PCB DESIGNER (SPECTRUM 48/128K)

CONTENTS

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INTRODUCTION

PCB LAYOUT: (PCB)
Allows you to produce printed circuits directly from your EPSON
RX/LX/FX or near compatible dot matrix printer using a dense 1:1
printout on positive photoresist coated copper laminate, or
professional quality using the DOUBLE SIZE print routine with photo
reduction. PCB has many features such as a large library of pads, see
back of this manual, WYSIWYG display showing a large uncluttered view
of pads, tracks and drill holes, 0.1" grid. Block move/copy/rotate /X
mirror/Y mirror, erase, fill, undo, preview layout, dimensionally
accurate printer routine and custom pad design.

COMPONENT LAYOUT : (LAYOUT)
Draw component layouts directly or from existing layouts produced in
'PCB', using the unique track reducing routine. A library of standard
components are provided, see the back of this manual. All the block
commands and print facilities mentioned in PCB above are included in
this program also.

CIRCUIT DIAGRAMS: (DIAGRAM)
Has features similar to both PCB and LAYOUT above with a library of
electronic symbols, including resistors, capacitors, ic's, diodes,
transistors.

LIMITATIONS
(1) The maximum board size that can be drafted in one go is 4.4" by
6.4". This will allow you to produce up to EURO CARD size allowing for
spacing around the edge of the card. Larger boards of course could be
attempted by drafting several layouts! It is surprising how many
professionally produced boards are actually smaller than this limit.
More significantly, home or college projects rarely use boards above
this size.

(2) No simultaneous double sided drafting facility. More elaborate
computers allow you to draf t double sided boards using different
colors for each side. The Spectrum screen display renders this
impossible to achieve as colours are displayed in blocks, not
individual pixels. You can still produce double sided boards by
adopting a particular method, see the section titled Double sided
drafts.

This program is used extensively to produce small professional printed
circuits in many companies around the world. See example layouts at the
back of the manual.

The minimum system requirement to produce UV exposure ready artwork is a Spectrum 48K computer and an Epson FX, RX, or LX 80 printer or compatible plus suitable interface.

Suitable interfaces are listed below:

Versions of 'PCB DESIGNER' compatible with the following centronic interfaces are available and should have been stated with your original order. Each requires a different printer driver and is therefore ordered as a specific version.

- Plus3

- Opus 'discovery' system

- The 'Disciple' system

- Tasman Centronics interface

- Kempston 'E'   ,,

- Kempston (earlier version)

- Datel 'inter printer'

- ZXLPRINT III interface

- Everyday Electronics
      Centronic Interface JAN 89

- Spectrum Hardware Manual
      Centronic Interface (Melbourne House)

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WHICH VERSION?
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Two main versions of PCB DESIGNER are available. Which subdivide into
TAPE, DISC and Micro Drive versions. Version V1.1 is simply a PCB
DESIGN program with separate PRINTER and ICON DESIGNER programs,
whereas V1.+ is a suite of programs to support PCB LAYOUT, COMPONENT
LAYOUT and CIRCUIT DIAGRAM production. Any later editions will be named
as V1.2 and V1.2+ and so on. If any upgrades are produced existing
users can obtain a copy at reasonable rates.
Any major re-writes of the program will be given a V2 prefix and will
not be available as an upgrade. The only possible rewrite envisaged at
the moment is a version for the 'SAM' computer by MILES GORDON
TECHNOLOGY, when it finally appears.


MAKING A WORKING DISC or M/D and LOADING the PROGRAM
---------------------------------------------------

CASSETTE versions : LOAD "program name" then ENTER

DISC/MD versions:
The disc and microdrive versions will normally be supplied on tape
unless specifically ordered as a certain disc size, as this forms a
convenient and reliable master.

To produce working discs/microdrive carts, (from now on generally
called 'discs') from the tape master, FORMAT a blank disc and leave it
in the drive.

Load the tape by simply typing LOAD "" then ENTER.

You will be prompted to STOP, and START the tape at various intervals
as each set of files are transferred to disc. Make sure you have enough
time to stay with the tape as it takes 20 minutes or so to transfer the
whole PCB DESIGNER SUITE V1.+ .

The suite of programs run from a MAIN MENU named "run". With MD and
Discovery versions "run" autoboots  by simply pressing 'RUN' then
ENTER.

DISCIPLE & PlusD owners must make a duplicate of "run" and name it
"AUTOLOAD" (ie. MOVE D1 "run" TO D1 "AUTOLOAD", then ENTER), and also
copy your system file onto the working disc, if you want the disc to
autoboot. NOTE: Both "run" and "AUTOLOAD" must be present on your
bootable working disc.
```

USING "PCB DESIGNER"

'PCB DESIGNER' is very easy to use and once mastered you will find it
difficult to go back to the manual method of laying out a pcb. To
become quickly acquainted with all the features of the package it is
advisable to work through the tutorial section entitled 'GETTING
STARTED'.
Included in the package is a loose page of key functions. For first
time users of the program it is useful to keep this handy by the
computer for reference.

The program runs,in two main modes, "CURSOR MODE" and "PLOT MODE" . It
is normal to start your layout in the cursor mode as this is the mode
for placing pads, amongst other things, and these should always be
placed prior to laying out tracks. The program automatically enters
'CURSOR MODE' every time 'EDIT LAYOUT' is entered from the main menu.
PLOT MODE is used to lay down tracks and to fill in large areas of the
draft when required.

In cursor mode the layout area is divided into 4 distict screens called
'PAGES'. As the cursor is moved to an inner edge of one page, the
display automatically jumps into the corresponding adjacent page. The
current page number is allways shown in the bottom left hand corner of
the screen. The page layout is shown below:

```
            |--------------------|
            |         |          |
            | PAGE 1   | PAGE  2  |
            |         |          |
            |--------------------|
            |         |          |
            | PAGE 3   | PAGE  4  |
            |         |          |
            |--------------------|
```

In cursor mode, the layout area is divided into distinct pages to show
immediately where you are in the overall work area.
In plot mode the screen area is automatically scrolled over the layout
as the 'PEN' is moved to the inner edges of the screen.

KEY FUNCTIONS

[SS] = Symbol Shift.   [CS] = Caps Shift.   ENT = ENTER.

CURSOR MODE
----

function	key	function	key
ENTER PLOT MODE	Q	RETURN TO MENU	M
ENTER TEXT MODE	P	LEAVE TEXT MODE	ENTER
PAD CARD 1	[CS] 1	PAD CARD 2	[CS] 2
PAD CARD 3	[CS] 3	PAD CARD 4	[CS] 4
USER ICONS CARD	[CS] 5	PLACE PAD	SPACE
OVER ON / OFF	[SS] N ENT	BLOCK COPY/MOVE	[SS] Z
BLOCK MIRROR	[SS] M	BLOCK ROTATE	[SS] R
CLEAR SCREEN	[SS] V	CLEAR LAYOUT	[SS] X
ERASER ON	O	ERASER OFF	ANY KEY
PLACE USER ICON	[SS] 0-9	CREATE USER ICON	[SS] L

PLOT MODE
----

function	key	function	key
CURSOR MODE	C	TRACK WIDTH	[SS] W ENT
PEN SPEED	[SS] Q ENT	DELETE TRACKS ETC	[SS] D
FILL	[SS] F	PEN ERASER ON	0
PEN ON	9	PEN OFF	N

KEY FUNCTIONS COMMON TO BOTH CURSOR AND PLOT MODES
----

function	key	function	key
RESTORE (UNDO)	[SS] S	PREVIEW LAYOUT	[SS] K
PRINTER DUMP	[SS] C	GRID ON/OFF	G

```
GETTING STARTED
---------------


LESSON 1:


(i)     In Disc & Microdrive versions all programs run from a single MAIN
        MENU, however with tape versions the programs must be loaded from
        tape separately. Load the PCB program, if you have not already
        done so.

            On loading, the prompt "LAYOUT TITLE ?" appears on screen....
            enter a name up to 10 characters long. This naam  will be
            printed above the layout during printout.

            The Main Menu is now displayed as shown below:


            PCB DESIGNER (SPECTRUM)
            ____  MENU ____

        1 / SAVE LAYOUT;
        2 / SAVE ICONS;
        3 / EDIT LAYOUT;
        4 / LOAD LAYOUT;
        5 / LOAD SCREEN;
        6 / LOAD ICONS ;
        7 / DISC CATALOGUE;  (disc  versions)
        8 / MAIN MENU.

(ii)    Select 'EDIT LAYOUT' from the Menu....  then ENTER
        The screen clears to a blue background with a flashing cursor and
        PAGE 1 identifier in the bottom Left Hand corner of the screen.

(iii)   Press an ARROW KEY (5,6,7 or 8)
        The x,y co-ordinates of the cursor now appear, on the bottom of
        the screen and represent multiples of 0.1 inch. The screen co-
        ords start at (0,0) (ie. x=0, y=0, the top left hand corner
        of 'page 1') and end at (63,43). (The bottom right hand corner
        of 'page 4').
        The overall layout size is therefore 6.4 inches by 4.4 inches.
```

(iv)   Hold down KEY 5 to move the cursor to the LH edge of the
        screen.... A 'buzz' followed by the warning, "OFF PCB AREA" will
        occur if the cursor goes off the edge. Press any key to restore
        the   cursor.

(v)   Move the cursor to the top LH corner of 'page 1' until the co-ords
        (0,0) are displayed,(going too far will again result in the "OFF
        PCB AREA" warning).

(vi)   Now hold down KEY 8 (right arrow) and notice the momentary pause'
        as the cursor passes off the RH edge of page 1 into the EH side of
        page 2.
            Continue pressing KEY 8 until the RH edge of page 2 is
     reached.   Going too far will again invoke the "OFF PCB AREA"
     warning.

(vii)   Hold down KEY 6 (down arrow) and again note the pause as the
        cursor moves off the bottom edge of page 2, into the top of page
        4. Continue pressing the key until the bottom of the page is
        reached.

(viii) Hold down KEY 5 to move the cursor leftward into page 3.
        Continue pressing the key until the LH edge of page 3 is reached.

(ix)   Finally hold down KEY 7 (up arrow) and move the cursor back into
        page 1.

In addition to the main arrow keys: the keys 1 to 4 move the cursor
diagonally as shown below;
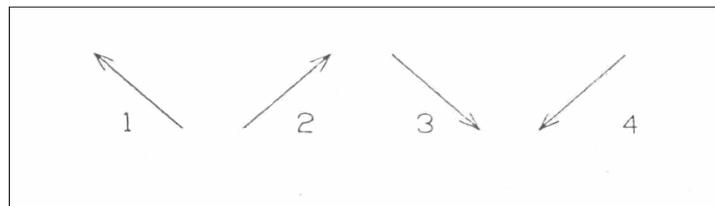
Figure 1.

(x)   Practice moving the cursor over the layout area using the eight
        Cursor keys, (keys 1 to 8).

