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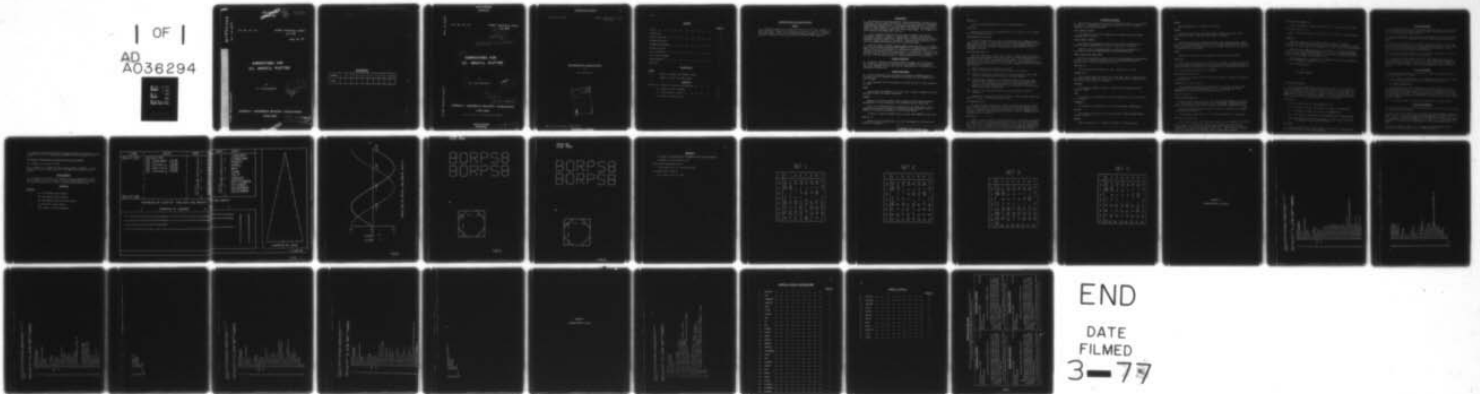
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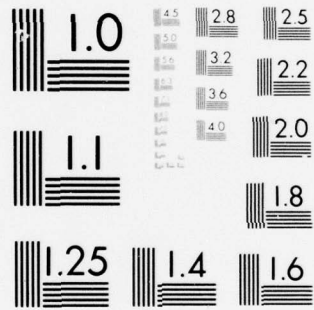
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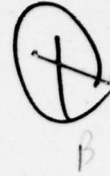
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SUBROUTINES FOR ICL 1904/CIL PLOTTER

BY

W. J. BUTTERWORTH



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July, 1976

SUBROUTINES FOR ICL 1904/CIL PLOTTER

by

W. J. Butterworth

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CONTENTS

	<u>Page No.</u>
Précis	1
Introduction	3
Initial Conditions	3
Primary Subroutines	3
Secondary Subroutines	5
Plotters available	8
Use of Subroutines	8
Use in ALGOL programs	8
Acknowledgement	9
References	9

ILLUSTRATIONS

Figure

- 1 - 2 Examples of graphs from FORTRAN programs
- 3 Example of graph from ALGOL program

APPENDICES

Appendix A: Examples of character sets available	11
B: Programs written in FORTRAN	21
C: Program written in ALGOL	29
D: Index of subroutine names	31

SUBROUTINES FOR ICL 1904/CIL PLOTTERPRECIS

1. A Package of subroutines is offered for use on the ICL 1904S computer, to output characters on paper tape which can then be used to drive a CIL Plotter via a tape reader. Their use in FORTRAN and ALGOL is demonstrated. A means is available of using the same tapes on plotters attached to PDP computers.

INTRODUCTION

2. The advantage of obtaining graphical output from computer programs is well recognised, and the purpose of this note is to describe a graph plotting package for operating a digital plotter. The programs described have been developed on AUWE's ICL 1904S computer in conjunction with a CIL (Computer Instruments Ltd.) digital plotter operating in delta mode (their terminology). The increment size is 0.1 mm and the plotting width is 34 cm.
3. It was considered essential that the system be simple to use and yet sufficiently flexible to produce a complex graph. This has been achieved by designing two types of subroutine: primary ones for moving the pen and secondary ones which modify the effect of the former. Graph plotting is possible by the use of the primary subroutines and these are specified first.
4. Since the output is passed through a buffer (usual practice), it is necessary to use an initialising subroutine (RESET) and a closing subroutine (GRAFINI). Usually the plotter is connected to a teletype and incoming data has to be directed to the teletype, called print mode, or to the plotter, called plot mode. Also the pen may be set in the raised position, called pen up, or lowered, called pen down. The mode and pen status is checked automatically by the software.

INITIAL CONDITIONS

5. Initially a cartesian co-ordinate system is assumed, with its origin at the initial pen position, and the x-axis along the paper. The co-ordinates (x, y) are expressed in cms. Other initial conditions will be described as the subroutines are specified.

PRIMARY SUBROUTINES

6. All the subroutines have been written following the FORTRAN convention. This means that all variables starting with I, J, K, L, M or N are INTEGER and the rest are REAL.
7. Each subroutine will be introduced by its name and list of formal parameters (if any).

RESET

As described above RESET must be called first in order to prepare the buffer area and to preset the initial conditions.

GRAFINI

Empties the current transfer buffer, switches to print mode and outputs approximately 10 cm of blank tape. This subroutine must be called last.

The 10 cm of blank tape gives an indication on the paper tape so that if graphs have been drawn by means of a loop and any graph is faulty it can be redrawn or the tape can be advanced to draw the next graph.

It should be noted that RESET should be re-used when GRAFINI has been used.

MOVE (X, Y)

Raises the pen and repositions it at the co-ordinates X, Y (initially as defined in Paragraph 5).

4.

DRAW (X, Y)

Lowers the pen and repositions it at the co-ordinates X, Y.

LINE (X, Y)

Draws a dashed line to the co-ordinates X, Y. The type of line is defined by the following subroutine.

