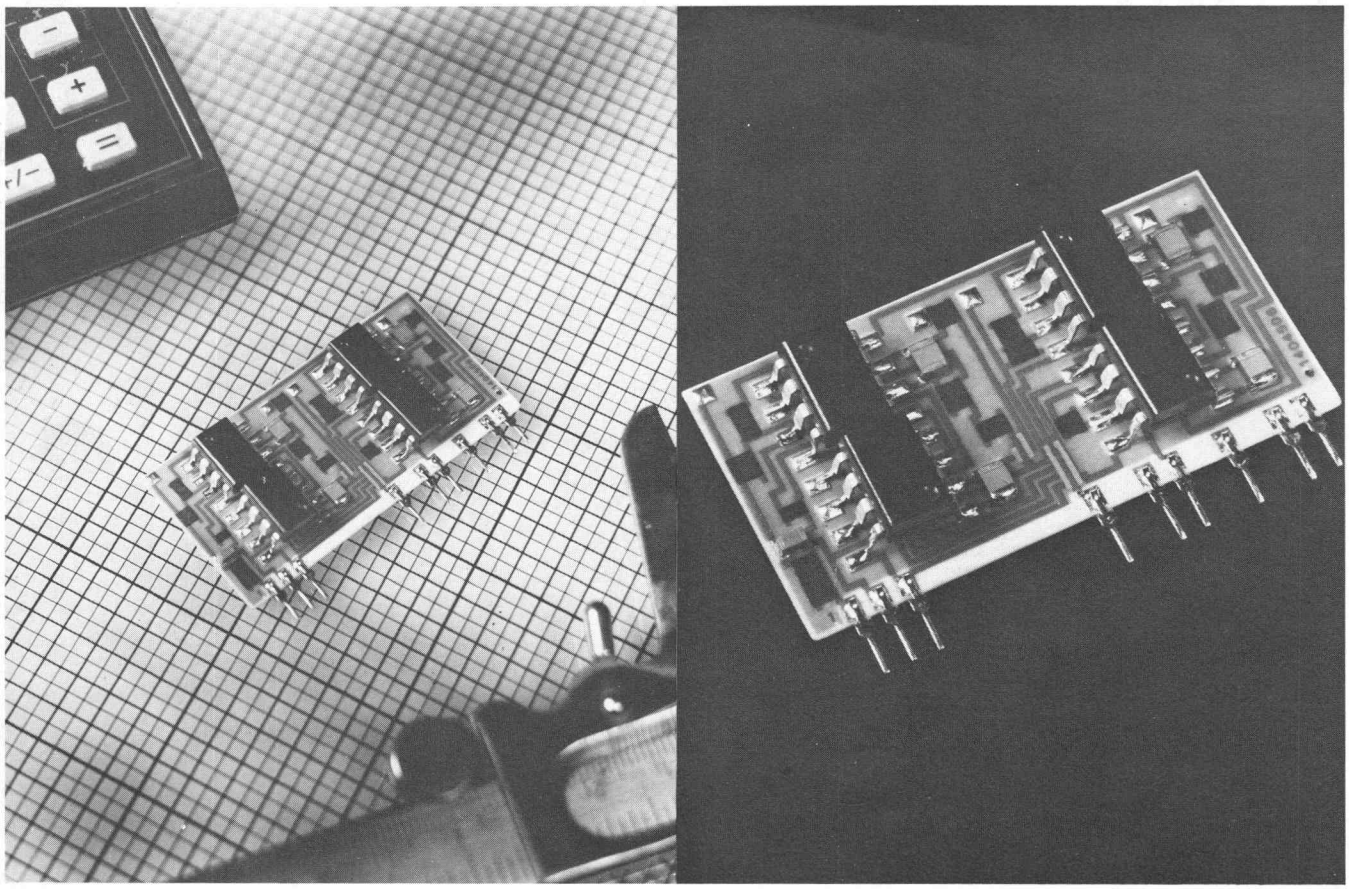
Teknigues

The 4050 Series Applications Library Newsletter December 17, 1979 Vol. 3 No. 8



The Hybrid Active Filter shown is typical of telephone switching circuit designs simulated by the Advanced Techniques Section of the Materials and Apparatus Laboratories of Automatic Electric Laboratories using graphical input-output simulators. (Photographs courtesy of GTE Automatic Electric Laboratories, Northlake, IL.)

