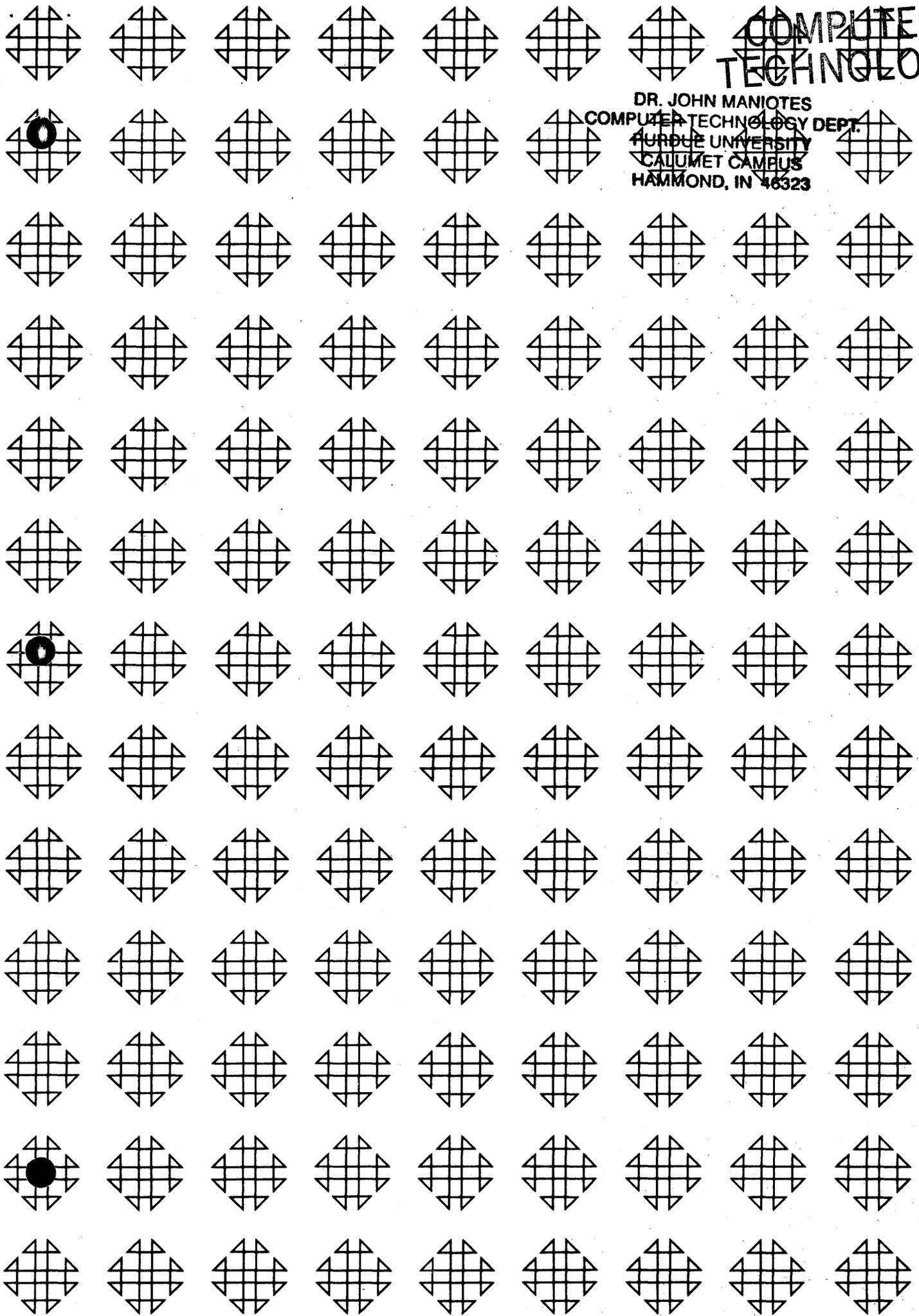


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Plot Subroutine for FORTRAN with Format
(1620-FO-004 Version 1)

