

REFERENCE



NBS TECHNICAL NOTE 847

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Dataplot 70:
Fortran-Callable Plotting Routines

QC

100

.U5753

no. 847

1974

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards¹ was established by an act of Congress March 3, 1901. The Bureau's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the Nation's physical measurement system, (2) scientific and technological services for industry and government, (3) a technical basis for equity in trade, and (4) technical services to promote public safety. The Bureau consists of the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Institute for Computer Sciences and Technology, and the Office for Information Programs.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement; coordinates that system with measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of a Center for Radiation Research, an Office of Measurement Services and the following divisions:

Applied Mathematics — Electricity — Mechanics — Heat — Optical Physics — Nuclear Sciences² — Applied Radiation² — Quantum Electronics³ — Electromagnetics³ — Time and Frequency³ — Laboratory Astrophysics³ — Cryogenics³.

THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to improved methods of measurement, standards, and data on the properties of well-characterized materials needed by industry, commerce, educational institutions, and Government; provides advisory and research services to other Government agencies; and develops, produces, and distributes standard reference materials. The Institute consists of the Office of Standard Reference Materials and the following divisions:

Analytical Chemistry — Polymers — Metallurgy — Inorganic Materials — Reactor Radiation — Physical Chemistry.

THE INSTITUTE FOR APPLIED TECHNOLOGY provides technical services to promote the use of available technology and to facilitate technological innovation in industry and Government; cooperates with public and private organizations leading to the development of technological standards (including mandatory safety standards), codes and methods of test; and provides technical advice and services to Government agencies upon request. The Institute consists of a Center for Building Technology and the following divisions and offices:

Engineering and Product Standards — Weights and Measures — Invention and Innovation — Product Evaluation Technology — Electronic Technology — Technical Analysis — Measurement Engineering — Structures, Materials, and Life Safety⁴ — Building Environment⁴ — Technical Evaluation and Application⁴ — Fire Technology.

THE INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY conducts research and provides technical services designed to aid Government agencies in improving cost effectiveness in the conduct of their programs through the selection, acquisition, and effective utilization of automatic data processing equipment; and serves as the principal focus within the executive branch for the development of Federal standards for automatic data processing equipment, techniques, and computer languages. The Institute consists of the following divisions:

Computer Services — Systems and Software — Computer Systems Engineering — Information Technology.

THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS and other agencies of the Federal Government; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System; provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world. The Office consists of the following organizational units:

Office of Standard Reference Data — Office of Information Activities — Office of Technical Publications — Library — Office of International Relations.

¹ Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.

² Part of the Center for Radiation Research.

³ Located at Boulder, Colorado 80302.

⁴ Part of the Center for Building Technology.

+ acc - Ref

2100
5753
.847
274

Dataplot 70: Fortran-Callable Plotting Routines

Carol V. Young and
Philip G. Stein

U.S. Institute for Basic Standards
National Bureau of Standards
Washington, D.C. 20234

t. Technical note no. 847



U.S. DEPARTMENT OF COMMERCE, Frederick B. Dent, *Secretary*
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, *Director*

Issued October 1974

Library of Congress Catalog Card Number: 74-600142

National Bureau of Standards Technical Note 847

Nat. Bur. Stand. (U.S.), Tech. Note, 847, 32 pages (Oct. 1974)

CODEN: NBTNAE

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1974

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
1	INTRODUCTION	
	1.1 General	2
	1.2 Hardware Requirements	2
	1.3 Software Requirement	3
	1.4 Axis of Plot	3
2	DATA FORMATTING	
	2.1 General	4
	2.2 Data Format	4
	2.3 Range of Data	4
	2.4 Data Formatting Subroutines	4
	2.4.1 OPEN	4
	2.4.2 ORIG	5
	2.4.3 VECT	5
	2.4.4 CURR	5
	2.4.5 CHAR	6
	2.4.6 SYMBOL	7
	2.4.7 NUMBER	8
	2.4.8 SCALE	9
	2.4.9 DATA	9
	2.4.10 AXIS	11
	2.4.11 CLOSE	12
	2.5 Sample FORTRAN Calling Program	12
	2.5.1 Problem Statement	12
	2.5.2 Listing	12
	2.5.3 Explanation of Calls	13
	2.6 Loading Procedures	16
	2.7 Execution	16
	2.8 Error Messages	17
	2.8.1 I/O Errors	17
	2.8.2 Data Errors	17
3	PLOTTER ROUTINES	
	3.1 General	18
	3.2 Data Format	19
	3.2.1 Vector	19
	3.2.2 Character	20
	3.3 Size of Data Buffer	22
	3.4 Sort	22
	3.5 Operating Considerations	22
	3.5.1 OS Modification (BOSS) Method	23
	3.5.2 Program Method	23
	3.6 Procedures for Loading	23

3.7	Execution	24
3.7.1	With Mass Storage Device	24
3.7.2	With Paper Tape Device	24
3.7.3	Sorted Files	25
3.8	Error Messages	25
3.8.1	I/O Errors	25
3.8.2	Plot Errors	26

DATAPLOT 70:
FORTRAN-CALLABLE PLOTTING ROUTINES

by

Carol V. Young
and
Philip G. Stein

Office of Measurement Services
Institute for Basic Standards
National Bureau of Standards

A description is given of Dataplot 70, a program which enables plotting (1) lines between pairs of X-Y coordinates, and (2) a string of ASCII characters at a given X-Y coordinate on the electrostatic printer/plotter. Detailed instructions are provided enabling the user to (1) convert data to plotter format, (2) draw axis, (3) label axis, (4) scale data, (5) handle arrays, (6) produce symbols at end points, and (7) offset the origin. Hardware and software requirements as well as loading and operating instructions are given.

A sample FORTRAN calling program is included and each instruction is explained in detail. The output of the calling program is shown. Error messages produced by Dataplot 70 are explained.

Key Words: Digital plotter; graph; graphics; minicomputer; plotter

DISCLAIMER: Mention of commercially produced equipment or programs by brand name may not be construed as an endorsement or approval of such products by the National Bureau of Standards. No tests or evaluations of these products have been conducted.

This plotting program was adapted or derived from a VDM copyrighted plotting program DATAPLOT-II for the VDM 620 series computer.

Approval has been granted for use in this publication.