Using the 4051 as a Computer-Aided Design Aid

by Edward J. Moran
GTE/AE Laboratories
Northlake, IL

At the GTE Automatic Electric Laboratories, in Northlake, Illinois, complex electronic circuit design and analysis is a daily task for the engineering staff. In order to work quickly and efficiently, much of their design effort is aided by computer-based circuit simulation. Using this method, engineers feed a complex circuit design into a mainframe computing system, along with the operating parameters of the devices in the circuit. The computer can then analyze the performance of the projected circuit before it is committed to hardware. This, briefly, is the function of the design staff and the system in which they work.

Within the Design Automation section of GTE Automatic Electric Laboratories, the circuit analysis and simulation group is responsible for providing the design staff with the easy to use electronic circuit simulation aids that they need. The key words here are "easy to use"; to us this means "interactive graphic input and output" for the computer-based circuit simulation system. The objective

In This Issue

is to provide tools that allow the designers to communicate their problems to the circuit simulators in the designers' own language (schematic symbols), and to recover solutions from the simulators in the form of graphic interpretation.

When any kind of language processor is designed for graphic simulator input, the subtask of generating a symbol set is readily seen. That is, a vocabulary of symbols is required regardless of the nature of the system to be simulated. In the case of electronic circuit simulation, the vocabulary set is open-ended; technological growth in the state of the art implies an ever-expanding set of symbols.

Enter SYMBOLGEN

The SYMBOLGEN program was designed to meet the need for a vocabulary of graphic symbols, and to provide an efficient means for generating arbitrary graphic symbols. The 4051 Graphic System with its local intelligence, graphic input and output capability, and data communications interface, is uniquely capable of automating the symbol library generation process economically. Simulation, in general, requires very large mainframe computer resources, and is expensive. Any tasks associated with the generation of simulator input should, for economy, be automated and off-loaded from the host as much as possible.

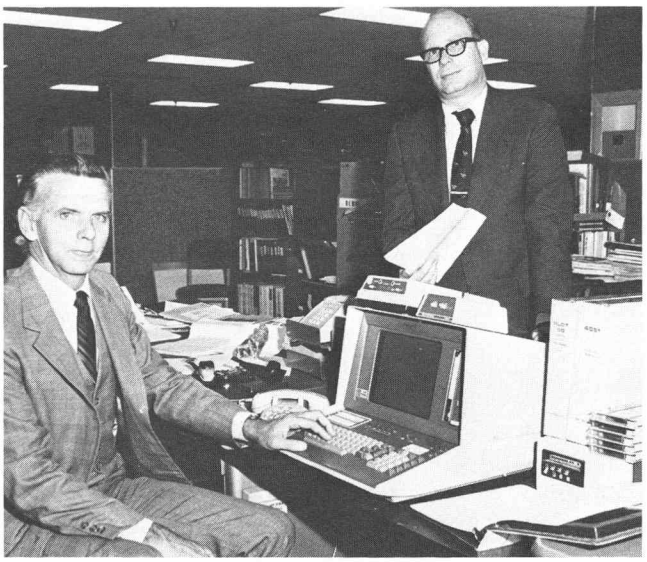


Fig. 1. Dr. J.A. Dyer (standing), supervisor of the Circuit Analysis and Simulation Group, and E.J. Moran at the 4051 keyboard. The 4952 Joystick is shown on top of the graphic system with an acoustic coupler. In the foreground under the tape data cartridges is a 1200 baud modem for communicating with a remote host computer. (Photograph courtesy of Datu Tamel, Tektronix, Inc., Chicago, IL.)

The graphic input portion of the systems, which translate user-input graphics to simulator format, are written in PL/I language, invoking TEKTRONIX PLOT 10 graphics support for all graphics. They convert single user keystrokes into meaningful graphic symbols and interconnects, which are displayed for the user via PL/I symbol drawing procedures. The set of all available PL/I symbol drawing procedures forms the graphic vocabulary of the input processor (see Figure 2).