```
LESSON 2: PLACING PADS
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(i)      Press 'G' to toggle the transparent layout GRID ON and OFF a few
         times. Finally leave the grid ON;
         Note: Adjust your TV contrast and brightness controls to give an
         acceptable display for both the 'grid on' and 'grid off'
         screens. A low contrast setting generally gives the best and
         least tiring display.

(ii)     Move the cursor to (0,0);

(iii)    Press [CS]2 (Cap Shift and '2' key together). PAD CARD 2 is
         displayed. Select pad 'J'. Move cursor to (18,0).

(iv)     Press [CS]2 and select pad 'K';

(v)      Move cursor to (18,20);

(vi)     Press [CS]2 and select pad 'L';

(vii)    Move cursor to (0,20);

(viii)   Press [CS]2 and select pad 'M';

(ix)     Move cursor to (3,3);

(x)      Press [CS]1 and select pad 'I';

(xi)     Move cursor to (5,3) and press SPACE BAR (SP);

(xii)    Move cursor to (7.7) press (SP);

(xiii)   Move cursor to (9.3) press (SP);

(xiv)    Press [SS]N (symbol shift and the 'N' key together) The prompt
         'ICON OVER ON' appears. Press any key except ENTER and the
         prompt 'ICON OVER OFF' is shown. Select 'OVER ON'.

         The 'OVER ON' function allows pads to be over printed in a
         special way. (For the technically minded; the pixels already on
         screen are EXCLUSIVE 0RED with the pixels making up a pad. So
         placing a pad on top of the same pad already on screen, results
         in NO pad! and placing a small pad over a bigger pad results in
         an open pad.)

