installation Instruction Leaflet

The minimum hardware required to use the system is:

- * A EEC model B fitted with Acorn DFS.
- * A single 40 track single sided disc drive.
- * An Epson compatible dot matrix printer.

With this minimum configuration, drawings with two colours (ie background and foreground) are easily produced in mode four. Adding a 6502 second processor will allow the diagrams to be created in mode 0, 1 or 4, with four colours available in mode 1. Its additional processing power and memory will allow faster drawing speed and larger diagrams. The BEG B-PLUS will provide similar enhancements with certain limitations (listed elsewhere in the manual). Use of double sided and dual drives will make the system more convenient to use.

This manual has been written with both new and experienced users in mind. The chapters which deal with the use of the system have been written in tutorial style and might appear long winded to the experienced users. For this purpose, a brief summary of all commands has been given at the end so that an experienced user can get through the manual fairly quickly. It is highly recommended that a new user tries out each command as it is introduced and practices its use before proceeding further. In this way he will be able to master the use of NOVACAD most efficiently.

2 USING THE SYSTEM

2.1 OUTLINE OF THE SYSTEM

The design criteria of the NOVACAD system has been to produce a package of programs and utilities that will utilise the capacity of the BBC micro to the maximum. The main part of the program is contained in the 16K eprom. Utility programs which are required for supporting the main rom programs and some example diagrams¹ are contained on the disc.

Insert the disc in drive 0 and enter ***CAT**.

You will note that there are two sets of files. The first set will have files with names abbreviated to one or two characters and six help files. These are all utility programs and must be present on the utility disc when the NOVACAD system is being used.

The second set of files will all have a directory designation. All these files apart from two are example files and are not essential for the operation of the NOVACAD system. The two utility programs are, HOONFIG and T.HELP which are required by the system.

2.2 GETTING STARTED

You should have installed the NOVACAD rom by following the instruction sheet supplied with the package. This rom will not show itself on ***HELP** command.

First of all you must make a copy of the utility disc and put away the master disc in a safe place. Use the ***COPY n m *.*** command to make the copy where n is the source drive and m the destination drive. If you are using a single drive, these would both be 0. It is possible that you have been supplied with a dual format disc in which case it would also contain a file called DUMMY. This is just a separator file and will not be copied.

Having made your copy utility disc you are ready to start exploring the NOVACAD system. Insert the disc in drive 0 and enter ***CAD**. Note that entry of most NOVACAD commands will require you to press the **RETURN** key. To maintain clarity of text, pressing of RETURN key will not be mentioned. Where necessary return will be referred to as **<RET>** and escape as **<ESC>**. Generally, when it says 'enter', the command finished is with a **<RET>** and where it says 'type' it refers to just pressing the particular key.

The screen will clear when the command is entered and the following message will appear.

WELCOME TO NOVACAD FROM TECHNOMATIC

If you have a 6502 2nd processor or if you are using a BBC PLUS micro you will also be offered a choice to select from modes 0, 1 or 4. If not, mode 4 will be automatically selected. As modes 0 and 1 require more screen memory, they are not available for use with the standard model B. Briefly the additional features available on the three different modes are:

Mode 0	Higher resolution and pixel density, any two colours and text size as in 80 columns.
Mode 1	Standard resolution and pixel density, any four colours and text size as in forty column mode.
Mode 4	Standard resolution and pixel density, any two colours and text size as in forty column mode.

Once the mode has been selected, the screen will clear and you will be asked:

Diagram disc on drive 0 (Y/N)?

Your response to this should be **Y** or just **<RET>** which will be taken as Y. What is happening is that the program H.CONFIG which keeps tabs on the system configuration, has specified that currently all diagrams are contained on drive 0. You will be shown later on in the manual how to reconfigure the drive allocation. If you were to answer the question with **N**, you will be asked to specify the drive you wish to use. That drive will be used only for loading the diagram - any subsequent saving of a diagram will still be on drive 0. This will only change when the system is reconfigured. Once you have replied you will be asked:

Diagram name?

The program is now waiting for you to enter the name of an existing diagram that you wish to edit or a new diagram you want to create. Names must start with a letter and can be of up to seven characters long. No spaces are allowed but there is no restriction on the type of characters used after the first letter - There are two example diagrams on the disc called PCB and HOUSE. However, for the moment we need a blank screen in order to try out some of the facilities and will look at the example diagrams later on.

Enter **TEST**. The program will look on the disc for a diagram of that name but since it won't find one, you will be asked:

New diagram (Y/N) or C for Catalogue?

Entering C will give a catalogue of all files on the disc. You will note that some of the files start with directory designation X, P or D. These designations are added by the system and do not need to be entered by you, e.g. you can see that the diagram HOUSE is stored under two directories as P.HOUSE and Q.HOUSE.

The facility to catalog is incorporated at this stage to enable you to reconfirm the name of a diagram that you think exists on the disc, but is not found by the system.

At the bottom of the screen you will see the message **<RETURN> to continue** Enter **<RET>** and you will be asked again:

Diagram name?

Enter **TEST** as before, and you will again be asked:

New diagram (Y/N) or C for Catalogue?

Enter **Y** (this must be capital Y) and you will be asked on a new screen:

Function key definition file?

Your response to this should be the name of the file which associates the function keys with the icon names. There is one such file on the disc called X.GENERAL. Creation of this type of file is explained in a later section. If you reply with anything other than GENERAL you will be asked:

**The file xxxx is not on this
disc. Do you wish to leave
the function keys undefined (Y/N)?**

Entering **Y** will carry on to the next stage of the program, entering **N** will result in a request for a file name again. Enter the name **GENERAL**.

This file will then be loaded into the memory. You are now in the NOVACAD input mode. There are three lines of text at the bottom of the screen and a cross bar cursor will be drawn at the bottom left hand corner of the drawing area. The information given at the bottom of the screen will be:

903 LINES; 625 CURVES: 1161 CHARS
ZOOM OFF: WINDOW: 1,2: SCALE: 1.0
LEVELS: 0 1 2 3 4 5 6 7 COLOUR

The first line refers to the memory available for your use in terms of lines, curves and characters. Everytime a line or a curve is drawn or a character typed all the numbers will be reduced. If you have a 6502 2nd processor connected, or if you are using a BBC Plus, these numbers will be considerably larger because of the extra memory available. The memory available does not vary with the screen mode chosen.