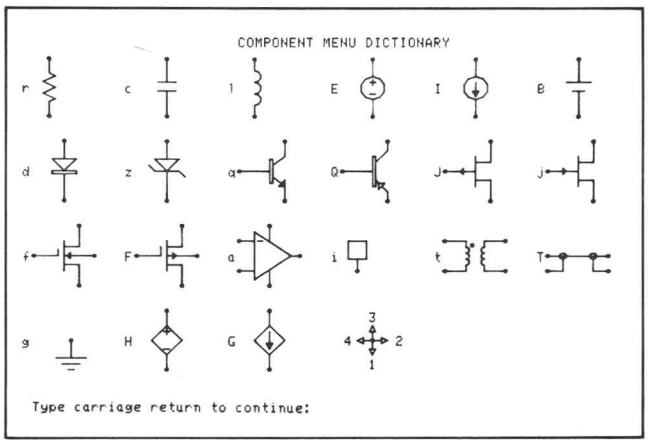


Fig. 2. The graphic vocabulary of the input processor is displayed on the 4051 graphic screen.

Each procedure is "written" in PL/I language by the stand-alone SYMBOLGEN program, from a "sketch" of the desired symbol that the user creates with the 4952 Opt. 2 Joystick attached to the 4051. The composed, bug-free PL/I procedure is then "shipped" to the host via the Data Communications Interface, ready for compilation and linking into the simulator input processor.

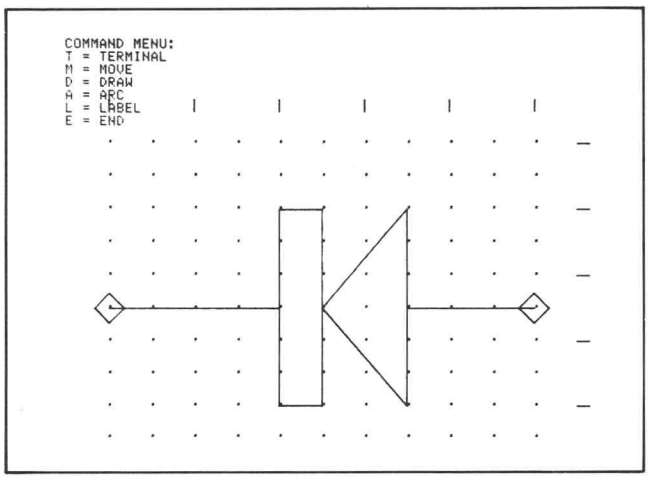


Fig. 3. The user sketches his desired symbol with the 4952 Joystick.

