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GRAFI
A PACKAGE FOR PROGRAMMING THE IBM 2250 DISPLAY UNIT

by

A. ENDRIZZI

1972

Joint Nuclear Research Centre
Ispra Establishment-Italy

Scientific Data Processing Centre-CETIS

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ABSTRACT

The GRAFI package provides the Fortran Cobol and PL1 programmer a flexible and easy to use interface with the IBM 2250 display unit.

Programs requiring graphic output and/or man-machine interaction, may be implemented using GRAFI subroutines for displaying graphic forms, for scaling and plotting of variables and for communication between the program and the 2250 operator. They are written using IBM Graphic Subroutine Package and may be used in conjunction with it.

KEYWORDS

IBM 360
COMPUTERS
PROGRAMMING
IMAGE TUBES
GRAPHS

INDEX

Introduction *)

This publication describes subroutines that can be called from a Fortran, Cobol, PL1 program to display graphic data on the screen and communicate with an IBM 2250 display unit attached to an IBM S/360 Computing System. The GRAFI package allows the programmer to create graphic output and to make his programs interactive even if he is not familiar with the IBM 2250 and its basic software.

This publication is divided into five sections. The first section presents the procedure for generating data sets containing graphic informations that can be displayed at a later time. This use of the 2250 is very similar to the use of a off-line plotter. The second section describes subroutines that enable communication between the 2250 user and his program. The third section presents some utility programs for displaying curves, for displaying printed results and for updating cards from 2250 console.
The package GRAFI has been implemented using IBM Graphic Subroutines Package and may be used in conjunction with it. That is the subject of the fourth section.
The final section gives the system information for having GRAFI running on a IBM S/360 configuration.

Before using this publication the reader must be familiar with the following reports:

Programmation relative au Calcomp	EUR 2280
Contour map subroutines	EUR 2241

by P. Moinil, J. Pire

This publications contain the subroutines for generating graphic forms, scaling and plotting of lines.
The user of GRAFI may create the image on the screen by calling the subroutines described in the publications listed above.

Note that at the beginning of the image the cathode ray is supposed to be positioned at the lower left corner of the screen which corresponds to the origin of the user's system of coordinates.

*) Manuscript received on October 7, 1971

Using the IBM 2250 display unit as a plotter

The programmer may not be interested in the interactive facilities of the display unit, but in using it as a plotter. His program does not require the 2250 as a resource but generates a data set which contains graphic data that will be displayed by another program.

The user describes the images,using subroutines listed in ref. 1 and 2. Each new image must be preceeded by a call to GIMAGE.

CALL GIMAGE (SIZE, NFILE)

must be the first GRAFI subroutine called.
All graphic subroutines (Ref. 1 and 2) executed next to CALL GIMAGE generate forms belonging to the same image.

SIZE (cm.) defines the size of the screen.
IBM 2250 has a 30.48x30.48 cm screen and usually is SIZE = 30.48. That means that you want a 1 by 1 scale representation on the screen. If SIZE is greater (less) than 30.48 all dimensions will be automatically reduced (incremented) by 30.48/SIZE.

NFILE definesthe Fortran logical number of the sequential data set you have at disposal for storing graphic data

//GO.FTXXF001 DD card with XX = NFILE containing the description of this data set must contain the following
DCB = (RECFM = VB , LRECL = 16 , BLKSIZE = 1604)

GRAFI will write on this data set the graphic orders for generating the images.

CALL GDISPL (NFILE, N2250)
This subroutine activates the IBM 2250, reads the previously generated data set and displays the images.

NFILE is the Fortran logical number of the data set containing graphic orders

N2250 is the Fortran logical number of the IBM 2250
Ex.: N2250 = 10 if JCL cards contain:
//GO.FT10F001 DD UNIT = (2250-1)

During GDISPL execution function key 0, 22,31 are lit. Depressing FKO means: erase image and display the next one (if there is any).
FK 31 means return from GDISPL. FK 22 rewinds the data set.
If the image occupies the whole buffer of the 2250 a message will appear and graphic forms not represented will take place in another image.

Communication between the program and the IBM 2250

Following subroutines activate the IBM 2250 for use, enable light pen, function key and keyboard operations and permit some graphic operations on the image.