LINE TYPE (M1, S1, M2, S2)

Defines a dashed line by the four real parameters which represent mark 1, space 1, mark 2, space 2. Mark refers to the distance, in cms, moved by the pen when down, and space is similar with the pen up. This mark/space sequence is preserved between calls to LINE. Initially M1, S1, M2, S2 set to 1, 1, 1, 1 when RESET is called.

PLOT TEXT ('string', N)

The first parameter is simply a text constant and may be set up in any of the usual ways, for example as an array by means of a DATA statement (Reference 1). The direct method shown is considered the most useful. N is the number of characters in the string, and plotting will commence at the current pen position. Initially the character height is set to 0.36 cms. Appendix A shows the character sets available.

Special effects can be obtained as follows:

"nS" Where n, an unsigned integer, causes n spaces to be plotted.

"nC" Causes n newlines, with reference to the first character of the string, and with a line spacing of $1\frac{1}{2}$ times the character height.

"nB" Causes further characters to be selected from set n (n = 1, 2, 3, 4). An actual text constant can only contain the usual 64 characters shown in set 1. This technique allows any of the other characters to be plotted, for example "2B"A would cause the character a to be plotted and "4B"Z would plot the character z.

"P" Because " has a special effect, this notation is used to plot the character ".

Combinations of these sequences can be used to obtain compound effects and when n = 1 it may be omitted, for example "C7S".

PLOT NUM (VAL, N, M)

The quantity VAL is plotted with N digits before the decimal point and M after. Positive numbers are preceded by "space" and negative numbers by '-'. If N = 0 a floating point layout is obtained, and if M = 0 an integer layout is obtained. Output is always followed by two spaces. Initial conditions set the character height to 0.36 cms.

PLOT CH(N)

Plots the single character whose code number is N. Characters are numbered in sequence 0-255 and the first 64 (0-63) are identical with the 1900 internal set. Each character (except 249-255) commences at its lower left and finished at its lower right including the correct inter character spacing. Numbers 249 to 255 are plotting symbols which are centred at the current pen position.

SECONDARY SUBROUTINES

8. The following subroutines may be used to extend the effect of the preceding subroutines. The parameters concerned are preset and it is not therefore essential to use these subroutines.

SCALE (XSCALE, YSCALE)

Pen movements are scaled, not applicable to character drawing routines. Initially set to 1.0,1.0.

ORIGIN (XSHIFT, YSHIFT)

The origin is repositioned, relative to the initial pen position (i.e. where the pen was when RESET was called). Initially set to 0.0,0.0.

Together these two subroutines have the effect that co-ordinates X, Y are actually plotted as $X*XSCALE+XSHIFT$ and $Y*YSCALE+YSHIFT$ cms.

LIMITS (XMIN, XMAX, YMIN, YMAX)

The pen is constrained to remain within the box specified by the parameters, relative to the current co-ordinate system (i.e SCALE and ORIGIN apply). Initially set to 0, 42.0, 0, 29.8 cms; A3 size.

CHAR SIZE (S)

Set the character size (height in cms). Initially set to 0.36.

ROTATION (PHI)

The co-ordinate axes are rotated at an angle PHI. Zero is along the paper (the initial x-direction) and positive PHI is anti-clockwise. Initially set to zero and the units chosen to be degrees.

CARTESIAN

Pen movements represent cartesian co-ordinates (as already described). Initially chosen.

POLAR

Pen movements are interpreted as R, θ and converted to X, Y. Initially θ is in degrees.

INCREMENTAL

Pen movements are increments to the last pen position; SCALE applies.

ABSOLUTE

Pen movements are relative to the fixed origin; SCALE and ORIGIN apply. Initially chosen.

DEGREES

Angular parameters to be expressed in degrees. Initially chosen.

6.

RADIANS

Angular parameters to be expressed in radians.

PRINTER

Switches to print mode; the normal output routines can then be used to print on the teletype. Switching to plot mode is automatic.

NONRPT

Alters the format of the characters drawn by the plotting routines. RESET results in curves being drawn in "SPR" etc. This takes some time on the plotter and this subroutine causes straight lines to be drawn. This is not too noticeable in characters up to .5 cm high.

REPORT

This alters the format of the characters back to that set in RESET.

GRAFST (Y)

This can be used in place of the first call to RESET. It draws a dotted line across the paper (to ensure that the ink in the pen is flowing) then positions the pen Y cms from the right hand side of the paper and sets the origin (see Para. 5).

9. The following routines are also provided:

AXIS (XO, YO, X1, Y1, D, P)

Draws a line from XO, YO to X1, Y1 with tick marks at interval D and perpendicular height P.

LOGAXIS (XO, YO, X1, Y1, AN, P)

This subroutine draws an axis from XO, YO to X1, Y1 with log scale of AN cycles and tick marks of perpendicular height P. It operates only on axes perpendicular to or parallel to the x-axis (see Para. 5) i.e.

$XO = X1$ or $YO = Y1$.

CURVE (F, XMIN, XMAX, TOL)

Draws a curve of the function $Y = F(X)$ between XMIN and XMAX. The function F is a user provided function segment, and its smoothness is determined by TOL, which is the length, in cms, of the straight line segments composing the curve.

The user is reminded that the function F should be included in an EXTERNAL statement (see Reference 1).

The subroutine draws the curve of a continuous function as a solid line.

FIT (X, Y, N, M, S1, S2)

Fits a smooth solid curve through the N points X_i, Y_i contained in the arrays X, Y. If M is zero then the initial and final slopes of the curve will be calculated by the routine. The initial slope may be specified in S1 if $M = 1$, and the final slope may be specified in S2 if $M = 2$. Both slopes are specified if $M = 3$. When $X(N) = X(1)$ and $Y(N) = Y(1)$ a closed curve is drawn.

CURVE2 (F, XMIN, XMAX, TOL)

Draws a dashed-line (defined by LINE TYPE) in a similar manner to CURVE.

FIT2 (X, Y, N, M, S1, S2)

Fits a smooth dashed-line curve (defined by LINE TYPE) in a similar manner to FIT.

GRAFERR (I)

Since the graph plotting subroutines output by means of a buffer (see Para. 4) an error may result in an incomplete buffer existing and the graph drawn from the paper tape will not terminate at the point where the error occurred.