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DIODE
DIODE

 2
      CALL MOVER( 0., 55.)
      CALL MOVER( -5., 0.)
      CALL DRAWR( 5., 5.)
      CALL DRAWR( 5., -5.)
      CALL DRAWR( -5., -5.)
      CALL DRAWR( -5., 5.)
      CALL MOVER( 5., 0.)
      CALL DRAWR( 56., 0.)
      CALL DRAWR( 0., 33.)
      CALL DRAWR( 14., 0.)
      CALL DRAWR( 0., -66.)
      CALL DRAWR( -14., 0.)
      CALL DRAWR( 0., 33.)
      CALL MOVER( 14., 0.)
      CALL DRAWR( 28., 33.)
      CALL DRAWR( 0., -66.)
      CALL DRAWR( -28., 33.)
      CALL MOVER( 28., 0.)
      CALL DRAWR( 42., 0.)
      CALL MOVER( 0., 0.)
      CALL MOVER( -5., 0.)
      CALL DRAWR( 5., 5.)
      CALL DRAWR( 5., -5.)
      CALL DRAWR( -5., -5.)
      CALL DRAWR( -5., 5.)
      CALL MOVER( 5., 0.)
```

Fig. 4. SYMBOLGEN converts the symbol into coordinates and PL/I procedures.

The equipment used is a 16K 4051 with 4952 Opt. 2 Joystick and Option 1 Data Communications interface. The 4051 communicates with the circuit simulation program through the IBM TSO system. The software is the "SYMBOLGEN" program written in 4050 Series BASIC; SYMBOLGEN appears in the new abstracts section of this issue.

The user selects a tape file to be used to hold graphics commands, then sketches his symbol using any combination of the implemented commands:

m	=	move
d	=	draw
t	=	terminal
a	=	arc
l	=	label
e	=	end

After a scaled down version of the symbol is displayed, the user is prompted for required textual data (procedure name, etc.). The output is a complete PL/I language program which, when called from a higher level procedure, will redraw the symbol at any selected location(s) on the screen.

Showing Some Advantages

Prior to the existence of the SYMBOLGEN program, graphic symbol generation was a purely manual process; it required a manual drawing of each symbol on graph paper, manual pick-off of coordinate points for each segment in a digitizing process, manual encoding of the PL/I symbol procedure (and redraw to debug the code, and finally, saving of the debugged symbol program. This process was very time-consuming.

The 4051-based SYMBOLGEN program has several advantages over the previous system. It is more efficient than hand generation: Using the 4051 with SYMBOLGEN, an average PL/I symbol procedure (about 150 lines) can be produced in 10 minutes by a non-programmer. This extrapolates out to an amazing 900 lines of PL/I code per hour.

In addition, the system is easy to use, since the user need only know the shape of the desired symbol and its associated textual data. And it's open ended, allowing the symbol set to be easily expanded to quickly meet changing requirements.

The graphics capabilities, the local intelligence, and the easy user interface of the 4051 Graphic System gave us the foundation upon which to develop a program to overcome a tedious and time consuming procedure.

TEKniques would like to thank Michael J. Donahue, Tektronix Sales Engineer at Chicago, for initially bringing this application to our attention. We'd also like to thank the Public Relations department at GTE/AE for their assistance in bringing this article to publication.

* Editor's Note

New Contest Rolling Along

Our new Applications Library contest is rolling along; entries will be accepted until the contest deadline of March 31, 1980. The theme is interfacing for data acquisition or instrument control, with awards to be made in three categories.

The categories are divided by interface.

Category I—Application using the General Purpose Interface Bus (GPIB)

Category II—Application using the Option 1 Data Communications Interface (RS-232)

Category III—Application using any other type of interface—commercially constructed or "home built".

Awards