(xv)     With the cursor still at (9.3); press the space bar and the pad
         disappears. Press it again and it reappears!
         This is a useful function as it allows an incorrectly placed pad
         to be quickly removed and replaced correctly.
```

WITH 'OVER ON' THE SPACE BAR PLACES OR DELETES THE CURRENTLY
          SELECTED PAD AT THE 'CURSOR POSITION'

(xvi)   Place the current pad (pad 'I', CARD 1) at (9,7); (7,3); (5,7)
         and (3,7) (ie move the cursor to each coordinate and press
         (SP)).

(xvii)   Move the cursor to (5,11), Press [CS]1 and select pad 'A';

(xviii) Place this same pad at the following co-ordinates:
              (5,12); (5,13); (5,14; and (8,11); (8,12); (8,13); (8,14)

(xix)   Move the cursor to (2,17), press [CS]1 and select pad 'G' ;

(xx)   Place the same pad at co-ords, (3,16) and (3,18)

(xxi)   Move the cursor to (5,16) and press [CS]1 and select pad 'K';

(xxii)   Place the same pad at (8,16).

You should now have 21 pads and 4 corners on the screen as shown below
in figure 2:
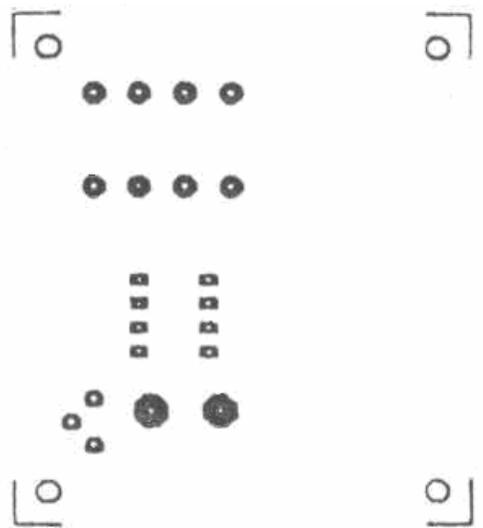
          Figure 2: How your layout should look at this stage.

If you wish to take a break, save the present state of your layout, it
is needed for the following lessons.
 To do this:
Ensure you are on the page containing your layout.... press 'M' for
Main Menu and ENTER 'Y' to the prompt "SAVE THIS SCREEN?". Type in a
suitable file name such as 'FIRSTPCB'. (See saving/loading layouts for
more info.)

LESSON 3: LAYING TRACKS ON SCREEN

ENTERING PLOT MODE

(i)   Press key 'Q' (plot);

   After a brief pause, as the present layout is saved to memory, a
   small flashing square will appear, (similar to the cursor in cursor
   mode). The page ID and co-ords disappear and 'PEN OFF' appears at
   the bottom of the screen.
   The flashing square represents the 'nib of the pen' and this can be
   changed to several different widths to suit various track sizes. The
   pen can be ON; OFF; or set to ERASE. Also the plotting speed of the
   pen can be altered to 'very slow', 'slow', 'medium', 'fast' or 'very
   fast'. For fine work a medium to slow speed is probably best,
   whereas for drawing long lines and moving around the screen, a
   'fast' to 'very fast' speed setting is more suitable.

   SELECTING TRACK WlDTH
   The width of the 'pen nib' and hence the width of the track drawn on
   screen is selected by [SS]W:
   Press [SS}W and the prompt 'LINE WIDTH IN MM' is displayed. Pressing
   any key except 'ENTER', will change the current width setting
   progressively between values of 0.3 mm to 5.1 mm. These values
   relate approximately to the final printout track widths. To select
   the currently displayed width, press 'ENTER'.

    SELECTING PLOT SPEED

(ii) Press [SS]Q (for plot speed); 'PLOT SPEED: VERY SLOW' appears.

(iii) Press any key except ENTER until 'VERY FAST' appears and then
      press ENTER.

(iv) Hold down direction key 8;
      Notice how the screen scrolls to the left as the pen reaches the
      right hand edge of the screen. Continue moving the pen right until
      the 'OFF PCB AREA' prompt appears.

(v)   Hold down key 5 until your PCB layout reappears.
      Practice moving the pen around the screen in various directions,
      Note 'PEN OFF' should still be displayed. Change the width and speed
      settings. Finally return the speed value to 'medium' and the width
      value to '0.6 mm' before continuing.

(vi) Using figure 3 below for reference, have a go at laying the track
      labelled 1;
    To do this, move the pen to the top of pad A in fig 3. Keep the
    'nib' in line with the centre of the pad, (do not place it directly
    over the centre hole otherwise the hole will be filled in!), and
    press key 9 for 'PEN ON'.

    'PEN ON' is how displaced at the bottom of the screen.

    Press the up arrow key (KEY 7). (note: A press and release action
    gives a more controlled feel to the pen, rather than continually
    pressing on the key.), until the nib is in line with the centre of
    pad B and then press key 8, to move right, until the nib touches pad
    B. Now press 'N' (over) for PEN OFF. 'PEN OFF' should now be
    displayed on screen.

(vii) Attempt to draw in the tracks 2, 3, and 5 as shown below in figure
   3:
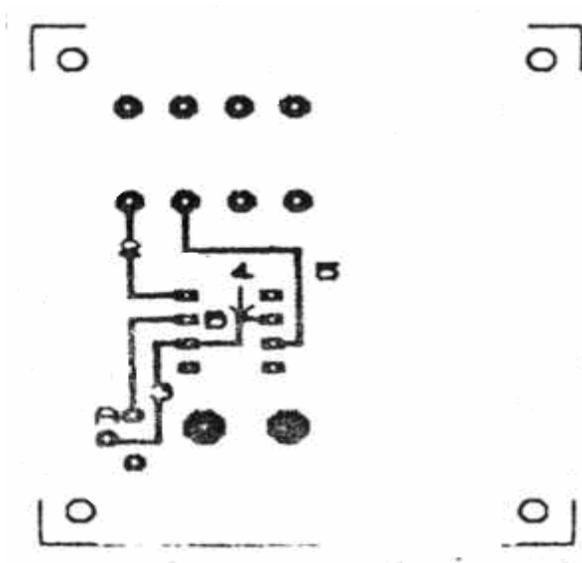
Figure 3.

If the pen over shoots a required position, press key '0' for 'PEN
ERASE' and retrace back, along the track until the correct position is
reached, and then reselect 'PEN ON'.

USEFUL TIP:
To overcome errors in the 'pen plotting', such as overrunning onto a
pad resulting in pad obliteration, it is a good practice to
occasionally scroll the screen by moving the pen over an adjacent
screen edge and back again (do this with the PEN OFF of course!). This
action causes all the current screens to be saved to memory. Any errors
can then be removed by restoring the 'OLD' screen by pressing [SS]S
(restore).
It is of course also possible to repair a pad by erasing it and
replacing it in cursor mode.

(viii) Press 'PEN OFF' 'N', and select 1.3 mm track width, ([SS]W),
       attempt to draw the tracks 6 to 11 shown on figure 4 below.
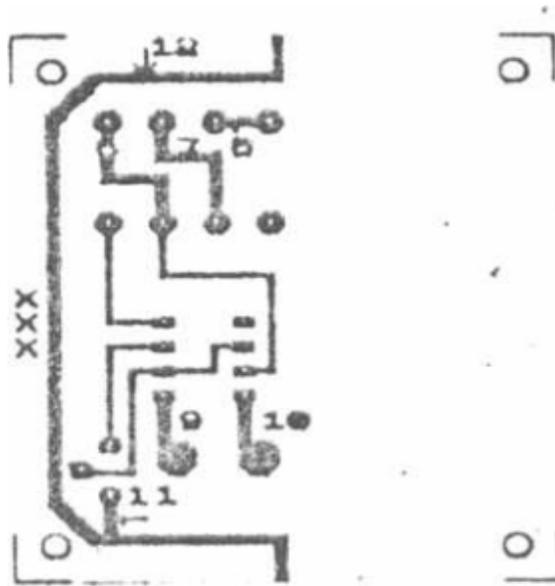
Figure 4.

If you wish to take a break, save the present state of your layout, as
it is needed for the following lessons.

LESSON 4: FILLING IN LARGE AREAS

(i)   Draw in track 12 as shown in figure 4 overleaf: Use a pen width of
        1.3 mm, as in the last part of lesson 3;
        Ensure that track 12 contains no gaps otherwise when the 'FILL'
        command is invoked, the ink will leak into the rest of the
        drawing.

(ii)   Select 'PEN OFF','N', and move the cursor inside track 12 loop,
        (eg. position 'xxx' in figure 4.)

(iii)   Press 'F' to 'Fill' the enclosed area.

UNFILL

To stop the filling operation while the fill is taking place, press any
key, and the layout will revert back to the previous state.
If the fill operation is complete and you wish to revert back to the
previous condition press [SS]S (restore).

(iv)   Practice filling and restoring the layout a few times. Finish by
        filling the area enclosed by track 12.

The state of your layout should be as shown below in figure 5:
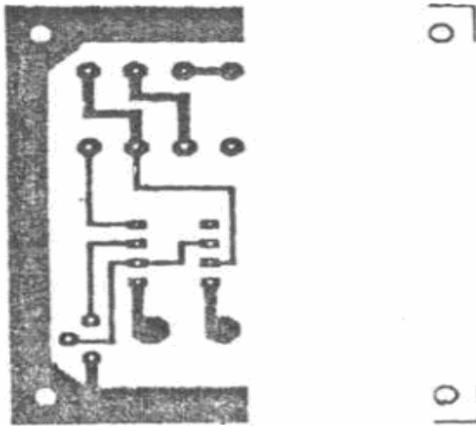
Figure 5.

LESSON 5: DELETING TRACKS

There are two ways to delete an unwanted track, they are:
(a) Use 'PEN ERASE',(ie key O) and retrace the track, thus deleting it
manually;
(b) Cut off the track at each end and use the auto delete to erase the
track.

The first method is obvious and will not be practiced here. The second
method will be looked at further:
We will delete track 5 of your layout, (don't worry it can be restored
again afterwards).

(i)   Set PEN WIDTH [SS]W, to 0.6 mm, and with 'PEN OFF', move the 'nib'
        to track 5 and press [SS]D for 'Delete';
        Notice that the whole of track 5 together with the attached pads
        is deleted. This is useful if you want to remove the pads as well!

(ii) Restore your original layout by pressing [SS]S

(iii) Now move the pen to one end of track 5 and cut through the track
        just before the pad, using 'PEN ERASE' (i.e. key O). Do the same
        for the other end of the track. Remember to turn the pen off while
        you move the pen.

See figure 6 below to clarify this:
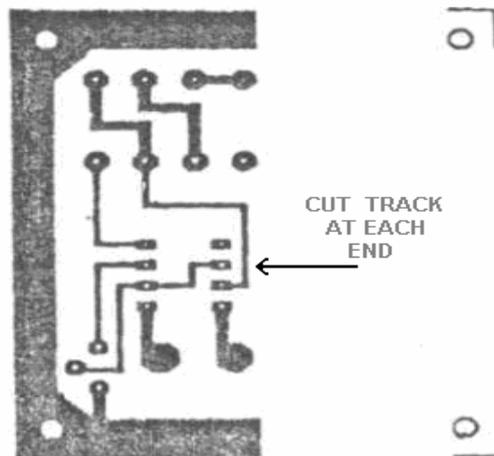
Figure 6.

(iv)   Now place the 'nib' on track 5 and press [SS]D. The track should
        neatly disappear, leaving the pads intact.

(v)   Press [SS]S to restore your old layout.

You will have to repair the cut ends of the track by turning the pen ON
at each end.

Useful hint:
To delete parts of a layout eg. when modifying an existing layout, the
delete facility can be very useful. As several parts of the layout can
be removed quickly and selectively.
This can be done by drawing a line through all of the parts to be
removed. Ensuring that only the unwanted parts are linked, the pen is
then lined up on an unwanted part and [SS]D is pressed. The unwanted
bits magically disappear.

Note: When using the RESTORE facility:
Prior to executing the auto delete action, the existing layout is
automatically saved to memory. After drawing a line through a layout as
in the above case, auto deleting, and then restoring will return the
old layout line and all!

So if a layout is to be modified in this way ensure that a copy has
been saved to disc (tape), beforehand just in case you wish to restore
the original.

If you wish to take a break, save the present state of your layout, if
you have not already done so, as it is needed for the following lessons.
To do this: press 'C' to go back to cursor mode;
then press 'M' for Main Menu;
Select option 1 / SAVE LAYOUT;
and ENTER a suitable file name such as 'FIRSTPCB'.

LESSON 6; COPYING AND MOVING A BLOCK

(i)   Press 'C' to return to Cursor mode;
       Page 1 should appear. Move into page 1 if you are on a different
       page.

COPYING A LAYOUT BLOCK

Ensure your layout is still on screen. If it isn't, load it from
disc/tape.

(ii) Move the cursor to co-ordinates (0,0) and press [SS]Z (copy key);

NOTE:
The present cursor position is the START of the block. The start
position of all block operations is the top left hand corner; The end
position of a block is always the bottom right hand corner.
The prompt: "COPY SCREEN BLOCK Y/N?" appears....

(iii) ENTER 'Y' or Yes;
The prompt: "MOVE CURSOR TO END OF BLOCK & ENTER" is now given.

(iv) Move the 'cursor to position 'END1' shown in figure 7 below;

This is the bottom RH side of the filled in area of your layout.

(v)   Press ENTER

The prompt: "M0VE CURSOR TO DESTINATION" appears at the bottom of the
screen.
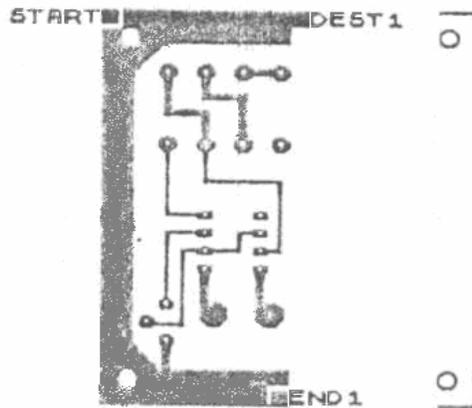
Figure 7.

(vi) Move the cursor to position 'DEST1' shown in figur 7 overleaf
      and press ENTER.
      After a brief pause the block is copied across to the
      destination requested.

The layout now appears as figure 8 below:
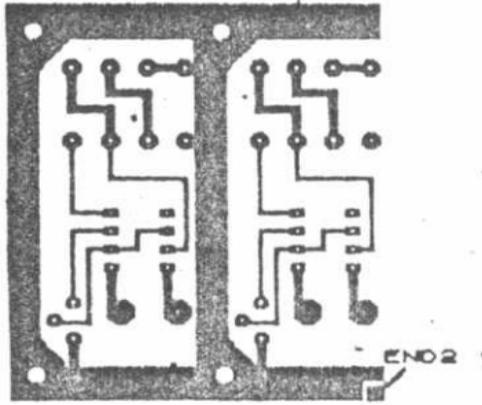
Figure 8.

MOVING A BLOCK

To MOVE a block the same procedure as above is carried out, except that
after pressing the 'Z' (copy key), enter 'N' to the prompt "COPY SCREEN
BLOCK Y/N ?", the prompt is then changed to "MOVE SCREEN BLOCK Y/N ?";
Entering Y will invoke the MOVE BLOCK routine which is identical to the
procedure above from (iv) onwards.

LESSON 7 : MIRROR A BLOCK

(i)   Still in CURSOR MODE move the cursor to (10,0) and press [SS]M for
        'Mirror'; The prompt: "MIRROR IN 'Y' DIRECTION Y/N ?" is issued.

(ii)   ENTER 'N' or 'No';
        The prompt changes to: "MIRROR IN 'X' DIRECTION Y/N ?"

(iii)   ENTER 'Y' or 'Yes';
        A further prompt, "MOVE CURSOR TO END OF BLOCK & ENTER" appears.

(iv)   Move the cursor to position END 2 of your layout, shown in figure
        8 overleaf, and press ENTER.

The layout should now appear like figure 9 below:
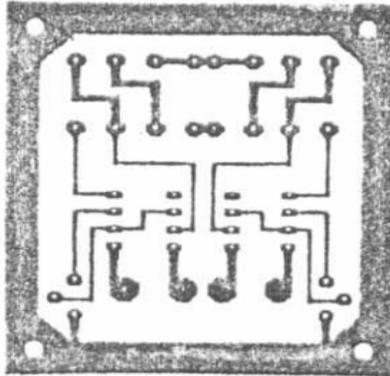
Figure 9.

LESSON 8: ROTATE A BLOCK

(i)   In CURSOR MODE move the cursor to the top left hand corner of
       the pcb (10,0) and press [SS]R for 'Rotate';

(ii)   The prompt: "Rotate block Y/N ?" appears.

(iii) Enter 'Y' or 'Yes';
       The prompt then changes to "MOVE CURSOR TO END OF BLOCK &
       ENTER";

(iv)   Move the cursor to the bottom RH corner of the pcb layout and
       press 'ENTER'.

The top of the screen will momentarily flash and then the block will
turn through 90°.

Use this facility with care as the rotated block can wipe out
overlapping areas of the layout. Ie. Be careful when rotating parts of
a larger overall layout. See figure 10 below:
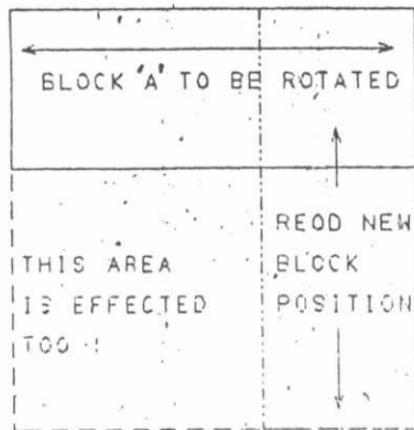
Figure 10.

The Rotate Block command rotates a square section of the layout.
Therefore use with caution when rotatig rectangular blocks.

LESSON 9:   SAVING & LOADING PCB DRAFTS

There are two methods of saving a layout depending on the size of the
draft.
They are:

(a)   Single screen saves: Used when a draft is confined to one
       'page' only;
and,
(b)   Complete layout area save: Used when a layout covers several
       screens;

The reason, for giving these two options is to save disc/tape storage
space where possible and to reduce saving and loading times
particularly with tape based systems.
REMEMBER only use the single screen save facility when your draft
covers one screen only!

SINGLE SCREEN SAVE:

To save a small layout in this way:

(i) Go to CURSOR MODE, if you are not already there and move into the
     screen containing your layout, then type 'M' for 'MAIN MENU';

(ii) The prompt "SAVE THIS SCREEN Y/N ?" appears, type 'Y' and enter a
     suitable file name. The current layout as seen on screen will be
     saved to disc/tape. The main MENU is then entered.

To load a previously saved single screen,

(iii) Select 'LOAD SCREEN' from the main menu. The prompt "ARE YOU
      SURE" is displayed. (this is to prevent accidental overwriting of a
      current layout);

(iv) Enter 'Y' and you are asked to 'enter layout name', type the
     required file name and ENTER, and the prompt "ENTER PAGE 1 TO 4" is
     shown;

(v) Enter a page number 1 to 4 and the file is loaded to the
     corresponding screen;

The program automatically enters the PCB EDITOR in cursor mode
displaying the current screen.