CALL GRAFI (N2250) must be the first GRAFI subroutine called.
It activates the display unit.

N2250 is the Fortran logical number of the IBM 2250 unit.
The job deck must contain the card
//GO.FTXXF001 DD UNIT = (2250-1)
where XX = N2250

CALL GSIZE (SIZE) defines scaling factor for images produced by using Ref. 1 and 2 subroutines.

SIZE see subroutine GIMAGE above.
If GSIZE is not called default value
SIZE = 30.48 is assumed.

CALL GWAIT(I_1, I_2, I_n, IREP) $1 \leq n \leq 34$
This subroutine displays the image, activates one or more attention sources, stopsthe execution of the program, waits the operator's action on an activated source ,gives information about operator's action and then returns.

I_i must belong to the set:
0, 1, 2 31, 32, 34
where 0,1 31 are function key numbers
32 designates the ALT END key
34 designates the light pen

The I_i are the names of the sources the program activates, by which the operator can transmit his decision. Note that CALL GWAIT (5,-8,IREP) is equivalent to CALL GWAIT (5,6,7,8 IREP).

IREP is the variable in which GWAIT will put the reply of the operator. IREP will contain the value N if the operator pushed the N-th function key.
IREP will contain the value 32 if ALT-END was depressed
IREP will contain the value 34 if the operator's light-pen detect was on a point of the image not belonging to any named group (a point without name).

If light pen detect was on a named group (a part of the image that can be retrieved, for it has its proper name), IREP will contain the name of the detected group. For generating named groups see GGROUP, GWRT, GWRF, GWRI.

CALL GGROUP (INAME) and CALL GENDGR

This subroutine allows to assign a name to the graphic form generated from the call to this subroutine until another CALL GGROUP or CALL GENDGR is executed.

INAME must be an integer value. INAME's value is the name of the group.

If no GGROUP is called, that means that the programmer is not interested in retrieving parts of his image for include - omit operation or for light pen depending decisions.
The parts of image generated outside the couple CALL GGROUP and CALL GENDGR have no name. It is suggested to assign INAME values that will not generate ambiguity in the interpretation of the replay IREP of the GWAIT subroutine.

CALL GOMIT (INAME)

The graphic group designated by INAME is put in omit status i.e. is kept in the 2250 buffer but is not displayed.

CALL GINCL (INAME)

The graphic group designated by INAME is redisplayed.

CALL GCANCL

The whole image disappears and is erased from the buffer of the 2250. Then the buffer is ready for accepting a new image which will be generated as usually using Ref. 1, 2 subroutines and making it visible by a CALL GWAIT instruction.

Utility subroutines

This section describes some subroutines that are very useful in IBM 2250 programming. These subroutines allows character strings display and typing, printed results display, automatic x-y plotting of curves and cards deck updating.

```
CALL GWRT (TEXT, NC, X, Y, INAME) for text
     GWRF (F, NC, X, Y, INAME)    for floating point variable
     GWRI (I, NC, X, Y, INAME)    for integer * 4 variable
```

These subroutines make use of the character generator feature of the 2250. They produce the graphic orders for displaying NC characters on the screen starting at position (X, Y) expressed in basic coordinate (i.e. 0. - 4095.) and assign the name INAME to the string.

TEXT is a vector containing the text to be displayed

F is the floating point variable which value is to be displayed

I is the integer variable which value is to be displayed

NC is the number of characters to be displayed.
In GWKF the floating point value will appear in E format with NC-7 decimal places to the right of the decimal point.
In GWRI the integer value will be displayed in I nc format

X, Y are the coordinates of the starting point of the string. They are floating point values in the range 0. - 4095. which refers to the basic coordinates grid of the screen.
Note that if X or Y is a negative value the string will be concatenated to the previously created string

INAME is the group name assigned to the string for include - omit operations, light pen retrieval or updating from keyboard (see GRDT, GRDF, GRDI).

If INAME = 0 the string is generated without name and none of the above operations can be performed.

CALL GRDT (TEXT, NC, INAME)   for text
     GRDF (F, NC, INAME)   for floating point variable
     GRDI (I, NC, INAME)   for integer * 4 variable

These subroutines may be used for updating from the keyboard text, floating point and integer variables.