This subroutine enables an asterisk to be output at the point in question followed by the text EXECUTION ERROR: I (where I is the error number as given in the relevant compiler manual), GRAFINI is called and the program halted after writing the same message to the output monitor.

The subroutine has to be included in an EXTERNAL statement (see Reference 1) and a call to FTRAP (see References 1 and 3).

i.e. EXTERNAL GRAFERR

```

      .
      .
      .
      CALL FTRAP (GRAFERR)
      .
      .
      .
  
```

PLOT MONTH (NB, M, NA, NS)

Plots in text the month whose numerical value is M. NB is the number of spaces to precede the text and NA is the number of spaces to follow it. NS is the set number (as described in "nB" under PLOT TEXT). If NS=1 the text is in upper case and if NS = 1 the text is in lower case with the initial letter in upper case. It should be noted that attempts to write from sets 3 and 4 result in the use of set 2 since Greek characters would be meaningless.

PLOT DATE (N)

Plots the current date in a format specified by N.

N = 0 as eight characters e.g. 12/02/67 represents 12 February 1967

N = 1 with month in upper case text e.g. 12 FEBRUARY 1967

N > 1 with month in lower case as for PLOT MONTH e.g. 12 February 1967.

Note: The subroutine, once it has obtained the date, stores it for use in subsequent calls to the subroutine.

PLOT TIME

Plots the current time as eight characters e.g. 08/19/59 represents eight hours nineteen minutes and fifty-nine seconds.

8.

PLOTTERS AVAILABLE

10. As mentioned in Para. 2, the subroutines given have been written to produce paper tapes which can be used in conjunction with CIL Plotters having 0.1 mm increment size and 34 cm plotting width.

11. Pairs of characters on the tape govern the number of increments the plotter is driven in the X and Y directions (or switch to plot mode or set pen UP or DOWN).

12. With 0.2 mm incremented size plotters the pen will be moved twice as far. Consequently three further routines RESET2, SCALE2 and GRAFST2, having the same effect as RESET, SCALE and GRAFST, are included for such plotters. They effectively halve the scale used by MOVE, DRAW etc.

13. Subroutines GRAFSTL and GRAFSTL2 are included for plotters with a width of 70 cms (0.1 mm and 0.2 mm increments respectively).

14. In many applications, output from an ICL 1900 computer can usefully be plotted remotely on a plotter controlled by a free-standing PDP minicomputer. A program has been written for the PDP which enables it to read the paper tape and plot the requisite graph. Copies of this program are available from the author.

USE OF SUBROUTINES

15. Currently the subroutines are available at AUWE in semi-compiled form in :LIBAA.SUBGROUPE3 to all users.

16. A file needs to be assigned to TPO in ALLCHAR mode when running the program to receive the output which can then be listed on the tape punch i.e.

```
AS *TPØ,FILENAME(ALLCHAR)
```

17. Sample programs are shown in Appendix B. The first three give rise to a composite graph in Fig. 1. It can be seen that the first program was run on 22nd January 1976 (see DATE column) and the third on 11th March 1976 (see date in bottom right hand corner). The tapes were plotted in the order 1,2,3 without moving the paper in the plotter between plots. The graph from the fourth program is given in Fig. 2.

18. The characters shown in Appendix A were produced on the graph plotter.

USE IN ALGOL PROGRAMS

19. The subroutines, with the exceptions mentioned in Paras. 21-23, can be called from programs written in ALGOL.

20. They require to be explicitly declared as 'external' procedures (Reference 5) remembering the convention for REAL and INTEGER variables mentioned in Para. 6 above. Calls to libraries SUBGROUPSRA3 and SUBGROUPSRF7 are needed after the call to SUBGROUPE3 (Reference 4) remembering to include calls to the relevant SEMI parameters in the call to the compiling macro. These two subgroups are held in :LIB.

21. Algol procedures cannot be used as parameters for a FORTRAN procedure (Reference 5) which precludes the use of CURVE and CURVE2.

22. Because of the different method of handling strings of characters in ALGOL, PLOTTEXT above has to be replaced by PLOTTEXTA with the following 'external' call:

```
'PROCEDURE' PLOTTEXTA(STR,N); 'STRING' STR; 'INTEGER' N; 'EXTERNAL';
```

23. GRAFERR is not usable in ALGOL.

24. An example of a program written in ALGOL is given in Appendix C and the graph drawn in Fig. 3 showing the effect of NONRPT and the effectiveness of LIMITS.

ACKNOWLEDGEMENT

25. Development of subroutines for remote plotting of output from the AUWE central computer was started by Mr. C. Richardson and extended by the author. The present note unifies and replaces previous in-house publications.

REFERENCES

Reference

- 1 ICL 1900 FORTRAN Language Manual.
- 2 ICL 1900 FORTRAN Compiler Manuals.
- 3 ICL 1900 FORTRAN Compiler Libraries Manual.
- 4 ICL 1900 ALGOL Compiler Manual.
- 5 IBID, chapter on mixed programming.

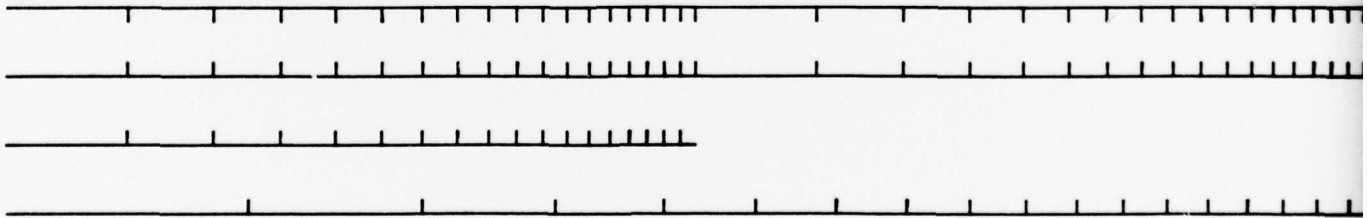
TIME	DATE	MON	T
09/47/00	22/01/76	1	J
	22 JANUARY 1976	2	F
	22 January 1976	3	M
	22 January 1976	4	A
	22 January 1976	5	M
		6	J
		7	J
		8	A
		9	S
		10	O
		11	N
		12	D
09/47/30			