The second line indicates that the zoom mode is off, current window coordinates, and the scale at which the icons will be drawn if called from the icon library. All this is explained later in the relevant chapters.

Line three indicates the current level (the number highlighted by reverse video) and the current foreground colour.

This mode is referred to as the drawing or input mode. The other modes are the zoom mode and the text mode which will be discussed later.

2.3 MOVING THE CURSOR

The cursor is moved about by the four cursor control keys. You will notice that the cursor moves in small jumps (each step is 6 pixels long). To position the cursor accurately, you will need to press the **SHIFT-LOCK** key with the cursor key - you will find that the cursor moves one pixel at a time on the screen. Some times you may find that the crossbar cursor is not convenient to use - in this case a dot can be used as an alternate cursor. This is obtained by typing '.'. You can toggle between the two cursors simply by typing '.'.

Experiment with the two cursors and you will find that the dot cursor moves a lot faster across the screen than the cross bar cursor. To increase the speed of the cursor, hold down the **SHIFT** key while moving the cursor. If you lose the cursor by moving it off the screen then press the 'E' key (no need to use the shift key) and the cursor will be returned to the centre of the window. (Note: This is not the centre of the screen)

2.4 DRAWING LINES

Now we will try drawing some lines. Move the cursor to any position on the screen and press the **S** (START) key. This will mark the start position of the line or curve to be drawn. Move the cursor to any other point on the screen and press the key **D** (DRAW). A flashing line will be drawn between the starting point and the current cursor position. Move the cursor about the screen and you will find that the line will 'rubber band' with the cursor. If you wish to retain the line, enter **<RET>**, if not enter **<ESC>**. You can select any point on the screen as a starting point by moving the cursor to it and entering **S**.

Two other types of lines can be drawn using **V** or **H** instead of **D**. **V** will cause two lines to be drawn connecting the starting point and the current cursor position. The first will be a vertical line and the second a horizontal **H** is similar except that the first line will be horizontal and the second a vertical. To draw a rectangle, mark a starting point and move the cursor to another position on the screen and not in either vertical or horizontal line with the starting point. Press **H** and **<RET>** to accept it. Then repeat the same process with **V**. You will have drawn a rectangle with just two entries. Remember that you can move your final cursor position before accepting or rejecting a line.

The last type of line is an arc. This is drawn by entering **A** instead of D, V or H. The arc will be drawn in an anti-clockwise direction from the start position to the current cursor position.

Once you have pressed **A** you cannot move the end position of the arc, but you can alter the radius of the arc by pressing the + or the - key. (Shift is not required with the + key). Holding down the shift key with the + or the - key will increase the speed of the change.

Try drawing an arc and changing its radius. You will notice that as soon as you have entered **A** a crossbar cursor will appear at the centre of the arc no matter what type of cursor you had previously selected. The cursor will move as you change the radius and makes it easier to adjust the radius. <RET> and <ESC> are used as before to accept or cancel.

Summarising briefly, there are five basic drawing commands in NOVACAD system namely S (Start), D (Draw), V (Vertical & Horizontal), H (Horizontal and Vertical) and A (Arc) which are all logically selected, and with little practice, are very easy to use.

2.5 GRID

You have already found how the cursor moves in jumps unless you press the SHIFT LOCK key at the same time. The size of these jumps can be changed as described in the chapter on TAB key facility later in the manual. The purpose behind these jumps is to make it easier to draw to a given scale. The size of the jumps is chosen as a number of pixels and is set at six pixels on the utility disc.

2.6 THE COPY KEY

As each line is entered on to the drawing, it is saved in the computer's memory. The last line drawn is available for the user to repeat at any position on the screen by simply pressing the COPY key. Therefore, if lots of similar lines have to be drawn, the user needs to draw it only once and then use the COPY function to duplicate as many lines as required. The copied line will remain flashing until accepted by <RET> or cancelled by <ESC>. The cursor position indicates where the end of the copied line will be. The copied line can be repositioned by using the cursor keys while it is still flashing. This facility can be used for producing lines of varying thicknesses.

NOTE: The line being duplicated will be the LAST line you drew and the original must still be on the screen. When drawing with V or H command, two lines are drawn. Only the second of these two lines will be duplicated with the COPY key. If you haven't drawn a line or a curve, pressing the COPY key will result in a message "Nothing to copy".

2.7 DELETING

So far we have looked at the ways of drawing lines on the screen, it is also clearly necessary to be able to remove them again. This can be done in two ways, LINE DELETE and BLOCK DELETE. As the names imply, line delete will delete a single line or a curve at a time, while block delete will delete a section of a drawing at a time.

2.7.1 Deleting Line. or Curves

Pressing **DELETE** will take you into the delete mode with the message:

Move Cursor onto line
Press DEL to delete, ESC to leave

Position the cursor on the line you wish to delete and press **DELETE**. After a short delay the line will start flashing and you have a choice of deleting it by pressing **DELETE** or **<ESC>** to abort.

If the line to be erased is a curve, position the cursor close to the curve, and press **<DELETE>**. As before, after a few seconds the curve will start flashing and the option of deleting or retaining the curve will be offered.

Whenever the cursor is not on a line and the delete command is executed, the system looks for the nearest curve to delete. If there is no curve, the screen will display:

Not on line or no curve near

This message will disappear after a few seconds and will be replaced by a request to reposition the cursor.

Note that if you delete a line that is crossing another line, a pixel wide blank space will be left on the other line.

If you wish to delete a diagonal line, position the cursor nearer to one of the ends.

To quit the delete mode press **<ESC>**.

2.7.2 Block Delete

Block delete mode is used to delete sections of a drawing in one go. To enter this mode enter **<CTRL> DELETE**. The utility will be Loaded from the disc and a small square box will appear at the cursor position. The screen will display the message:

+ - to change height; <> to change width
Cursor keys move BOX
ESC to exit RET to delete

Move the box around the screen using the cursor keys and then position it centrally over the area you wish to delete. Increase the size of the box by pressing + and > so that the area you wish to delete is covered by the box. Enter **<RET>** and you will be asked to confirm **Delete (Y/ N)?** Enter **Y** and after a slight delay the section you had enclosed in the box will be deleted. Remember that lines and curves which do not originate within the box will not be deleted. If there are too many of these lines within the box, there may be a longer delay before the deletion is complete.