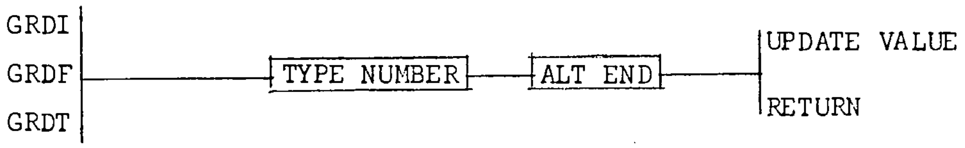
TEXT is the vector in which GRDT will put the content of the INAME string after it was updated from kexboard

F is the floating point variable in which GRDF will put the updated value

I is the integer variable in which GRDI will put the updated value

INAME
NC } are the same as in the corresponding GWRT, GWRF, GWRI

Before using one of these subroutines the corresponding GWRT, GWRF, GWRI must have been issued and the image must appear on the screen (by a CALL GWAIT).
Cursor will appear underneath the first character of the designated string.
Operator may type in new value. Return from these subroutines follows the ALT-END key depression.
Floating point and also integer values are accepted in any of the I, E, F formats

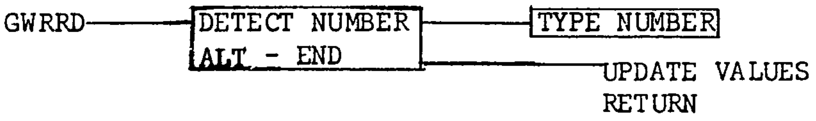


CALL GWRRD (H_1, X_1, H_2, X_2 H_n, X_n) $1 \leqslant n \leqslant 25$

This subroutine displays variables names with the corresponding floating point values which may be updated from the keyboard.
This subroutine puts the whole image created by the program in omit status, displays the variables and waits for operator's action.
The operator select the variables to be updated by light pen detect and types in new values.
Redisplay of the image and return follow the ALT-END key depression.

H_i is a 4 characters text variable containing the name of the X_i variable

X_i is the floating point variable



CALL GLIST (NFILE)

This subroutine erases the image created by the program and displays the content of the NFILE data set. The user can have an overall vew at his printed results by page up/page down operations.
User's program writes its results on the logical data set number NFILE just like it does on the printer unit. JCL card:

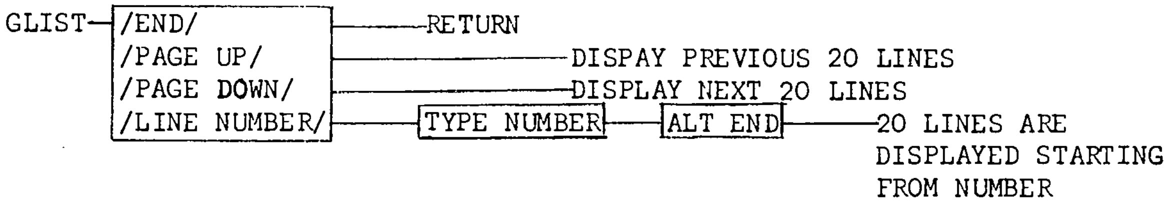
```
//GO.FTXXF001  DD ....... DCB = (RECF = F, BLKSIZE = 132)
```

is required with XX = NFILE
Subroutine GLIST does not alter the record positioning of the NFILE data set i.e. at its return NFILE is repositioned at the same point it was found.

NFILE logical number of the data set to be listed at the display unit

A set of options appear to the operator. He can take his decision by light pen detect on:

/END/ return from GLIST
/PAGE UP/ display previous 20 lines
/PAGE DOWN/ display next 20 lines
/LINE NUMBER/ followed by typing value and ALT-END key.Display 20 lines starting from the inserted value.



CALL GDES (TAB, VARNMS, NVAR, NP)

This subroutine performs x-y linear scaling and plotting of variables. It gives the operator the possibility to choose the variables to be associated with the x and y axis and allows some graphic operations such as including and omitting curves and displaying detected points coordinates.

TAB is a NVAR by NP matrix containing in the I-th line NP floating point values of the I-th variable.