↑ EXAMPLES OF PLOTS OF TIME, DATE AND MONTH ↑

↓

EXAMPLES OF LOGAXIS

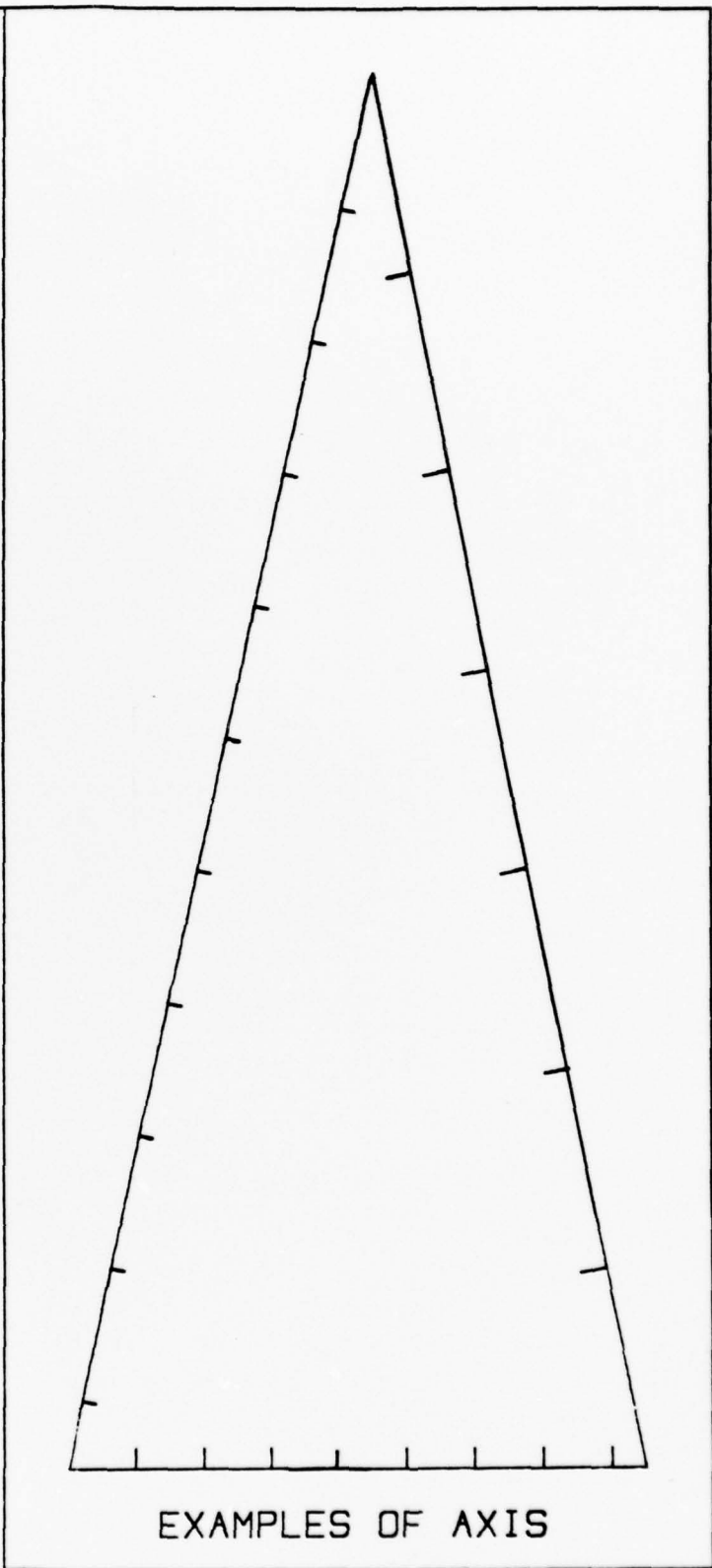
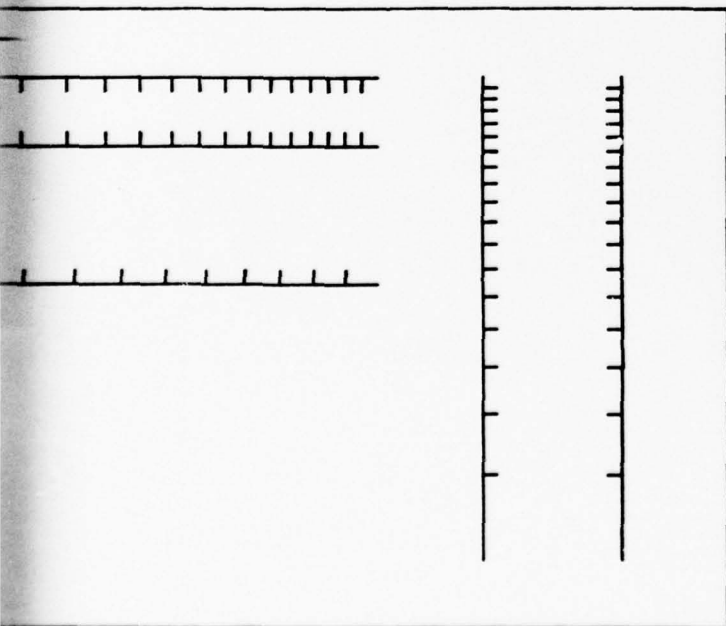
↓



MON	TEXT
1	JANUARY
2	FEBRUARY
3	MARCH
4	APRIL
5	MAY
6	JUNE
7	JULY
8	AUGUST
9	SEPTEMBER
10	OCTOBER
11	NOVEMBER
12	DECEMBER