Once the deletion is complete, you will automatically exit from the delete mode and revert to normal input mode. The block delete mode can delete a maximum of 500 lines at a time. If you have more than 500 lines in the box, you will be offered the option of deleting part of the contents of the box.

2.8 MEASURING DISTANCES

At any time while not actually drawing a line, a curve or an icon (see later), pressing the 0 key will result in the horizontal and vertical displacement between the start point and the current cursor position being displayed at the bottom of the screen. Mark a start point on the screen and whilst moving the cursor keys press the 0 key at the same time and you will see the figures displayed at the bottom of the screen changing. The horizontal distance will be negative if the cursor is moved to the left of the start point and the vertical distance will be negative if the cursor key is moved below the start point: -

```

-horiz : +horiz
+vert  : +vert
----- S -----
-horiz : +horiz
-vert  : -vert

```

The distances are displayed in multiples of 10 pixels, i.e. 123 pixels will be displayed as 12.30. Using the TAB key facility you can alter this scaling if you wish so that a line of 100 pixels length is equated to any whole number between 1 and 30,000.

An example of use of this facility would be when drawing a plan of a house, you may decide that 100 pixels could represent 1m. Using TAB facility you can set this up and then all subsequent use of the Q key would give the distances in meters, i.e. 25 pixels would be shown as 0.25m (100 pixels = 1m ; 1 pixel = 0.01m)

2.9 WINDOW(S)

You will note that the second line of text at the bottom of the screen in the input mode displays the window coordinates as 1,2. Press key **W** and a flashing rectangle about two thirds the size of the screen will appear on the left hand side. This is the window 1,2. Altogether there are 20 windows available for each diagram, arranged as 4 columns and 5 rows as shown in the diagram below.

```

-----
4  :  :  :  :
-----
3  :  :  :  :
-----
2  : S :  :  :
-----
1  :  :  :  :
-----
0  :  :  :  :
-----
  0  1  2  3

```

The window marked S is the one you started in and is the one you will enter each time you use the system. The windows are numbered as shown above and the current window number appears in the text as:

Window: **Column No, Row no.**

Movement from one window to the next is executed by pressing the control key and the relevant cursor key pointing in the direction you want to move. When you press **CTRL ->**, the drive will start loading the move utility and at the same time the screen will clear. After a few seconds delay, a **PLEASE WAIT** message will appear. If you want to move to a further window repeat **CTRL ->** and the same process will be repeated. The display will revert to normal a few seconds after the please wait message.

When you reach the windows on the right hand or top edge you will find that the cursor disappears when it crosses the window's outside borders and that you will not be able to draw anything outside these borders.

The reason for creating the window size smaller than the screen size is to enable the user to see parts of the adjoining windows so that the drawing references and continuity can be maintained easily between the windows.

Note: You will find that if you have done a full screen drawing in any window adjoining the outside windows, and then move to the outside window, pans of the drawing can appear outside the external diagram border. Ignore this as it will be cleared up when you move again.

2.10 ZOOMING:

It may be necessary for you to look more closely at a particular section of the screen. This can be done using the zoom facility by entering **CTRL Z**. A message "**Select centre and press RET**" will appear. Move the cursor to the point of interest and press **<RET>**. The diagram will be redrawn on the screen with your point of interest centred and a part of the diagram will be enclosed in a box. The message at the bottom of the screen will be

+ - alters zoom RET uses, ESC quits

zoom value 1

The box indicates the area which will be magnified to fill the window. If you press the + key, the size of the box will reduce and the zoom value will be incremented for each key entry. Pressing the - key will result in a reverse process. Once you have chosen the zoom value, press **<RET>** and the diagram will be redrawn on the screen. If the diagram covers a number of windows, the wait may be a little longer. The screen display at the bottom of the screen will change from **ZOOM off** to **ZOOM ON * n** where n is the selected value of the zoom.

The maximum zoom value is 50. Some of the standard functions do not operate in the zoom mode:-

- 1 The copy key will no longer be functional.
- 2 ICONs cannot be created in the zoom mode, (see chap 3).
- 3 The text used with the NOVACAD package is from the standard BBC character set and cannot be enlarged in the zoom mode. However the space between the characters will be enlarged.
- 4 Moving between windows is carried out as in the normal mode, but the process is a little slower as the data for much larger diagrams has to be created.

When moving between windows or at any time the screen is redrawn, the lines of the diagram will appear one at a time in the order in which they were initially created.

There are also certain constraints imposed in the zoom mode. Lines drawn in with a high zoom value may not be easily deleted in modes with a lower zoom value, as the cursor cannot always be positioned exactly on that line though visibly this may appear to be the case.

If an icon is called to the screen in the zoom mode, the icon will be added at a size determined by the current scale value regardless of the current zoom value. In other words, if you add an icon at a zoom value of 4 and the scale is set to 2, then when the zoom is turned off the icon will have a size corresponding to 2/4 (i.e. half) its normal size. You are recommended to return to this section after reading about icons in chap 3.

A diagram created with circles which are drawn in modes with large zoom values may cause a problem when the diagram is loaded back from the disc. With smaller zoom values the diagram will be drawn in the normal way, but when the zoom value is increased, the circles may not close. This can produce distorted drawing and once in a while put the machine in an endless loop, exit from which can only be achieved by pressing **BREAK**.

To exit from zoom mode and return to normal mode, press **CTRL Z** again. The screen will be redrawn with the changes made in zoom mode.

2.11 SAVING THE DIAGRAM ON DISC

While creating the diagram all the information needed to define it is stored in the computer's memory. If you switch off the computer, press break accidentally or suffer a power failure, all this information will be lost. Therefore it is a useful practice to save your current work on the screen with regular frequency. To do this press **<ESC>** while in the drawing (input) mode. The screen will display the message:

Diagram disc in drive 0
RET when ready ESC to quit

The diagram disc may be in a different drive if you had altered the parameters in which case you will be offered the appropriate drive number. The drive number shown will be the one that appeared on the screen the first time you entered into the NOVACAD system. It is not possible to change the drive number at this stage. If the drive is the correct drive enter **<RET>** otherwise **<ESC>** and reset the parameters through the TAB P sequence. If you enter **<RET>** you will then be asked:

Use name "file name" (Y/N)?