VARNMS is a REAL*8 vector dimensioned NVAR.
Each VARNMS(I) contains 6 characters describing the name of the I-th variable.

NVAR number of variables

NP number of points

In the first step of its execution GDES requires operator's choise of the variables to be represented. It displays the menu:

/END//SELECT VAR FOR X AXIS//SELECT VAR.S FOR Y AXIS/

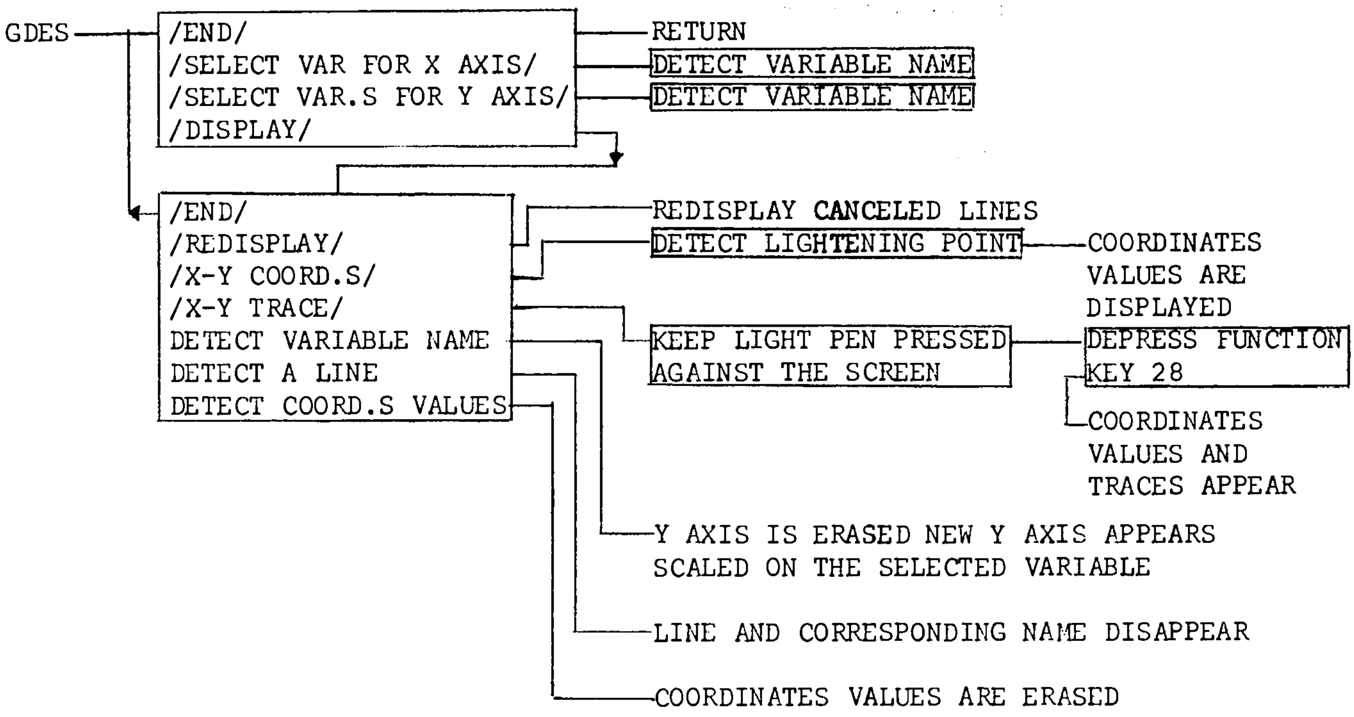
together with the list of variables names. /END/ means return form GDES. The operator detects one option and then detects the variable name. In this way he designates the x axis variable and one or more y axis variables. Action on /DISPLAY/ option displays the scaled x and y axis and the selected lines.
At this point many operations are possible:

/END/ go back to the first step for another x-y combination, or return.
/REDISPLAY/ redisplay all canceled lines
/X-Y COORD.S/ followed by a displayed point detect, display the coordinates values of the designated point
/X-Y TRACE/ must be followed by the action:
keep light pen depressed against a point of the screen and depress function key number 28; coordinates of the selected point and x-y traces will appear.
The coordinates refer to the displayed x-y axis.