1. INTRODUCTION

1.1 General

The Dataplot 70 package enables plotting of (1) lines between pairs of X-Y coordinates and (2) a string of ASCII characters at a given X-Y coordinate, on an electrostatic printer/plotter. Provisions are made to draw and label axes, scale data, handle arrays (sets of X,Y locations of data points), produce symbols at end-points and offset the origin.

The package consists of two parts: (1) a special run-time library for data formatting made up of 5 FORTRAN and 6 ASSEMBLER subroutines, and (2) a load module containing the assembler language plotter and driving routines.

The user writes a FORTRAN program to call the data formatting subroutines. These convert his floating point data coordinates and ASCII labels and titles to properly formatted data for input to the plotter routines. This formatted data is output to a mass storage device.

The plotter routines will read this file from the mass storage device, sort and process the data, and produce a plot on the electrostatic printer/plotter.

Paper tape punch and reader can be substituted for the mass-storage device.

Files to be input directly into the plotter can be prepared on other computers but must be in the proper format (see Section 3.2). The plotter is capable of accepting files which are unsorted, or are sorted in either ascending or descending order.

1.2 Hardware Requirements

The hardware required to support the Dataplot 70 consists of:

- A. Any one of Interdata models 5, 70, 80, 85, 74, 7/16, 7/32 with high speed ALU of software supports for floating point.

- B. 8 KB of core (minimum)
- C. Some binary data storage peripheral device (paper tape reader and punch, disc, tape, or cassette)
- D. Operators console to print error messages
- E. Varian Statos 31 plotter with Varian interface to Interdata I/O multiplexor bus

1.3 Software Requirements

BOSS or other Interdata operating system, modified to allow user direct I/O as described in section 3.5 is required to support the Dataplot 70 package. The package is not designed for use in a real-time environment.

1.4 Axis of Plot

The origin of the plot is in the lower left-hand corner of the plot area. The X direction is in the direction of the paper movement. The Y direction is across the width of the paper. See Figure 1.4.

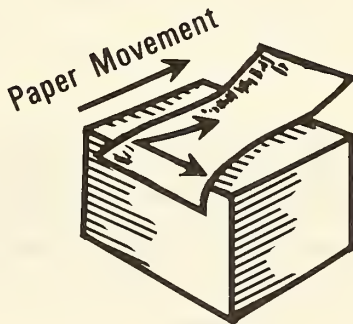


FIGURE 1.4.

A plotter unit of X corresponds to one step (0.01") of paper movement in the printer. A plotter unit of Y corresponds to 0.01" across the page and represents the smallest stylus interval.

2. DATA FORMATTING

2.1 General

A user's FORTRAN program first reads in or generates data to be plotted. Next, it calls the data formatting subroutines. These process the user's data producing data in the proper format for input to the plotter routines. The first call must be "CALL OPEN" and the last call must be "CALL CLOSE."

Each set of formatted data (vector or character) produced by the data formatting subroutines requires 8 bytes (see Section 3.2). The subroutines use a 512 byte buffer which holds 64 sets of formatted data. The subroutines process 64 sets of data and then output the entire buffer as one record to a mass storage device. This is repeated until all the data has been processed and output.

2.2 Data Format

All X and Y coordinate data are input to the data formatting subroutines as single precision floating point numbers representing displacement (in inches) from the origin. The subroutines output the data to a mass storage device as positive integers (15 bits) in plotter units (100 plotter units/inch).

2.3 Range of Data

The value of the X coordinate must be positive. The value of the Y coordinate must be positive and less than 14.08 inches. If any of the floating point coordinate data are outside these ranges, then either the data must be scaled, (see Section 2.4.8) the origin offset, (see Section 2.4.2) or both.

2.4 Data Formatting Subroutines

2.4.1 OPEN

Subroutine OPEN initializes pointers and rewinds the mass storage device.

Calling Sequence: CALL OPEN

2.4.2 ORIG

ORIG offsets the origin.

Calling Sequence: CALL ORIG (X,Y)

Where:

X Is the distance (in inches) along the X axis by which the new (relative) origin will be offset from the old. (Floating point)

Y Is the distance (in inches) along the y axis by which the new (relative) origin will be offset from the old. (Floating point)

Each coordinate processed by the data formatting subroutine after this call will be relative to the new origin.

2.4.3 VECT

VECT generates the vector end point data which, when input to the plotter routines will draw a line between the given pairs of X-Y coordinates.

Calling Sequence: CALL VECT (X1, Y1, X2, Y2)

Where X1, Y1, X2, Y2 are single precision floating pointing numbers representing inches of displacement from the origin.

Provision is made for plotting a continuous series of points. The second X-Y coordinate from the most recent VECT call are saved as continuation points. If in a VECT call X1 = 999. and Y1 = 999., the current continuation points are used as X1 and Y1. The initial continuation point can be set by the subroutine CURR (see Section 2.4.4).

2.4.4 CURR

CURR initializes the beginning point when plotting a continuous series of points (see VECT above).

Calling Sequence: CALL CURR (X,Y)

Where X and Y are single precision floating point numbers representing distance in inches from the origin.

Example:

```
CALL CURR (X(1),Y(1))
DO 10 I = 2,N
10 CALL VECT (999., 999., X(I),Y(I))
```

2.4.5 CHAR

The subroutine CHAR generates the code which when input to the plotter writes the ASCII string starting at the given X-Y coordinate. The characters are software generated dot matrix characters in two sizes: small (0.05" x 0.07") and large (0.10" x 0.14") and two orientations: Upright (0 degrees rotated from the Y axis) and sideways (-90 degrees rotated from the Y axis). The standard spacing for small characters is 0.03 inches and for large characters is 0.04 inches.

Calling Sequence: CALL CHAR (X, Y, STRING, ISAOR, NCHAR, ISPAC)

Parameters:

X, Y	X and Y coordinates (in inches) of the first letter (upper left-hand corner of an upright character, lower left-hand corner of a sideways character). (Floating point)
STRING	Address of the first word containing the ASCII character string to be plotted. It can be given as a variable name, or as per the example below.
ISAOR	Size and orientation: 0 = small, 0 degrees rotation from Y direction 1 = small, -90 degrees rotation from Y direction 2 = large, 0 degrees rotation from Y direction 3 = large, -90 degrees rotation from Y direction (Integer)
NCHAR	The total number of characters to be plotted in the string. (Integer)
ISPAC	Spacing constant in styli or scans from the starting coordinate of the previous character.