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PLOT SUBROUTINE
FOR FORTRAN
WITH FORMAT

(1620-FO-004 Version 1)

DECK KEY

1. FORTRAN Plot Demonstration Deck to Read Values from and Compute the Sine, Cosine and Natural Log
2. Plot Subroutine Program Deck
3. Plot Subroutine Source Deck
4. Plot Subroutine Demonstration Data Deck

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Plot Subroutine for FORTRAN with Format
(1620-FO-004 Version 1)

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- A. Purpose/Description: This program presents a subroutine which can be easily used in FORTRAN for plotting single or multiple curves without the GOTRAN problem of determining which curve has the lower magnitude. Also this method can be used to generate the curves on cards for off-line printing.
- B. Method: N/A
- C. Restrictions and Range: Normally a range of 0-70 should be the limitation for typewriter output since the carriage can handle only 80 to 85 positions. The range for card output should be 72 characters minus the digits in the independent variable.
- D. Accuracy: Negative numbers, floated numbers, and numbers outside of the allowable range produce an ERROR F9 message.
- E. Machine Configuration: Basic 1620 Card system with minimum of 20K memory. The program is designed to work with the FORTRAN system without automatic divide.
- F. Program Requirements: The subroutine requires 432 core locations.
- G. Source Language: Fortran
- H. Program Execution Time: N/A
- I. Check Out Status: N/A
- J. Sample Problem Running Time: Approximately 45 minutes.
- K. Comments: Major modifications must be made to use this subroutine with the FORTRAN version with automatic divide. This program and its documentation were written by an IBM employee. It was developed for a specific purpose and submitted for general distribution to interested parties in the hope that it might prove helpful to other members of the data processing community. The program and its documentation are essentially in the author's original form. IBM serves as the distribution agency in supplying this program. Questions concerning the use of the program should be directed to the author's attention.

Plot Subroutine of IBM 1620 FORTRAN with Format

INTRODUCTION

Since many IBM 1620 applications are in areas where a rough plot of the results can be quite useful, it was felt that a subroutine incorporated into FORTRAN was necessary. GOTRAN provides a statement for plotting requiring a separate program and a knowledge of GOTRAN language. This write-up presents a subroutine which can be easily used in FORTRAN for plotting single or multiple curves without the GOTRAN problem of determining which curve has the lower magnitude. Also this method can be used to generate the curves on cards for off-line printing.

METHOD OF USE

Since a method of plotting multiple curves with any special characters was desired, the normal method of output (PRINT or PUNCH) was utilized with the incorporation of a new type FORMAT character Z. This subroutine is used with the output routines rather than the normal arithmetic statement. The basic FORTRAN statements to use this plot subroutine are:

```
PRINT      2, X, M, N, J
          2  FORMAT  (F10.5, 3Z *+.)
```

The first variable in the list is the independent variable which can be either fixed or floated point number. This variable will be handled in the regular output routine where the value is printed. The Z character in the format accomplishes the following:

1. The remaining values in the list will be plotted instead of printed.
2. The Z is handled by the compiler in the same routines designed for the H character except that the address compiled will be the address in the symbol table corresponding to the subroutine whereby the FORTRAN input/output package will branch to this address then to the relocated subroutine. The number and type of plot characters are stored similar to the H type.
3. The remaining values in the list are assumed to be fixed variables previously scaled to the range of output record minus the digits in the independent variable. (Example: for the case shown, the numbers should be scaled between 0 and 87 minus 10 (or 77). Normally a range of 0-70 should be the limitation for typewriter output since the carriage can handle only 80 to 85 positions. The range for card

output should be 72 characters minus the digits in the independent variable. Negative numbers, floated numbers, and numbers outside of the allowable range produce an ERROR F9 message.

4. The first character after the Z will be used to plot the first variable in the list to be plotted. Remaining list values will use the next character until the list is satisfied. Therefore, no limitation on the number of variables exists except the 72 character statement size. If the number of variables in the list exceeds the number of plot symbols, an ERROR F9 message will occur.
5. The range of the plot starts at the next position after the last digit of the independent variable. Therefore, if the value of the variable to be plotted is 0, the plot symbol will be inserted in the first position after the independent variable.