```
NORMAL FULL LAYOUT SAVE:
------------------------

To save a current layout to tape/disk ;

(i)   In cursor mode, select 'M' for 'Main Menu' and the
      prompt "SAVE THIS SCREEN Y/N ?" is displayed;

(ii)  Enter 'N' for the main menu. Select 'SAVE LAYOUT' and the
      prompt "ENTER LAYOUT NAME" appears;

(iii) Enter a name up to 10 characters long. The layout is saved
      /verified and then the menu is redisplayed.


To load a layout from tape/disk;;

(iv)  Go to main menu and select 'LOAD LAYOUT'. Answer 'Y' to the
      prompt "ARE YOU SURE Y/N ?";

(v)   Enter the required layout name as requested. The layout loads
      and the MENU is re-entered.

NOTE: IF A LAYOUT FAILS TO LOAD DUE TO INCORRECT FILE NAME ENTRY FOR
EXAMPLE, THEN THE PROGRAM WILL DEFAULT TO BASIC. TO RE-ENTER THE MENU
ENTER 'GOTO 20'.
```

LESSON 10: USER GENERATED PADS

'PCB DESIGNER' has the facility for producing custom pcb pads and
motifs. These user made pads will be referred to as 'USER ICONS'. It is
possible to save 10 icons (0-9) each of maximum size of 0.5" * 0.5" (5
by 5 grid squares), in each user icon library.

There are two methods of producing these 'user icons':

(1)   From within the PCB EDITOR, using the track layout in
        'plotmode';

[2]   Using the separate supplied program 'ICON MAKER'. Both methods
        will be practiced here:

1/ USER ICONS WITHIN THE PCB EDITOR:

Enter the PCB Editor from the main menu and press 'Q' for PLOT MODE.

(i)   Select 'GRID ON' by pressing 'G'. Select the smallest pen width
        [SS]W and draw the outline of a motif or pad shape. Use the
        'FILL' facility or a thicker pen width to fill in the 'pad'.
        The motif should be no larger than 0 .3" x 0.5" ie. five by five
grid squares.
        You will find it easier to select a slow pen speed for this task.

(ii) When you are 'happy' with your motif, select 'C' for cursor mode
and move the cursor to the top LH corner of the image and   press [SS]
L. Enter 'Y' to the prompt: "STORE A NEW ICON Y/N   ?";

(iii) "ENTER USER ICON 0-9" now appears at the bottom of the screen.
        Enter a number, say '0' as this is your first icon!

(iv)   The prompt "MOVE CURSOR TO ICON END" is shown. Do this by
        moving the cursor to the bottom RH corner of your motif and press
'ENTER'.

(v)   The motif is saved to memory as 'user icon 0'. The message at
        the bottom of the screen changes to 'ICON STORED; ANY KEY TO
        CONTINUE'. Press a key to return control back to the cursor.

(vi)   Check to see if your icon has been placed in memory by
        displaying the "USER ICON LIBRARY" [CS]5.

To use your new icon at any time, you can either select the 'USER ICON LIBRARY' [CS]5 and select the appropriate letter, or simply press [SS]0-9.

NOTE: When 'PCB DESIGNER' is quitted at the end of a session, all user generated icons will be lost. It is therefore advisable to save user icons to tape/disc immediately after creation. See below:

SAVING AND LOADING USER ICONS:
Once you have produced some useful user icons they can be saved to tape/disk for subsequent use. This is similar to saving and loading pcb files from the main menu and will not be considered further.

2/ USING THE ICONMAKER PROGRAM

LESSON 11:

ICONMAKER is a program to help you easily design your own symbols, pads, and components called 'icons'. You can easily design up to ten 'icons' per. 'card' and save several cards under different file names, eg: 'CMOS-ICONS', 'TX-ICONS', 'RELAY ICONS' etc. It is a good idea to use 'icons' as a prefix or suffix in the filename, as then no confusion over the file types can arise. User icon cards can then be loaded into PCB, DIAGRAM, and LAYOUT as a fifth set of symbols, and called up by [CS]5 (ie. holding down capshift then pressing S.)

TO RUN ICONMAKER

CASSETTE VERSION:
RESET your Spectrum and type: LOAD "ICONMAKER" then ENTER.

DISC/MD VERSIONS:
Select 'ICONMAKER' (option 2) from the MAIN MENU.

On loading you are presented with the main menu as shown below;

ICON GENERATOR
1/ LOAD ICONS;
2/ DISC DIRECTORY;
3/ SAVE NEW ICONS;
4/ ENTER ICON EDITOR.

(i)   ENTER 4: the screen clears and a large layout grid and smaller
        box appear on screen. Notice the small flushing cursor at the
        bottom LH corner of both boxes. This represents your "DRAWING
        PEN". The current 'PEN STATUS' is shown in the bottom RH
        corner, this should show 'PEN OFF' at, the moment.

(ii)   Move the 'PEN' around the grid by pressing the direction keys
        1-8. Notice how the cursor in the small square follows
        precisely the movement of the 'PEN'.

The grid area and corresponding small square represent the maximum
0.5" x 0.5" printed size of a 'USER ICON'. The small squares on the
grid represent a single 'pixel' (smallest picture element). The 25
larger squares each form a character of 6 by 8 pixels (0.1" x 0.1"
when printed out).
Pads can be made by simply filling in areas of the grid with the
'PEN'.

The commands available in "ICON MAKER" are listed below:

```
keypress          function
-------------------------------------------------------------
1-8       direction keys: moves the pen or scrolls the icon in  eight
          compass directions.
0         PEN ERASER 0N: wipes out areas of the icon as the pen moves.
9         PEN ON: fills in a pixel square as the pen moves.
D         Delete filled in area. (use with care!)
F         Fill enclosed area. (use with care!)
G         0.1" grid ON/OFF.
N         PEN OFF.
Q         QUIT editor, the current icon is lost.
[SS] 0-9  GET ICON 'n' from icon library for editing.
[SS] L    Store current USER icon in library.
[SS] Q    PLOT speed: used to adjust pen speed.
[SS] R    Enter scRoll mode: current grid contents are scrolled using
cursor keys (1-8). Useful to position icons     accurately on the 0.1"
grid.
          In fact any pads < 0.5" x 0.5" within PCB DESIGNER can be
          saved as icons and transferred to ICON MAKER and scrolled
          to a different
          grid position, and then resaved as a USER icon.
          Using this facility, pads can be placed over any grid
          position within 1/80th of an inch.