The filename being the name you gave to the diagram when starting the system (TEST). You can rename the diagram by entering **N**. The diagram will then be saved on the disc. Once this is done, you will be asked:

FINISH PROGRAM (Y/N)?

If you answer YES, you will be asked to reconfirm and the display will change to:

PROGRAM ENDED ENTER *COMMAND

You can now enter the name of the language (e.g. BASIC) or any other utility in your computer. You can also use CAD to re-enter the CAD package again. Answering NO to the question will return you to your diagram and you can continue with your original drawing.

If there is not enough room to save the diagram on the disc, the screen will display the fact. Similarly a disc fault will be displayed if there is a disc fault.

If you catalogue the disc after saving the diagram, you will find the following new files:

P.Filename; Q.Filename; & X.name (the one you used for function definition file)

The first two files contain the data of your drawing and the third one is the function key definition file. The last file will be discussed in detail later in the manual.

Now you can try loading example diagrams from the disc, or your own if you had created and saved one while following the manual. To do this press **BREAK**. The disc will boot itself, and you will as before be asked to name a diagram. The two example diagrams are HOUSE and PCB.

When you name a diagram that already exists on the disc, you will not be asked about the function key definition file as this information is already held in the diagram data on the disc. This enables you to associate a particular function key definition file with a diagram. Similarly, other data relating to a particular diagram like, display parameters, grid scaling etc are saved with the diagram.

2.12 SUMMARY OF COMMANDS

(ccp = current cursor position)

CURSOR KEYS	Moves the cursor around the screen
SHIFT LOCK	When used with the cursor keys, makes the cursor move in single pixel steps.
SHIFT	When used with the cursor keys, speeds up the movement of the cursor.
S	Marks the start position of a line or an arc.
D	Draws a straight line between the start and the ccp.
H	Draws a horizontal line from start to a point vertically in line with the ccp and joins that point to the ccp with a vertical line.
V	Draws lines as above but starting with a vertical line and following it with a horizontal line.
A	Draws an arc in an anticlockwise direction from the start position to the ccp.
+ -	When used with the arc, it increases or decreases the radius. When used with block delete, it increases or decreases the delete area When used with zoom-mode, alters zoom value.
COPY	Redraws at ccp the line or the arc last drawn on the screen.
DELETE	Deletes the line the cursor is on, if not on a line then the nearest arc.
CTRL DELETE	Selects the block delete mode to delete an area.
CTRL Z	Enters (or exits from) zoom mode.
Q	Measures the horizontal and vertical displacement in units chosen from the start position to the ccp.
W	Displays the current window frame.
ESCAPE	When used alone, it saves the current diagram to disc. otherwise aborts any command which it follows.
*	Toggles between cursors

3 USING THE SYSTEM - ICONS

ICONS can be explained as predefined shapes which can be used for building up more complex drawings. Normally, the frequently used shapes like nuts, bolts, IC's, valves etc are drawn on their own and saved on a section of the disc called the icon library. Whenever such a shape is required on a drawing, it is called up on the screen from the library, adjusted in scale and orientation, lined up with the main drawing and drawn on the screen.

NOVACAD offers a facility to create an icon library of up to 60K and it can hold up to 1000 icons. An individual icon can be built with a maximum of 500 lines, which can be a complex drawing. On average, an icon will have about 20 to 30 lines and will require about 70 bytes of storage space. The icon file on the utility disc is only 20K so it will fill up fairly quickly.

A function key definition utility is provided to enable the function keys to be defined with particular icon names. This utility will also print out a function key strip which can be placed under the keyboard strip to provide easy reference between the icon name and the function key defined with it.

3.1 USING ICONS FROM DISC

If you recall, you were asked to name a function key file when you loaded a new diagram called TEST. Such a file called GENERAL is included on the disc as an example. So start a new diagram. When you are asked about the function key file give the name GENERAL. You will have a blank screen. Position the cursor centrally on the screen. Press **f1** and the screen will display the message:

Icon 'DOOR' Drive 0
<RET> use <ESC> Ignore

If you enter **<ESC>** the screen will revert to the normal input mode and nothing will have happened. Enter **<RET>** and a door will be drawn on the screen with the message:

Cursor Keys Move; + - To Change
R Rotates; > Mirrors; Scale: 1.0
<RET> To Keep <ESC> To Ignore

The message means: use the cursor keys to move the icon position.
 Pressing **R** will result in the icon being rotated 90 deg. in clockwise direction.
 + or - will increase or decrease the scale by 0.1. If these keys are used with the SHIFT key the scale will change by 1.0. Each time the icon will be erased and drawn to the new scale.
 > will produce a mirror image.

Any of these operations will cause the icon to be redrawn on the screen. You will also note that the icon will have been drawn with lines which look incomplete.

Enter **<RET>** and the icon will be drawn in full on the screen and the display will revert to normal.

If you press the + - keys in the normal input mode you will find that the scale will also change accordingly. If an icon is loaded after you have altered the scale the icon will be drawn to the altered scale. Therefore you can preset the scale level before drawing the icon to speed the drawing process. The scale change can be speeded up using the SHIFT key with the + - keys.

Try pressing any of the function keys from f1 to f9 alone, with SHIFT, with CTRL and with SHIFT and CTRL keys together and you will get a message giving the icon name or stating that the key is undefined. In this way you can have up to 36 icons allocated on function keys. The way to create such a definition file is explained later.

Now press **f0**. You will be asked the icon name. Now you can specify any icon that exists on the icon library. The **f0** key can be used to call any icon and it does not matter whether that icon is associated with another function key and whether or not you are using a function key definition file.

3.2 CREATING NEW ICONS

Now let us try creating an icon. Draw a shape on the screen. The simplest is a rectangle drawn using the **H** and **V** commands. Draw an arc on one side and possibly a diagonal so that the shape is asymmetrical. Position the cursor centrally on the shape. Now enter **CTRL C** (copy icon). A box will appear at the cursor position. Adjust the size of the box so that it encloses the shape completely. Any line either starting or ending outside the box will not be copied. Press **<RET>**. After a short pause you will be asked:

Add to icon file (Y/N)?