A negative number causes default standard spacing. (Integer)

Example: CALL CHAR (1.0, 1.0, 6HSTATOS, 2,6, -1)

2.4.6 SYMBOL

SYMBOL generates code which, when input to the plotter routines will produce a symbol centered at the given X-Y coordinate.

Calling Sequence: CALL SYMBOL (X, Y, IEQ)

X, Y Single precision floating point coordinates

IEQ Positive integer designating symbol to be produced. (1, 2, 3, 4, or 5.)

The types of symbols indicated by these integers are shown in Figure 2.1.

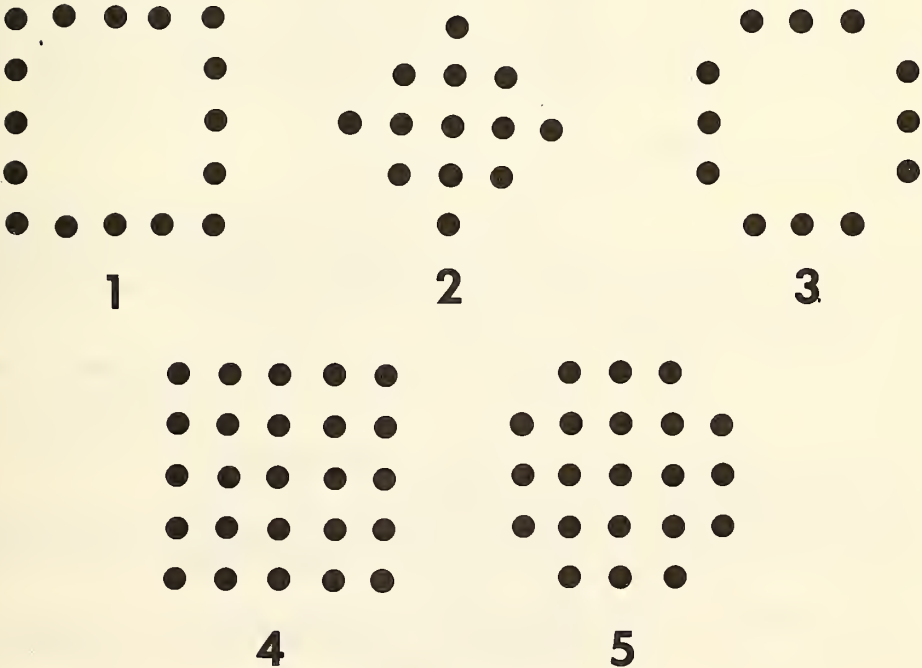


FIGURE 2.1.

2.4.7 NUMBER

NUMBER converts single precision floating point numbers to ASCII code and generates code which when input to the plotter routines will print the number starting at the given X-Y coordinate.

Calling Sequence: CALL NUMBER (X, Y, FPN, ISAOR, NDEC)

This call will plot the floating point, single precision number FPN at the point X, Y.

Parameters:

- X, Y Coordinates (in inches) of the first number in the string (upper left-hand corner of upright number, lower left-hand corner of sideways number). (Floating point)
- FPN Floating point number to be plotted. If negative, will be prefixed with a minus sign. Leading zeros will be suppressed, except the zero to the left of the decimal point. The floating point number is rounded by adding 5 to the digit to the right of the last digit to be plotted, then truncating the result. (Floating point)
- ISAOR Size and Orientation:
- 0 = small, 0 degrees rotation from Y direction
 - 1 = small, -90 degrees rotation from Y direction
 - 2 = large, 0 degrees rotation from Y direction
 - 3 = large, -90 degrees rotation from Y direction
- (Integer)
- NDEC Number of decimal places to be plotted to the right of the decimal point. (Integer)
- If $0 < NDEC \leq 4$, NDEC digits will be plotted to the right of the decimal.
- If NDEC = 0, only the decimal will be plotted to the right of the integer portion of the floating point number.
- If NDEC = -1, the decimal point is omitted along with the fraction.

If NDEC < -1, NDEC-1 numbers are truncated from the right side of the integer portion of the floating point number. The number of characters plotted, regardless of NDEC, is always greater than or equal to 1.

If NDEC > 4, only the first four digits will have any meaning. This subroutine will handle floating point numbers whose integer part is less than 32768 and will write up to 4 digits to the right of the decimal point.

2.4.8 SCALE

This subroutine calculates a scale factor and a displacement factor.

Calling Sequence: CALL SCALE (ARR,NPTS,PGSZ,INC)

- | | |
|------|--|
| ARR | The name of the (floating point) array to be scaled. |
| NPTS | The number of points to be scaled in the array. Normally, all points are scaled. (Integer) |
| PGSZ | The size of the page (linear interval in inches) within which the data must fall. (Floating point) |
| INC | The increment at which the array is to be sampled. (Integer) |

The calling FORTRAN program dimensions the array to have NPTS + 2 dimensions. The SCALE subroutine stores the displacement factor in ARR (NPTS+1) and the scale factor as ARR (NPTS+2). The scale factor and displacement factor are used by the subroutine DATA. (See below.)

2.4.9 DATA

The subroutine DATA with one call takes two arrays of equal size, one containing the X values and the second containing the corresponding Y values and produces the formatted data which when input to the plotter routines will plot each point.

Calling Sequence: CALL DATA (XARR, YARR, NPTS, INC, LTY, IEQ)

Parameters :

- XARR The name of the array from which X values are to be extracted. (Floating point)
- YARR The name of the array from which the Y values are to be extracted. (Floating point)
- NPTS The number of data points to be plotted from each array to the end of the array. (Integer)
- INC The increment at which the arrays are to be sampled. INC = 1 means every X, Y pair is plotted; INC = 2 means every other pair, etc. (Integer)
- LTY Indicates the type of line desired.
LTY<0: A symbol will be plotted at each selected point, but no lines will connect the symbols.
LTY=0: A line will be drawn connecting each selected point. No symbols will be drawn.
LTY>0: A symbol will be plotted at each selected point and a line will connect all symbols.
- IEQ Positive integer designating symbol to be produced (1, 2, 3, 4, or 5). (Integer) (See Figure 2.1.)

