DECUS
PROGRAM LIBRARY

DECUS NO.	8-383C.
TITLE	DRAWING APPLICATIONS PROGRAM
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SOURCE LANGUAGE	

DRAWING APPLICATIONS PROGRAM

1. ABSTRACT

The program described in this report is intended to show the facilities the DEC-338 system offers when considered as a drawing board.

The program allows the user to:

1. Draw straight lines of "free hand" over a total of 75x75 inch area.

2. Include symbols which may be formed by means of the program.

3. Label the drawing in alphanumeric and other characters.

4. Delete items drawn.

5. Output the display and symbol files created.

6. Input a display file and its symbols for updating.

The program incorporates a tracking cross and raster and the co-ordinates of the tracking are shown when required. Control is obtained by a set of light buttons and push buttons and the switch register.

The report gives possible core location changes for adapting the dimensions drawn to special cases if required.

2. INTRODUCTION

The starting address for the program is 400. On starting the program, a display similar to Figure 1 should appear. (A raster will also appear momentarily.) The light buttons at the bottom of the display initiate actions and give an indication of the current state of the program. The meanings of these light buttons are as follows:

V = Next line drawn will be in visible mode.

I = Next line drawn will be in invisible mode.

X = Restrict tracking cross movement to X direction.

Y = Restrict tracking cross movement to Y direction.

E = Allow tracking cross movement to any direction.

F = Enter free hand drawing mode.

C = Set to Clear display file.

PF = Set to Punch display file.

PL = Set to Punch library display file.

RF = Set to Read display file.

RL = Set to Read library display file.

$\longleftrightarrow\updownarrow$ = Move display in arrow direction, continuously or step by step.

O = Return display to origin.

TL = Transfer "special" display file to library.

When the light pen is pointed to any of the light buttons V $\longrightarrow$ RL, the corresponding mode is set and is reflected by the light button blinking. The V, E mode is entered automatically when no other is chosen.

X=Ø512   Y=Ø512
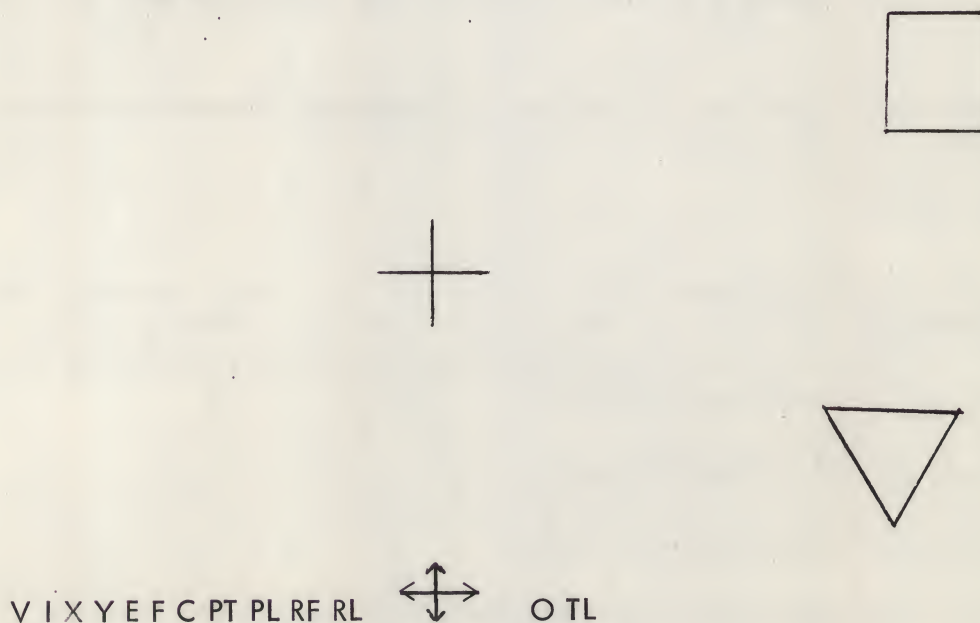
V I X Y E F C PT PL RF RL $\updownarrow$ O TL

FIGURE 1

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A tracking cross will also appear at the centre of the display with its co-ordinates at top left. If push button 5 is ON then some library symbols will appear on a vertical line at the right hand side.

