

United States Department of Interior
Geological Survey

Potential-Field Geophysical Programs for VAX 7xx Computers

by
Branch of Geophysics¹

Open-File Report 89-115 *A*
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89-115A Documentation (Paper Copy)
89-115B Source Code (Programs A-G)
89-115C Source Code (Programs H-P)
89-115D Source Code (Programs R-Y)

Disclaimer

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Table of Contents

	Page
Introduction.....	1
List of Computer Programs.....	2
Appendix A Standard Grid.....	8
Appendix B Standard Gravity File.....	11
Appendix C Post File.....	15
Appendix D Plot System.....	16

Introduction

This report contains a collection of potential field geophysical programs that are widely used by members of the Branch of Geophysics on VAX 750 and 780 computers. The programs and brief descriptions of their functions are listed on the following pages. If a detailed explanation of a program's operation or development of algorithms is available elsewhere, it is referenced at the end of the brief description. Source code for the programs is provided on three 5-1/4 inch high density (1.2 mb) diskettes. Some programs have a short explanation of the program in a separate file on the diskettes. These files have the program name as a prefix and .hlp as the suffix.

Common formats for data input and output are used in all these programs to facilitate ease of use and the addition of new programs to this system. The standard format for gridded data is described in Appendix A, the standard format for gravity data is explained in Appendix B and the most common format for point or profile data (post format) is described in Appendix C. Most programs that use the post format also allow input data to be of the form x, y and z.

Those programs that generate graphic output use a USGS-developed, device-independent plotting system, explained in Appendix D.

All of the programs are written in Fortran, and many contain VAX Fortran extensions to Fortran 77; therefore some conversions will be necessary to port these programs to other computers.

List of Computer Programs

Programs that do not use graphics

A2POS converts MAD ascii files to post files. See POS2A and POS2AGRF. (part of the MAD suite of programs).

ACDEPTH automatic depth-to-magnetic-source on profiles, by Werner deconvolution.

ADDGRD performs point-by-point arithmetic operations (+,-,*,/,mask) between two grids of equal size.

ASCII2SF converts standard-format grid from ascii to binary.

AVER2D fast lowpass filtering of grid data by averaging operator.

BOUNDARY automatically performs horizontal-gradient method of Cordell and Grauch to find physical-property boundaries (Blakely and Simpson, 1986, Geophysics, V. 51, p. 1494-1498)

CHESS arbitrary-surface continuation by Cordell-Hildenbrand chessboard method. (Institute of Geophysics, University of Lausanne, Switzerland, Bulletin No. 7, p. 96-99)

CHNGEPOS manipulates and performs arithmetic operations on channels in a post file

CHNGEXYZ manipulates and performs arithmetic operations on data in xyz format

CKGRAD checks a post file for gradients within a given range. (part of the MAD suite of programs.)

CKVALUE checks a post file for values within a given range. (part of the MAD suite of programs.)

COMPGRD compares edges of two grids for compatability in merging.

CORREL compares the grid-point values of two grids and outputs a grid of correlation coefficients

DECIMATE samples grid at integer intervals.

EDITCOL general purpose reformatting program for all ASCII files

EXPCNV converts post files to/from express (bundled) format. For use with EXPSTACK

EXPREMD removes a polygonal subset from xyz, post or express files.

EXTRACT extract rectangular subset from data in xyz, post, express or gravity format.

FFT_COF User provides frequency domain filter which is then used to modify coefficients by appropriate folding to preserve real-valued symmetries. Uses FFTFIL coefficient file format.

FFTFIL 3D linear operators (continuation, pseudogravity, etc) with FFT. USGS Open-File Report 83-237

FLDEL deletes a flight line from a MAD post file. (part of the MAD suite of programs).

FLDIST calculates distance on ground between data points, given a MAD post file. (part of the MAD suite of programs).

FLGET extracts a flight line from a MAD post file. (part of the MAD suite of programs).

FLOOD set minimum/maximum bounds of a grid.

FLSPECS prints minimum, maximum and other specifications of the flight lines in a MAD post file. (part of the MAD suite of programs).

FLTOPO calculates topography elevations from height above terrain channel in a MAD post file. (part of the MAD suite of programs).

G2XYZ converts grid points to an xyz file. (part of the MAD suite of programs).

GENPROJ forward and inverse projections for post and xyz files.