If LTY = 0, IEQ has no meaning.

Prior to the call, the two arrays must be dimensioned to provide two extra locations at the end of each array. These locations must contain the displacement and the scale factor in that order.

The subroutine DATA will use these factors to operate on each floating point datum as follows:

$$X' = \frac{X(I) - \text{Displacement}}{\text{Scale Factor}}$$

OR

$$X' = \frac{X(I) - X(NPTS+1)}{X(NPTS+2)}$$

The subroutine SCALE (see above) will calculate these factors and store them in the proper locations. However, note that the scale factor for the X array and the scale factor for the Y array are independent of each other. The programmer can calculate these factors and store them in the proper location. Care should be taken with the sign of the displacement since it is a value to be subtracted from each datum.

2.4.10 AXIS

Subroutine AXIS produces an axis on the plot with tic marks every inch, an axis label and number labels for each tic mark.

Calling Sequence: CALL AXIS (X, Y, AXLH, IDIR, BCD, NCHAR, VLO, SF)

Parameters:

- X, Y The starting point on the page of the axis to be drawn. (Floating point)
- AXLH The length of the axis in inches. The value given will be truncated to the next smallest integer value. (Floating point)
- IDIR Axis direction. Zero for X direction. Non-zero for Y direction. (Integer)
- BCD The first word address of a character string to be plotted as a label for the axis. If there is no label, use a dummy space.
- NCHAR NCHAR is the number of letters contained in the character string to be plotted as a title. (Integer)

If NCHAR > 0, the title, tic marks, and interval labels will be plotted to the left of the vertical axis and above the horizontal axis.

If NCHAR < 0, the title, tic marks and interval labels will be plotted to the right of the vertical axis and below the horizontal axis.

- VLO The number to be plotted at the starting point of the axis. By making $VLO = ARR(NPTS+1)$, the axis and data will have the same starting point. (Floating point)
- SF The scale factor (units/inch) to be used in labeling the 1 inch intervals. By making $SF = ARR(NPTS+2)$ (see Scale routine), the axis and data will have the same scale factor. (Floating point)

NOTES:

1. The intervals labels will be scaled by powers of 10 if they are too large or small to fit into 2 decimal place accuracy. Thus, assuming a scale factor of 1000./inch, 12000. would be printed 12.00 on the interval tic mark, but a note would be added to the axis label: " $*10^3$."
2. The SCALE routine should be used prior to using AXIS if $SF = ARR(NPTS+2)$ and $VLO = ARR(NPTS+1)$.

2.4.11 CLOSE

The subroutine CLOSE will output the last partial record which contains the software end-of-file mark and will rewind the mass storage device.

Calling Sequence: CALL CLOSE

This call must be the last statement in each data generation FORTRAN calling program.

2.5 Sample FORTRAN Calling Program

See Figure 2.2.

2.5.1 Problem Statement: Produce a plot of $X = \sin Y$ as Y varies from 0 to 8π .

2.5.2 Program Listing

```
DIMENSION X(723),Y(723)
DATA X(722),X(723)/-1.,.5/
J=0
DO 1 I=1,1441,2
J=J+1
```

```

Y(J)=(FLOAT(I-1))*3.14159/180.
1 X(J)=SIN(Y(J))
CALL OPEN
CALL ORIG(1.,.9)
CALL SCALE(Y,721,13.,1)
CALL DATA(X,Y,721,1,0,1)
CALL AXIS(0.,0.,4.,0,6HSIN(Y),6,-1.,X(723))
CALL AXIS (2., 0., 12., 1, 1H , -1, Y(722), Y(723))
CALL CHAR(-.5,6.5,1HY,2,1,-1)
CALL CLOSE
STOP
END

```

2.5.3 Explanation of Calls

DATA X(722),X(723)/-1.,.5/

Set up the X displacement and the X scale factor. The displacement of -1 units is necessary to insure all X values output for plotter will be positive. The scale factor of 1/2 units/inch is arbitrary.

CALL OPEN

Initializing routine

CALL ORIG(1.,.9)

Offsets the origin by 1 inch in the X direction and 0.9 inches in the Y direction. This allows room to the left of the plot and below the plot for axis labels. All data processed will be with respect to this new origin.

CALL SCALE(Y,721,13.,1)

Scales all 721 values in the Y array to fall between 0 and 13 inches by calculating a displacement and scale factor and storing these values in Y(722) and Y(723) respectfully. The Y values vary from 0 to about 25.1 yielding a scale factor of 2 units/inch and a displacement of zero.

CALL DATA(X,Y,721,1,0,1)

Processes each value in each array by subtracting the displacement and dividing by the scale factor, and then generates and outputs the formatted data for input to the plotter routines for each of the 721 points.

CALL AXIS (0., 0., 4., 0, 6H SIN(Y), 6, -1., X(723))

Generates and outputs formatted data for the plotter routines to draw the X axis tic marks, axis label, and interval labels. The axis is to be started at the relative

origin (0.,0.) to be 4 inches long, and to be labeled SIN(Y). The number of characters argument is positive causing the labeling to be done to the left of the axis. The label for the starting point of the axis is -1. and the same scale factor is used as is used in the DATA call.

CALL AXIS (2.,0.,13.,1,1H,-1,Y(722), Y(723))

Generates and outputs formatted data for the plotter routines to draw the Y axis, tic marks, and the interval labels. The axis is started at the origin of the sine plot. Since the displacement is -1 units in the X direction and the scale factor is 1/2 unit/inch, the origin of the sine plot is 2 inches above the relative origin of the plot area. In the Y direction there is no difference between the sine plot origin and the relative origin of the plot area since the Y displacement, Y(722), is zero.

No axis label is desired since the axis subroutine would print the label close to the axis which in this case would interfere with the graph. In some cases when no label is desired, the "number of characters" argument can equal zero and the ASCII argument can be a dummy argument. However in this case, in order to print the tic marks and the interval labels below the axis, the "number of characters" argument must be negative. A label of one ASCII blank is therefore called for with the "number of characters" argument being -1.

The scale factor is the same as used in the DATA call.