If you answer with **N**, the box will disappear and you will revert to normal input mode. Enter **Y** and the following message will appear:

**Icon disc in drive 0
Name for ICON ?**

Ensure that the icon disc is in drive 0 (the drive number can be changed see later chapter) and type the name you wish to give the icon. The icon name can be up to 10 characters where the starting character must be a letter and no spaces are permitted within the name.

Your diagram will then be saved as an icon. If the name you gave it is already on the file, you will be asked:

**xxxxxx is already on the file
do you wish to overwrite it (Y/N)?**

Answering with **N** will result in a request for new name and **Y** will result in the new icon data overwriting the old one.

Now press **f0** and call the icon you just created on to the screen. You will now appreciate the ease with which you can create and manipulate a shape on the screen. You can enlarge or shrink it, rotate it, produce a mirror image (an asymmetrical shape will show the effect more clearly) or move it around the screen with complete ease.

If your answer was **No** to the first question **Add to icon file?**, you would have returned to the normal input mode. However, the data you had copied will still be held in the memory. Move the cursor to a clear part of the screen and press **C**. The shape you had copied will be redrawn. So, whilst you did not create an icon and save it, you can still redraw that shape anywhere on the screen as many times as you like. This facility is very useful when you want to create a drawing where the same shape is used repetitively. Even if an icon exists, you may find it simpler and faster to use this facility.

Restrictions in creating an icon are:

It can contain a maximum of 500 lines. If there are more than 500 lines you will have the option of creating an icon with the first 500 lines drawn.
It cannot contain any text.

3.3 EDITING EXISTING ICONS

Once an icon is accepted on the screen by the final return, it can be treated as any other part of your diagram and you can edit it at will. You can edit an existing icon in this way and then either create a new icon or save it under the old name.

3.4 SUMMARY OF ICON COMMANDS

CTRL C	Creates a box to copy an icon to disc f0 Selects an icon by name
f1-f9) SHIFT) CTRL)	Select an icon by predefined function key
+ -)	When used in conjunction with icons, alters the size of icon
SHIFT)	Using shift alters size in larger jumps.
R	Rotates an icon in clockwise direction through 90 deg.
>	When used in conjunction with icons, swaps the icon left to right, ie produces a mirror image.
C	Draws the shape copied by using CTRL C

4 USING THE SYSTEM - TEXT

Most drawings require some text on them to indicate dimensions or descriptions. This can be done quite easily with NOVACAD which uses the built in BBC character set.

Enter the text mode by pressing **CTRL T**. The text utility will be loaded from the disc and the shape of the cursor on the screen will have changed to that of a inverted T. The display at the bottom of the screen will change to indicate the text mode.

The cursor can be moved around the screen with the cursor keys in exactly the same way as in the input mode. Type in a character and it will be written on the screen in the same way as the normal BBC text and the cursor will move to the next character position. The shape of the character will depend on the mode you are in and will be the same as the normal BBC text. The characters can be positioned accurately anywhere on the screen by using SHIFT LOCK key with the cursor keys.

If you now press **CTRL R** the cursor will rotate in clockwise direction by 90 deg. You will find that the text will be written sideways and vertically down the screen. Repeat the rotate command and the cursor will be turned a further 90 deg and the text written upside down and right to left. The next rotation will result in text being written up the screen. One further rotation and the cursor will return to the normal position.

4.1 DELETING TEXT

Naturally there will be occasions when you wish to delete text characters for one reason or another. To do this you **MUST** be in the TEXT mode and the text cursor must be in the same orientation as the character you wish to delete. Move the cursor close to the character you wish to delete and press **DELETE**. The character will be deleted and the cursor will move to the deleted character's position. This allows you to replace any character on the screen easily.

NOTES:

All functions not related to TEXT mode will become non functional in the text mode, so you cannot use COPY, ZOOM, PRINT, LEVEL etc in the this mode. However, text mode can be selected once you have gone into zoom mode or changed levels.

As NOVACAD uses the EEC character set, the text size will remain the same for any zoom value (zoom being used in input mode with characters already on the screen), though the spacing between the characters will change with the zoom value. Therefore, if you are entering text when in zoom mode ensure that you leave sufficient room between the characters, otherwise the text will be jumbled when you return to normal screen. For this reason entering text in zoom mode should be avoided if possible.

To exit the TEXT mode enter **CTRL I** and you will return to the input mode.

5 USING THE SYSTEM - LEVELS

There are many types of drawings where it would be useful to be able to include different parts of the diagram on the same drawing and then have the choice of selecting only the specific parts to be shown. Such cases include:

The design of a wall where the wall, the plumbing and the wiring can be shown separately or combined as desired.

The floor plan of a house including choices of furniture where you wish to show the plan with and without the various options.

NOVACAD will allow you to create diagrams with eight different levels of drawings. Each level can have its own characteristic independently set so that when you are not working in that level, everything drawn in that level will either be shown dotted, or not shown at all, or in a different colour (6502 2nd processor and B + users only).

The levels are changed by typing **L**. This will cause the prompt:

New Level (0 to 7) ?

Enter any number between 0 and 7 and that level will be selected for you.

The level status is shown on the last line of the three line text display at the bottom of the screen. The number with the inverse video indicates the current level. Default level is zero. The levels which are configured so that they are not displayed when not current, will also not be displayed on the level status line. So if level 2 is set so that it is not displayed in other levels, number 2 will not be displayed on level status line in any other level.

As with everything, it is best to try out the concept to understand it thoroughly. Load the example diagram PCB. You will note that some of the lines appear dotted. Now change the working level from 0 to 1 by pressing the **L** key. You will see that the lines which were dotted are now solid and the ones which were solid are now dotted. Examine the individual ic pad by zooming into one with a zoom value of about 10.

Draw a line on the screen in level 1. Now go back to level 0 and you will see that the line has become dotted. If you now change to level 2, draw a line and go back to level 0 or 1. The line will not be displayed at all.

The chapter on the TAB key facilities explains in detail how to alter the display characteristics of individual levels. The display characteristic of a level will remain the same whichever other level it is viewed from, in other words you will not be able to define level 2 so that it will appear differently from levels 0 and 1.

When you save a diagram, its display characteristics are saved with it.

