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## Chapter 1: INTRODUCTION

### 1.1 Purpose

This program provides basic control routines for the digital plotter. It may be used to move the pen, to draw a line between two points, with the pen raised or lowered, and to draw characters.

### 1.2 Form of Distribution

QPLOT is distributed as a SIR mnemonic tape:

### 1.3 Method of Use

QPLOT is assembled as a block of the user's program and entered as a sub-routine. The entry must be followed by a parameter word.

## Chapter 2: FUNCTIONS

## 2.1 Notation

$(X_1, Y_1)$  are the co-ordinates of the current pen position  
 $(X_2, Y_2)$  are the co-ordinates of the final pen position

The point  $(0, 0)$  may be assumed to be anywhere relative to the plot. Starting from this point increments along the x- and y- axes are measured positively to the right and upwards: the unit of length is the step size of the plotter.

The y- co-ordinates must lie in the range  
 $-131071 \leq y \leq 131071$

The x- co-ordinates must lie in the range  
 $-x_m \leq x \leq x_m$

$x_m$  is determined by the plotting width of the plotter used. Values are given for two models below.

Plotter Model Width      Step	Maximum value of x ( $x_m$ )	Maximum y distance
14"      0.005"	2800	about 54 ft.
34cm    0.01cm	3400	about 13 metres

If a plot is required to continue along a greater y distance than is shown in the table,  $Y_1$  should be reset at intervals and a count kept of how often this has been done. A suitable technique is to reduce  $Y_1$  by 100000 whenever it is observed to exceed 120000 and to increase it by 100000 whenever it drops below 10000 and has been previously reduced.

## 2.2 Line Drawing

To draw a straight line to any point,  $(X_2, Y_2)$  from the present pen position  $(X_1, Y_1)$ ,

Entry

Place       $X_2$  in QPLOT +3  
               $Y_2$  in QPLOT +4  
              and enter 11 QPLOT  
                          8 QPLOT+1

The location immediately following the entry to QPLOT must contain a parameter word as described in 2. 2. 1 (below). Exit is made to the location after the parameter word.

On exit  $(X_1, Y_1)$  is reset to the new pen position.

If manual indexing is used  $(X_1, Y_1)$  must be set before re-entry to QPLOT. If this is done it is recommended that the point  $(0, 0)$  is considered as the bottom left-hand corner of the plot, but the position of the origin is arbitrary.

### 2. 2. 1 Parameter Word for Line Drawing Function

The parameter word is an integer which controls the raising and lowering of the pen. The parameter words and their significance are as follows:

Integer	Significance
+0	No pen change required
+1	Raise pen before drawing line
+2	Lower pen before drawing line

An impermissible parameter word causes output of an error indication (see 3 below).

### 2. 3 Character Drawing

Either (i) to draw a character along the line  $y = Y_1$ , or (ii) to draw a character centred on the present pen position  $(X_1, Y_1)$ . The character will terminate with the pen raised at the point  $(X_1, Y_1)$ .

Entry

Place the SIR internal code for the character in the accumulator, and enter

11 QPLOT  
8 QPLOT+2

The location following the entry must contain a parameter word, as described in 2. 3. 2. (below).



2.3.1 Available Characters

The characters available are defined by their SIR Internal codes; they are listed in Table 1 (below).

TABLE 1  
Characters available in QPLOT

Character	SIR Internal Code (Octal)	Output Obtained	Character	SIR Internal Code (Octal)	Output Obtained
Ⓢ	00	Ⓢ	˘ (grave)	40	Plot C ! *
Ⓛ	01	Plot C ! *	A	41	A
"	02	Plot C ! *	B	42	B
½	03	Plot C ! *	C	43	C
\$	04	Plot C ! *	D	44	D
%	05	Plot C ! *	E	45	E
&	06	Plot C ! *	F	46	F
˘ (acute)	07	Plot C ! *	G	47	G
(	10	Plot C ! *	H	50	H
)	11	Plot C ! *	I	51	I
*	12	*	J	52	J
+	13	+	K	53	K
,	14	Plot C ! *	L	54	L
-	15	-	M	55	M
.	16	.	N	56	N
/	17	Plot C ! *	O	57	O
0	20	0	P	60	P
1	21	1	Q	61	Q
2	22	2	R	62	R
3	23	3	S	63	S
4	24	4	T	64	T
5	25	5	U	65	U

Character	SIR Internal Code (Octal)	Output Obtained	Character	SIR Internal Code (Octal)	Output Obtained
6	26	6	V	66	V
7	27	7	W	67	W
8	30	8	X	70	X
9	31	9	Y	71	Y
:	32	Plot C !*	Z	72	Z
;	33	Plot C !*	[	73	Plot C !*
<	34	Plot C !*	£	74	Plot C !*
=	35	=	]	75	Plot C !*
>	36	Plot C !*	↑	76	Plot C !*
10 (sub-script)	37	10	←	77	Plot C !*

\* displayed on teleprinter (see Chapter 3).