The statement may be either PRINT or PUNCH depending on whether the output is on the typewriter or cards. The subroutine sets up the FORTRAN output area with the independent variable and all plot symbols before giving the write command. For typewriter output, a record mark is inserted in the next position after the highest plot value to conserve typing time (A minimum of 20 characters is always typed). This produces a much faster method than GOTRAN and eliminates all problems of relative magnitude of curves.

FORTRAN Processor Modifications

To make the plot routine useable on a 20K card system, space was used where the ACCEPT TAPE and PUNCH TAPE statements were previously located. If these commands are called, an error message indicating a missing format number will occur. These changes are:

Card No. 3024

<u>Location</u>		<u>New Instruction</u>	<u>Card Col.</u>
2030	CM	14 17323 00069	21-32
2042	BNE	47 04022 01200	33-44
2054	B	49 02174	45-52

<u>Location</u>		<u>New Instruction</u>	<u>Card Col.</u>
2162	B	49 02218 00000	13-24
2174	TDM	15 08719 00001	25-36
2186	TFM	16 03493 19870	37-48
2198	TR	31 17322 17324	49-60
2210	B	49 04118	61-67

Card No. 3053

<u>Location</u>		<u>New Instruction</u>	<u>Card Col.</u>
4070	TFM	16 04243 00031	31-42
4082	BNE	47 02030 01200	43-54
4094	TR	31 17322 17324	55-66
4106	TFM	16 0349	67-72

Card No. 3054

<u>Location</u>		<u>New Instruction</u>	<u>Card Col.</u>
4112		3 04264	3-8
4118	TFM	16 03620 04174	9-20

These patches allow the processor to check for the Z format, insert the subroutine name location, and set for subroutine load. The instructions at 2174 and 2186 assume that the subroutine will be the first added after the normal six from IBM. If this is not true, then the addresses of 2174 (8719 for subroutine load) and 2186 (19870 for subroutine address) must be changed. The normal rules for adding a subroutine must be followed.

Plot Subroutine

Enclosed at the end of this write-up is an SPS listing and flow charts of the Plot Subroutine for the FORTRAN subroutine deck without automatic divide. For use with automatic divide, the address for the symbols of the input/output package must be changed. This includes CON2 which refers to the instruction in SWC.

The subroutine requires 432 core locations. The trailer card requires a value of 00434 in Col.1- 5 as stated in the FORTRAN write-up.

General Comments

With format control, the output plot can be quite complete. The following technique which can be used in FORTRAN provides a means of printing

the graph scales:

```
PRINT 5, 0, 50, 100, 150, etc.
PRINT 5, 1, 1, 1, 1, 1, 1, etc.
5  FORMAT (I 11, I5, I5, I5, etc.)
```

FORTTRAN will print the variables in the list as the value of each quantity. The I11 can be made so that the first value prints after the independent variable. Example (using previous example)

```
      0 50 100 150 200 250 300 350 400
      1 1  1  1  1  1  1  1  1  1
50000          *          .+
```

Although the previous sections of this write-up indicates that only one independent variable may be printed, this is not true. Assume it is desired to print x and y and also plot y. This could be done as follows:

```
PRINT 6, X, Y, MY
6  FORMAT (F10.5, F10.5, 1Z*)
```

This will print as follows:

```
      x      y
+xxx. xxxxx+xxx. xxxxx *
```

Where X and Y are printed and MY (Y after scaling) is plotted. The range of MY must be reduced to keep the over record with limits. The general rule is that any variable to the left of the first plot variable in the list will be printed under normal FORTRAN rules.

The name PLOT must not be used in the program since the compiler will assume this to be a function name.

Modifications for Extra Memory

To convert this program for machines with 40K or 60K, the compiler modifications previously described must be altered. The digit in column 44 of card 3026 (shown as 1) must be changed to 3 or 5 depending on the amount of additional memory.