Awards will be given to three places in each category. Each winner will have his/her choice of 4050 Series ROM Packs, PLOT 50 software, or Applications Library software, at catalog price, up to the award amount for his/her placing.

	Category I	Category II	Category III
1st Place	$750	$750	$750
2nd Place	500	500	500
3rd Place	375	375	375

All entrants will receive three programs in exchange for

theirs. This exchange, of course, is in addition to any award that might be received.

Complete rules can be found in the previous issue of TEKniques (Vol. 3 No. 7). Entry deadline is March 31, 1980.

So, clean-up those programs, complete the documentation, and send it in. If you need documentation guidelines or any of the forms, send us a note; our address is shown under **UNITED STATES** on page 16

New Members Wanted

Last issue we sent out some membership cards so that 4050 Series System users who are not already Applications Library members could join. Well we're still looking. In fact, we're always ready to hear from potential new members. Just pass the cards on to someone you think might be interested. (If you have no remaining cards, just drop us a note at the appropriate Applications Library office; addresses are located at the back of each issue.)

4052 and 4054 Users. . .

We'd like to feature some applications for the 4052 and 4054 Graphic Computing Systems in upcoming TEKniques issues. If you're using either of these new systems, we'd like to hear from you. We'll edit your article for you or help you write it, if you wish. Just drop us a note or give us a call; addresses are found at the back of each issue.

Programming Tip Exchange

Send in your programming tip. Anyone of the following 4051 Applications Library programs* will be yours when it's published. Simply jot down a brief description of the function, the code, and your choice of program. Mail it to the 4050 Series Applications Library serving you; Library addresses are listed at the back of each TEKniques issue.

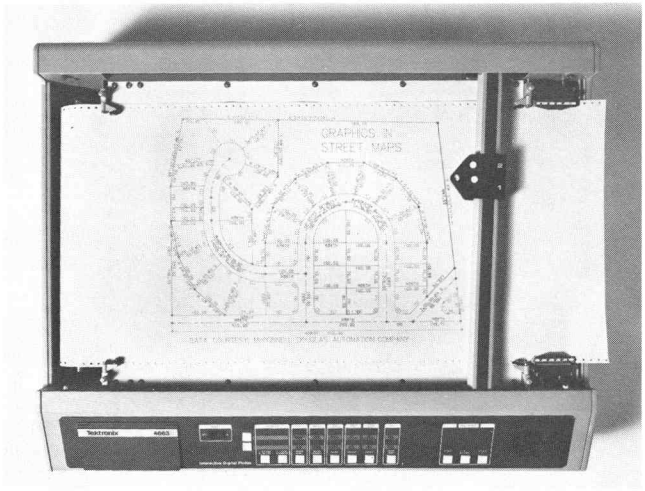
51/00-0101/0	51/00-5503/0
51/00-0702/0	51/00-7002/0
51/00-0715/0	51/00-8006/0
51/00-1401/0	51/00-9505/0
51/00-1402/0	51/00-9511/0
51/00-5401/0	51/00-9521/0

***Documentation and listing only.**

A Big Thank You!

As we come to the end of our third year of publishing TEKniques, we'd like to thank all of you who've contributed to the newsletter and to the Applications Library. Its your tips, programs, and articles that have made TEKniques the success it is. We'd also like to thank those of you who've written to us, both with complimentary and critical letters. We appreciate the interest, and your comments keep us on our toes. Again, thank you and **Happy Holidays from the whole TEKniques staff.**

Expanding Your Plotting Capabilities: Introducing the 4663



The TEKTRONIX 4663 Interactive C-size Digital Plotter is an intelligent, powerful companion to the 4050 Graphic Systems.

by Terry Davis
TEKniques Staff

Graphics are the heart of many applications for 4050 Series systems, graphics that show us complex data through an easy to grasp picture. Because graphics are so important, many systems today include a plotter to neatly record graphic output in a form that can be shared as well as saved. But the more pictures you plot, the more chances you get to bump into the boundaries of a small, local plotting device. Maybe you'd like a larger picture, or automated production of multiple plot copies, or two colors to highlight a graph. Now meet the 4663: an Interactive Digital Plotter that pushes back the boundaries of both size and usability in a local plotter.