[SS] R    Leave scRoll mode
[SS] S    Restore key: Restore previous state of icon before a Fill
          or Delete operation
[SS] V    CLS: Clear current grid contents
[SS] 5    Show ICON library
```

(iii) Enter the ICON EDITOR if you are not there already and press '9'
       for 'PEN ON'. Draw something in the grid area and notice a
       smaller version of your drawing in the small box.

(iv)   Press [SS]V to clear the screen. You are prompted to verify that
       you wish to clear the current icon. Enter 'Y', and your 'artistic
       efforts' disappear for ever!

(v)   Using 'PEN ON'; 'PEN OFF'; &'PEN ERASE' where every necessary,
       draw the pad shape shown below: N.B. Use [SS]Q to slow the pen
   speed if you find the plot speed too fast for comfort.
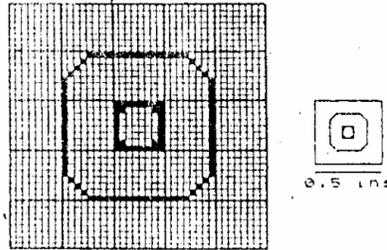
Figure 11: drawing a pad outline

(vi)   Having drawn the pad outline we will now fill it in. To do this
       press 'N' for 'PEN OFF' and move the pen to the center of the
       area to be filled. Press 'F' for 'FILL', and the pad should have
       a similar shape to the pad shown in figure 12.

       NOTE : If the fill leaked into the wrong part of the pad pres
       [SS]S (restore key), to restore the previous state of the icon.

(vii) Now we will position the pad to fit between the 0.1" grid, using
       the 'scRoll' mode. To do this press [SS]R and move the pad to the
   position shown in figure 12 overleaf.
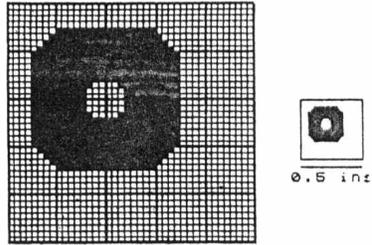
Fig 12: ScRolling the pad to a new position.

(viii) Now to store the pad in the 'USER ICON LIBRARY', Press [SS]L and
ENTER 'Y' to the prompt; "STORE A NEW ICON Y/N?". The prompt
changes to "ENTER USER ICON 0-9"

(ix) ENTER any number from 0 to 9 as the library is empty at present.
(0 is perhaps the ideal number for the first entry). The promp
again changes to "ICON STORED: ANY KEY TO CONTINUE" . Press a key.

(x) To view the library contents; Press [CS]5. You should see your
beautiful piece of work placed neatly in the library!

(xi) We will now clear the layout area and recall your pad from the
library; to do this go back to the grid layout if you are still
viewing the library, by pressing 'ENTER'. Press [SS]V, and answer
'Y' to the prompt "CLS: ARE YOU SURE Y/N? ". The grid layout
clears.

(xii) Now re select your icon number 'n' by pressing [SS] 'n'. Your PAD
appears back on the layout screen.

(xiii) An alternative way to select an ICON from the library is to view
the library [CS]5; and select the corresponding letter.

(xiv) Play about with the editor commands as listed on page 25. If you feel up to it at this moment in time, create some useful pads to suit RELAYS, PCB SWITCHES, MINIATURE TRANSFORMERS, D-TYPE connectors, ETC.

(xv) To Quit the icon editor at any time (except when in scRoll mode), Press 'Q', and answer 'Y' to the prompt. You will be returned immediately to the main menau. Remember to save to tape/disc any ICONS you wish to keep.

LESSON 12: USING THE EPSON PRINTER (OR COMPATIBLE) PRINTER ROUTINE

The built in 'LAYOUT' and 'DIAGRAM' printer routine prints your work
the same way up as it appears on screen and can be used as a final
hardcopy. However the printer routine within 'PCB' prints a mirror
image of draft quality only, and is used for checking dimensions etc.
prior to final printing in the main 'PRINTER' program.

NOTE: The mirror image printout was adopted to keep ..xt the right way
round, ie. on the copper side of the PCB. If you prefer to draft your
layout looking from the top (component side) rather than the copper
side then it will be necessary to MIRROR your final work prior to
printing.
Remember that any text will need to be mirrored separately if you do
this!
This also applies to work from DIAGRAM or LAYOUT. For example: if you
wish to print (a circuit diagram DOUBLE SIZED you will have to 'X
mirror' the whole layout prior to entering the 'PRINTER' program.
Note all user generated diagrams or layouts will be generally referred
to as 'layouts' for the rest of this lesson.

TO PRINT YOUR WORK FROM WITHIN PCB, DIAGRAM or LAYOUT

The printer routines are invoked in an identical manner in PCB,
DIAGRAM, and LAYOUT. The fllowing therefore applies to each:

(i)   LOAD 'PCB','DIAGRAM', OR 'LAYOUT' and to the prompt "layout
       name ?" enter a name up to 10 characters long. You could simply
       enter the date if you wish. This name will appear on the printed
       layout.

(ii)   Load the layout you wish to print by selecting '4' or '5' from the
       program menu. If you are already working on a layout make sure you
       have saved it prior to using the printer.

(iii) Enter the LAYOUT EDITOR: Press '3' from the menu.

(iv)   The display will jump into your layout, and default to 'CURSOR
       MODE'. If you are happy that the correct layout has loaded and
       there are no glaring errors present, press [SS]C (Lprint key) to
       invoke the built in printer routine.

(v)   The prompt "PRESS A KEY TO PRINT" appears at the bottom of the
       screen. After a brief pause the printer should print a copyright
       message, the layout name, and then the layout proper.
(vi)   As soon as the printer has printed the layout, the screen returns
       back to the layout editor.

(vii) Check the quick printout for any unforseen errors in track
       spacing, missing pads etc. When you are happy with the layout you
       can use the main 'PRINTER' program to produce a final dense 'x1'
       or large 'x2' hardcopy.

USING THE SEPARATE PRINTER PROGRAM

TO RUN 'PRINTER':

From TAPE:...... LOAD "PRINTER" then ENTER

From DISC:...... SELECT 'PRINTER' from the MAIN MENU
On loading the following menu options are presented:

              1/   LOAD LAYOUT;
              2/   DISC DIRECTORY;
              3/   QUICK PRINT;
              4/   NORMAL PRINT;
              5/   DOUBLE SIZE;
              6/   MAIN MENU.

'PRINTER' enables you to print high quality hard copies of your work in
1:1 or 2:1 magnification. As the program has been optimised for PCB
layouts, one attribute square on the original draf corresponds to 0.1"
x 0.1" in NORMAL mode (ie. 1:1),or 0.2" x 0.2" in DOUBLE SIZE mode (ie.
2:1).
The 'DOUBLE SIZE' option contains an elaborate routine that smooths out
jagged diagonals resulting in a high quality hard copy requiring 2:1
photo reduction. The results obtainable are of a quality suitable for
small professional printed circuit boards.
The 'NORMAL' hard copy can be used directly as a positive for ULTRA
VIOLET LIGHT exposure, where the inked parts form 'opaque' areas and
the paper forms a light transmissive base. The hardcopy from PRINTER is
capable of producing very dense print but ultimately the results depend
on the quality of the printer ribbon and paper. A thin paper with small
fibres produces far better results than a cheaper grade.

Quick Print produces a draft output for checking dimensions
/orientation etc.

EXAMPLE: You wish to produce a single prototype PCB from the layout
already saved under the filename "DEMOPCBT":

1) LOAD the 'PRINTER' program and when the menu appears select (1) to
   LOAD your layout. You are prompted to enter the LAYOUT NAME;

2) Type 'DEMQPCB' then ENTER;
   You are then asked to enter the date (this is useful if you are a
   prolific pcb designer as it helps you to identify the various
   versions you have produced over a period of time.)

3) Enter todays date eg. '2-5/2/89' (or, any comment up to 10
   characters long.)
   The layout loads and control is returned to the menu.

4) Select 'NORMAL PRINT'.
   You are now prompted to enter a PRINTOVER number from 1 to 3.
   PRINTOVER is the number of times the head prints across the paper
   before executing a paper feed. Normally one pass is enough with a
   new ribbon. The contrast of the printed image increases with larger
   printover value, however the time to complete a hard copy also
   increases in proportion.

5) Type '1' then ENTER;

6) You are now asked to enter the required DENSITY MODE, '3' for QUAD
   DENSITY or '4' for NORMAL DENSITY. 'MODE 3' prints 240 dpi (dots per
   inch) and 'MODE 4' prints 80 dpi in the horizontal direction. Mode 3
   produces a very dense hardcopy but can blur closely spaced tracks
   when printing in 1:1.
   Type 3 or 4 then ENTER.

7) Your printer should now burst into life and print a copyright
   message followed by the layout name and the date. Finally the layout
   will be produced. This process can take 15 minutes to print a 1:1
   layout or over an hour to print a 2:1 hard copy. The actual time
   taken depends on the printer, and the various modes selected.

Note: If you' have problems getting a correct hardcopy see the HELP
page overleaf:

PRINTER HELP

SYMPTOMS: CHECK

1 No printer output from any program: is this version correct for your
                                       centronic interface?-

2 Prints garbage: is your printer EPSON compatible?
                                       see printer pokes (p35)

3 Prints ok but dimensions are wrong: your printer is probably not EPSON
                                       compatible, head pin spacing must be
                                       1/72" and print 80 or 240 dpi
                                       horizontally.

4 Leaves a gap after each line: turn off AUTO PAPER or LINE FEED
                                       DIP switch on printer.

5 Part of layout is not printed   normal for 80 column printers!
  in DOUBLE PRINT mode: 0.8" approx. is lost from width.

6 Printer prints ok for first prints   Reset printer (switch off/on).
  but then prints characters instead
  of graphics:

7 Printer head pauses in mid travel   Normal with some printers due to
  and then continues. Especially in   the small buffer size and large
  quad density mode: amount of data per line. Printout
                                       should be perfectly ok however.

8 Printer takes a long time to print   Yes it does, particularly with
  a DOUBLE SIZE layout!   older printers. However this is
                                       usually no longer than a proper
                                       profesionnal plotter would take
                                       to do a similar sized layout!

```
HINTS FOR PRODUCING CONSISTENT RESULTS
--------------------------------------


It is not the intention of this manual to give a description of PCB
manufacture. However a few simple hints will be mentioned to help the
user produce consistent results.

Use:

(i)    'POSITIVE PHOTORESIST COATED COPPER LAMINATE';

(ii)   An ULTRA VIOLET LIGHT EXPOSURE BOX or (UV Lamp 12" above the
       surface of the layout/pcb);


(iii)  Correct-strength 'Sodium Hydroxide' developer solution;

(iv)   Fresh copper etchant solution usually 'FERRIC CHLORIDE';

(v)    Thin reasonably transparent printer paper. It is essential to
       choose a suitable grade of paper. Thick fibrous, grades produce
       very poor results.