6 USING THE SYSTEM - UTILITIES

This facility allows the user to either clear the screen, view the complete diagram, save the screen or the complete diagram for use outside the NOVACAD environment. It is called by entering **CTRL U**. The text display at the bottom of the screen will change to:

Restart.....	C	Display Drawing	D
Screen to disc	S	Normal Screen	N
Return to prog	R		

C This will clear all the windows. You will be asked to confirm that you wish to clear as no data can be retrieved after the screen has been cleared.

S Normally any diagram created using the NOVACAD system cannot be loaded on a screen unless the NOVACAD rom is installed in the computer. However, this facility will allow a single screen to be saved to disc so that it can be used outside the NOVACAD environment using the *LOAD command. The diagram will be loaded on the screen in the same mode it was saved in. So 6502 second processor users and BBC+ users can save single screens in mode 0, 1 or 4 for display on computers not having the NOVACAD rom. Mode 1 diagrams can be in four colours. Standard BBC users will be restricted to mode 4 diagrams and two colours. Replace your utility disc in drive 0 with any other formatted disc and press S. You will be asked to name the file on which it is to be saved. The diagram will then be saved on that disc as screen memory. To display the diagram in any other BBC computer switch to the mode it was saved in and enter ***LOAD filename**.

D This will display the complete drawing on one screen. Any test characters entered on the drawing will be displayed as single dots so as not to clutter up the reduced drawing. The complete drawing can also be saved using the **S** command.

N This will display the current window without having to exit from the UTILs mode.

R returns you to the NOVACAD input mode. Once you have used CTRL U you have to enter R to return to the system whether you use any of the facilities or not.

7 THE TAB KEY

Pressing of the TAB key will cause the screen to clear and a menu of commands to be displayed:

C	Catalogue
E	Erase files
I	Icon Utilities
S	Remove spaces from the icon file
H	Help with instructions
P	Change hardware/printer parameters
D	Change display parameters
O	Change grid spacing
L	Select logical colours
B	Build function key definitions
M	Make icon disc ready for use
Q	Set scale factor
*	Op system command
<RET>	Return to program

Each of these options will now be described in turn:

C Catalogue

This is the normal *CAT command and will list the files on the drive selected.

E Erase Files

This command makes use of the *WIPE command of the disc filing system in the BBC micro. You name the file you wish to delete and after reconfirmation from you it will be deleted.

I Icon Utilities

Selection of this option will result in a secondary menu to be displayed on the screen.

C Change icon's name.

L List icon names on the screen.

P Print icon names on the printer.

<RET> Return to main menu

Command?

C will first ask you for the current name of the icon and the new name you wish to give it. A check is then made that the icon disc is in the correct drive, that the old name you gave does exist and that the new name you require is not already in use. If any of these do not check out you will be told - otherwise the name will be changed.

L will cause the screen to blank and the list of icon names will be given one page at a time. At the end of each page you will be asked:

RETURN for more ESCAPE to exit

If there are no more icon names to give you will be asked:

Finished press RETURN

P will first tell you to ensure that the printer is connected and on line and then the list of icon names will be printed. You can interrupt the printing at any time by pressing <ESC>. If a serial printer is used, the serial port should have been enabled using *FX52 before entering the NOVACAD system.

H This will give a brief summary of the available commands.

P Change hardware/printer parameters

The following display will appear on the screen:

ICONS on drive		0	
Diagrams on drive		0	
Print files on drive		0	
2nd Byte	Normal	42	*
2nd Byte	Condensed	76	L
3rd Byte	Normal	5	
3rd Byte	Condensed	-1	

Do you wish to make changes (Y/N)?

Answering N will just return you to the main menu again. Y will cause a further question

Hardware (H) or Printer (P)?

Answering H will let you redefine the drive numbers for the various files. Note that utility files must be in drive 0 at all times otherwise you may find that the computer will hang up for no apparent reason.

The printer parameters shown are typical for EPSON FX80 and give a linear print out (that is a square on the screen appears as a square on the print out). These codes can be changed to suit other EPSON compatible printers which have different codes for obtaining a linear output. This facility may not be available on all EPSON or compatible printers.

When printing a diagram, a choice between normal and condensed print will be offered. This allows 3 or 4 windows to be printed via condensed mode.

The values shown represent the decimal equivalent of the ASCII value of the printer control code. The first code to be sent to the printer is always ESCAPE (27) so it is not included in the variable option. The default values of the second code for the normal and condensed prints are as shown. Any negative value is not sent to the printer. As the condensed mode does not require a third code, it is given a negative value.

Setting of hardware and printer parameters will be set on your utility disc and will affect all your operations with the NOVACAD.

D Display Parameters

As mentioned earlier you can set the display characteristics of each of the 8 levels. When you enter D the following table appears on the screen:

FORE		BACK		
LEVEL	COLOUR	COLOUR	SOLID	DISPLAY
0	4	1	Y/N	Y/N
1	4	1	Y/N	Y/N
2	4	1	Y/N	Y/N
3	4	1	Y/N	Y/N
4	4	1	Y/N	Y/N
5	4	1	Y/N	Y/N
6	4	1	Y/N	Y/N
7	4	1	Y/N	Y/N

When you are working in a given level it is said to be in the foreground and all other levels are in the background. Therefore if you look at the table, level 0 will have colour four when it is in the foreground or it will have colour 1 when you are not working in level 0.

If you are working in mode 0 or 4 you have a choice of only two colours, and four colours when you are in mode 1 (only 6502 2nd processor or BBC + users can use modes 0 and 1). The setting of the colours is done by using L as shown later.

When a level is in background you can decide whether the display is going to be solid or not (ie full lines or dotted lines) and you can also choose which levels are going to be displayed (or not) when drawing in other levels.

For example, if you set level 1 not to be solid, any line drawn when in this level, will appear dotted when viewed from other levels. If level 2 is set not to display, any line or shape drawn in this level will not be visible when viewed from any other level. If you set any level not to be displayed, when you return to the normal mode you will note that the number representing this level does not appear in the bottom text.

Setting of the display parameters affects only the diagram you are currently working with and this data will be saved with the diagram. If you start a new diagram, these characteristics would revert to default values as shown above.