Sample Program

Included with this write-up is a sample program and listing to illustrate the use of this subroutine. This program works as follows using data values of 1 to 89:

1. Switch 1 on - switch 2 off
SIN, COS and LGN are printed on the typewriter and punched on cards.
2. Switch 1 off - stops typewriter output.
3. Switch 1 on - switch 2 on
SIN, COS and LGN are punched on cards.
SIN and COS are plotted.

It should be noted that without typewriter output, this program permits almost complete overlap of input, output, and computing providing an effective demonstration of the 1620 card buffering.

SAMPLE PROBLEM LISTING

```

08300 C 1620 FORTRAN DEMONSTRATION TO READ VALUES FROM 1 TO 89
08300 C AND COMPUTE THE SINE,COSINE AND NATURAL LOG OF THESE NUMBERS
08300 C SWITCH 1 ON TO OBTAIN TYPEWRITER OUTPUT
08300 C SWITCH 2 OFF TO LIST VALUES ON TO PLOT SIN AND COS
08300 100 IF(SENSE SWITCH 1) 10,20
08320 10 IF(SENSE SWITCH 2) 11,12
08340 11 PRINT 6
08364 PRINT 5,0,1,2,3,4,5,6,7,8,9,10
08508 PRINT 5,1,1,1,1,1,1,1,1,1,1,1
08652 GO TO 20
08660 12 PRINT 1
08684 20 PUNCH 1
08708 DO 150 N=1,89,2
08720 READ 2,1
08744 A=1
08780 X=A*3.1415926 /180.
08828 B=SINF(X)
08852 C=COSF(X)
08876 D=LOGF(A)
08900 PUNCH 3,1,B,C,D
08960 IF(SENSE SWITCH 1) 110,150
08980 110 IF(SENSE SWITCH 2) 120,130
09000 120 MPLOT = 50.* B
09048 NPLOT = 50.*C
09096 PRINT 7,1,MPLOT,NPLOT
09144 GO TO 150
09152 130 PRINT 3,1,B,C,D
09212 150 CONTINUE
09248 PRINT 4
09272 PAUSE
09284 GO TO 100
09292 1 FORMAT(3H I 6X6HSIN(I) 6X6HCOS(I) 6X6HLGN(I))
09436 2 FORMAT(15)
09458 3 FORMAT(15,F12.7,F12.7,F12.7)
09496 4 FORMAT(37HRUN COMPLETE,PRESS START FOR NEXT SET )
09594 5 FORMAT(17,15,15,15,15,15,15,15,15,15,15,15,15,15,15 )
09676 6 FORMAT(24HBASE=1,*=SIN(I),+=COS(I))
09748 7 FORMAT(16,2Z*+)
09782 END

```

PR0G SW 1 ONFOR SYMBOL TABLE, PUSH START

```

39999 SIN
39989 SINF
39979 COS
39969 COSF
39959 ATAN
39949 ATANF
39939 EXP
39929 EXPF
39919 LOG
39909 LOGF
39899 SORT
39889 SORTF
39879 PLOT
39869 PLOTF
39859 O100
39849 O010
39839 O020
39829 O011
39819 O012
39809 O006
39799 O006
39789 O005

```

SAMPLE PROBLEM LISTING (Con't.)

```

39779 O005
39769 O000
39759 O001
39749 O002
39739 O003
39729 O004
39719 O005
39709 O006
39699 O007
39689 O008
39679 O009
39669 O010
39659 O001
39649 O001
39639 O150
39629 N
39619 O002
39609 O002
39599 I
39589 A
39579 X
39569 3141592601
39559 O00
39549 1800000003
39539 B
39529 C
39519 D
39509 O003
39499 O003
39489 O110
39479 O120
39469 O130
39459 MPLOT
39449 5000000002
39439 NPLOT
39429 O007
39419 O007
39409 O004
39399 O004