Some push buttons are used to issue dual commands to those of some light buttons. (L. B.); other push buttons (P. B.) may bring certain display items, initiate certain actions, and control operations.

3. TRACKING CROSS

The tracking cross (T. C.) is used to draw lines and move symbols. Push button 8 (P. B. 8) enables the light pen (L. P.) to the tracking cross when ON. The tracking cross can be moved to anywhere in sector $\emptyset$ (REF 1.). If an edge is reached the cross will reappear at the median with respect to the opposite edge.

If the L. P. is moved too fast for the tracking cross to follow, a raster appears covering the display area. The position the L. P. is pointing to is detected and the T. C. is moved to that point if free to do so. The raster will disappear as soon as the T. C. is detected again. If the L. P. is moved away from the display area and the shutter is closed, then the raster will continue for about 1 second and then disappear. If the L. P. is enabled to the tracking cross (i.e. P. B. 8 in ON) and the L. P. is pointed to the T. C. while none of L. B. X, Y, E or F mode is chosen, a warning is given in the form of teletype bell strike.

3.1. TRACKING CROSS CO-ORDINATES

If P. B. 9 is ON, the T. C. centre co-ordinates will appear on the top left of the display as X = NNNN Y = NNNN. These values will be in decimal if accumulator switch register 1 (A. C. 1) is DOWN (=$\emptyset$). If AC 1 = 1 (i.e. UP) co-ordinates shown will be in octal.

3.2. LIGHT PEN APERTURE SIZE AND SENSITIVITY SETTING

The T. C. should follow slow L. P. movements in a smooth manner. The size of the tracking cross arms give optimum results with L. P. aperture size = 1/8" diameter. In addition the L. P. sensitivity setting should be slightly above the minimum required for detecting a L. P. hit. A high sensitivity will result in excessive appearance of automatic raster and jerky T. C. movement.

4. STRAIGHT LINE DRAWING IN X, Y AND E MODE

When the program is started L. B. V & E will be set on blinking mode. This means that the tracking cross can be moved in any direction and a visible straight line will be drawn from the initial T. C. position to the current position. This, in effect, constructs elastic or "rubber band" lines.

The line drawn can be restricted to the horizontal or vertical direction by choosing X or Y mode respectively. This can be done by making a L. P. hit on X or Y. This will automatically "fix" the last line drawn. For L. B. X → RL only one mode may be chosen i.e. choosing a new mode will cancel any other and fix the last drawn line.

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If the current mode is V (i.e. visible) and a L. P. hit on I (i.e. invisible) is made, the L. B. I will be set blinking while V will not blink any longer. This will NOT change the line drawn to become invisible UNTIL the L. P. is pointed to the T. C. Also changing from V→I will NOT fix the line. The above applies when changing from I → V.

4.1. FIX LINE AND DUAL COMMAND PUSH BUTTONS

P. B. 2 when pressed will fix the line drawn without changing current drawing mode in X, Y and E. This can be done without moving the L. P. from the T. C.

It is also possible to simulate L. P. hit on L. B. V→F by P. B. 1,6 and 7. Hence pressing P. B. 1 will change mode from V→I or I→V; P. B. 6 will enter into mode X when first pressed and change to Y and back to X when P. B. 6 is pressed repeatedly.

Similarly, P. B. 7 will enter into E mode when first pressed and change to F and back to E when a P. B. 7 is pressed repeatedly.

The above P. B.s have exactly the same effect as if there was a L. P. hit on the corresponding L. B.; the program will always clear P. B. 1, 2, 6, and 7 when one is pressed.

It should be noted that changing modes between X, Y, E without moving the T. C. will add a vector of two words to the display file like any finite length vector. Similarly, if mode is changed to F and back to X, Y or E a short vector of length $=\emptyset$ is created.

4.2. LOCKING DISPLAY FRAME RATE TO MAINS FREQUENCY

If P. B. 3 is pressed to be ON, the display cycle will be synchronized with the mains cycle or a multiple of the mains cycle. The effect on the display file being created is to lower its frame rate which is reflected as a step down in intensity. But there is a compensation since the display will not have any mains ripple. This makes it easier to position the T. C. within 1 raster point (in 1Ø24)i.e. a distance of 0.00922 inches. This can be done by reading the T. C. co-ordinates and disabling the L. P. to the T. C. (P. B. 8 off) when the exact position is obtained.