(vi)   A good printer ribbon.


If you are fairly experienced in making PCB boards using drafting
tapes, and clear film, and familiar with typical exposure times for
such methods, then using the printout from 'PCB DESIGNER' directly will
require exposure times of at least 3 to 4 times that normally used.
This is necessary to allow the UV time to penetrate the paper. In a
typical UV box exposure times from 10 to 12 minutes are required.
The way to get the ultimate results is to experiment with different
exposure times, printer paper, etc., until you get consistently good
PCBs.
PCB DESIGNER has been used continuously for well over 12 months prior
to publication and has indeed produced good results.
```

DOUBLE SIDED DRAFTS

'PCB DESIGNER (spectrum version)', will only allow a single side to be
drafted at any one time. This is due to the limitation of the ZX
Spectrum colour screen. However it is still possible to produce double
sided layouts by laying out each side separately. To do this carry out
the following:

(i)   Start the draft by placing all the pads down first;

(ii)   When you are happy with the pad layout, save it to tape/disk;

(iii) Draft the bottom layout (non component side), with any awkward
       tracks that can't be fitted, reserved for the top layout.

(iv)   Save the layout, then 'QUICK PRINT' the bottom layer;

(v)   Load back the previous pad layout and proceed to draft the top
       layout, using the printout and corresponding pads as a guide.

```
PRINTER COMPATIBILITY
---------------------


PCB DESIGNER is capable of producing good quality printed output. To
ensure you obtain the best results possible, use a good ribbon and high
quality paper (ie. A grade with small fibres), the thinner the better.
The printer must be compatible with the Epson RX/FX/LX pin printers,
otherwise when using the printer routines the printer will either print
garbage or the final results will be dimensionally incorrect. The
essential parameters being as follows:
(1) CENTRONIC. (IE. PARALLEL) PORT;
(2) Vertical pin spacing (actuel head pin spacing) 1/72";
(3) Horizontal dot pitch. 80 dots per inch or integral multiples
    of 80 ie. 160 DPI or 240 DPI.

The Epson range of dot matrix printers use:
ESC "*" mode; n1; n2 for graphics, where mode can be 0,1,2,3 or 4.
The two modes used in PCB DESIGNER are mode 4 (80 DPI) and mode 3 (240
DPI).

Some printers only use ESC "K" (80 DPI) or ESC "L" (160 DPI ).
These printers can be accomodated , assuming pin spacing and dpi
parameters, are identical, by altering the printer drivers as described
on the following page.

WARNING: The following pokes should only be attempted on a backup copy
of PCB DESIGNER, not on the original software. It is assumed that the
user is reasonably familiar with SPECTRUM and associated BASIC COMMANDS.
DO NOT carry out these pokes if your printer IS EPSON COMPATIBLE!
```

```
MODS FOR PRINTERS NOT SUPPORTING ESC "*"
----------------------------------------


TAPE USERS: MAKE A BACKUP OF THE WHOLE TAPE using a tape copier
program, or save the files manually, details on page 37.


MD & DISCIPLE/plusD USERS: Make a backup disc. Then proceed (You will
of course need to change the LOAD and SAVE prefixes to suit your
system).
OPUS DISCOVERY users see pages 37 & 38. Do not use these POKES!

Using the backup: CAREFULLY alter the following files as directed.
(NOTE: remember to press ENTER after each entry)

Enter: CLEAR 26899

LOAD "C1" CODE
POKE 33276,75 ........(CHANGES MODE TO "K") ,
POKE 33280,0.: POKE 33281,0: POKE 33282,0: POKE 33283,0
POKE 33284,0 .......(CLEARS UNWANTED CODE)
Rewind tape to start of "C1"
SAVE "C1" CODE 26900,8570

LOAD "D1" CODE
POKE 33279,75 .........(CHANGES MODE TO "K")
POKE 33283,0: P0KE 33284,0: POKE 33285,0: POKE 33286,0
POKE 33287,0 ..........(CLEARS UNWANTED CODE)
Rewind tape to start of "D1"
SAVE "D1" CODE 26900,8570

LOAD "L1" CODE
POKE 33279,75 ............(CHANGES MODE TO "K")
POKE 33283,0: POKE 33284,0: POKE 33285,0: POKE 33286,0
POKE 33287,0 ..........(CLEARS UNWANTED CODE)
Rewind tape to start of "L1"
SAVE "L1" CODE 26900,8570

LOAD "LP" CODE
POKE 30293,0: POKE 30294,0: POKE 30295,0
POKE 30515,0: POKE 30516,0: POKE 30517,0:
POKE 30518,0: P0K£ 30519,0 .....CLEARS UNWANTED CODE
POKE 30563, 2 .....CHANGES M0DE AND NO OF BITS
POKE 30568,192 ....FOR SINGLE AND DOUBLE DENSITY
POKE 30573, 76
POKE 30587, 75
POKE 30600, 5
POKE,30605,128
POKE 30610, 76
POKE 30668,0: POKE 30669,0: POKE 30670,0
Rewind tape to start of "LP"
SAVE "LP" CODE 29995,1600


You should now have a working copy that drives your printer.
```

POKES FOR TTL COLOUR MONITORS

Some users have TTL type monitors connected to their Spectrum system
particularly those with 128 +2 und 128 +3 computers. Unfortunately
using such monitor prevents the use of the BRIGHT range of attribute
colors and 'bright' and 'dull' white is used to form the drawing grid
in 'PCB DESIGNER'. However by poking two high luminance colours such as
'yellow and white' or 'cyan and white' in place of the existing
attributes will give a reasonably pleasing grid.

GRID ATTRIBUTE 1: POKE 29812, (8 x PAPER COL)
      (normally White ie. 56)
GRID ATTRIBUTE 2: POKE 29817, (8 x PAPER COL)
      (normally BRIGHT white ie. 120)

Example: On a particular monitor the best grid colours are cyan and
white. To change them:
Ensure you have a tape backup of PCB DESIGNER,
type LOAD "C1" CODE then ENTER;
rewind to start of file;
POKE 29817,40 then ENTER ((29812) is not altered in this example);
finally SAVE "L1" CODE 26900,8570
Make identical pokes for files 'Dl' and 'L1' (code start and length the
same as 'C1' in each case.)

PCB DESIGNER PROGRAM INFORMATION

'PCB' BASIC SHELL;
'C1' CODE 26900,8570; **'C2'** CODE 58000,7200

'PRINTER' BASIC SHELL;
'LP' CODE 29995,1600

'ICON MAKER' BAS1C SHELL;
'I1' CODE 26900,3400; ,**'I2'** CODE 57000,8100;

'DIAGRAM' BASIC SHELL;
'D1' CODE 26900,8570; **'D2'** CODE 58000,7200

'LAYOUT' BASIC-SHELL;
'L1' CODE 26900,857O; **'L2'** CODE 58000,7200

ALL PCB LAYOUTS AND CIRCUITS TAKE UP 22528 BYTES AND START AT 35470. NO
COMPACTION HAS BEEN INCLUDED AS SINGLE SCREEN SIZED-DRAWINGS CAN BE
SAVED IF REQUIRED.
USER ICONS ARE STORED AS A SINGLE BLOCK OF CODE AT 61536 AND TAKE UP
2380 BYTES.

```
OPUS DISCOVERY VERSION
----------------------

MODS FOR PRINTERS NOT SUPPORTING ESC "*"

Ensure the 'write protect' tab is up on your original disc!

Make a backup copy of the whole disc using MOVE "d";1 TO "d";2

Then CAREFULLY alter the following files as directed:

Enter: CLEAR 26899;
LOAD *1; "C1" code;
POKE 33289,75 ........(changes mode to "K")
POKE 33293,0: POKE 33294,0: POKE 33295,0: poke 33296,0
POKE 33297,0 ..........(clears unwanted code)
SAVE * 1; "C1" code 26900,8570.

LOAD *1; "D1" CODE;
POKE 33285,75 ........(changes mode to "K")
POKE 33289,0: POKE 33290,0: POKE 33291,0: POKE 33292,0
POKE 33293,0 ..........(clears unwanted code)
SAVE * l; "D1" code 26900,8570

LOAD *1; "L1" code;
POKE 33285,75 ........(changes mode to "K")
POKE 33289,0: POKE 33290,0: POKE 33291,0: POKE 33292,0
POKE 33293,0..........(clears unwanted code)
SAVE * 1; "L1" code 26900,8570

LOAD *1; "0P" code;
POKE 30296,0: POKE 30297,0: POKE 30298,0
POKE 30520,0: POKE 30521,0: POKE 30522,0
POKE 30523,0: POKE 30524,0 ...(clears unwanted code)
POKE 30568,2 ........(changes modes and no of bits)
POKE 30573,192 ......(for single and double density)
POKE 30578, 76
POKE 30592. 75
POKE 30605, 5
POKE 30610,128
POKE 30615, 76
POKE 30673,0: POKE 30674,0: POKE 30675,0
SAVE * 1; "OP" code 29995,1600