GI3 3D gravity inversion by Cordell-Henderson method. Geophysics, v. 33, no. 4, p. 596-601; NTIS Report no. PB196979, 1970.

GMERGE puts multiple input grids into one output grid with no interpolation. see JIGSAW,TILT,UTILITY.

GRADIENT performs directional derivative operations on grid.

GRAVDUP winnows gravity stations from one or two post files given a user-defined latitude-longitude radius.

GRAVPOLY 3D forward gravity modeling using Talwani method, modified to allow for exact formula and to invert for density. USGS Open-File Report 83-346.

GRDMAX gives minimum, maximum and histogram of grid values.

GRDSCALE calculates the scaling factor (slope) and datum in a linear regression between two grids.

GRDSTAT calculates the mean, sum, RMS difference, and standard deviation of one grid or of the difference between two grids.

GREDDUC gravity reduction from time, location and meter-reading, to observed gravity.

HAMMER calculates Hammer zone terrain corrections.

HYPEREMP removes a polygonal subset from a grid.

ID prints the header information of a grid file.

IGRFGRD International Geomagnetic Reference Field (IGRF) calculated on either a draped or constant-elevation surface grid.

INSERT inserts a subgrid into a master grid.

JIGSAW trim multiple grids to consistent boundaries for merging.

MAD A suite of programs to Manipulate Aeromagnetic (flight-line) Data (M.A.D.) in post format. MAD post files are formatted the same as regular post files, but the contents of the 6 z values (occurring after the 8-character id, x and y location values) are (1) total field residual (IGRF removed), (2) total field, (3) height above terrain (meters), (4) barometric altitude (meters), (5) fiducial number, and (6) year and Julian day in format XX.XXX. The programs in the MAD suite are POS2A, POS2AGRF, A2POS, PHIST, CKVALUE, CKGRAD, PSORT, PWINNOW, PSCREEN, FLSPECS, FLDEL, FLGET, TIEDEL, FLDIST, FLTOPO, and G2XYZ.

MADSUBS subroutines that are shared by the MAD suite of programs.

MAGMRG joins the edges of two grids by cubic-spline interpolation.

MAGPOLY 3D forward magnetic modeling using Talwani method, modified to allow for exact formula and to invert for magnetization. USGS Open-File Report 83-345.

MAGVECTR computes mean remanent and/or total magnetization vector from given individual sample values.

MEGAPLUG extrapolate data over no-data areas in large grids. (plug function in UTILITY is used for small grids.)

MINC creates 2D grid from randomly spaced data using minimum curvature. USGS Open-File Report 81-1224.

PATS converts ascii xyz profiles to grid form. See PROFFT, PROFFILT, PROFSPEC, SAKITOP0 (part of PROFPROG suite).

PFGRAV3D 3D forward gravity calculation of slabs having irregular surfaces by Parker-Blakely method. See PFMAG3D.

PFMAG3D 3D forward magnetic calculation of slabs having irregular surfaces by Parker-Blakely method. USGS Open-File Report 81-298.

PHIST prints a histogram of values in a post file. (part of the MAD suite of programs.)

POS2A converts a post file to ascii format. See A2POS. (part of the MAD suite of programs).

POS2AGRF same as POS2A but adds a marginal graph. (part of the MAD suite of programs).

PRINTSTD prints header of a standard-format grid and selected row or column values, with the option to create a subset.

PRJGRD projection of data in grid form using cubic splines. (Polyconic, UTM, Lambert, Mercator, or Albers).

PRJPT projection of one input latitude, longitude coordinate at a time.

PRJREC projection of data in xyz or post form. (Polyconic, UTM, Lambert, Mercator, or Albers).

PROFFILT applies various filters to FFT coefficients from PROFFT. See also PROFSPEC, PROFPLOT, PATS, and ROWORCOL (part of PROFPROG suite).

PROFFT transforms profiles to frequency domain and vice versa. See PROFSPEC, PROFPLOT, PROFFILT, PATS, and ROWORCOL (part of PROFPROG suite).

PROFPROG Not one program, but a suite of programs to work on profiles in grid format. Emphasis is on FFT filtering. The programs are PROFFT, PROFFILT, PROFPLOT, PATS, PROFSPEC, ROWORCOL, and SAKITOPPO.

PSCREEN extracts one post file record per grid cell. (part of the MAD suite of programs.)

PSORT sorts a post file on user-given channels. (part of the MAD suite of programs.)