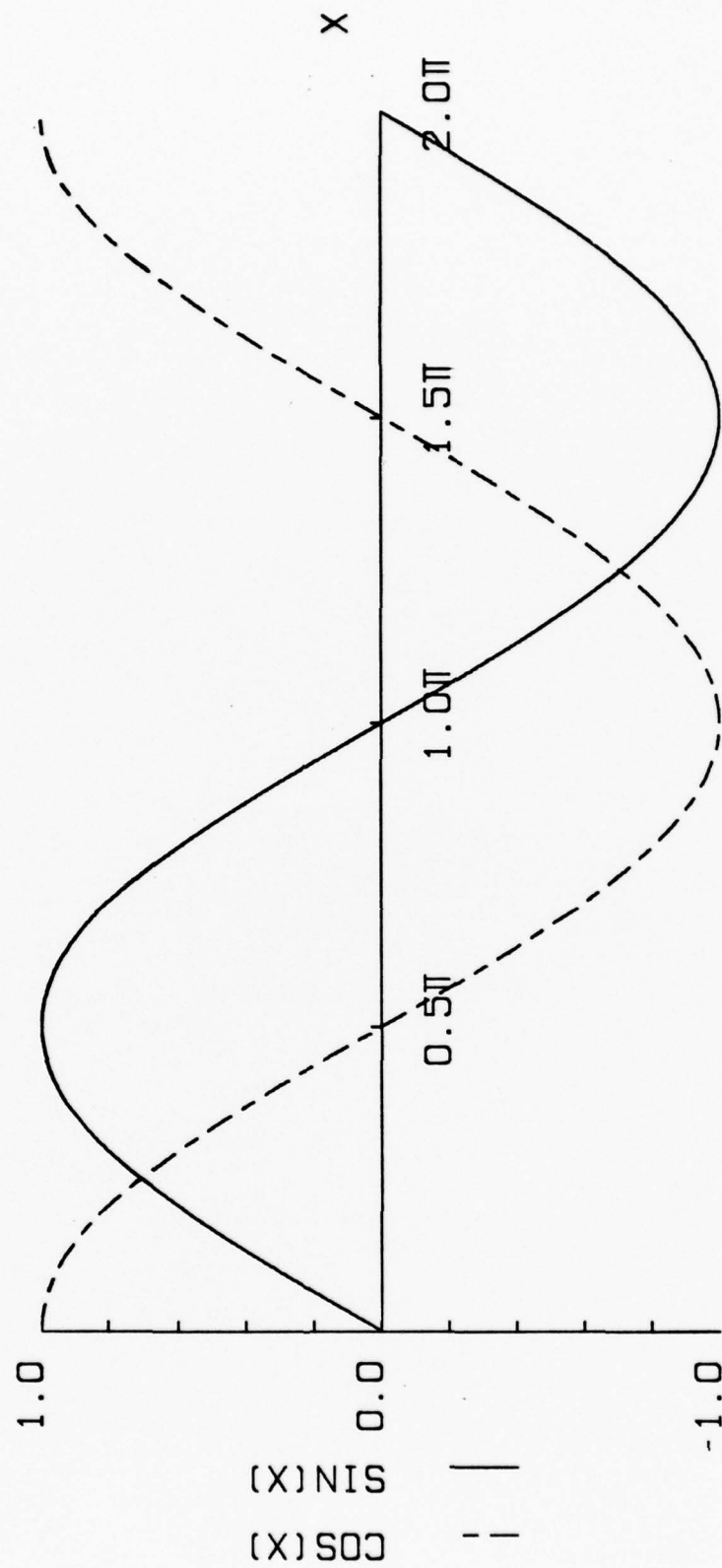
DATE AND MONTH ↑

S ↓



11/03/76

FIG. 1



VARIATION OF SIN(X) AND COS(X) WITH X

FIG.2

B O R P S 8
B O R P S 8

+

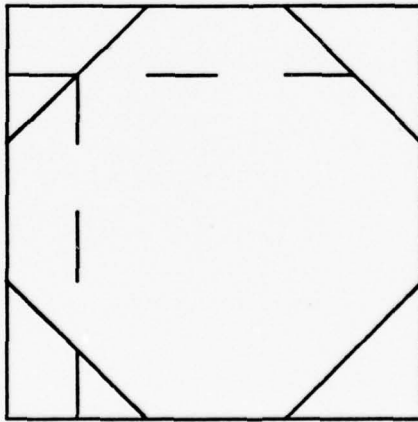


FIG.3

DRAWN BY
ALGOL PROG

B O R P S 8
B O R P S 8

+

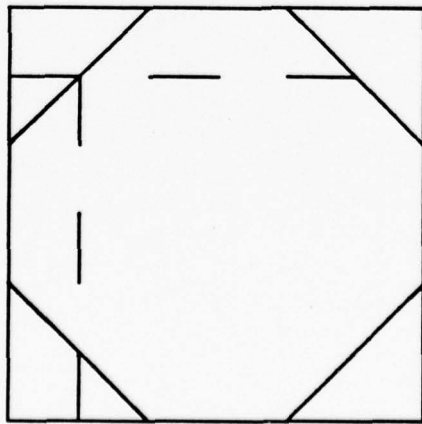


FIG.3

APPENDIX A

To obtain N for presentation to PLOTCH use the following formula

$$N = (\text{SET} - 1) \times 64 + \text{ROW} \times 8 + \text{COL}$$

i.e. to get N for the & in Set 1

$$N = 0 \times 64 + 2 \times 8 + 4 = 20 \text{ (or octal } 24)$$

or to get N for ? in Set 4

$$N = 3 \times 64 + 1 \times 8 + 7 = 207$$

SET 1

	0	1	2	3	4	5	6	7
0	0	1	2	3	4	5	6	7
1	8	9	:	;	<	=	>	?
2		!	"	#	£	%	&	'
3	()	*	+	,	-	.	/
4	@	A	B	C	D	E	F	G
5	H	I	J	K	L	M	N	O
6	P	Q	R	S	T	U	V	W
7	X	Y	Z	[§]	↑	←

SET 2

	0	1	2	3	4	5	6	7
0	0	1	2	3	4	5	6	7
1	8	9	:	;	<	=	>	?
2		!	"	#	£	%	&	'
3	()	*	+	,	-	.	/
4	@	a	b	c	d	e	f	g
5	h	i	j	k	l	m	n	o
6	p	q	r	s	t	u	v	w
7	x	y	z	â	š	▽	□	10