The automatic raster which appears when the T. C. is lost from the L. P. field of view will disappear more quickly if P. B. 3 is ON since the mains ripple causes the T. C. to oscillate between two raster points which causes the raster marker to be regenerated.

5. FREE HAND MODE

When F- Mode is entered, a continuous line is drawn following the path of the T. C. This will always be in visible mode irrespective of whether V or I is chosen. The program in fact creates a short vector in the display file which is automatically fixed whenever (LX or Ly) is $\geq 1\emptyset_{(10)}$. Further in this mode the automatic raster is inhibited from appearing when the T. C. is lost from its field of view. If (LX) or (Ly) $> 17_{(18)}$ then the program automatically enters V, E state; deposits the new line in the display file in $^{(18)}$ vector mode and re-enters F mode.

The automatic fixing of (LX or Ly) short vectors depends on the setting of A. C. 9, 1Ø and 11 switches. Considering these to form a value between Ø and 7 with AC11 as the least

significant; then a short vector is fixed when its length is $10_{(10)}$ -(values set by AC9, 10,11) e.g. if AC10 is up then the short vector is fixed when (LX) or (Ly) $\geq 10_{(10)} - 2 \geq 8$.

If AC9, 10 and 11 are up, then (LX) or (Ly) need only = 3 to be fixed. This will cause extra spurious short lines to appear on the display file due to the mains ripple.

6. RASTER FACILITY

Putting P.B.11 ON will display the raster permanently. This can be used to align parts of the drawing with respect to others and see the total area available for drawing.

The raster has a fixed number of 127 points in the X-direction   (i.e. successive points at SC8). The number of points in the Y-direction can be varied. It is set in core location 4323.

If the value in core location 4323 is set to:

    3 then y-step length = X step length
    4 then y-step length = 2 (x-step length)
    5 then y-step length = 3 (x-step length) etc.

The program has value 4 in core location 4323 to reduce flicker. A value of 0, 1 or 2 should not be chosen. If a large y-step length is chosen (larger than L. P. aperture) then the T. C. may not be relocated if the L. P. is moved too fast. The display format of this raster is the same as the automatic raster which appears when the T. C. is lost from L. P. field of view.

6.1. "HOT" RASTER FACILITY

If P. B. 8 is OFF, then raster intensity is increased to the highest level and every point of the raster can be sensed by the L. P. This in effect enables the L. P. to the raster.

When the L. P. is pointed to the raster in this case the co-ordinates of the point are noted and the T. C. centre is moved to coincide with the point detected. It is possible to draw in X, Y, E, and F mode using the 'hot' raster.

6.2. VARIABLE RASTER FACILITY

If AC 6 = 1 (i.e. up) and manual interrupt is pressed TWICE, then a raster of 16 x 16 points will appear as the permanent raster. This raster is intended to be variable in X as well as Y direction.

The step for Y is set in core location 4704. This is set to $10_{(8)}$. The step for X is set in core location 4573.   This is set to $4010_{(8)}$ where 4000 is the escape bit which should always be added to the X-Step value.

(It should be noted that a single step in X and Y in the above rasters correspond to SC8 setting in the display logic. It is possible to use SC1, SC2 or SC4 steps.) The scale setting core store location for the variable raster are $4666_{(8)}$ and $4702_{(8)}$ for Y and X respectively.

To return to the original, raster AC6 is set down (=∅) and the manual interrupt is pressed twice.

7. LIBRARY SYMBOLS

The Library (manu) symbols consist of display items which have a certain shape that will be used as an entity. A total of 3∅ symbols can be included. These are divided into 2 sets of 15 each.

The first set occupies absolute core locations 64∅∅ – 6757 and the second 676∅ – 7327. Each symbol is up to $2\emptyset_{(8)}$ core locations, and can be programmed using VEC, SVEC, INCR, CHAR, or $PJMP_{(8)}$ The last instruction of the symbol display file must be a POP $(=3\emptyset\emptyset\emptyset_{(8)})$.

If P. B. 5 is ON, then one of the above sets will be displayed.