PWINNOW winnows by keeping only every nth record in a post file. (part of the MAD suite of programs.)

REGRID interpolate 2D grid at a specified increment using cubic splines or linear interpolation.

RMS Root-mean-square difference between two grids.

ROWORCOL extracts row or column from a grid into a one-row profile grid. see PROFFT, PROFFILT, PROFPLOT, PROFSPEC, and PATS (part of PROFPROG suite).

SAKITOPO converts top surface of a SAKI model into an ascii profile (part of PROFPROG suite). See SAKI.

SF2ASCII converts standard-format grid from binary to ascii.

SHODVALS quickly shows areas of no data on terminal.

SKIM replaces grid values above and(or) below given levels with dummy values (dvals).

SLICE trim borders of a grid that have no data.

SURFIT fit trend surfaces of up to 19th order to input grid using orthogonal polynomials.

SWAPPOST merges post files together and manipulates post channels.

TAYLOR arbitrary-surface continuation by Cordell-Grauch Taylor's series method. USGS Open-File Report 84-501.

THINGRID thins a grid by extraction of every nth row or column.

THIS calculates minimum, maximum, mean, and standard deviation of a grid file and plots histogram of grid values.

TIEDEL deletes all tie (cross) lines in a MAD post file. (part of the MAD suite of programs.)

TILT adds a plane with specified edge gradients to a grid.

ULTRTAPE copies disk files from/to magnetic tape in a standard format.

UTILITY grid utility operations: extract subgrid, list, plug, rotate, transpose, change header, edit and conversion to xyz data.

VARMAG magnetic-terrain correction by Grauch variable magnetization method. USGS Open-file Report 86-268.

XYZMAX gives maximum and minimum of xyz, post and express files.

Programs that involve graphics (using PLTSYS)

CONTOUR general contouring program for gridded data, with provision for plotting points. USGS Open-File Reports 82-797 and 88-593A.

EXAMPL demonstrates some aspects of the plot system PLTSYS.

EXPSTACK plots stacked profiles from express files. See EXPCNV to get express formatted files.

FUPLOT subroutine that changes PLTSYS calls to CALCOMP calls.

GRAFEDIT interactive graphic editing of xyz and post data sets by grid inspection.

PLOTCHAN plots multiple channels of a profile from express file input.

PLTSYS plotting system subroutines of Evenden-Wahl. USGS Open-File Report 75-317.

PROFILEX graphically extracts profiles from a grid.

PROFPLOT plots either row or column extracted from up to 3 grids (part of PROFPROG suite).

PROFSPEC plots spectrum of FFT coefficients output from PROFFT. See also PROFFT, PROFFILT, PATS, and ROWORCOL (part of PROFPROG suite).

SAKI semi-automatic 2.5D gravity and magnetic modeling using generalized inversion and graphics. USGS Open-File Report 85-122.

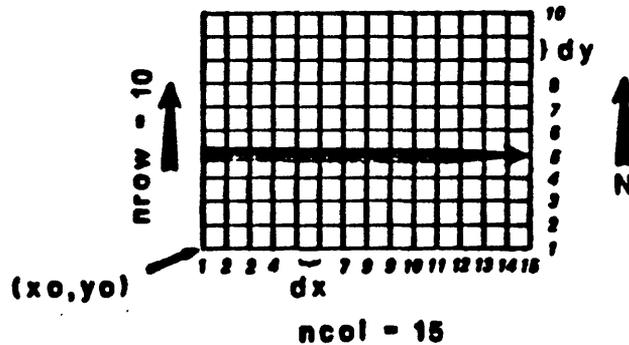
SHADE plots stacked profiles in line form, or shaded reflection-trace style using the second horizontal derivative.

TIDEPLOT plots gravity tidal curves at a location.

Appendix A

Standard Grid

Gridded input and output to all the programs use a standardized binary grid format. As originally conceived, this format provided for generalized non-gridded data as well, and vestiges of these provisions remain in some of the older programs. In practice, the standard grid is used for grids having square or rectangular cells, and non-gridded data are handled by "post" (appendix C) or other formats. In its current form the standard grid consists of a header record followed by one record for each row of data. Row 1 is the first row stored.