SET 3

	0	1	2	3	4	5	6	7
0	0	1	2	3	4	5	6	7
1	8	9	≤	≥	<	=	>	?
2		≈	≡	±	≠	‰	&	'
3	()	*	+	,	-	.	/
4	√	A	B	Γ	Δ	E	Z	H
5	Θ	I	K	Λ	M	N	Ξ	O
6	Π	P	Σ	T	Υ	Φ	X	Ψ
7	Ω	△	▽	□	◇	○	+	×

SET 4

	0	1	2	3	4	5	6	7
0	0	1	2	3	4	5	6	7
1	8	9	\leq	\geq	$<$	$=$	$>$?
2		\approx	\equiv	\pm	\neq	$\%$	$\&$	'
3	()	*	+	,	-	.	/
4	$\sqrt{\quad}$	α	β	γ	δ	ϵ	ζ	η
5	θ	ι	κ	λ	μ	ν	ξ	\omicron
6	π	ρ	σ	τ	υ	ϕ	χ	ψ
7	ω	\triangle	∇	\square	\diamond	\circ	$+$	\times

APPENDIX B
PROGRAMS WRITTEN IN FORTRAN

ELISTING OF : WORKFILE AAA00001615(1/1) PRODUCED ON 25MAY76 AT 15.00.57
EOUTPUT BY LISTFILE IN 'AAH UCWB99' ON 25MAY76 AT 15.04.43
DOCUMENT

TAPE LISTING OF : AAHB. GRDEM1 (3/ARCH)
WRITTEN AT 14.36.00 ON 25MAY76

```

0 SHORTLIST(LP)
1 LIBRARY(ED, SUBGROUPUME3)
2 LIBRARY(ED, SUBGROUPUME1)
3 MAP
4 PROGRAM(DEMO)
5 CONTACT
6 COMPRESS INTEGER AND LOGICAL
7 INPUT 1=CRO
8 OUTPUT 2=LFO
9 OUTPUT 5=TPO
10 TRACE 0
11 END
12 MASTER GRDEM
13 READ(1,100)ALAB
14 WRITE(2,101)ALAB
15 100 FORMAT(A8)
16 101 FORMAT(1X,A3)
17 CALL MILL(ML)
18 WRITE(2,102)ML
19 102 FORMAT(1X,19)
20 CALL RESET
21 CALL MOVE(1,0,0,0)
22 CALL DRAW(0,0,0,0)
23 CALL DRAW(0,0,1,0)
24 CALL MOVE(41,0,0,0)
25 CALL DRAW(42,0,0,0)
26 CALL DRAW(42,0,1,0)
27 CALL MOVE(42,0,28,8)
28 CALL DRAW(42,0,29,8)
29 CALL DRAW(41,0,29,8)
30 CALL MOVE(1,0,29,8)
31 CALL DRAW(0,0,29,8)
32 CALL DRAW(0,0,28,8)
33 CALL MOVE(3,0,2,0)
34 CALL DRAW(41,0,2,0)
35 CALL DRAW(41,0,26,0)
36 CALL DRAW(3,0,26,0)
37 CALL DRAW(3,0,2,0)
38 CALL CHAR SIZE(0,5)
39 CALL LIMITS(3,0,41,0,2,0,26,0)
40 CALL MOVE(3,5,25,25)
41 CALL PLOT TEXT('CS"TIME"12S"DATE"10S"MON"4S"TEXT',33)
42 CALL ORIGIN(3,0,2,0)
43 CALL MOVE(19,0,13,0)
44 CALL LINE(19,0,13,0)
45 CALL MOVE(15,5,13,0)
46 CALL LINE TYPE(1,0,0,5,1,0,0,5)
47 CALL LINE(15,5,24,0)
48 CALL MOVE(5,5,24,0)
49 CALL LINE TYPE(0,5,1,0,1,0,0,5)
50 CALL LINE(5,5,13,0)

```

```

51 CALL MOVE(0, 0, 23, 0)
52 CALL DRAW(26, 0, 23, 0)
53 CALL MOVE(26, 0, 24, 0)
54 CALL DRAW(26, 0, 13, 0)
55 CALL MOVE(26, 0, 10, )
56 CALL DRAW(26, , 1, )
57 CALL ORIGIN(3, 5, 2, 0)
58 X=0
59 Y=22 25
60 CALL MOVE(X, Y)
61 CALL PLOT TIME
62 X1=5, 5
63 X2=15, 0
64 NE=2
65 NA=1
66 DO 1 I=1, 5
67 II=I-1
68 CALL MOVE(X1, Y)
69 CALL PLOT DATE(II)
70 1 Y=Y-0, 75
71 Y=22, 25
72 DO 2 I=1, 12
73 A=I
74 CALL MOVE(X2, Y)
75 CALL PLOT NUM(A, 5, 0)
76 CALL PLOT MONTH(NB, I, NA, 1)
77 2 Y=Y-0, 75
78 CALL MOVE(X, Y)
79 CALL PLOT TIME
80 CALL MOVE(-0, 5, 13, 0)
81 CALL DRAW(25, 5, 13, 0)
82 CALL MOVE(X+4, 35, 12, )
83 CALL PLOTCH(62)
84 CALL CHAR SIZE(0, 36)
85 CALL PLOT TEXT('EXAMPLES OF PLOTS OF TIME, DATE AND MONTH', 40)
86 CALL CHAR SIZE(0, 5)
87 CALL PLOTCH(62)
88 CALL MOVE(25, 5, 1, )
89 CALL DRAW(-, 5, 1, )
90 CALL GRAFINI
91 CALL MILL(ML)
92 WRITE(2, 102)ML
93 STOP
94 END
95 FINISH
96 *****
97

```

ELISTING OF : WORKFILE AAAC00001615(1/) PRODUCED ON 25MAY76 AT 15. 01. 23
 OUTPUT BY LISTFILE IN : AAH_UJCM899' ON 25MAY76 AT 15. 05. 11
 DOCUMENT