G Change grid spacing

When the cursor is moved, it moves in jumps. The size of these jumps is determined by the grid spacing. Using this option allows you to change this spacing for easier scaling on a diagram. For example if you know that 22 pixels correspond to 1 cm on your printer(or plotter), you could set the grid spacing to 22 then each cursor movement would represent 1 cm on a printed diagram. The grid spacing can also be set in conjunction with Q, the scaling factor described below.

The screen display will show what the current spacing is and you will be asked to specify the new spacing.

The spacing you set will be peculiar to the current diagram and will revert to default with a new diagram.

B Build Function Key Definition File

When you press B you will be presented with a table of function keys used alone, with SHIFT, with CTRL and with both SHIFT and CTRL. and spaces for allocating icon names to these keys.

You can define the keys with the names of icons you have already created and saved on the icon library.

You have already used the GENERAL file which probably will not suit your requirements and you may wish to have separate definition files for different types of applications e.g. ELECTRONICS, ARCHITECTURAL, MECHANICAL etc.

To create a new definition file, start a new diagram. When you are asked for a function key file name give the name you require i.e. ARCHIT and proceed to the input mode. Enter TAB and B. Define the keys as required. Save the diagram with the name you had chosen. Now catalog the disc and you will see three new names on the disc:

P.Name; Q.Name and X.ARCHIT

Delete the first two files as they contain no data. The third file X.ARCHIT is your function key definition file and now you can load it with any diagram you are going to create. Once you use a definition file with a diagram, the file data is also saved with the diagram so when the diagram is next loaded, the definition file will also be automatically loaded.

There is also a facility to print a function key definition strip, which will be a useful aid when you have several definition files. This can be placed above the computer keyboard under the clear plastic strip.

M Make icon disc ready for use

Before you can store icons on a library, it must be set up correctly. When you enter M you will be asked to insert a formatted disc in the drive you allocated for the icons, drive 0 if you not did not reset the hardware parameters. You will then be asked if you want to delete the contents of the disc. Therefore care should be exercised if you have any important files on this disc. Specify the number (maximum 1000) of icons for which you wish to create the library and the actual space required (max 60 Kbytes).

As a guide to the size required for the icons themselves, a single line or curve will take approx 10 bytes to store. So 60 Kbytes will allow approx. 6000 lines as a total for the lines and curves forming all the icons. A typical icon might consist of 10 to 20 lines. Therefore, 60 Kbytes will allow storage of between 300 to 600 icons.

If you are using a single drive it is suggested that you create the icon library on a blank formatted disc. After that, copy all the files listed below from the utility disc.

1. All files in the \$ directory. This can be done by:

COPY 0 0 \$.

2. T.HELP using the command *COPY 0 0 T.HELP
3. H.CONFIG using the command *COPY 0 0 H.CONFIG

If you are using a dual drive or a double sided drive then you can have the icon library on a different disc surface and set your hardware parameters accordingly.

L Set the logical colours

This facility will let you set the foreground and background colours. In mode 0 and 4 any two of the 15 colours can be chosen and in mode 1 any four can be chosen.

Q Scale Factor

This utility will allow you to set a scale in units of 100 pixels.

***Op system command**

Typing * will result in message **Command *** to appear. Enter the command without the *. Take care when entering this command as you might by mistake exit from the NOVACAD and lose your data. Typical uses are to catalogue the files on a disc.

RET Return to program

This returns you to the input mode.

8 USING COLOUR

This chapter shows how colour can be used in a diagram This is applicable only to 6502 2nd processor and BBC Plus users.

Modes 0 and 4 allow the use of only 2 colours and these have to be set using the TAB facility.

In mode 1 and 4 colours are available, one for the background and three for the foreground. You can select any of the four colours from the 15 logical colours available on the BEG computer using the TAB facility. You can then change the three foreground colours at will in input mode by pressing the relevant colour number (i.e. 1, 2 or 3). The colour chosen will be displayed by a colour band at the bottom of the screen.

In mode 1, you can select one of the three foreground colours to be the same as the background colour, after you have created the diagram, so that the details you do not want to show (like centre line, reference markers) but want to retain can be hidden. This is a simpler & faster alternative to using different levels. This setting is done using TAB L facility.

9 PRINTING A DIAGRAM

Once a diagram is created, you will want to print it or plot it. The plotter driver program is available as an optional extra and is supplied on a separate disc with its operating instructions.

The printer routine included with this package is suitable for all EPSON and EPSON compatible printers with a graphics capability.

The printer should be set so that it generates its own line feed when a carriage return is received. The printer manual will have the details on how to set this.

To select the printer routine you enter **CTRL P** and the following message will appear on the screen:

Print (1) / exit(0)?

Replying with 0 will exit from the print routine and return you to your diagram.

If you reply with 1 the printer routine will be loaded. The printer routine is in two parts. The first part, STORE MODE converts the diagram data into a suitable format for printing and stores it on the disc as print files. The second part, PRINT MODE utilises this data to carry out the printing.

You will be asked to confirm that the print files are on drive n (where n is the drive number you had specified for the print files under TAB P). If you want to save the print files on a different surface you can answer no and then specify the drive number required. However, you must ensure that the disc surface you specify has sufficient space, as each window requires 5.6K of space for mode 4 and 11.6K for modes 0 and 1.

You will then be presented with a menu of options:

D: Save to disc
F: Print from disc
Q: Quit

Q will return you to your diagram.

Entering **D** will result in the first part of the printer routine being used to save the diagram in a printable form on the disc.

The whole diagram will be redrawn on the screen, reduced in size so that all 20 windows can be accommodated on a single screen. A box representing the area of 20 windows will surround the drawing. The screen message will read:

LRTB to select edge STORE MODE
Use cursor keys to move edge
RET to use, ESC to exit

LRTB represent left, right, top and bottom. If you enter L, the second line of message will change to:

Use cursor keys to move left edge

Therefore using the L, R, T and B you can move each of the four edges of the box to specify the area you wish to save. Note that the the cursor key must be pressed and released for each step and that the movement of each edge is in single window jumps. You will not be able to reduce beyond one window height and width.

Once you have marked out the area, press **<RET>**, a message saying "Checking Disc" will appear and the system will ensure that there is adequate space on the disc for the number of windows specified. If there isn't enough space, you will be told. Otherwise, each window in turn will be redrawn on the screen and saved to disc.