Reading fifth row

A. Header record (23 4-byte words long)

id: 56 ASCII characters of identification (14 words).

pgm: 8 ASCII characters of creation program identification (2 words).

ncol: number of columns of data (integer, 1 word).

nrow: number of rows of data (integer, 1 word).

nz: number of words per data element (integer, 1 word). For single

precision use 1, double precision or complex use 2, double
precision complex use 4.

xo: position of first column of data (real, 1 word).

dx: equal spacing interval of columns (real, 1 word).

If equal to zero, then coordinates for each column are in
the following data record; otherwise the following record
consists of data for row one.

yo: position of first row of data (real, 1 word).

dy: equal spacing interval of rows (real, 1 word). If equal to zero,
the coordinate for each row is the first word of each
data record row.

- B. Data record. Each data record contains one row of real data. The first
word should contain the row coordinate, but in most programs this
coordinate value is a dummy. Record length is $(ncol*nz)+1$ words.

In the original, more general case, i/o for this standard file can be
stated in Fortran as:

```
dimension g(iz,ix,iy),id(14),pgm(2),x(ix),y(iy)
read or write (..) id,pgm,ncol,nrow,nz,xo,dx,yo,dy
if (dx.eq.0.) read or write (..) (x(i),i=1,ncol)
if (dy.ne.0.) go to 15
do 10 j=1,nrow
10 read or write (..)y(j),((g(k,i,j),k=1,nz),i=1,ncol)
go to 25
15 do 20 j=1,nrow
20 read or write (..) dum,((g(k,i,j),k=1,nz),i=1,ncol)
```

25 continue

In the usual case where dx and dy are constant (but not necessarily equal) nz=1, the code simplifies to:

```
dimension g(ix,iy),id(14),pgm(2)
Read or write (..) id,pgm,ncol,nrow,nz,xo,px,yo,dy
DO 10 J=1, nrow
10 read or write(..) dum,(g(i,j),i=1,ncol)
```

As defined, the grids are rectangular in shape, whereas the actual area of data coverage may be an irregular shape within the rectangle. Regions within the grid rectangle but outside the data area are identified as "DVALS". All the programs recognize these as no-data areas and these areas are blanked out automatically in contouring and other graphics programs.

DVALS are identified by a very large number. In the current U.S. Geological Survey DEC-VAX computer, DVALS are commonly assigned the largest hexadecimal number: 'ffff7fff'x, which is approximately 1.7e38. Other very large numbers are sometimes used also; normally the DVAL is defined near the start of each program.

Appendix B

Standard Gravity File

The standard gravity file in ASCII format has three records of identification followed by one record for each station (see example below). The first two lines of identification are user-supplied descriptive text of up to 80 characters each. The third line contains an integer value in column 1, followed by 7 fields of 8 characters each.

LINES 1 and 2

User-supplied descriptive text...

LINE 3

<u>Columns</u>	<u>Contents</u>
1	Code for data type: 0 = gravity meter readings 1 = meter reading converted to mGal 2 = observed gravity
2-9	gravity meter identification
10-17	project identification.

- 18-25 elevation units; either elev=f for elevation in feet, carried to tenths, or elev=m for elevations in meters, carried to hundredths.
- 26-33 precision of gravity values in mGals; either gu=.01 or gu=.001.
- 34-41 sort key used in gravity reduction program. srt= one of the following: id, tme (for time), lat, lon, elv, grv, itc, otc, spc, c1 or c2.
- 42-49 range of Hammer zones used for inner terrain corrections (.g., itc=a-g). This field is non-blank only if one of the Hammer zones F, G, or H was used.
- 50-57 range of zones used for outer terrain corrections. (e.g., otc=h-x). The ending letter 'x' is used to represent 166.7 km from the station (Hayford-Bowie zone '0'), which is the standard distance used in program Bouguer. This field is non-blank only if one of the Hammer zones F, G, or H was used.

The gravity station records have the following format:

<u>Columns</u>	<u>Data</u>	<u>Units</u>	<u>Format</u>
1-8	Station Identification	AAAAAAAA	2A4
9-10	Year	NN	I2
11-13	Day of the year	NNN	I3
14-17	Time	HHMM	I4
18-21	Time Zone (central = 6)	N.N	F4.1
22-24	Latitude Degrees	SDD	I3
25-28	Latitude Minutes	MM.MM	F4.2
29-32	Longitude Degrees	SDDD	I4
33-36	Longitude Minutes (Positive or negative degree values are acceptable for west longitudes)	MM.MM	F4.2
37-42	Elevation (Feet) or Elevation (Meters)	FFFFFF.F FFFF.FF	F6.1 F6.2
43-44	State Code	SS	A2
45-51	Station Gravity - 900,000	mGal	F7.2
	or		
44-51	Microgal Station Gravity - 900,000. This field would correspond to the precision of gravity values explained previously under Col 26-33 on the third line of the header record. If microgravity is used, the State Code field is not used.	mGal	F8.3
52-57	Inner Terrain-Correction	mGal	F6.2
58-63	Outer Terrain-Correction	mGal	F6.2
64-69	Special Field (e.g., isostatic anomaly)	mGal	F5.2
70-74	Tide Correction	mGal	F5.2
80	User codes. A 'D' means ignore this station in program GREduc.		A1