The TEKTRONIX 4663 is a smart C-size plotter that represents an engineering first—the versatility of large plotters combined with the convenience and operating ease of a small plotter. The 4663 gives you a choice of plotting media; its electrostatic hold-down platen will accommodate any standard media size up to U.S. C-size (17 x 22″) or European A2-size (420 x 594 mm). Larger plotting needs can be accommodated: The plotter will hold media up to 21 x 28-1/2″ and draw plots up to 17.8 x 23.5″ using one pen only. For automated production of multiple plot copies, an optional programmable paper advance for roll stock is available. And, like the 4662, plotting can also be done on acetate film for preparing transparencies, and the like.

The media choice is complemented by an equally wide choice of pens; fiber tip pens, ball point pens, and wet ink pens are all available in a variety of colors. The 4663 features a dual-pen carriage with programmable pen selection for fast two-color plotting. And for each pen station, the operator can assign optimum pen pressure and pen velocity.

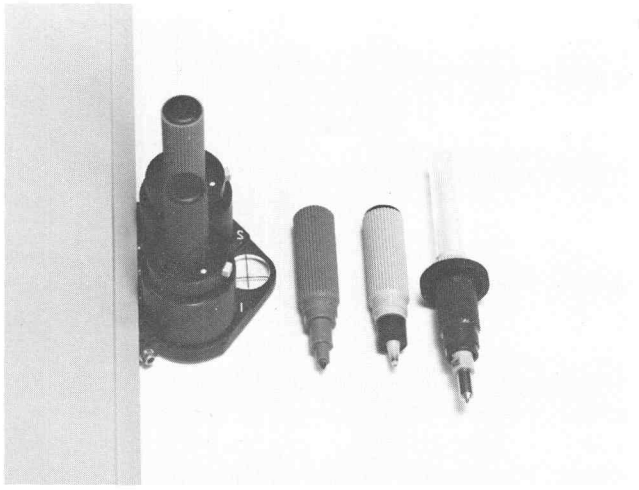
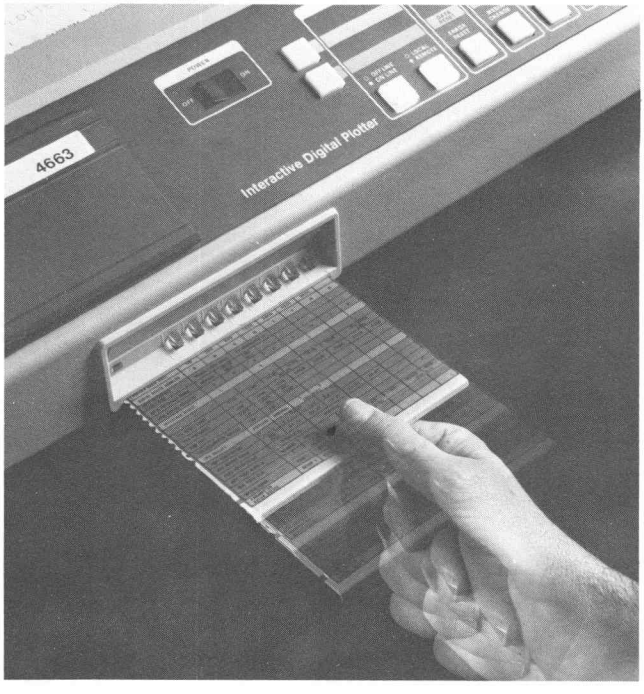


Fig. 1. The 4663 features a dual-pen carriage with programmable pen selection for fast two-color plotting.

Versatile but Simple

One design goal for the 4663 was increased flexibility—to provide a plotter that would be equally at home in diverse applications like printed circuit board layout, numerical control, mapping, drafting, report generation, and a host of others. But an equally important part of the design goal was that the versatility not bring a like increase in operating complexity. Ease of use is reflected in the plotter's simplified control panel, as well as in its unique parameter entry device (Fig. 2).



The parameter entry device replaces the profusion of switches, jumper straps, and other rear panel arrangements common to most plotters and similar peripheral equipment. About a dozen system parameters, and a like number of interface parameters, can be preset using the parameter entry card. As the card is moved in or out, one line at a time, the lighting of the eight LED-lit pushbuttons indicate the parameter status. All that's required to change a parameter is to press its associated pushbutton.

The selections are stored in the Parameter RAM, backed up by a battery to keep the memory alive. In the standard instrument, this RAM will retain one complete user-environment specification for at least 90 days, even if the plotter is turned off for the entire time. An option is available to add additional Parameter RAM, to store up to four user-environment specifications; a single keystroke will recall any one of the four and place the 4663 in the selected operating mode. This is very useful when changing from one computing system to another, as in changing from the 4050 Series to a host mainframe computer.

Easy Front Panel

The front panel controls provide manual selection of a variety of commands, in addition to the selections available through the parameter entry device. Eight major control groups, in conjunction with two color-coded shift keys, allow control of over twenty functions from an uncluttered, easy-to-understand front panel (see Fig. 3). The "PLOT CONTROL" group, for instance, enables a pause in plotting with continued data buffering, a solid outline of the viewport, or tic marks indicating viewport corners.

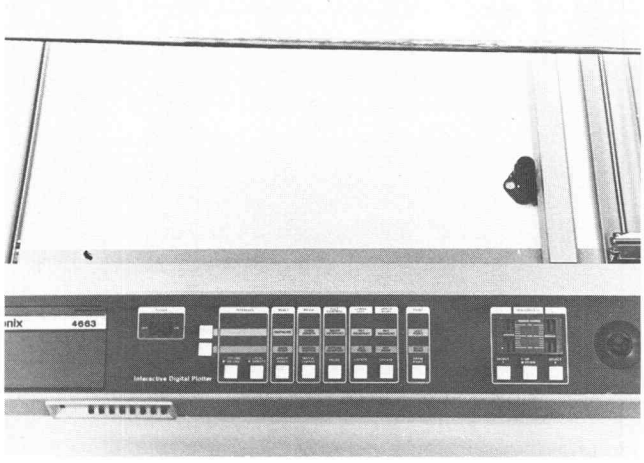


Fig. 3. The front panel controls over 20 functions.

The control provided by the front panel and the parameter entry device afford great flexibility in how the plotter is to be used. But few, if any, selections are required to "get a plot". They simply provide convenient local control over plot production without the bother of

program changes. For instance, graphics that have just been previewed at high speed on the display screen can be replotted as a C-size drawing, at maximum speed, using a ball-point pen and the fast coarse alpha characters. The same graphics can then be plotted again as an A-size drawing (in vertical format, as for a notebook) using wet ink pens and enhanced (high-precision) alpha characters. Both plots can be drawn without making changes to the source program.