DETECT ON VARIABLE NAME erase the y axis and substitute it with a new y axis that refers to the designated variable

DETECT ON LINE make the line and its name invisible

DETECT ON COORDINATES   erase the detected coordinates


GDES
/END/
/SELECT VAR FOR X AXIS/
/SELECT VAR.S FOR Y AXIS/
/DISPLAY/
RETURN
DETECT VARIABLE NAME
DETECT VARIABLE NAME
/END/
/REDISPLAY/
/X-Y COORD.S/
/X-Y TRACE/
DETECT VARIABLE NAME
DETECT A LINE
DETECT COORD.S VALUES
REDISPLAY CANCELED LINES
DETECT LIGHTENING POINT
COORDINATES VALUES ARE DISPLAYED
KEEP LIGHT PEN PRESSED AGAINST THE SCREEN
DEPRESS FUNCTION KEY 28
COORDINATES VALUES AND TRACES APPEAR
Y AXIS IS ERASED NEW Y AXIS APPEARS SCALED ON THE SELECTED VARIABLE
LINE AND CORRESPONDING NAME DISAPPEAR
COORDINATES VALUES ARE ERASED

CALL GUPDAT (NFILE1, NFILE2)

This subroutine allows cards manipulation and updating from keyboard.

NFILE1 is the logical number of the data set containing 80 characters records to be updated. Records must be less thean 180 and NFILE1 must contain the end of file.

NFILE2 is the logical number of the data set that on return from GUPDAT will contain the updated cards. NFILE2 may be equal to NFILE1.

The image is erased and cards are displayed on the screen.
Following are operator's actions:

/END/ return from GUPDAT

/DELETE/ followed by light pen detect on a line:
erase the selected line

/INSERT/ followed by detect on a line: blank card is
inserted next; operator may type in and then depress
ALT-END key

/PAGE UP/ previous 40 lines are displayed

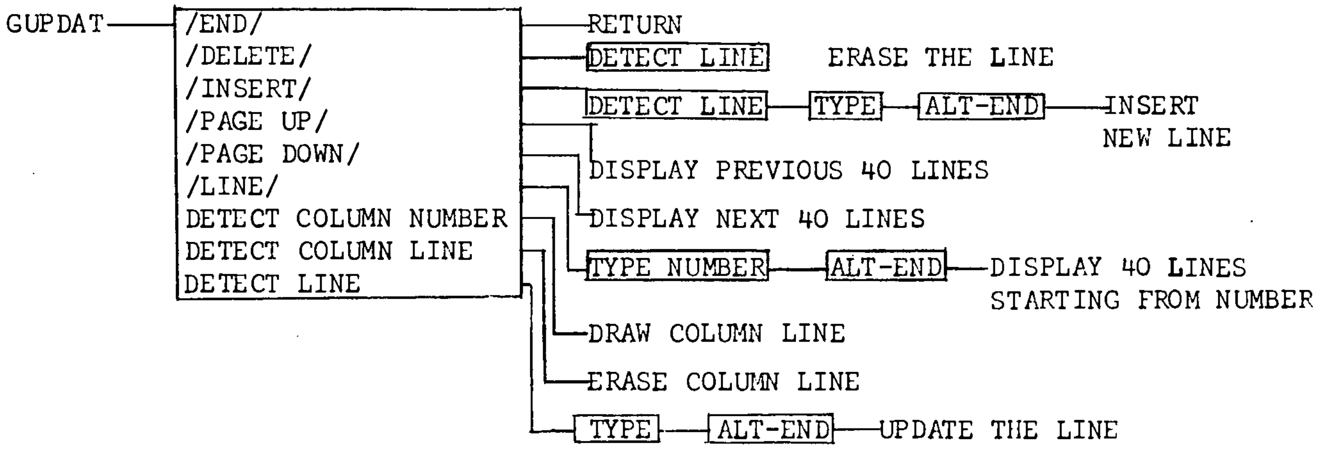
/PAGE DOWN/ next 40 lines are displayed

/LINE/ type in number, then ALT-END and 40 cards will be
displayed starting with number

DETECT COLUMN NUMBER the corresponding vertical line will be drawed
for column alignment

DETECT COLUMN LINE line is erased

DETECT LINE type in for updating and then ALT-END. The card will be updated.