Example of input file

San Rafael, Utah

August 1987

2g-2

elev=f gu=.01 srt=tme

11	872402017	6	385941-1104039	57650	ut7954675
12	872402027	6	385808-1103948	59240	ut7953656
13	872402045	6	385573-1103603	64840	ut7950557
21	872411047	6	384362-1104405	67820	ut7947436

Appendix C

A post file is a Fortran unformatted file containing x and y coordinates and any number of dependent variables. Each record contains a minimum of four fields with the maximum number dependent on the programs that use the file.

Field

1. Character*8 Identification for the record. These can be any ASCII characters. Common examples are line numbers for profile data or station identifications for gravity data.
2. real*4 The x coordinate location for the record. This can be longitude in decimal degrees or projected data such as UTM coordinates (usually in kilometers).
3. real*4 The y coordinate location for the record. This can be latitude in decimal degrees or projected data such as UTM coordinates (usually in kilometers).
4. - n real*4 Dependent variables: examples are observed gravity, elevation, Bouguer anomaly, magnetic anomaly, etc.

Input/output for this type of file can be stated in Fortran as:

```
Character*8 id
real*4 z(6)

read or write (..) id, z
```

An express file is a bundled form of a post file and written in direct access. Newer profile and utility programs contain options to use this format. Each express record has three words of size information followed by a data array which contains a variable number of post logical records.

Field

1. integer*4 nword - number of words (commonly 32 bits) in each logical record
2. integer*4 nlog - number of logical records (post or xyz) in this express record.
3. integer*4 ntotal - length of the data array. 3 + ntotal is equal to Fortran RECL in the open statement.
4. float*4 data - where data are dimensioned (nword,nlog)

I/O can be stated in Fortran as

```
dimension Z(nword,nlog)
or dimension Z(ntotal)

read/write (iunit,rec=xx) nword,nlog,ntotal,Z
```

Appendix D

Plot System

The programs that involve graphics use a USGS plot system that is device independent (See USGS Open-File Report 75-317). Output devices are controlled by using the parameter IPLOTR in subroutine PLTSET. A brief description of the plot system subroutines follows. These are simplified explanations, especially for VCHAR. The reader is referred to the above open-file report for a more detailed explanation.

ENDPT(ie) - terminates a plot

ie: an integer*4 array that contains plot diagnostics. If ie(1) = 0 or 1, no diagnostics are returned.

LINE(x,y,n,icon,ipn) - draws a line

x: real*4 array containing x coordinates in data units.

y: real*4 array containing y coordinates in data units.

n: an integer*4 variable that contains the number of x and y points.

icon: an integer*4 variable that determines whether a line continues from a previous one. 0 means start a new line; non-zero means

continue from previous line.

ipn: an integer*4 variable that determines the type of line to be drawn (solid or dashed). The line type for each IPN is:

<u>IPN</u>	<u>Plotted line</u>
0	_____
1	_____
2	_____
3	_____
4	_____
5	_____
6	_____

NEATL - draws a border around the data area.

PLTSET(iplotr,xbd,ybd,isl) - initializes plot system.

iplotr: an integer*4 variable that contains a number that determines the plot device to be used.

0 = Calcomp 700 with controllers 900-925

1 = Tektronix 4010

2 = Texas Instruments terminals 743 & 745 with Texplot

3 = Hewlett-Packard 7203A

4 = Tektronix 4014

5 = Hewlett-Packard 7580 or 7585

6 = General vector output, e.g., electrostatic printer/plotter

xbd: a real*4 variable in which the maximum x size of the plotter selected is returned.

ybd: a real*4 variable in which the maximum y size of the plotter selected is returned.

isl: an integer*4 array of length one where isl(1)=1 for inches to be used for the plot units or =2 for centimeters to be used as the plot units.