Local configuration capability is ideal for applications where the plotter is used for output involving several media and pen types, several different presentations (standard drawings, text illustrations, overheads), or several different hosts or local storage devices. The 4663 is one plotter that's smart enough to provide the desired output under this wide range of conditions.

In many instances it's desirable to use only a portion of the page for plotting; this is accomplished through the SET VIEWPORT function. A special, often-used viewport (such as a mailing label) can be saved as a "user-defined" page via the parameter entry card. The viewport can also be set by the host computer via the VIEWPORT command.

The front-panel PAGE function can be used to locally calibrate the plotter to the absolute media dimensions, which will exhibit minute size variations as a function of humidity and printing variations. Other front-panel controls let you operate the plotter on- or off-line and in a local or remote mode.

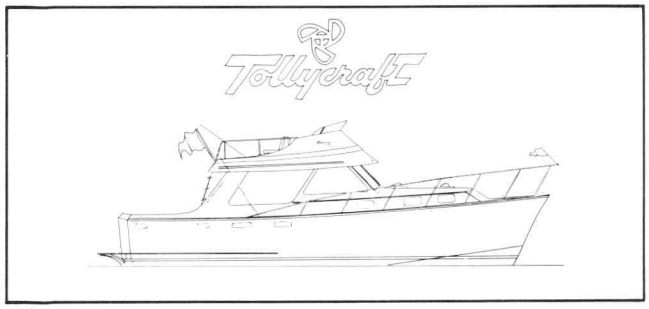
Versatility in Graphics

A comprehensive set of graphic plot commands allows a choice of dimensional coordinate units, the type of line to be drawn (solid, dashed, etc.), the coordinate type (absolute or relative), and the choice of which pen will be drawing.

The choice of dimensional coordinate units (graphic units) includes World Units and Device Units. (World Units are the units defined by the current window.) When Device Units are chosen you have a further selection of Addressable Device Units (ADUs), Graphic Device Units (GDUs), or millimeters.

ADUs provide device-dependent device addressing, with a numeric addressable range of from 0 to 4096 on the longest axis of the viewport. The range of the shortest axis is determined by the current aspect ratio.

GDUs are the standard unit for the 4050 Series; they provide device-independent addressing with a numeric addressable range of from 0 to 100 on the shortest axis of the viewport. Using GDUs ensures that any graphics containing only coordinates between 0 and 100 will be plotted without clipping, no matter what the current aspect ratio is. For millimeters, the numeric range is the actual axis length in millimeters. These units give a plot of the same physical size, regardless of the current viewport size.

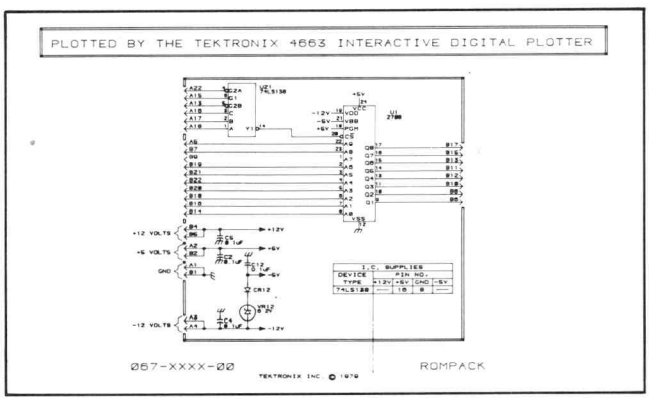


A circular interpolation option is also available to further enhance the graphics. This permits drawing circles or arcs with a single command. For circles, you need only to specify the radius, and the circle is drawn around the current pen location. Arcs are defined by specifying two points on the arc, which begins from its current pen location. You can choose the smoothness of the arc or circle, to meet the need for a quick overview or a high resolution finished plot.

Versatility in Alphanumerics

Graphics versatility in the 4663 is complemented by equal versatility in alphanumerics. Included are a self-contained character generator, provision for up to 15 character fonts (nine of which are resident in the 4663), and a host of commands that operate on the alphanumerics. One font can be designated as the standard font, and another as the alternate. The characters can be rotated, scaled up or down, or slanted, independent of the graphics and all under program control.

There are commands to set the character size and spacing, if you desire settings other than the default. You can also print centered characters, for applications such as identifying a line on a graph. And the pen can be moved specified X and Y distances in fractions of the current character size, to facilitate drawing superscripts and subscripts.



