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DECUS NO.	12-106
TITLE	$PLOT
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SOURCE LANGUAGE	LAP6

$PLOT

ABSTRACT

This is a FOCAL-12 overlay that allows an incremental, digital plotter to be operated from a FOCAL program on a PDP-12. It can be used to draw lines or points with FOCAL's extra function FX, or to draw characters with FOCAL's extra function FZ.

LOADING PROCEDURE

· After loading FOCAL-12, type:

L L,$PLOT,u

where u is the unit number of the device (linctape or disk) containing $PLOT. Then enter the desired indirect FOCAL statements to complete the program and store in an appropriate file with a L S command. Subsequent reloading of the completed program with a L L command will load the FOCAL indirect statements and the overlay.

The file $CHAR must also be available on linctape or disk.

CALLING SEQUENCE TO DRAW A LINE OR MOVE A PEN TO A POINT (FX)

To define the current pen position as the origin (X= 0, Y= 0) for subsequent movement:

S A= FX(-1)

To move to the point (X, Y) with pen up:

$$S \quad A = FX(1, X, Y)$$

To move to point (X, Y) with pen down:

$$S \quad A = FX(0, X, Y)$$

X and Y coordinates are in plotter increment steps. They can range from -2047 to + 2047.

CHARACTERISTICS OF FX

This routine moves the pen in the stepped path most closely approximating the straight line. The line is exact for lines at 0°, ± 45°, or 90° to the coordinate axes.

The value of the function returned to "A" is garbage and should be ignored.

PROCEDURE USED FOR DRAWING CHARACTERS (FZ)

FZ is a routine which returns successive coordinates which are then used by FX to plot characters.

The text which is to be plotted must first be written on the top line of the PDP-12's CRT. The text may be placed on the top line by executing an OUTPUT CLEAR followed by a TYPE in an indirect statement, or by direct entry from the keyboard. The line must be terminated by a carriage return.

FZ <u>always ignores the first two characters of the text</u>. The reason for this is that when text is entered from the keyboard, the line will begin with FOCAL's "*" and be followed by a "C" for comment. These two characters are not to be plotted. When text is generated by an indirect statement, two leading dummy characters (blanks) should be inserted.

CALLING SEQUENCE FOR WRITING TEXT (FZ)

To start plotting a new line of text already written on CRT:

$$S \quad A = FZ(k) \qquad k \neq 0.$$

All subsequent calls are

$$S \quad A = FZ(0)$$

until $A = -1.$

After each call for which $A \geq 0$, the value of A contains the next pen motion in the form $A = 8*DX + DY$. They can be decomposed by

$$S \quad DX = FITR(A/8); \quad S \quad DY = A - 8*DX$$

If X0 and Y0 are the coordinates of the lower left corner of the character (in normal orientation), each part of the character can be drawn by

$$S \quad A = FX(k, X0 + M*DX, Y0 + M*DY)$$

where $k = 1$ on the first call (to raise pen) and $k = 0$ thereafter until character is finished. M is a multiplier for the character size. The smallest characters ($M = 1$) are 5×7 plotter steps.

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Characters may be rotated by properly interchanging DX and DY. For example, to write along the +Y axis, replace DY by DX and DX by -DY.

Three special returns from FZ exist:

A = -1: Entire text has been written.

A = -2: Call FZ again, but make next motion with pen up. This occurs in two-part characters such as ":" and ";" .

A = -3: The current character is complete. The next call to FZ will give the first motion of the next character and must be made with pen up. Also the character origin must be reset. For horizontal text use

S X0=X0 +6*M.

ADDITIONAL REQUIREMENT TO USE FZ

The table of pen motions used by FZ is in the file \$CHAR. Before using FZ, \$CHAR must be opened as an integer file Fn (n=0, ..., 7) and it <u>must</u> be in one of FOCAL's two core buffers. To insure that it is in core (and has not been swapped out for another data file), it should be referenced when making the initial call to FZ, for example

S A=FZ(Fn(0)) .