If P. B. 4 is ON the symbol in 6400 ——— 6757 will be displayed.

If P. B. 4 is OFF the symbol in 676∅ ——— 7337 will be displayed.

7.1. LIBRARY SYMBOLS INCLUSION IN DISPLAY FILE

When it is required to include any symbol in the display file, the L. P. is pointed to the symbol wanted. This will cause the symbol to appear at the end of the last point drawn to. The library will be set to blinking mode to signify that a symbol has been chosen.

If the symbol appearing in the display file is not the one wanted, it can be ignored by hitting L. B. I and the correct symbol is chosen. The symbol chosen can be in the same size or twice as large. If P.B. ∅ is ON the symbol in the display file will have the same size. If P. B. ∅ is OFF, it will be twice as large. This size can be made 4,8 times as large by changing core location 16∅2 to 6∅∅ and 7∅∅ respectively.

If the symbol chosen is the correct one, it can be fixed by pressing P. B. 2. This will also put library on non-blink mode and move the T. C. to the end of the symbol if it is not a closed figure.

A symbol can only be chosen in X, Y or E state, otherwise a bell warning is given. The symbol chosen can be moved before fixing. This should only be done when the chosen symbol is at the end of a non-fixed line. (If this is not followed the display file will be corrupted which might also cause corruption of the program.)

7.2. LIBRARY SYMBOLS POSITIONS

As mentioned previously, the symbols can be programmed in a maximum of $2\emptyset_{(8)}$ locations starting at 64∅∅, 642∅ 644∅ – 732∅. Each set of symbols 64∅∅ – 6757 and   676∅ – 7337 are positioned at x = $17\emptyset\emptyset_{(8)}$ and Y = $1\emptyset\emptyset_{(8)}$ $2\emptyset\emptyset_{(8)}$ $3\emptyset\emptyset_{(8)}$ – 17∅∅.

When a symbol is pointed to, the position of the L. P. hit is compared to see if it is above $14\emptyset_{(8)}$, 24∅ 34∅.......174∅ and the address to be inserted after the PJMP in the display file is obtained from a set table.

Hence if a symbol extends into the reserved Y length of the other symbols, a different address will be obtained corresponding to another symbol.

7.3. LIBRARY SYMBOL FORMATION

It is possible also to form new symbols using the program. The display file should first be cleared; P. B. 3 should then be pressed. The symbol to be replaced is then pointed to and the display file cleared again. P. B. 3 would be put OFF by the program. This operation in effect chooses the address for the library symbol display file that is to be formed.

The shape of the library can now be drawn. Use of the "hot point" raster can be made. Up to seven vectors (the last of which should not be fixed) in X, Y and E mode can be drawn, or up to 12 short vectors in F mode or 22 characters or a combination of these. Other library symbols may be included as an equivalent to one line in X, Y or E mode. Finally the L. P. should then be pointed to the TL (Transfer to Library) L. B. The symbol created will appear in the library set and also in address 6400 - 6417. If the number of words to be transferred are greater than the above values, no transfer occurs but a warning bell strike is given. The display file can then be cleared and the symbol re-drawn more efficiently.

The library symbol in 6400 - 6417 is used as a DUMMY (in case the L. P. is pointed to TL in error) and so nothing permanent should be programmed in this area.

Under no circumstances should the address chosen for a library transfer be included in a symbol being formed. If an attempt to transfer to library is made the program will be corrupted.

8. CHARACTER GENERATOR LABELLING

The teletype keyboard can be used to display characters. This is simply done by typing the character. The character will appear on the display and the T. C. is moved to the end of the display format of the character.

The characters displayed use the character generator, and are packed two to a word (i.e. 6 bit format). The character can appear in two sizes. If P. B. 0 is ON, the small size is chosen. If P. B. 0 is OFF the size is doubled.

The latter size can be made 4 or 8 times as large by altering core location 2407 to 0617 and 0717 respectively. The character generator dispatch table and routines occupy core locations 5000 - 5650.

8.1. CHARACTER TABLE

The characters dispatch table is based on a trimmed (to 6 bits) alphanumeric ASCII code. Hence the program traps CR, LF or code 337 (37 being the escape code). Substitution of display CR, LF and a negative space is made respectively.