Conjunction with IBM Graphic Subroutine Package

GRAFI has been implemented using IBM GSP. Some applications may require GSP programming. The conjunction can be established introducing the

```
  COMMON /GRAF1/ IGSP,NULL(1),  I2250,IDEV, IGDS, IATL
```

statement in the user's program.
The names of the variables are self-explaining. The variables are initialized by the CALL GRAFI subroutine . We note that IGDS is the only graphic data set used by GRAFI and IATL the only attention level.

Following informations explain how GRAFI works:

- all Ref. 1 and 2 subroutines generate graphic orders into IGDS graphic data set as well as all subroutines mentioned in this report.
- IGDS is inizialized with the GSP default options
- GGROUP establishes a new GSP "sequence" which correlation value is INAME
- GWRT, F, I generate text graphic elements with INAME as correlation value. No correlation value is set if INAME = 0
- designated attention sources are enabled by CALL GWAIT and disabled at the return from GWAIT
- GWAIT subroutine also issues a CALL EXEC(IGDS)
- on light pen detect GWAIT puts in IREP the sequence correlation value of the detected point, if this is not the case it looks for graphic element correlation value, if this is also zero then puts 34 in IREP.

System informations

Package GRAFI is written in Assembler and mainly in Fortran language. It has been designed for Fortran users but may be called from Cobol and PL1 programs.

The process of incorporating the GRAFI package into a private library is relatively straightforward. The package is distributed on a tape containing three **partitioned** data sets:

File	DSName	Members
1	GRAFI.DECKS	SAMPLES LKEDDECK
2	GRAFI.SOURCE	All GRAFI subroutines
3	GRAFI.OBJMOD	All GRAFI subroutines modules

Following are control cards for loading GRAFI partitioned data sets onto a DASD

```
//LOADGRA EXEC IEHMOVE
//SYSPRINT DD SYSOUT=A
//TAPE DD UNIT=TP, VOL = SER = GRAFI, LABEL = (1,NL),
//     DISP = (OLD,PASS), DCB = (DEN=2, DSORG = PO, RECFM = FB, BLKSIZE = 800
//     LRECL=80)
//DISK DD UNIT = 2314, VOL = SER = VOLGRAFI, DISP = (OLD, KEEP)
//SYSUT1 DD UNIT = 2314, VOL=SER = VOLGRAFI, DISP = OLD
//SYSIN DD *
   COPY   TO=2314=VOLGRAFI,FROM=TP=(GRAFI,1),FROM DD=TAPE,PDS=GRAFI.DECKS
   COPY   TO=2314=VOLGRAFI,FROM=TP=(GRAFI,2),FROM DD=TAPE,PDS=GRAFI.SOURCE
   COPY   TO=2314=VOLGRAFI,FROM=TP=(GRAFI,3);FROM DD=TAPE,PDS=GRAFI.OBJMOD
/*
//PUNCH EXEC IEBPTCH
//SYSPRINT DD SYSOUT = A
//SYSUT1 DD UNIT = 2314, VOL=SER=VOLGRAFI,DISP = (OLD,KEEP),
//          DSN = GRAFI.DECKS
//SYSUT2 DD SYSOUT = B
//SYSIN DD *
  PUNCH    TYPORG=PO,MAXNAME = 2
           MEMBER NAME = SAMPLES
           MEMBER NAME = LKEDDECK
/*
```

Mount the distribution tape containing GRAFI on a nine track tape drive and run the two steps above. This will punch the LKEDDECK that consists of the JCL and control cards for generating the private library SYS1.LIBGRAFI. Run this third step and then run the sample problems obtained from step two.

Sample problems decks contain necessary informations for the 2250 operator.

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MOINIL, P., PIRE, J. : Contour map subroutines, EUR 2241

Graphic subroutine Package, IBM for C 27-6932

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To disseminate knowledge is to disseminate prosperity — I mean general prosperity and not individual riches — and with prosperity disappears the greater part of the evil which is our heritage from darker times.

Alfred Nobel

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