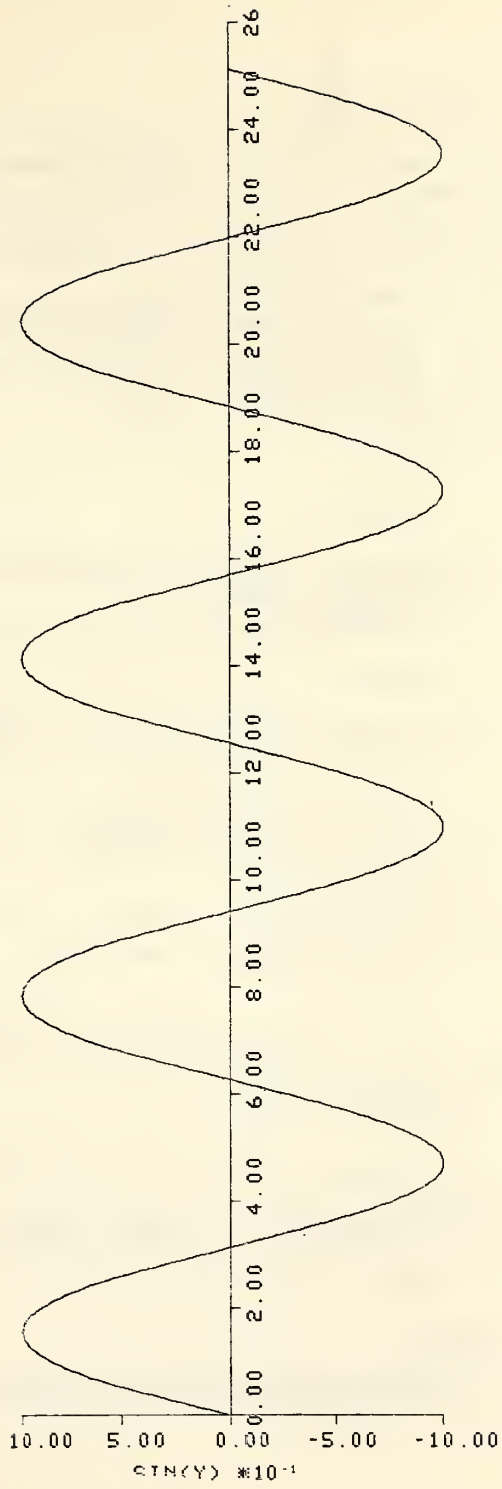
CALL CHAR (-.5, 6.5, 1HY, 2, 1, -1)

Produced a label for the Y axis below the graph area. Since the relative origin of the graph area in the X direction is offset one inch above the origin of the plot area, the X coordinate Y -.5 will position the label 1/2 inch below the graph area but will fall within the plot area.

CALL CLOSE

Outputs the last partial buffer to the mass storage device.

SAMPLE OUTPUT
FIGURE 2.2.



2.6 Loading Procedures

The data formatting calling program is loaded with the OS library loader.

1. Compile the FORTRAN calling program.
2. Assign logical units to
 - a. FORTRAN calling program (object) (LU)
 - b. User's subroutine (object) if any (LU')
 - c. Special run time library (LU'')
 - d. FORTRAN run-time library (LU''')
3. Load the OS library loader
4. Start loader
5. Set bias

BIAS bbbb

where bbbb is the desired program origin expressed in hexadecimal notation.

6. Load FORTRAN calling program (object)

LOAD LU

7. Link FORTRAN user subroutines, if any

LINK LU' (as required)

8. Edit special run-time library

EDIT LU''

9. Edit the FORTRAN run-time library

EDIT LU'''

10. Produce a memory map

MAP LU

Memory map is output on logical unit LU.

11. Return control to operating system.

END

2.7 Execution

1. Assign logical unit A to a scratch area on a

mass storage device or to a paper tape punch device.

NOTE: Operating system must be generated to include at least 12 logical units to allow logical unit A to be used.

2. Start at the program origin.

The program will output the unsorted data formatted for input to the plotter routines on logical unit A.

2.8 Error Messages

2.8.1 I/O Errors

These messages are produced if an I/O error is encountered during an attempt to output to logical unit A. The xxxx is the status byte.

1. DEVICE UNAVAILABLE xxxx
Cause: Device not on line
Program response: Pause
Operator response: Turn on device, type CONTINUE
2. BEGIN/END OF DEVICE xxxx
Cause: End-of-medium encountered
Program Response: Terminate run and return control to operating system
Operator response: Assign a larger scratch area to logical unit A and restart program at origin.
3. I/O ERROR xxxx
Cause: Unrecoverable error
Program response: Terminate run and return control to operating system

2.8.2 Data Errors

A data error message is produced when the value of a floating point coordinate is outside the range handled by the data formatting subroutines

DATA ERROR xxxx

The value of xxxx indicates which coordinate and in which subroutine the error occurred.

<u>ERROR MESSAGE</u>	<u>COORDINATE</u>	<u>SUBROUTINE</u>	<u>RESPONSE</u>
Data Error 0103	X	CHAR	Data ignored*
Data Error 0104	Y	CHAR	Data ignored*
Data Error 0203	X	VECT	Data ignored*
Data Error 0204	Y	VECT	Data ignored*
Data Error 0303	X	CURR	Program terminated. Control returned to operating system.
Data Error 0304	Y	CURR	Program terminated. Control returned to operating system.
Data Error 0403	X	ORIG	Program terminated. Control returned to operating system.
Data Error 0404	Y	ORIG	Program terminated. Control returned to operating system.

* After 20 data error messages from either CHAR or VECT, the program is terminated and control is returned to the operating system. This feature can be altered by changing the maximum error count. The constant is at location X'28' relative to the entry point OPEN.

3. PLOTTER ROUTINES

3.1 General

The plotter routines, started at the origin will:

1. Calculate and request as much core as is available for use as the data buffer.
2. Read the entire data file from the mass storage device into the data buffer.
3. Sort the entire file in descending order.
4. Output the entire sorted file to the mass storage device.
5. Read the sorted data from the mass storage device, one record at a time.
6. Convert from vector format to raster format.
7. Output the raster data to the printer/plotter through driver routines.
8. Read and process consecutive records until end-of-file is reached.

9. Release buffer storage and return control to the operating system.

3.2 Data Formats

Data to be read by the plotter routines must be in either Vector Format or Character Format. Each set of data are contained in 8 bytes.