The translation for the rest of the codes are as follows:

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CODE	DISPLAY	CODE	DISPLAY
Ø, 2ØØ, 3ØØ	≠	343	-space
A Z	A Z	336	- LF
Ø 9	Ø 9	?	≡
Ø	Ø	[	[
)	)	]	]
(	(	.	.
		,	,
		;	;
		+	+
		-	-
		%	%
		/	/
		*	*

9. 75 x 75 INCH AREA MOVEMENT

The area of 9 3/8 x 9 3/8" on which the T. C. can move is really a window on part of a total drawing area of 75 x 75 inches. Switching the zoom on will show the total area of 75 x 75" reduced by a factor of 1/64.

The display file can be moved over this area by pointing the L. P. to the appropriate arm of the L. B. ⟷ This will perform repeated steps in the direction chosen if P. B. 4 is OFF. If P. B. 4 is ON then the L. B. ⟷ will be set blinking and the display file can be moved one step at a time by pointing the L. P. to the appropriate arm and pressing P. B. Ø repeatedly.

The step length is set to SC8 in core location 1ØØ27. This can be changed to SC1, SC2 and SC4 if smaller steps are required. Further the number of steps per L. P. hit on ⟷ is 1 + the value set in AC 9, 1Ø and 11.

It should be noted that the L. B., T. C. and library symbols do not move from sector zero. Further if the zoom is set on, then the ⟷ L. B. will reappear at the same size near its previous position.

9.1. 75 x 75 INCH AREA DRAWING

To make a display cover an area other than sector zero, the file is moved in the appropriate direction. The T. C. will be at the last point drawn to and will be with the display file till an edge is reached where it will disappear to come back at the opposite edge. This will cause a displacement between the T. C. and the vector it is drawing. Hence, the display file can be moved until the T. C. reaches the edge, in a single displacement.

When a display file is moved, any non-fixed line or manu will automatically be fixed. Further, if mode chosen was F, it will change to E.

9.2. ORIGIN LIGHT BUTTON

The movement of the display file is controlled by attaching the created display file to the end of an invisible vector. A L. P. hit on L. B. 0 will set $X=Y=1\emptyset\emptyset_{(8)}$ for the vector which at SC8 positions the start of a cleared display file to the centre of sector zero.

10. ERASING DISPLAY FILE ITEMS

To erase a line, symbol or label, the manual interrupt button is pressed once. This will cause all L. B.s, T. C., and library to disappear and the display file only will be shown with the light pen enabled to the display file.

To erase any part, the L. P. is simply pointed to it. The action taken depends on the item. For a line drawn in X, Y or E mode the intensity bit is dropped to make the line invisible. For a library symbol the PJUMP; ADDRESS is changed to $\emptyset;\emptyset$. Hence if the library symbol was not a closed figure (i.e. end and start point coinciding), a shift of one part of the display file with respect to the other takes place. For a character, a space character is substituted to keep the displacement constant.

It should be noted that there is a delay of about 6 μ sec between the light entering the L. P. aperture and the setting of L. P. hit flag. Hence it is advisable not to erase short lines (e.g. less than .1 inch) and short vectors drawn in F mode.

Further, if a library symbol contains characters, then it will be erased as a library symbol, hence it is advantageous to make frequently used labels as symbols, since they can be moved to the correct place after calling and when deleted will not cause invisible points to be drawn.

When the display is in the erase mode, the display shown is only the display file created and will be at its least flicker rate. To escape from erase mode, the manual interrupt button is pressed once again.

11. CLEARING THE DISPLAY FILE

The display file created is strictly serial in its format. The display file is in memory field 1 and starts at core location $2\emptyset$. In $2\emptyset$ up to 33, the scale, intensity, PJMP to T. C., PJMP to L. B., etc. are set. The first word of the display file created is put in core location 34 upwards. After every time the display is updated the loop for the display is completed by JUMP 1; $2\emptyset$.

To clear the display file, L. B. C is hit and set blinking, then this command is confirmed by hitting L. B. V; the result is a jump to location 400 in the program, i.e. clearing the display file is analogous with starting the program. This will reset all the markers, set blink off to all L. B. and put JUMP 1;20 in core location 10034 and 10035 respectively.