You now have a working opus discovery disk.
```

INTRODUCTION TO 'LAYOUT'

This program will enable you to produce component layouts from scratch
or from an existing pcb layout produced from 'PCB DESIGNER'. Your work
can be printed from within the program itself or exported to the main
'Printer' program.

Several components are provided in the program at the back as four icon
cards. These are illustrated at the back of this manual.
They are as follows:

ICON CARD 1: 1/4, 1/2, 1 watt; fixed/preset resistors;

ICON CARD 2: Various capacitor outlines;

ICON CARD 3: IC outlines; Diodes;

ICON CARD 4: Transistor outlines.

A fifth card shows user icons and these can be loaded from the main
menu or generated within the program.

To produce a component layout it is simply a matter of placing the
various component outlines (available in 'CURSOR' mode), in the
required order on the work area. Any components not available from the
icon library can be drawn by entering 'PLOT' mode.

A unique method of producing a component layout from an existing PCB
draft, produced from 'PCB DESIGNER', is also available. This can
produce a very pleasing result showing a 'shadow' track layout as well
as components.
See the example printouts at the back of this manual.

LESSON 13: USING LAYOUT

To produce a simple component layout :

1/ Load the 'PCB' program, not 'LAYOUT', and following the PCB 'getting
started' tutorial on page 6, draft the simple example layout and save
it.

2/ Now load the 'LAYOUT' program and select 'EDIT LAYOUT' from the
menu. (If you have not just executed '1' above, you will have to load
the example layout first.)

3/ You are now prompted to either enter the layout directly by pressing
'ENTER', or to 'THIN' the track layout that is present in memory, by
pressing 'T'. Press 'T' to 'thin' your example layout.
The screen jumps into page 1 and your previous layout is now displayed
and stored in memory as a series of dots. See figure 13 below.

From now on when entering from the main menu always select 'ENTER', do
not press the 'T' key, otherwise any components placed in the layout
will also become a series of dots!
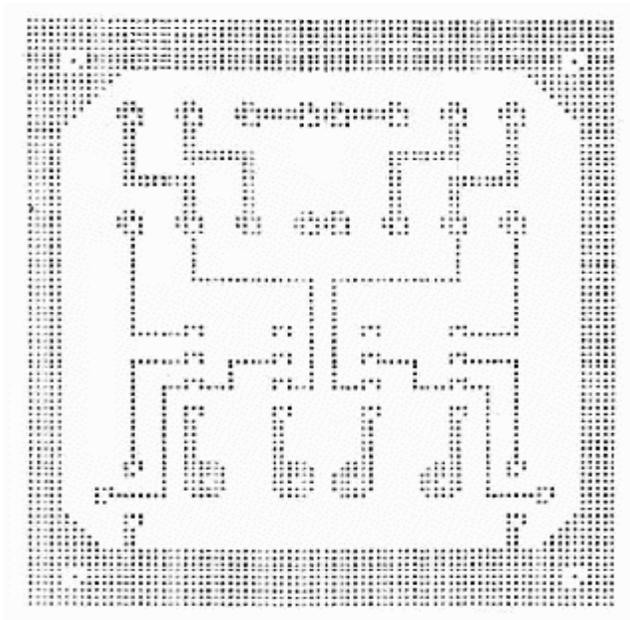
Figure 13.

4/ Move the cursor to (3,3) Press [CS]1 to display icon card 1 and
select resistor 'A'. Ensure that the 'OVER' key [SS]N is in the 'OFF'
mode, (otherwise placed components will merge with the track outline
and will be poorly defined).
Note: When producing a straight layout without a track outline, OVER
'ON' is the best setting.
A resistor should appear neatly placed across the holes in the track.

5/ Place resistors in the following positions by simply moving the
cursor to the co-ords below and pressing space:
                 (6,3); (14,3); (16,3)

6/ Move the cursor to (7,3) and select the CAPACITOR Card, [CS]2.
Select 'C' and the capacitor is placed. Now move the cursor to (12,3)
and press SPACE to insert the second capacitor.

NOTE: If you inadvertently place a component over the wrong part of the
layout, (with 'OVER' OFF so you cannot correct it by pressing SPACE
again), you can restore the old layout with the 'RESTORE' KEY [SS]S.
However you may lose some of the previously placed components. It is
advisable therefore to save the current screen to the virtual screen,
(the overall bit map area in memory) as frequently as possible. Do this
by simply moving the cursor over into another screen and back or by
simply selecting 'PREVIEW' [SS]K or SCREEN$ on the 48K Spectrum
keyboard).

7/ Move cursor to (9,3) and select diode '0' from card 3. ([CS]3 then
'0'). Move cursor to (10,3) and select diode 'P' ([CS]3 then 'P').

8/ To insert 8 pin dil ICs: move cursor to (5,11), select pad card 3
and item 'B' ([CS]3 then 'B'). Now move cursor to (11,11) and press
SPACE. (This places the top of the ICs).
Move cursor to 11,12 and select item 'A' from pad card 3, place this
item at the following cursor positions:
                 (11,13); (11,14); (4,14); (5,13); (5,12)

You now have two ICs minus their bottom edge. (These can be drawn in
later using PLOT MODE, as only a single horizontal line is required for
each.)

9/ Move the cursor to (2,16) and select pad card 4 item 'E' to select a 'left facing transitor'.
Move the cursor to (16,16) then select pad card 4 item 'F' to select a right facing transistor.

10/ TEXT can be entered in exactly the same manner as in PCB and DIAGRAM. ie. [SS]P ('PRINT' key on 48K keyboard.)
The cursor is moved to the required text position and a character is printed by pressing the relevant key. To print a word it is necessary to move the cursor each time a new character is inserted. Using this seemingly clumsy method prevents parts of the layout being overtyped in error as would be the case if text was pre-typed before being inserted. Also text can be typed in any direction.
If you wish, type in the text as shown below in figure 14. See LESSON 15 'PLACING TEXT', page 47.

11/ Finally Enter PLOT MODE (Q) ('PLOT' on 48k keyboard). Draw in the bottom of the ICs using the smallest PEN width. Also any unwanted dots can be removed to tidy up the layout as required.
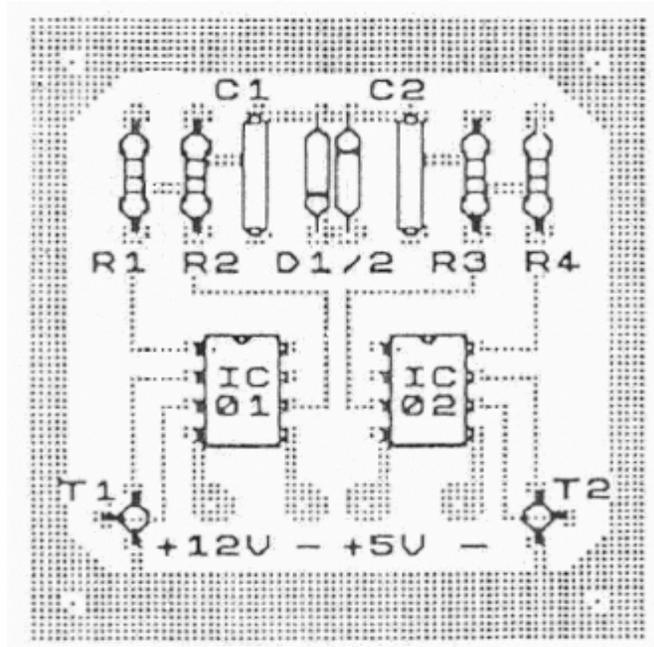

Figure 14.

12/ To print your masterpiece press [SS]C ('LPRINT' on 48K machine).
The printer will print a normal density dump or your layout.

A larger or more dense printout can be obtained by exporting your
layout to the main 'PRINTER' program.
Normally when you load in the PRINTER program after using either,
'PCB', 'LAYOUT' or 'DIAGRAM', (assuming you have not reset the machine
in the meantime!), your existing work is still retained in the virtual
screen area, the printer routine checks for the presence of either of
these programs and allows the printing of the current 'virtual screen'.
In other words there is no need to load in your work each time the
PRINTER program is invoked. Incidentally if you try to print, having
entered PRINTER from cold you will be prompted to "LOAD A LAYOUT
FIRST!".

To call up the PRINTER routine from either of the three programs, Disc
users simply-press 'M' in cursor mode to return to the program menu.
Then select '8' to return to the MAIN MENU.
Tape users first need to BREAK out of the BASIC SHELL by pressing [CS]6
and then LOAD "PRINTER".

Note: The printout from within LAYOUT is as seen on screen and not
reversed as in the PCB printout. Also dimensions are not based on 0.1"
per attribute. When printing from the PRINTER program however the
dimensions are retained and reverse printing is carried out. To print
the 'correct way round' it is necessary to first mirror the layout
before entering the PRINTER program.

Hints: If you inadvertently wipe out some of the 'track dots',
particularly in TEXT MODE and cannot recover them with 'RESTORE', it
would be extremely tedious to redraw each dot! However you could save
an 8 by 8 dot part of the layout as a 'USER ICON' and use this to patch
up the dots!

As in all the BASIC shells, it is possible to BREAK OUT, intentionally
or inadvertently, eg. when trying to load a filename that is non
existant on the current DISC. To return to the program simply type GOTO
20, this applies to all the programs except the 'run' file, (not
present on TAPE versions.)

```
INTRODUCTION TO DIAGRAM
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Diagram uses the same commands as PCB and LAYOUT. The main difference
is the library of ICONS. These allow you to draft, save, and edit
circuit diagrams without the fuss and bother of conventional pen and
ink drafting. The maximum size printout is approximately 8.8" by 12.8"
using the Double size printout. Due to the width restriction of 80
column printers approx 0.8" will be lost from, the RH side.

The electronic symbols or ICONS are stored as four CARDS in the same
way as PCB and LAYOUT see below:

ICON CARD 1: Resistors and misc parts;
ICON CARD 2: Various Transistor/Fet inductor outlines;
ICON CARD 3: Diodes, Switches, OP-AMPs, LS, etc.;
ICON CARD 4: Logic Symbols.

A fifth card shows any symbols you may have loaded/ using
the 'load user icon' option.
```

```
LESSON USING DIAGRAM
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To get a feel for the use of this program, have a go at drafting this
simple UHF mast head amplifier circuit:

1/ Load the 'DIAGRAM' program, enter EDIT MODE and insure the GRID is
ON ([SS]G) and the OVER function is ON ([SS]N) (the 'OVER' key on 48K
keyboards.)

2/ Move the cursor to (10,7) and select COMPONENT CARD d ([CS]2) and
press 'G' to select the horizontal NPN transistor.

3/ Cursor to (7,11) and select a vertical resistor, item 0 from CARD 1
([CS]1 then 0).