TAPE LISTING OF : AAHB. GRDEM2(3/ARCH)
 WRITTEN AT 15. 01. 07 ON 25MAY76

```

0  SHORTLIST(LP)
1  LIBRARY(ED, SUBGROUPWE3)
2  LIBRARY(ED, SUBGROUPWE1)
3  MAP
4  * PROGRAM(DEMO)
5  COMPACT
6  COMPRESS INTEGER AND LOGICAL
7  INPUT 1=CRO
8  OUTPUT 2=LPO
9  OUTPUT 5=TPO
10 TRACE 0
11 END
12 MASTER GRIDM
13 READ(1,100)ALAB
14 WRITE(2,101)ALAB
15 100 FORMAT(1X,A8)
16 101 FORMAT(1X,A8)
17 CALL MILL(ML)
18 WRITE(2,102)ML
19 102 FORMAT(1X,I9)
20 CALL RESET
21 CALL LIMITS(0,26,0,10,5)
22 CALL CHAR SIZE(5)
23 CALL MOVE(5,2,9,93)
24 CALL ROTATION(180)
25 CALL PLOTCH(62)
26 CALL INCREMENTAL
27 CALL MOVE(-15,35,0)
28 CALL PLOTCH(62)
29 CALL ABSOLUTE
30 CALL ROTATION(0)
31 CALL MOVE(9,19,9,5)
32 CALL CHAR SIZE(0,36)
33 CALL PLOT TEXT('EXAMPLES OF LOGAXIS',19)
34 AN=2
35 P=2
36 X=1
37 CALL LOGAXIS(X,7, X+20,7, AN,P)
38 CALL LOGAXIS(X+20,8, X,8, AN,P)
39 CALL LOGAXIS(X,6, X+10,6,1,1,P)
40 CALL LOGAXIS(X,5, X+20,5,1,1,P)
41 CALL LOGAXIS(24,5,1,24,5,8,1,1,P)
42 CALL LOGAXIS(22,5,8,22,5,1,1,1,P)
43 CALL MOVE(26,9)
44 CALL DRAW(0,9)
45 CALL MOVE(1,0)
46 CALL DRAW(0,0)
47 CALL DRAW(0,1)
48 CALL LIMITS(0,38,-1,1,1)
49 CALL MOVE(37,-1)
50 CALL DRAW(38,-1)

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24.

```
51 CALL DRAW(38,0.)  
52 CALL MOVE(38,-1.)  
53 CALL GRAFINI  
54 CALL MILL(ML)  
55 WRITE(2,102)ML  
56 STOP  
57 END  
58 FINISH  
59 *****  
60
```

ELISTING OF : WORKFILE AAAE00001615(1/1) PRODUCED ON 25MAY76 AT 15.01.51
 OUTPUT BY LISTFILE IN : AAH.UJWB99' ON 25MAY76 AT 15.08.36
 DOCUMENT :

TAPE LISTING OF : AAHB. GRDEM3 (3/ARCH)
 WRITTEN AT 15.01.30 ON 25MAY76

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0 SHORTLIST(LP)
1 LIBRARY(ED,SUBGROUPUM3)
2 LIBRARY(ED,SUBGROUPUM1)
3 MAP
4 PROGRAM(IBM)
5 COMPACT
6 COMPRESS INTEGER AND LOGICAL
7 INPUT 1=CRO
8 OUTPUT 2=LFO
9 OUTPUT 5=TPO
10 TRACE 0
11 END
12 MASTER GRDEM
13 READ(1,100)ALAB
14 WRITE(2,101)ALAB
15 100 FORMAT(A8)
16 101 FORMAT(1X,A8)
17 CALL MILL(ML)
18 WRITE(2,102)ML
19 102 FORMAT(1X,19)
20 CALL RESET
21 CALL LIMITS(-20,0,0,90.)
22 CALL ROTATION(90,0)
23 CALL MOVE(0,1.)
24 CALL DRAW(0,0)
25 CALL DRAW(1,0)
26 CALL DRAW(1,10.5)
27 CALL DRAW(24,0,10.5)
28 CALL MOVE(23,0)
29 CALL DRAW(24,0)
30 CALL DRAW(24,1)
31 CALL AXIS(23,0,5,0,2,5,9,5,2,0,0,2)
32 CALL AXIS(2,5,9,5,2,5,1,1,1,3)
33 CALL AXIS(2,5,1,0,23,0,5,0,3,0,0,4)
34 CALL MOVE(1,5,8,13)
35 CALL GRAFINI
36 CALL RESET
37 CALL LIMITS(0,20,-4,2)
38 CALL PLOT TEXT('EXAMPLES OF AXIS',16)
39 CALL MOVE(4,13,-1,3)
40 CALL PLOT DATE(0)
41 CALL MOVE(4,13,-3)
42 CALL CHAR SIZE(0,5)
43 CALL PLOT TEXT('FIG. 1',6)
44 CALL MOVE(15,-4)
45 CALL GRAFINI
46 CALL MILL(ML)
47 WRITE(2,102)ML
48 STOP
49 END
50 FINISH

```

ELISTING OF : WORKFILE: AAAM0001615(1/) PRODUCED ON 25MAY76 AT 15.04.41
 IOUTPUT BY LISTFILE IN : AAH.UUCWB99" ON 25MAY76 AT 15.10.36
 DOCUMENT