Further the T. C. is put at the centre of sector zero but the invisible vector which causes movement of display file is not reset to X=Y=100. Hence an <u>O HIT should always be made after clearing the display file.</u>

It should be noted that the display is not literally cleared but the loop jump is just moved to the starting position.

If the program is stopped at any time or comes to a 7402 instruction, it can be restarted at address <u>401</u>. This will not clear the display file.

12. OUTPUTTING DISPLAY FILE

To output the display file, the L. B. PF is hit first and the command is confirmed by L. B. V hit. The display will then only show the display file and in this case the L. P. is not enabled. The output is on the high speed punch if AC3 is UP and on the teletype if AC3 is down.

The format of the tape is exactly like any binary tape, and can be read by binary loader when checksum error should be ignored. Hence a leader code is given, then field setting 1, then address 20 then the contents of all the display file to the loop jump (JUMP 1;20). The size to be punched is obtained from auto-index register $11_{(8)}$. This is followed by two frames of runout to compensate for checksum which is not calculated and then the trailer.

This is immediately followed by leader, the contents of the core locations that contain the T. C. co-ordinates, the contents of auto-index register $11_{(8)}$ and finally trailer code, after which the display restores L. B.s etc.

Before the display file is punched core locations 10022 → 10025 are set to zero. (Overwriting the PJMP to T. C. and PJMP to L. B.). Thus it is possible to use this display output in conjunction with other display programs by inserting the PJMP; ADDRESS in 10022 → 10025. If the display file contained symbols and labels then these should be read as well.

The display file is set at core location $1600_{(8)}$ to be of maximum size of $7400_{(8)}$. This can be altered to other values. If the value of auto-index register $11_{(8)}$ reaches that set as maximum a message (DISPLAY BUFFER FULL) is given on the teletype. No more drawing can be made but the file may be punched out.

12.1. OUTPUT OF LIBRARY FILE

To output the library symbols file, the command PL is given and confirmed by a V hit. The result on the display and function of AC3 is the same as in display file output.

Hence a leader code is given, then address $6400_{(8)}$ then the contents up to $7400_{(8)}$ are punched followed by two frames of runout as checksum is not computed and ended by trailer code.

It is possible to punch in this binary format any block of core locations in field Ø by specifying the start and end address in core locations 34ØØ and 34Ø1 respectively (e.g. specifying 5ØØØ and 565Ø to output character generator dispatch table and routines).

12.2. PUNCHING AN ALTERED PROGRAM

The program occupies core locations Ø - 4777. This is followed by the character generator tables which extend up to 5777. From 6ØØØ - 6377 the display file for L. B. and positioning of library symbols, raster files etc. From 64ØØ - 74ØØ, the library files are contained.

If AC7 is UP and a library file output is requested, the start of punching is made from core location Ø and up to 74ØØ is punched with no trailer code at end. If now display file output is requested with AC1 up then no leader is given, the display file only is punched followed by trailer code. The T. C. co-ordinates are not punched. Thus a complete altered program may be obtained in this way.

13. INPUTTING DISPLAY FILE

To read a display file, the command RF. should be given and confirmed by a V hit. If AC3 is UP, the high speed reader is used; if AC3 is DOWN, the teletype reader is used. The paper tape can be positioned with runout or leader code on the reader.

The display will stop when reading is commenced and the program will read the display file proper and the T. C. co-ordinates and content of auto-index register $11_{(8)}$ and then restart the display. It is possible now to update this file.

If the teletype reader is used, it should be stopped manually when the second trailer is reached, otherwise the program will read the rest of the tape as equivalent to teletype keyboard hits i.e. character labelling.

13.1. INPUT OF LIBRARY FILE

This is done by giving the command RL and confirmed by a V hit. The display will stop and AC3 has the same control as above. The display is resumed when the trailer is encountered.

14. PUSH BUTTON LISTING

The diagram below gives the controls of functions of the push button and accumulator switch register.