An impermissible code causes an error indication to be output (see 3 below) as indicated in the table.

### 2.3.2 Parameter Word for Character Drawing

The parameter word is an even integer,  $\frac{1}{2}p$ , which determines the size of the character. The value of the parameter gives the character height in steps. The recommended range is  $+12 \leq p \leq +100$

To draw a character along the line  $y = Y_1$  the parameter must be positive; to draw a character centred on the point  $(X_1, Y_1)$  the parameter must be negative.

Entry with the parameter as +0 indicates no change in the scaling or positioning of the character. If no previous entry has occurred then characters are produced assuming a parameter value of +20.

## 2.4 Identifiers

QPLOT must be declared as a global identifier in all blocks which refer to it.

2.5 Example

(The following section of program moves the pen to the origin and then draws the character A)

```
.  
. .  
4 +0  
5 QPLOT+3  
5 QPLOT+4  
11 QPLOT  
8 QPLOT+1  
+1  
4 £ A (Space, Space A)  
11 QPLOT  
8 QPLOT+2  
+0  
. . .
```



## 2.6 Initial Entry to QPLOT

In any complete program using QPLOT, the first entries to QPLOT must define the origin and set the internal indicator which determines whether the pen is currently raised or lowered.

To do this, the pen must be lowered and raised by program, and then moved to the correct position for the origin, either by manual control or program.

An example of a program which positions the pen correctly at the origin is shown below.

```

4      +0
5      QPLOT+4
5      QPLOT+6
4      +4000
5      QPLOT+3
5      QPLOT+5
11     QPLOT      (set indicator to pen lowered,
8      QPLOT+1    do not move pen)
+2
4      -10
5      QPLOT+3    (move the pen until the
11     QPLOT      margin stop is reached)
8      QPLOT+1
+1     (pen raised)
4      +0
5      QPLOT+3    (move pen to the origin,
11     QPLOT      just clear of the margin)
8      QPLOT+1
+1

```

Chapter 3: ERROR INDICATIONS

If an error is detected a message is output on a newline of the teleprinter and 6 inches of blank tape are output on the punch. The detected errors are listed below. Continuation may be made by re-entry at 9.

<u>Message</u>	<u>Cause</u>	<u>Effect of re-entry</u>
PLOT L!	Impermissible parameter	"Pen down" is substituted.
PLOT C!	Impermissible character code	<space> is substituted.

## Chapter 4: METHOD

### 4.1 Line Drawing Function

A line is drawn as a combination of incremental steps along the axis and diagonal bounding the octant in which it lies. QPLOT outputs these steps in the optimum order: it outputs the minimum number of instructions possible. (e. g. a line from (0, 0) to (10, 1) is drawn as 9 "North" increments and 1 "North-East" increment).

A negative parameter word is taken as equivalent to its modulus.

$X_1$  and  $Y_1$  are held in QPLOT+4 and QPLOT+5 respectively.

### 4.2 Character-drawing Function

The turning-points of the characters are fed consecutively to the line-drawing routine. The storing of the co-ordinates is described below. Further characters may be made available by addition to the two tables described below.

Each character is designed in a square 20 x 20 increments, and is scaled from this design to the appropriate size. It is represented in Cartesian co-ordinates with the origin at the centre. All characters are designed so that they lie in the range

$$-7 \leq x \leq +7$$

$$-9 \leq y \leq +9$$

The co-ordinates of each turning point are stored in consecutive words with the x- and y- co-ordinates occupying the first and second halves respectively. The address of the first pair of co-ordinates is stored in a 64-location look-up-table starting at ADRES.

The end of the character is indicated by the absolute value of the final y- co-ordinate being increased by 16. After reaching this point the pen is raised and returned to the standard finishing point. If a line of the character is to be drawn with the pen raised then the absolute value of its y- co-ordinate is increased by 32.

Chapter 5: STORE USED

Line drawing function	approximately 270 locations
Character drawing function (which also uses the above)	" 500 "
Total	" 770 "

If the line drawing function only is required, only the coding from locations ODEV to PLOTX+1 are required. Reference is made to a location CHAR in this section of program, so the following should be assembled instead of the character drawing routine:

```
CHAR 11 ERROR
      8 ERROR+1
      0 MESSC
```

A tape containing the line-drawing routine only may be obtained from the library tape of QPLOT by using 903 EDIT with the following correction tape:

```
FL    PLOTX  O  QPLOT
FL    /8    2
IB
CHAR  11    ERRØR
      8    ERRØR+1
      0    MESS C
```

Ⓜ

Chapter 6: TIME TAKEN

QPLOT runs at the speed of the plotter.