3.2.1 Vector

A set of vector data (see Figure 3.1) consists of end point X and Y co-ordinates represented as positive integers in plotter units (100 plotter units per inch).

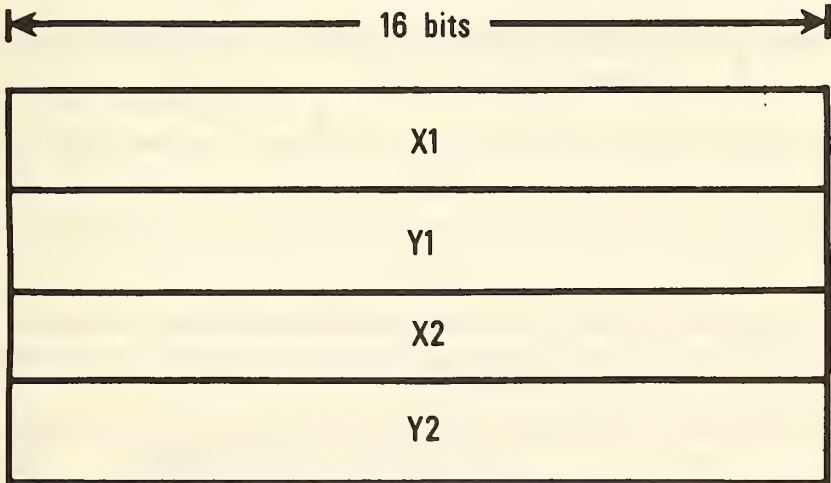


FIGURE 3.1.

The plotter routines will sort in descending order and therefore $X1$ will be greater or equal to $X2$. This is also true if data files are generated on other computers and presorted in descending order. However, if the files are presorted in ascending order, then $X2$ must be greater or equal to $X1$.

3.2.2 Characters

Character format (see Figure 3.2) consists of X and Y co-ordinates as positive integers in plotter units (100 plotter units per inch), a code indicating that the data is character data, the ASCII code of the character, and information indicating the size and orientation of the character.

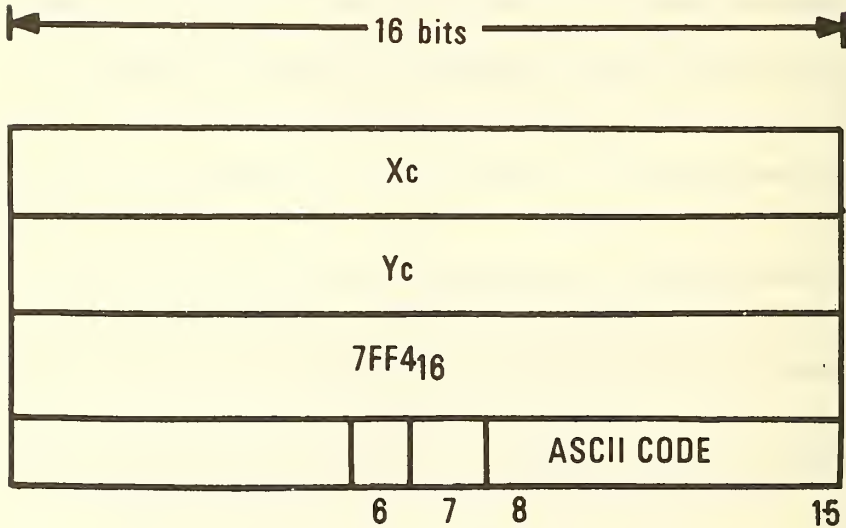


FIGURE 3.2.

Bit number 6 of the fourth word determines the size of the character:

- BIT 6 = 0 for small characters
- BIT 6 = 1 for large characters

Bit number 7 of the fourth word determines the orientation of the character:

- BIT 7 = 0 for upright characters
- BIT 7 = 1 for sideways characters

The X and Y coordinate refer to the upper left-hand corner of an upright character and the lower left-hand corner of a sideways character as shown in Figure 3.3

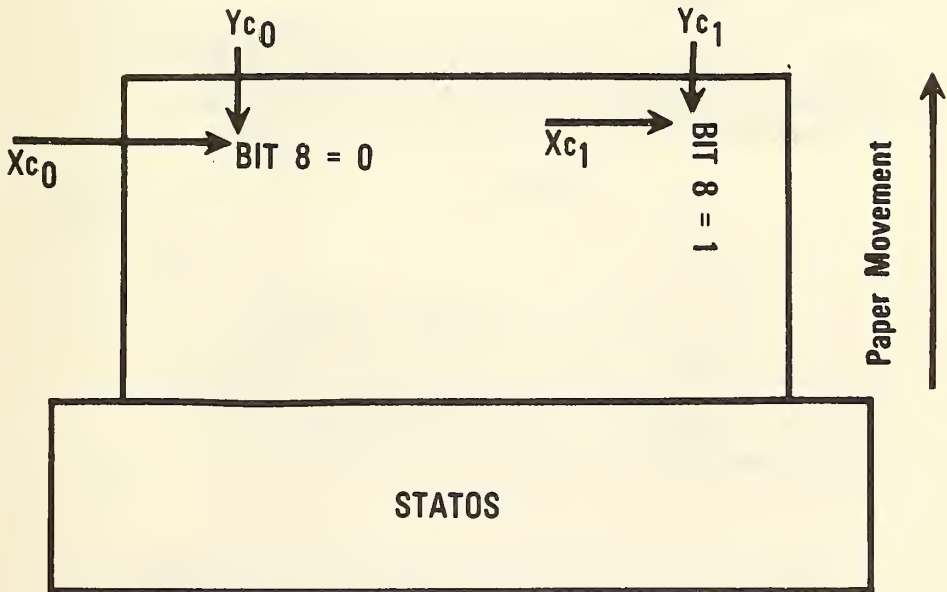


FIGURE 3.3.

C₀ in Fig. 3.3 refers to bit 7 = 0 in Fig. 3.2.

C₁ in Fig. 3.3 refers to bit 7 = 1 in Fig. 3.2.