Character and Library size 1 = small ∅ = large also single step movement	V ⟶ I I ⟶ V	FIX	Lock to mains. Set address of symbol	ON = first set OFF = second set ON = move by single steps	LIBRARY ON, OFF
X ⟶ Y Y ⟶ X	E ⟶ F F ⟶ E	On = Enable L.P. to T.C. OFF = enable L.P. to raster	T.C. Co-ordinate L.B. O TL	Used by program as a marker	RASTER

Frame Rate ↓	Show contents of core location Co-ordinates in binary ↑		High speed read & punch ↑			X,Y variable raster	punch program		set factor for F. Mode. Set step size per L.P. HIT		
∅	1	2	3	4	5	6	7	8	9	10	11

Co-ordinates in decimal (1) ↓

Low speed read & punch (3) ↓

Ordinary Raster (6) ↓

15. MISCELLANEOUS

15.1. REAL TIME FRAM RATE

If AC∅ is UP, then the content of the Y co-ordinate of the T.C. is incremented once every time 1 display cycle is completed. The value shown will be in decimal or octal according to AC1 being DOWN or UP, respectively.

15.2. CORE CONTENT DISPLAY

It is possible to examine the content (in octal) of any two core locations in memory field ∅ in a dynamic manner while the program is running. For the user, the two relevent are $11_{(8)}$ and $16_{(8)}$. The first holds the current size of the display file and the second holds the address less one of the library symbols to be transferred to.

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To show the contents, the address of the core locations is set in binary or its decimal equivalent on the T. C. co-ordinate by moving the T. C. to the appropriate positions. Then AC 1 and 2 are put UP.

The T. C. co-ordinates will immediately show the contents (in octal) of the addresses chosen in X & Y.

15.3. TRACKING CROSS ROUTINE

If the following four changes are made: 1Ø35 = 2ØØØ; 1036 = 1ØØ7; 1042 = 5261; 11Ø2 = 741Ø, then only the T. C. display routine and program interrupt are entered. This will give an indication of the speed of the T. C. without "overheads."

15.4. CONNECTING CORE DISPLAY PROGRAM

The Drawing Application Program (DAP) waits for interrupt at location 556 (which contains the instruction JMP .) From 557 ---- 567 the instructions necessary to stop the DAP and Jump to start of core display program are already included. This jump will occur if all P. B. are cleared. To allow this facility core location 556 should be changed to 7ØØØ.

15.6. SPURIOUS LIGHT PEN HITS

These usually take one of the following forms:

a - A jump of the T. C. to a random point (especially when "hot" raster is being used).

b - A change of mode in L. B. setting.

c - Selection of a random library symbol which need not be visible but this will always set the library on blink mode.

Other spurious L. P. hits should be trapped within the program. If the display stops while the program is still running a restart at 4Ø1 should be made.

15.7. PROGRAM TRAPS

While the program was being written, some routines contained a trap for possible errors. Some are taken care of by the program; others are listed below. The program can be made to ignore these traps if the contents of the core location specified by (PROGRAM COUNTER -1) are changed to 5171.

PROGRAM COUNTER	ACCUMULATOR	CAUSE	ACTION TO BE TAKEN
Ø5Ø3	7777	UNKNOWN INTERRUPT	PRESS CONTINUE, OR RESTART AT 4Ø1. The instructions to clear unknown flags can be put at 1171 - 1175 but must end with 2354; 5754.
Ø62Ø	ØØØØ	End of table for library reached without a symbol being chosen.	Restart at 4Ø1
Ø66Ø	ØØØØ	End of table for L.B. reached without a L.B. being chosen.	Restart at 4Ø1
3143	ØØØØ	A L.P. hit in erase mode, but item to be erased is not in PJMP, CHAR, VEC, SVEC, Mode.	Restart at 4Ø1
321Ø	ØØØØ	A L.P. hit on T.C. which does not correspond to one of its four arms.	Restart at 4Ø1
NOT ONE OF ABOVE	SOME VALUE	UNKNOWN	Note computer's program counter and AC value and display registers and restart at 4Ø1, if fault still exists, start at 4ØØ if fault still exists, re-load program.

16. REFERENCES

1. PROGRAMMED BUFFERED DISPLAY, 338 PROGRAMMING MANUAL (DEC-Ø8-G61B - D)

2. PDP-8 USERS HANDBOOD - F-85

3. CORE DISPLAY PROGRAM, DESIGN AUTOMATION DEPARTMENT.