SCALE(dyp,dyp,yp,nopts,ier) - defines the data range and the plot size (see figure 1).

dyp: a real*4 array of length two that contains the left and right limits respectively of the data in data units.

dyp: a real*4 array of length two that contains the bottom and top limits, respectively, of the data in data units.

xp: a real*4 array of length nopts where:

xp(1) = size of the data area along x axis in plot units.

xp(2) = 0 for linear representation of the x coordinates or 1 for a logarithmic representation.

xp(3) = offset along the x axis in plot units where the data area starts.

xp(4) = size of the plot area along the x axis in plot units.

Only xp(1) is required. xp(2) and xp(3) default to zero and if NOPTS is ≤ 3 , then xp(4) is = xp(1) + xp(3).

yp: a real*4 array of length nopts where:
 yp(1) = size of the data area along the y axis in plot units.
 yp(2) = 0 for linear representation of the y coordinates or 1 for a logarithmic representation.
 yp(3) = offset along the y axis in plot units where the data area starts.
 yp(4) = size of the plot area along the y axis in plot units.

Only yp(1) is required. yp(2) and yp(3) default to zero and if nopts is ≤ 3 then yp(4) is = yp(1) + yp(3).

nopts: an integer*4 variable containing the number of parameters in the xp and yp arrays.

ier: an integer*4 variable that contains a number returned by subroutine scale. 0 means no error; any other number indicates an error was detected and user action is needed.

VCHAR(x,y,ich, n, icode,size,theta,xoff,yoff) - writes characters on a plot.

x: a real*4 variable that contains the x coordinate(s) of the center of a character.

y: a real*4 variable that contains the y coordinate(s) of the center of a character.

ich: integer array containing a number of a symbol from the plot system character set (see figure 2) or the character or character string to be plotted.

n: an integer*4 variable containing the number of points or the number of characters to plot (see icode below).

icode: an integer*4 variable that determines the characteristics of the variables x,y and ich.

icode=1 means x and y are real*4 arrays of length n and that a character in ich will be plotted at each x,y location.

icode=2 means that x and y are single locations and that n contains the number of characters to plot at that location.

icode=3 has the same meaning as icode=2 except that the x any y locations are in plot inches from the lower left origin instead of in data units as in icode=1 or 2.

theta: a real*4 variable containing the rotation in radians of the character string before plotting. Counterclockwise is positive.

xoff: a real*4 variable containing the offset in plot units along the x axis of the first character to be plotted.

yoff: a real*4 variable containing the offset in plot units along the y axis of the first character to be plotted.

XAXIS(dxp,dyp,yp,del,ip,size,fmt,nfmt) - draws and labels the x axis.

YAXIS(dyp,dxp,yp,del,ip,size,fmt,nfmt) - draws and labels the y axis.

dxp,dyp,yp and yp have the same meanings as described under subroutine SCALE.

del: a real*4 variable containing the interval in data units of the tick marks.
ip: an integer*4 variable that determines the interval between each labeling of the tick marks.
size: a real*4 variable containing the size in plot units of the characters used to label the axes.
fmt: an integer*4 array containing the format for labelling the axes.
nfmt: an integer*4 variable containing the number of characters to use from FMT.