```

SW 1 OFF TO IGNORE SUBROUTINES, PUSH START

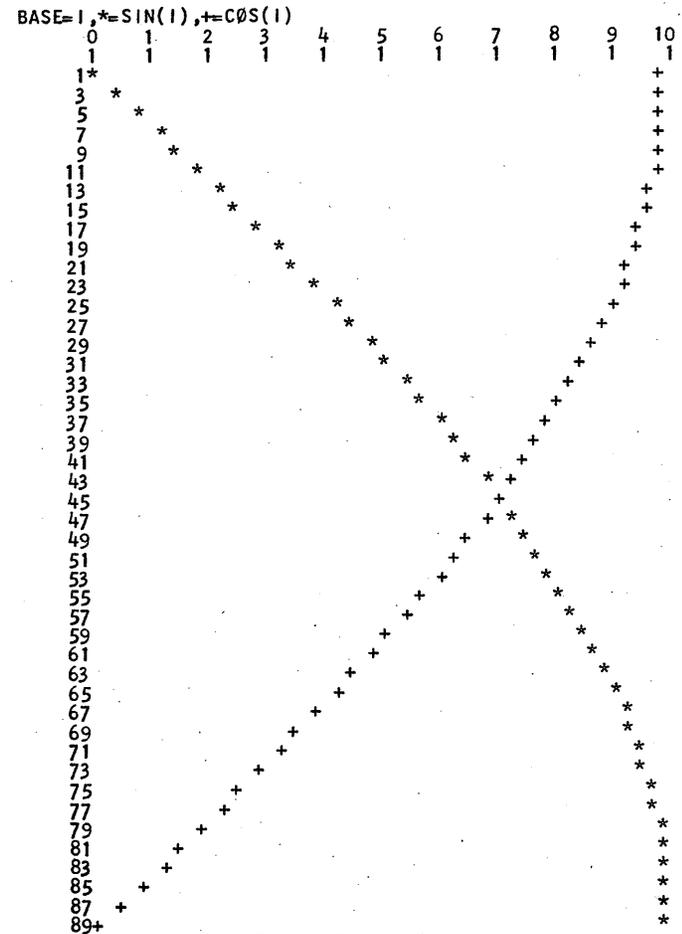
PROCESSING COMPLETE

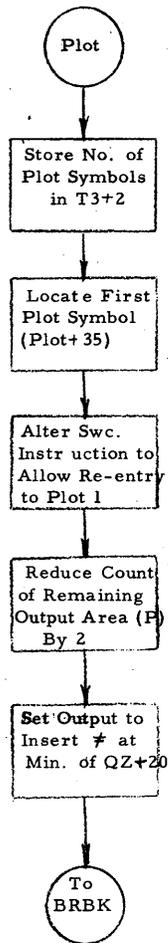
SAMPLE PROBLEM OUTPUT

L0AD DATA	SIN(I)	C0S(I)	LGN(I)
1	.0174524	.9998476	.0000000
3	.0523359	.9986295	1.0986122
5	.0871557	.9961946	1.6094379
7	.1218693	.9925461	1.9459101
9	.1564344	.9876883	2.1972245
11	.1908089	.9816271	2.3978952
13	.2249510	.9743700	2.5649493
15	.2588190	.9659258	2.7080502
17	.2923716	.9563047	2.8332133
19	.3255681	.9455185	2.9444389
21	.3583679	.9335804	3.0445224
23	.3907311	.9205048	3.1354942
25	.4226182	.9063077	3.2188758
27	.4539904	.8910065	3.2958368
29	.4848096	.8746197	3.3672958
31	.5150380	.8571673	3.4339872
33	.5446390	.8386705	3.4965075
35	.5735764	.8191520	3.5553480
37	.6018150	.7986355	3.6109179
39	.6293203	.7771459	3.6635616
41	.6560590	.7547095	3.7135720
43	.6819983	.7313537	3.7612001
45	.7071067	.7071067	3.8066624
47	.7313536	.6819983	3.8501476
49	.7547095	.6560590	3.8918202
51	.7771459	.6293204	3.9318256
53	.7986355	.6018150	3.9702919
55	.8191520	.5735764	4.0073331
57	.8386705	.5446390	4.0430512
59	.8571672	.5150381	4.0775374
61	.8746196	.4848096	4.1108738
63	.8910064	.4539906	4.1431347
65	.9063077	.4226182	4.1743872
67	.9205048	.3907312	4.2046926
69	.9335804	.3583680	4.2341065
71	.9455185	.3255682	4.2626798
73	.9563047	.2923717	4.2904594
75	.9659258	.2588190	4.3174881
77	.9743700	.2249510	4.3438054
79	.9816271	.1908090	4.3694478
81	.9876883	.1564345	4.3944491
83	.9925461	.1218694	4.4188406
85	.9961946	.0871558	4.4426512
87	.9986295	.0523360	4.4659081
89	.9998476	.0174524	4.4886363