3.3 Size of Data Buffer

Each record is 512 bytes long. The number of records, N, that can be handled is defined as

$$N = \text{integer } \frac{(\text{available core} - 2) \text{ bytes}}{512}$$

Each set of data (vectors or characters) require 8 bytes (see Section 3.2). The file is terminated with a software end-of-file mark ('X'7FFF'). The amount of data that can be contained in the buffer for the sort is 64*N sets. Data in excess of this amount will be lost. The number of records of sorted data output to a mass storage device will equal the number of records read except when the buffer is full in which case N+1 records are output.

There is no limit to the number of records that can be read in for conversion from vector to raster format. However, the number of sets which can be handled on any given plotted line is

$$\frac{512(N-1) + 2}{12}$$

3.4 SORT

The sort routine will sort the entire file on the first halfword of each 4 halfword sets of data in descending order. The sort is therefore on X for character sets and on X1 for vector sets. The vector data was formatted during the data formatting sub-routines so that X1 ≥ X2 in each set.

3.5 Operating Considerations

The plotter reads the formatted input data produced (for example) by the data formatting routines. It sorts the data and writes it out again. It then rereads the data one records at a time for plotting. All of these operations are done using supervisor calls compatible with Interdata operating systems (see sections 3.7.1 and 3.7.2).

Communications with the printer/plotter are done using stand-alone drivers as supplied by the manufacturer and modified at NBS. As such, the protect mode of the CPU as enabled by the OS prevents this communication.

To remedy this deficiency, it is necessary to turn off the protect bit.

3.5.1 OS MODIFICATION (BOSS) METHOD

Change the contents of location UPSW from X'3D00' to X'3C00'. This modifies the user PSW provided by the START command so that protect mode is disabled.

Similar procedures will work for other OS but will cause difficulty in a real-time environment. Use of this package implies dedication of the CPU to the Status 31 for the duration of the run.

3.5.2 PROGRAM METHOD

The following program will turn off the protect bit and jump to the plotter routines. If an SVC 0 is used anywhere else in the system, care must be taken to restore it.

PROFF	LH 0,X'9A'	Get new PSW for SVC's
	NHI 0,X'FEFF'	Kill protect bit
	STH 0,X'9A'	Put new PSW back
	LHI 0, (absolute address of origin of plotter)	Get start addr. of plotter
	STH 0,X'9C'	Put in new PSW (loc) for SVC 0
	SVC 0,0	Do the SVC 0

This program will disable protect mode, but the OS will restore it the next time the START command is executed unless the modification of section 3.5.1 has been made.

3.6 Procedure for Loading

The load-module is loaded with the OS resident loader.
(This example is for BOSS.)

BIAS xxxx

where xxxx is the desired program origin expressed in hexadecimal notation.

LOAD pa

where pa is the physical address of the device from which the program is to be loaded.

3.7 Execution

3.7.1 With Mass Storage Device

1. Assign logical unit A to the input file.
2. Assign logical unit 9 to a scratch area where the sorted data can be written.
3. Turn on the Varian printer/plotter
4. Start plotter routines at origin.

The program will read the entire data file from logical unit A, sort the data, write the sorted file on logical unit 9, read and process consecutive records from logical unit 9, position paper in printer to top of page, output raster data to the plotter and return control to the operating system.

3.7.2 With Paper Tape Device

1. Assign logical unit A to the paper tape punch/reader.
2. Assign logical unit 9 to the paper tape punch/reader.
3. Load input tape into the paper tape reader.
4. Turn on printer/plotter, paper tape reader and paper tape punch.
5. Start plotter routines at origin.

The program will read the input tape, sort the data and output the sorted data to the paper tape punch device.

6. Turn off the paper tape reader as soon as the read operation is complete and before the punch operation is complete.

The program will produce the messages:

DEVICE UNAVAILABLE xxxx
PAUSE

7. Load the tape of sorted data into the paper tape reader, turn on reader.
8. Type CONTINUE

The program will read and process consecutive records from this tape, output raster data to the plotter and return control to the operating system.

3.7.3 SORTED FILES

1. Assign logical unit 9 to the sorted file.
2. Start at ORIGIN + 8

If the file was sorted on another computer in ascending order, the program will print a message to the operator indicating an ascending sort and will plot the complement of the data.

3.8 Error Messages

3.8.1 I/O Errors

These messages are produced if an I/O error is encountered during the read or the write operations.

xxxx is the status byte.

1. DEVICE UNAVAILABLE xxxx
(See Section 2.8.1)
2. BEGIN/END OF DEVICE xxxx
(See Section 2.8.1)
3. I/O ERROR xxxx
(See Section 2.8.1)
4. EOF ENCOUNTERED IN VECTOR FILE xxxx
Cause: A file mark has been read during binary input.
Program response: Terminate run and return control to operating system.

3.8.2 Plot Error

1. VECTOR FILE TOO LARGE
Cause: Data file input from logical unit A is too large.
Program response: Continues to process all data in buffer. Additional data is lost.
2. CURRENT VECTOR FILE OVERFLOW
Cause: The number of sets of data to be plotted on the current line is too large.
Program response: Continues to process all data in buffer. Additional sets of data for that current line are lost.
3. PLOT ERROR xxxx
where xxxx indicates the cause of the plot error.

Plot errors occur when there is no data in the file or when the data is either out of range or in incorrect order.

<u>ERROR MESSAGE</u>	<u>CAUSE</u>	<u>PROGRAM RESP&ONSE</u>
Plot Error 0000	No data in file	Terminates run and returns control to operating system.
Plot Error 0001	No positive X data in file	Terminates run and returns control to operating system.
Plot Error 0002	Data out of order	Data ignored and run continues*
Plot Error 0003	X value out of range	Data ignored and run continues*
Plot Error 0004	Y value out of range	Data ignored and run continues*

The operator should check logical unit assignments. Failure to assign a physical address to logical unit A produces PLOT ERROR 0000. Assigning meaningless files to logical unit A or logical unit 9 will cause many error messages.

- * After 20 PLOT ERRORS the run is terminated and control returned to the operating system.