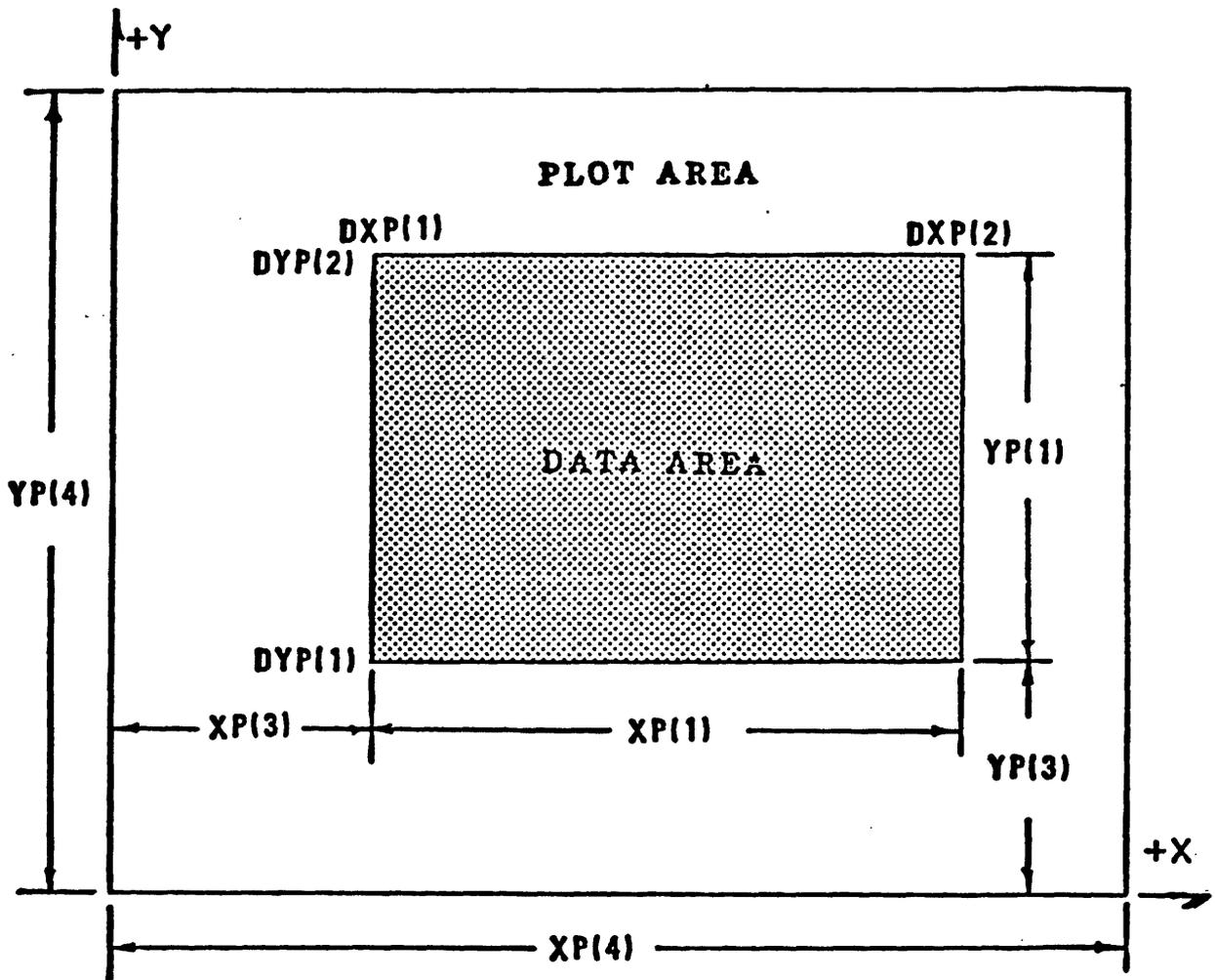


Figure 1. Relationship of plot and data areas

DXP and DYP are in data units.

XP and YP are in plot units.

Plot of Plot System Character Set

32	0
33	1
34	2
35	3
36	4
37	5
38	6
39	7
40	8
41	9
42	0
43	1
44	2
45	3
46	4
47	5
48	6
49	7
50	8
51	9
52	0
53	1
54	2
55	3
56	4
57	5
58	6
59	7
60	8
61	9
62	0
63	1
64	2
65	3
66	4
67	5
68	6
69	7
70	8
71	9
72	0
73	1
74	2
75	3
76	4
77	5
78	6
79	7
80	8
81	9
82	0
83	1
84	2
85	3
86	4
87	5
88	6
89	7
90	8
91	9
92	0
93	1
94	2
95	3
96	4
97	5
98	6
99	7
100	8
101	9
102	0
103	1
104	2
105	3
106	4
107	5
108	6
109	7
110	8
111	9
112	0
113	1
114	2
115	3
116	4
117	5
118	6
119	7
120	8
121	9
122	0
123	1
124	2
125	3
126	4
127	5

0	□
1	◇
2	×
3	*
4	+
5	-
6	Y
7	X
8	Δ
9	▽
0	.
1	0
2	1
3	2
4	3
5	4
6	5
7	6
8	7
9	8
0	9
1	0
2	1
3	2
4	3
5	4
6	5
7	6
8	7
9	8
0	9
1	0
2	1
3	2
4	3
5	4
6	5
7	6
8	7
9	8
0	9
1	0
2	1
3	2
4	3
5	4
6	5
7	6
8	7
9	8
0	9
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