RUN C0MPLETE,PRESS START F0R NEXT SET

SAMPLE PROBLEM OUTPUT



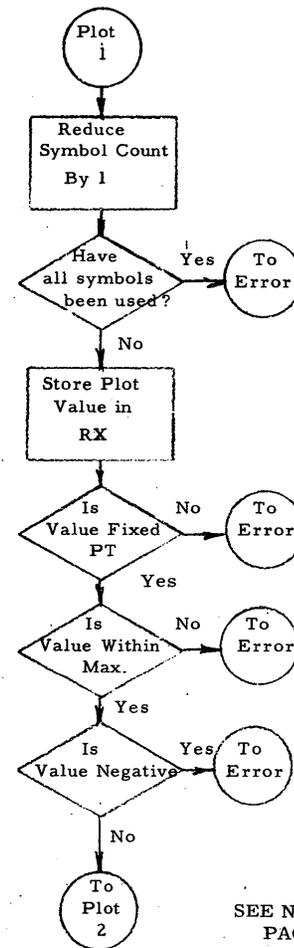


Plot Subroutine Flow Diagrams

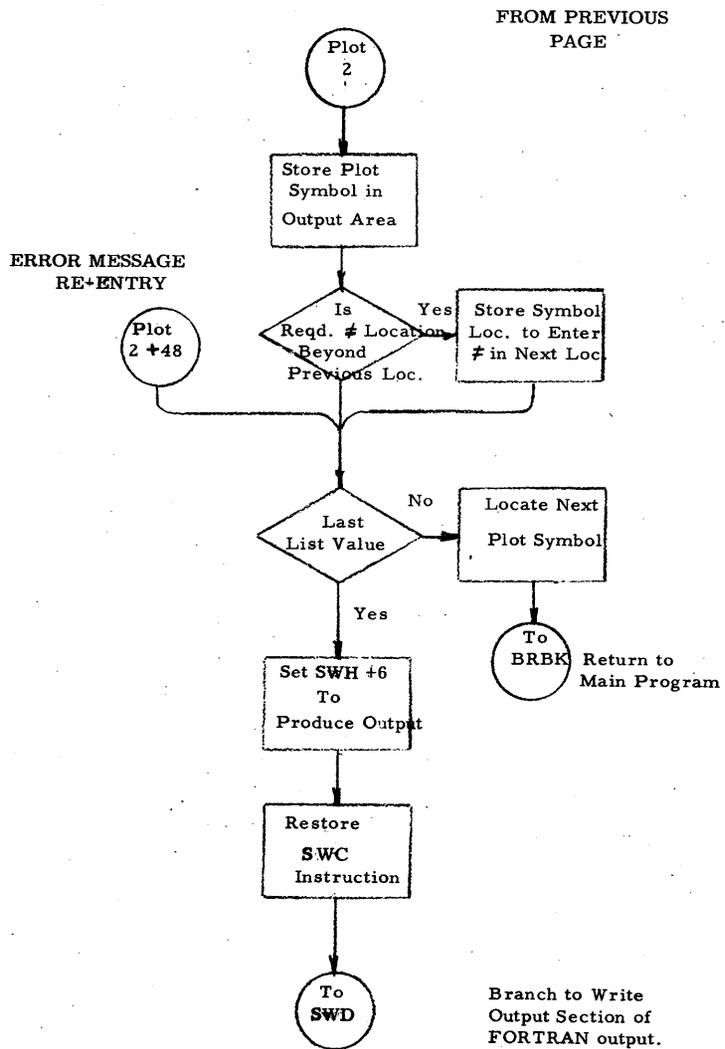
First Entry into Subroutine by Z Character.