TAPE LISTING OF : AAHB. GRDEM7 (3/ARCH)
 WRITTEN AT 15.03.45 ON 25MAY76

```

0 SHORTLIST(LP)
1 LIBRARY(ED.SUBGROUPUNE3)
2 LIBRARY(ED.SUBGROUPUNE1)
3 MAP
4 PROGRAM(DEMO)
5 COMPACT
6 COMPRESS INTEGER AND LOGICAL
7 INPUT I=CRO
8 OUTPUT 2=LPO
9 OUTPUT 5=TPO
10 TRACE 0
11 END
12 MASTER GRDEM
13 READ(1,100)ALAB
14 WRITE(2,101)ALAB
15 100 FORMAT(AS)
16 101 FORMAT(1X,A8)
17 CALL MILL(ML)
18 WRITE(2,102)ML
19 102 FORMAT(1X,I9)
20 CALL RESET
21 CALL LINE TYPE(4,2,2,2)
22 CALL ORIGIN(5,15)
23 CALL AXIS(0,0,18,0,4,5,0,15)
24 CALL AXIS(0,5,0,-5,1,0,15)
25 DO 1 I=1,4
26 CALL MOVE(4,5*I-0.9,-1)
27 1 CALL PLOT NUM(0,5*I,1,1)
28 DO 2 I=1,4
29 CALL MOVE(4,5*I+0.54,-1)
30 2 CALL PLOTCH(176)
31 CALL MOVE(19,18,0,5)
32 CALL PLOTCH(56)
33 DO 3 I=1,3
34 CALL MOVE(-1,8.5*(I-2))
35 3 CALL PLOT NUM(1-2,1,1)
36 CALL MOVE(-2,-2)
37 CALL DRAW(-2,-1)
38 CALL MOVE(-2,0)
39 CALL ROTATION(90)
40 CALL PLOT TEXT('SIN(X)',6)
41 CALL MOVE(-2,3)
42 CALL LINE(-1,3)
43 CALL MOVE(0,3)
44 CALL PLOT TEXT('COS(X)',6)
45 CALL ROTATION(0)
46 CALL MOVE(2,-7)
47 CALL PLOT TEXT('VARIATION OF SIN(X) AND COS(X) WITH X',37)
48 EXTERNAL SIN,COS
49 CALL SCALE(18,76,2831853,5)
50 CALL CURVE(SIN,0,76,2831853,0,2)

```

27.

CALL CURVE2(COS,0.6,2831853,0.2)
CALL MOVE(22,-15.)
CALL GRAFINI
CALL MILL(ML)
WRITE(2,102)ML
STOP
END
FINISH

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APPENDIX C
PROGRAM WRITTEN IN ALGOL

ELISTING OF WORKFILE ARAA00000232(1/) PRODUCED ON 27MAY76 AT 12.22.32
 LOUPTUT BY LISIFILE IN :AAH.UJW5011B' ON 27MAY76 AT 12.27.40
 DOCUMENT

TAPE LISTING OF : AAHB. GRDEMA (3/ARCH)
 WRITTEN AT 11.53.25 ON 27MAY76

```

0 'LIST' (LP)
1 'LIBRARY' (ED, SUBGROUPSRA3)
2 'LIBRARY' (ED, SUBGROUPSRA3)
3 'LIBRARY' (ED, SUBGROUPSRA3)
4 'PROGRAM' (DEMO)
5 'OUTPUT' 5=TF0
6 'BEGIN'
7 'PROCEDURE' RESET, 'EXTERNAL'
8 'PROCEDURE' NONRPT, 'EXTERNAL'
9 'PROCEDURE' MOVE(X, Y); 'REAL' X, Y; 'EXTERNAL'
10 'PROCEDURE' DRAW(X, Y); 'REAL' X, Y; 'EXTERNAL'
11 'PROCEDURE' LINE(X, Y); 'REAL' X, Y; 'EXTERNAL'
12 'PROCEDURE' PLOT TEXT A(STR, N); 'STRING' STR; 'INTEGER' N; 'EXTERNAL'
13 'PROCEDURE' PLOTCH(N); 'INTEGER' N; 'EXTERNAL'
14 'PROCEDURE' CHAR SIZE(S); 'REAL' S; 'EXTERNAL'
15 'PROCEDURE' LIMITS(XMIN, XMAX, YMIN, YMAX); 'REAL' XMIN, XMAX, YMIN, YMAX; 'EXTERNAL'
16 'PROCEDURE' GRAFINI; 'EXTERNAL'
17 'REAL' CHSZ; 'INTEGER' NO.
18 'BEGIN'
19 RESET, NO:=6; CHSZ:=2.4; MOVE(0, 15);
20 PLOT TEXT A('DRAWN BY "CALGOL" S="PROG"', 25);
21 MOVE(0, 6); CHAR SIZE(CHSZ); PLOT TEXT A('DORP88'), NO; NONRPT,
22 MOVE(0, 9); PLOT TEXT A('DORP88'), 6; CHAR SIZE(.72); MOVE(0, 0);
23 LIMITS(-1, 1, -1, 1); PLOTCH(254); LIMITS(2, 8, -8, -2); MOVE(0, -2);
24 DRAW(8, -2); DRAW(8, -8); DRAW(2, -8); DRAW(2, 0);
25 MOVE(5, -9); DRAW(9, -5); DRAW(5, -1); DRAW(1, -5); DRAW(1, -5); MOVE(3, 3);
26 LINE(3, -13); MOVE(0, -3); LINE(10, -3); LIMITS(-10, 50, -20, 25); MOVE(45, -10); GRAFINI
27 'END'
28 'END'
29 'FINISH'
30 ****
31

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These abstract cards are inserted in A.U.W.E. reports and notes for the convenience of librarians and others who need to maintain an information index

<p><u>UNCLASSIFIED - UNLIMITED</u></p> <p>A.U.W.E. Publication 42003 July, 1976 W. J. Butterworth</p> <p>Subroutines for ICL 1904/CIL Plotter</p> <p>A Package of subroutines is offered for use on the ICL 1904S computer, to output characters on paper tape which can then be used to drive a CIL Plotter via a tape reader. Their use in FORTRAN and ALGOL is demonstrated. A means is available of using the same tapes on plotters attached to PDP computers.</p> <p>The routines are implemented on an ICL 1904S computer based in the Computing division, A.U.W.E., Portland.</p>	<p>681.3.05</p> <p>A.U.W.E. Publication 42003 July, 1976 W. J. Butterworth</p> <p>Subroutines for ICL 1904/CIL Plotter</p> <p>A Package of subroutines is offered for use on the ICL 1904S computer, to output characters on paper tape which can then be used to drive a CIL Plotter via a tape reader. Their use in FORTRAN and ALGOL is demonstrated. A means is available of using the same tapes on plotters attached to PDP computers.</p> <p>The routines are implemented on an ICL 1904S computer based in the Computing division, A.U.W.E., Portland.</p>
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