When the program has been saved, you will be offered the same three options, D (save), P (print) or Q (quit). This time you select P and again the 20 window box will appear but the mode will be PRINT MODE. Set the box edges as before and enter <RET>.

If you had selected the diagram area wider than two windows, you will be asked:

This will require a wide printer is this OK (Y/N)?

If you say no, you will be returned to reselecting D, P or Q. If you say yes, a choice between condensed or normal graphics will be offered. If you are using a 80 column printer you will have to select condensed mode. In condensed mode the print out will not be linear. Ensure that your printer is ready before you answer otherwise the computer will hang and you will have to press BREAK to restart.

During printing, you can abort at anytime by pressing <ESC>.

NOTES:

Unless a diagram is first saved on a disc using the print routine, attempting to enter a print command directly will result in a blank sheet of paper being fed through the printer.

If you want to print a diagram or a section of a diagram which is contained in a single window then when you enter S to save on disc, you will be offered a choice to print directly from the screen, or to save or both together.

A 80 column printer will accommodate a two window wide diagram in normal printing in modes 1 and 4 and a single window wide diagram in mode 0. A 136 column printer will accommodate 4 windows in modes 1 and 4 and two windows in mode 0.

If you catalogue a printer file disc you will see that it has several files under directory W. Each window has a separate file. If you need to edit a diagram after it has been saved as a print Me, you do not have to save the whole diagram again. You just need to save the windows you had edited the original files for those windows will then be automatically overwritten.

10 TRACKER BALL/AMX MOUSE VERSION

This version of NOVACAD will allow you to use the MARCONI RB2 tracker ball or Amx Mouse to control the movement of the cursor across the screen. Although the full cursor control is available on the tracker ball/mouse a number of commands can only be operated from the keyboard. Therefore it is suggested that the user familiarises himself with the NOVACAD system using the keyboard before proceeding to use the tracker ball/mouse.

The text here will briefly describe the variations made in the system to allow its use with the tracker ball.

When a diagram is loaded on the screen, the top of the screen will display the following:

: DIRECT : START MENU DRAW

first entry enclosed within the straight line brackets indicates the function chosen. The other three entries indicate the function allocation of the three tracker ball/mouse keys in the same order.

Press the centre key on the tracker ball/mouse keys and the display at the bottom of the screen will change to display the menu as:

DIRECT VERT HORIZ ARC TEXT

ZOOM COPY DEL LINE DEL BLK PRINT

The DIRECT label will have the cursor marker on it indicating that it is the current function chosen.

The display at the top would have changed to:

DIRECT LEFT SEL RIGHT

Pressing the right hand key on the tracker ball/mouse once will move the cursor marker to the right on to VERT, pressing the same key again will move the cursor to HORIZ and so on. Pressing the left key will move the cursor backwards.

DIRECT refers to the straight line drawing function, i.e. the same use as using D from the keyboard. VERT is same as V, HORIZ as H and ARC refers to A.

When you have selected the function you require, press the centre key SEL. The screen will display the normal input mode display at the bottom while the top display will change to

: ARC : START MENU DRAW
(assuming ARC function was chosen)

Move the cursor using the ball to the starting point and mark your start position using the left hand key. Move the cursor to the position where the arc finishes and press the right hand key. The arc will be drawn as before in an anti clockwise direction from the start point. To move the centre of the arc you will have to use the + and - from the keyboard.

The display at the top of the screen would have changed to :

: ARC : ESC - - - RET

If the arc is not acceptable press the left hand key. Otherwise accept it by pressing the right hand key. Once the arc has been fully drawn, the top display will again change to **START MENU DRAW**.

There are various commands which remain on the keyboard and each time you have to use the keyboard, a message at the top of the screen will indicate that.

11 NOTES FOR THE BBC PLUS USERS

NOVACAD will allow you to make full use of the extra memory on the Model B PLUS.

Enter ***SHADOW** and hit break and enter ***CAD** and you will be offered a choice of using any one of the three modes(O,1 & 4). However you will find that some of the utilities under TAB do not function. If you need to use these facilities, then you have to do a hard reset. If you have a diagram on the screen, save it before resetting the machine. Enter *CAD without calling the shadow memory. You will be forced into mode 4. Set up the utilities as required. Your changes will be saved on the disc under the diagram name you had used in mode 4. Load this diagram again with the shadow memory operational and as before you can select any of the three modes. The utilities will be as set up before. Don't worry if the diagram name you used is not the final one. You can always change the name when you save it again.

12 FULL LIST OF COMMANDS

CURSOR KEYS	Move the cursor around the screen
SHIFT LOCK	When used with the cursor keys, makes the cursor move in single pixel steps.
SHIFT	When used with the cursor keys, speeds up the movement of the cursor.
S	Marks the start position of a line or an arc.
D	Draws a straight line between the start and the ccp.
H	Draws a horizontal line from start to a point vertically in line with the ccp and joins that point to the ccp with a vertical line.
V	Draws lines as above but starting with a vertical line and following it with a horizontal line.
A	Draws an arc in an anti clockwise direction from the start position to the ccp.
+ -	When used with the arc, it increases or decreases the radius. When used with block delete, it increases or decreases the delete area When used with zoom-mode, alters zoom value.
COPY	Redraws at ccp the line or the arc last drawn on the screen.
DELETE	Deletes the line the cursor is on, if not on a line then the nearest arc.
CTRL DELETE	Selects the block delete mode to delete an area.
CTRL Z	Enters (or exits from) zoom mode.
Q	Measures the horizontal and vertical displacement in units chosen from the start position to the ccp.
W	Display the current window frame.
ESCAPE	When used alone, it saves the current diagram to disc. otherwise aborts any command which it follows. Toggle between cursors
CTRL C	Create a box to copy an icon to disc
f0	Select an icon by name
f1-f9) SHIFT)	Select an icon by predefined function key
CTRL) + -)	When used in conjunction with icons, alters the size of icon
SHIFT)	Using shift alters size in larger jumps.
R	Rotates an icon in clockwise direction through 90 deg.
>	When used in conjunction with icons, swaps the icon left to right, i.e. produces a mirror image.

C	Draws the shape copied by using CTRL C
CTRL T	Enter text mode
CTRL R	Rotate Cursor
CTRL I	Exit text mode
TAB	Access Utilities
CTRL U	Screen Utilities
CTRL P	Enter Printer Routine