4/ Cursor to (10,11) and press SPACE.

5/ Cursor to (14,9) and select horizontal resistor, item L, from CARD
1([CS]1 then L).

6/ Cursor to (17,11) and select a vertical inductor, item I , from CARD
2 ([CS]2 then L).

7/ Cursor to (16,15) and select a vertical capacitor, item A, from CARD
3 {[CS]3 then A). Cursor to (12,12) and press SPACE.

8/ Cursor to (6,6) and select capacitor B from CARD 3.

9/ Cursor to (4,6) and select terminal I from CARD 1.

10/ Cursor to (4,9) and press SPACE, then repeat at (19,12) and (19,16).

11/ Now enter PLOT MODE (Q) and link up the symbols to form the circuit
shown overleaf in fig 15. {You need to select the thinnest 1ine width
for all connections except the '0 V' rail which can be thicker.)

Note how most of the component connecting points line up with the edge
of the GRID, this makes linking up very straight forward.
```

12/ Once you have made all the interconnections in PLOT MODE, return to
CURSOR MODE (C). Now move the cursor to (7,6) and select the junction
point K from CARD 1.
Press SPACE at the following locations;
                     (10,9); (12,9); and (16,9);

13/ As in LAYOUT and PCB, text can be added by entering TEXT MODE [SS]P
and placing characters at the cursor position. SEE LESSON 15 'PLACING
TEXT' page 47.
If you wish, enter the text as shown in the finished diagram, figure 15
below.
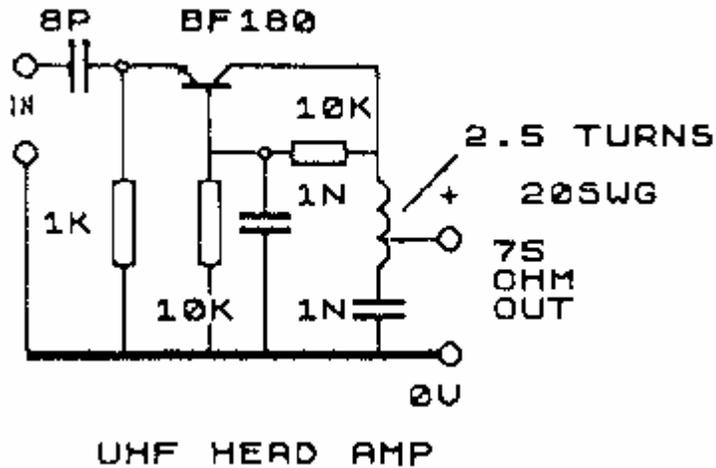
Figure 15.

LESSON 15: PLACING TEXT

In PCB, DIAGRAM and LAYOUT, the normal character set can be placed
anywhere on the 'drafting area'. Text can only be entered one character
at a time thereby lessening the chance of overwriting wanted parts of
your work.

Assuming you are at present editing your work in either 'PCB', 'LAYOUT'
OR 'DIAGRAM':

1/ Press 'P' to enter TEXT MODE ('PRINT' key on 48K keyboard). 'TEXT
MODE' should 'appear on the botton right of the screen, to indicate you
can only enter text, no other commands will function in this mode!

2/ Move the cursor to a blank area of your layout, you need at least
5.4" to the right of the cursor. You will type:
        TEXT CAN ONLY BE ENTERED AT THE CURRENT CURSOR POSITION
To do this, press 'T' then move the cursor right one position
(abbreviated to '8' for the rest of this lesson.

3/ Press E 8 X 8 T 8 SPACE 8 C 8 A 8 N 8 SPACE 0 8 N 8 L 8 Y
8 ....etc until you have typed in the whole line of text,

4/ Now type the word DIAGONAL in a North Easterly direction ie. by
pressing a letter then the NE cursor key (2):
Do this by pressing D 2 I 2 A 2 G 2 0 2 N 2 A 2 L 2

You will now type some numbers on the work area.
Obviously you can't type numbers by simply pressing a number key as
they are used as cursor keys!
To place numbers at the cursor position it is necessary to hold down
the CAP SHIFT [CS] key and press a number key.

5/ Type in 74LS244N in the horizontal direction:
ie. [CS]7 8 [CS]4 8 L 8 S 8 [CS]2 8 [CS]4 8 [CS]4 8 N

6/ To EXIT TEXT MODE simply press ENTER.
Remember to mirror or rotate text simply use the normal MIRROR and
ROTATE commands after exciting TEXT MODE.
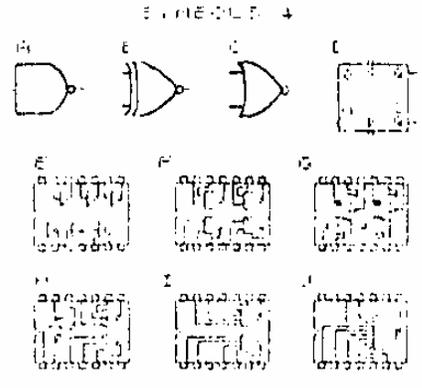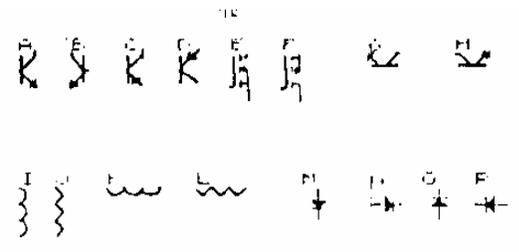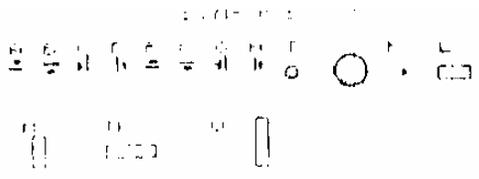
SYMBOL LIBRARY AVAILABLE WITHIN DIAGRAM

RESISTORS

CAPACITORS

ICS & DIODES

TRANSISTORS
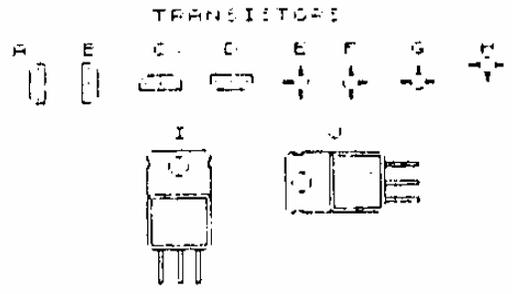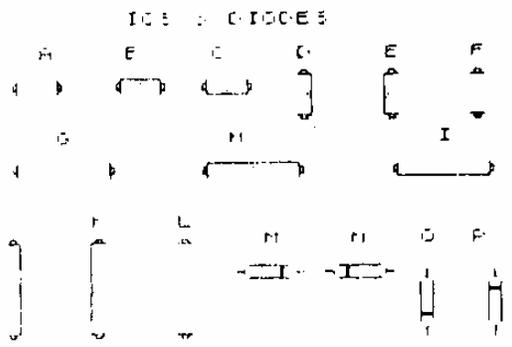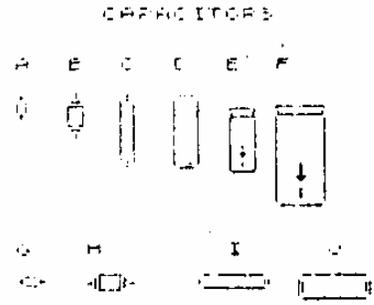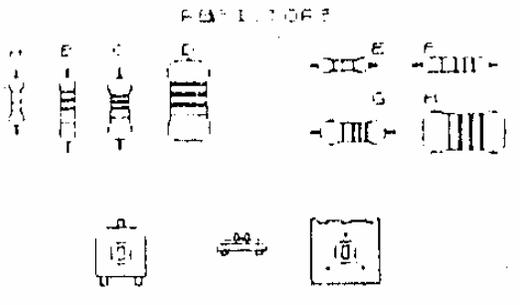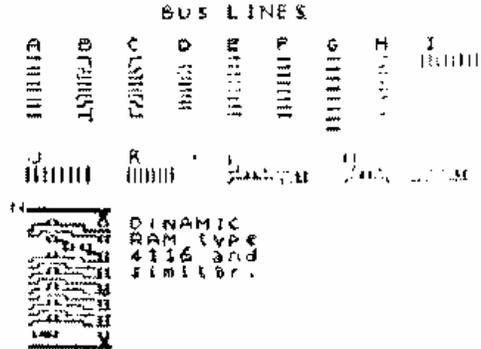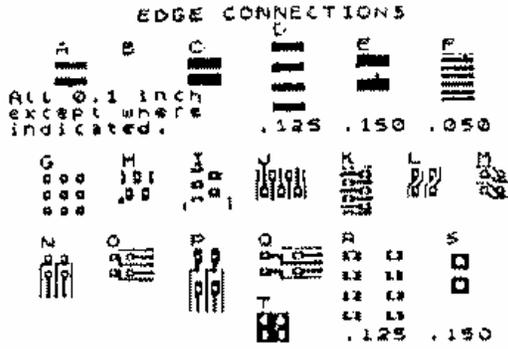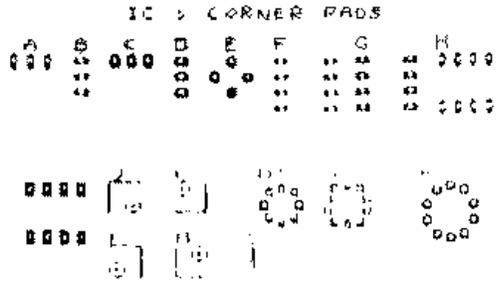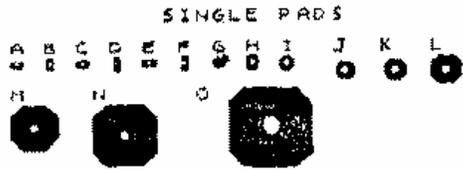
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