EXAMPLES OF USE OF FZ

$PLOT, as supplied on linctape, contains the following sample FOCAL program (groups 9. and 10.) which uses FZ to write a line of text (which was previously written on the CRT).

The text is written by executing a DO 9. An ASK statement at line 9. 05 requests the coordinates at which to start plotting, the size of the characters, and the orientation (H or V). This line can be deleted if those parameters are specified elsewhere in the program. The values for the orientation variable, "H", are "∅H" for horizontal plotting and "∅V" for vertical plotting.

```
C FOCAL-12

09.05  A  "X,Y,SIZE"X,Y,M,"H OR V"H
09.10  S  A=FZ(F7(0));S J=1;G 9.3
09.20  S  A=FZ(0)
09.30  I  (A)9.6;S DX=FITR(A/8);S DY=A-8*DX
09.35  I  (H-0V)9.5
09.40  S  A=DX;S DX=-DY;S DY=A
09.50  S  A=FX(J,X+M*DX,Y+M*DY);S J=0;G 9.2
09.60  S  J=1;I (A+2)9.7,9.2;S A=FX(1,X,Y);R
09.70  I  (H-0V)9.8;S Y=Y+6*M;G 9.2
09.80  S  X=X+6*M;G 9.2

10.10  L  0,F7,I,$CHAR,0
*
```

Statement 10. 10 must be executed once to open the file $CHAR.

If vertical plotting is not needed, statements 9. 35, 9. 40, and 9. 70 can be erased and 9. 80 renumbered as 9. 70.

MINIMUM HARDWARE AND SOFTWARE REQUIREMENTS

PDP-12 with 8K core and one linctape.

Incremental digital plotter.

FOCAL-12.

This program is written for the standard DEC plotter interface which allows the pen lift and drum down commands to be issued back to back and requires that they not be microprammed. For interfaces with the reverse requirements, change

SOURCE LOC	FROM	TO
DWNLFT+1	PLDD	NOP
DWNLFT+2	PLPP	PLDD! PLPL

or

OBJECT LOC	FROM	TO
4610	6514	7000
4610	6521	6535

VARIATION

By reassembling FX alone, it is possible to make an overlay for PDP-8 versions of FOCAL using 4K of core.

ALGORITHMS USED

Part of the character pen motion table and some of the algorithms used are taken from DECUS 8-168.

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CORE USE AND TIMING

The overlay uses location 4247 through 4612.   4613 to 4617 are free.

FX is limited by plotter speed.

FZ slows the plotter down a small amount.

ERROR MESSAGE

? 17. 67 means $CHAR is not in core.

POTENTIAL RARE PROBLEM

FZ does not use FOCAL's buffer handling routines.   It determines which of the two buffers contains $CHAR by looking to see which contains a 5 in its first location.   If by chance another file, Fm, is in the other core buffer, and Fm(0)= 5, unusual results may occur.

CHARACTER SET

All printing teletype characters except "@" and "?" are acceptable to FZ.   However, the following substitutions are made:

TTY CHARACTER	$PLOT CHARACTER
!	⌂
"	◯
#	△
$	▽
%	×
&	◇

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As with all other characters, the coordinates of these plotting symbols are with respect to their lower left corner. If their center is to be at (X, Y) and their size is M, their lower left corner should be set at (X-2*M, Y-3*M).

PEN MOTION TABLE

$CHAR is formatted two pen motions per word. Each pair of octal digits gives the X and Y coordinates, on a 5×7 grid, with (0, 0) at the lower left corner. There are two special combinations: 70 means pen up, and 77 means end of character. Additional special characters can be inserted in the table in place of existing characters. However, the maximum length of the table is 256 words (one tape block). If a character ends in the left half of a word, the right half of the last word is filled with 77. No half word other than in the last word of a character should be 77.