Return to Main Program through FORTRAN Output Routine.

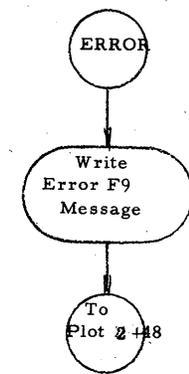
Re-Entry to Subroutine for each plot symbol.



SEE NEXT PAGE



ERROR MESSAGE ROUTINE



Return to Subroutine for Next Value.
(See Previous Page)

SOURCE LISTING

	DØRG 5000		05000
PLØT	TF **35,BLK10+11,0		05000 Z6 05035 07275
	AM **23,2,010		05012 T1 05035 000Ø2
	TF T3+2		05024 26 07428 00000
	AM PLØT+35,2,010		05036 T1 05035 000Ø2
	TF SWC+6,CØN1+6,1		05048 Z6 04998 05420
	AM BLK5+6,2,10		05060 11 06326 000Ø2
	SM P,2,10		05072 12 07807 000Ø2
	TFM PT+18,QZ+40		05084 16 07778 Ø8093
	B BRBK		05096 49 07360 00000
	DØRG *-3		05104
PLØT1	SM T3+2,1,10		05104 12 07428 000Ø1
	BN ERRØR,,0		05116 T7 05378 01300
	TR RX-9,ZØTZ-10		05128 31 00089 07994
	TF **23,SWC-1,0		05140 Z6 05163 04991
	TF RX		05152 26 00098 00000
	BNF ERRØR,RX-3,0		05164 T4 05378 00095
	C RX,P		05176 24 00098 07807
	BNL ERRØR,,0		05188 T6 05378 01300
	BNF **24,RX,0		05200 T4 05224 00098
	B ERRØR,,0		05212 T9 05378 00000
	TF PLØT2+6,BLK5+6,0		05224 Z6 05278 06326
	A PLØT2+6,RX,0		05236 Z1 05278 00098
	A PLØT2+6,RX,0		05248 Z1 05278 00098
	TF PLØT2+11,PLØT+35,01		05260 Z6 05283 05035

SOURCE LISTING

PLØT2	TF	0,0		
	C	PT+18,PLØT2+6,1		05272 26 00000 00000
	BNL	**24,,0		05284 T4 07778 05278
	TF	PT+18,PLØT2+6,1		05296 T6 05320 01300
	BD	PLØT3,T2,0		05308 Z6 07778 05278
	TFM	SWH+6,BRBK		05320 T3 05364 05365
	TF	SWC+6,CØN2,1		05332 16 07850 Ø7360
	B	SWD		05344 Z6 04998 05432
	DØRG	*-3		05356 49 04692 00000
				05364
PLØT3	AM	PLØT+35,2,010		05364 T1 05035 000Ø2
	BB			05376 42 00000 00000
	DØRG	*-9		05378
ERRØR	RCTY			05378 34 00000 00102
	WATY	ERCØNT		05390 39 07977 00100
	B	PLØT2+48,,0		05402 T9 05320 00000
ERCØNT	DS	,7977		07977 00000
T2	DS	,5365		05365 00000
ZØTZ	DS	,8004		08004 00000
CØN1	B	PLØT1,,0		05414 T9 05104 00000
CØN2	DC	7,4307876		05432 00007
BLK10	DS	,7264		07264 00000
T3	DS	,7426		07426 00000
SWC	DS	,4992		04992 00000
RX	DS	,98		00098 00000
P	DS	,7807		07807 00000
BLK5	DS	,6320		06320 00000

SOURCE LISTING

PT	DS	,7760	07760	00000
QZ	DS	,8053	08053	00000
BRBK	DS	,7360	07360	00000
SWD	DS	,4692	04692	00000
SWH	DS	,7844	07844	00000
	DEND		00000	

END OF PASS I I