REFERENCES

1. User's Guide for Dataplot-II With Varian 620 Series Computers, Varian Publication No. 03-996137
2. User's Guide for Statos 31 With the Interdata 70 Series Computer, Varian Publication No. 03-996160B
3. Interdata Model 70 User's Manual, Interdata Publication 20-261
4. Interdata Operating System (BOSS) Reference Manual, Interdata Publication 29-292
5. Interdata FORTRAN IV Reference Manual, Interdata Publication B29-220R01
6. Interdata BOSS FORTRAN User's Guide, Interdata Publication 29-246
7. Interdata Run Time Library Manual, Interdata Publication 29-242
8. Computer Hardware and Software, Abrams, M.D. & Stein, P. G., Addison-Wesley, 1973

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBS Technical Note 847	2. Gov't Accession No.	3. Recipient's Accession No.
4. TITLE AND SUBTITLE Dataplot 70: Fortran-Callable Plotting Routines		5. Publication Date October 1974	
		6. Performing Organization Code	
7. AUTHOR(S) Carol V. Young and Philip G. Stein		8. Performing Organ. Report No.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234		10. Project/Task/Work Unit No.	
		11. Contract/Grant No.	
12. Sponsoring Organization Name and Complete Address (Street, City, State, ZIP)		13. Type of Report & Period Covered	
		14. Sponsoring Agency Code	
15. SUPPLEMENTARY NOTES Library of Congress Catalog Card Number: 74-600142			
16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.) A description is given of Dataplot 70, a program which enables plotting 1) lines between pairs of X-Y coordinates and 2) a string of ASCII characters at a given X-Y coordinate on the electrostatic printer/plotter. Detailed instructions are provided enabling the user to 1) convert data to plotter format, 2) draw axis, 3) label axis, 4) scale data, 5) handle arrays, 6) produce symbols at end points, and 7) offset the origin. Hardware and software requirements as well as loading and operating instructions are given. A sample FORTRAN calling program is included and each instruction is explained in detail. The output of the calling program is shown. Error messages produced by Dataplot 70 are explained.			
17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons) Digital plotter; graph; graphics; minicomputer; plotter			
18. AVAILABILITY <input checked="" type="checkbox"/> Unlimited <input type="checkbox"/> For Official Distribution. Do Not Release to NTIS <input checked="" type="checkbox"/> Order From Sup. of Doc., U.S. Government Printing Office Washington, D.C. 20402, SD Cat. No. C13 46:847 <input type="checkbox"/> Order From National Technical Information Service (NTIS) Springfield, Virginia 22151		19. SECURITY CLASS (THIS REPORT) UNCLASSIFIED	21. NO. OF PAGES 32
		20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. Price \$.80

NBS TECHNICAL PUBLICATIONS

PERIODICALS

JOURNAL OF RESEARCH reports National Bureau of Standards research and development in physics, mathematics, and chemistry. Comprehensive scientific papers give complete details of the work, including laboratory data, experimental procedures, and theoretical and mathematical analyses. Illustrated with photographs, drawings, and charts. Includes listings of other NBS papers as issued.

Published in two sections, available separately:

- **Physics and Chemistry (Section A)**

Papers of interest primarily to scientists working in these fields. This section covers a broad range of physical and chemical research, with major emphasis on standards of physical measurement, fundamental constants, and properties of matter. Issued six times a year. Annual subscription: Domestic, \$17.00; Foreign, \$21.25.

- **Mathematical Sciences (Section B)**

Studies and compilations designed mainly for the mathematician and theoretical physicist. Topics in mathematical statistics, theory of experiment design, numerical analysis, theoretical physics and chemistry, logical design and programming of computers and computer systems. Short numerical tables. Issued quarterly. Annual subscription: Domestic, \$9.00; Foreign, \$11.25.

DIMENSIONS/NBS (formerly Technical News Bulletin)—This monthly magazine is published to inform scientists, engineers, businessmen, industry, teachers, students, and consumers of the latest advances in science and technology, with primary emphasis on the work at NBS.

DIMENSIONS/NBS highlights and reviews such issues as energy research, fire protection, building technology, metric conversion, pollution abatement, health and safety, and consumer product performance. In addition, **DIMENSIONS/NBS** reports the results of Bureau programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing.

Annual subscription: Domestic, \$6.50; Foreign, \$8.25.

NONPERIODICALS

Monographs—Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of high-level national and international conferences sponsored by NBS, precision measurement and calibration volumes, NBS annual reports, and other special publications appropriate to this grouping such as wall charts and bibliographies.

Applied Mathematics Series—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a world-wide program coordinated by NBS. Program under authority of National Standard Data Act (Public Law 90-396). See also Section 1.2.3.

Building Science Series—Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NBS under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The purpose of the standards is to establish nationally recognized requirements for products, and to provide all concerned interests with a basis for common understanding of the characteristics of the products. The National Bureau of Standards administers the Voluntary Product Standards program as a supplement to the activities of the private sector standardizing organizations.

Federal Information Processing Standards Publications (FIPS PUBS)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The purpose of the Register is to serve as the official source of information in the Federal Government regarding standards issued by NBS pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations). FIPS PUBS will include approved Federal information processing standards information of general interest, and a complete index of relevant standards publications.

Consumer Information Series—Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

NBS Interagency Reports—A special series of interim or final reports on work performed by NBS for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Service (Springfield, Va. 22151) in paper copy or microfiche form.

Order NBS publications (except Bibliographic Subscription Services) from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

BIBLIOGRAPHIC SUBSCRIPTION SERVICES

The following current-awareness and literature-survey bibliographies are issued periodically by the Bureau:

Cryogenic Data Center Current Awareness Service (Publications and Reports of Interest in Cryogenics).
A literature survey issued weekly. Annual subscription: Domestic, \$20.00; foreign, \$25.00.

Liquefied Natural Gas. A literature survey issued quarterly. Annual subscription: \$20.00.

Superconducting Devices and Materials. A literature survey issued quarterly. Annual subscription: \$20.00.
Send subscription orders and remittances for the pre-

ceding bibliographic services to the U.S. Department of Commerce, National Technical Information Service, Springfield, Va. 22151.

Electromagnetic Metrology Current Awareness Service (Abstracts of Selected Articles on Measurement Techniques and Standards of Electromagnetic Quantities from D-C to Millimeter-Wave Frequencies). Issued monthly. Annual subscription: \$100.00 (Special rates for multi-subscriptions). Send subscription order and remittance to the Electromagnetic Metrology Information Center, Electromagnetics Division, National Bureau of Standards, Boulder, Colo. 80302.

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

Washington, D.C. 20234

OFFICIAL BUSINESS

Penalty for Private Use, \$300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-215