Sometimes you want to draw alphanumerics in a paragraph format. A Set Margin Separation command activates the right margin and allows you to set the number of character spaces that separates the left and right alpha margins. Carriage Return and Line Feed functions will be automatically performed to draw a string of alphanumeric characters within the margins established.

The alphanumerics capability is enhanced with options that allow down-loadable character sets, programmable macros, and circular interpolation.

Digitizing Capabilities

The 4663 can also be used to digitize a plot and transmit the data to a host or to the 4050 Series System. The joystick, the crosshair on the pen carriage, and the front-panel POINT switches, which allow the point to be designated as a DRAW, MOVE, or LAST point, are used in this function. Digitizing in one axis only is greatly simplified by using the Joystick Axis Disable command. This command allows you disable either the X or Y axis, or both.

That's quite a set of capabilities for a local plotter. And whether you consider these performance capabilities (and the technological advances behind them), or the simplified user interface, you'll see that the 4663 expands the horizons of local plotting abilities. Its capabilities make it an ideal recording companion for a 4050 Series Graphic Computing System, for even the most complex of plotting needs. And, any programs that will drive the 4662 will drive the 4663—just plug the plotter in and it goes. If you'd like to know more about the 4663, just ask your local Tektronix Sales Engineer.

Options

4663	INTERACTIVE DIGITIAL PLOTTER STD is RS232
OPT 1	GPIB
OPT 4	GPIB ONLY
OPT 31	CIRCULAR INTERPOLATION & PROGRAMMABLE MACROS
OPT 32	MATH CHARACTER SET & DOWN LOADABLE CHARACTERS
OPT 36	PAPER ADVANCE
OPT 37	ADDED DEFAULT PARAMETERS

Programming Tips

Minimizing Data Transfer Time to 4907

by Jim Gish
Tektronix, Inc.
Irvine, CA

This article explores the interaction between a 4050 Series Graphic System and the 4907 File Manager, during data transfer. The 4907 is a mass storage unit, often used to store large amounts of numeric data. How this data is passed to the 4907 dictates how long the transfer takes, and must be considered by the applications programmer. The following study was made to determine the array sizes that make the most effective use of the 4907. The results provide the necessary information to evaluate compromises between increased program speed and larger array sizes.

The Study

Consider a program which writes 3000 numbers to the 4907. Although there are many ways to implement this, here we concentrate only on two variables: the number of values passed to the disc in each write, called the block size or record length, and the prior history of the disc file receiving the 3000 values. The block size subsequently determines the number of random access records in each file; more specifically, the product of the number of random access records multiplied by the block size will always yield the total number of values—3000 in our example. Since each record requires one write, the block size also determines the number of disc writes per file. The file history was split into two types. The first type was a newly created file; the second type was a file that previously existed on the disc, referred to here as a "conditioned" file. All files in the study were binary random files.

The same series of 20 tests were performed first on a 4051, then on a 4052. The 20 tests passed 3000 numeric values to the 4907 in a FOR/NEXT loop, with each test using different combinations of block sizes and, consequently, disc writes. Each test was executed twice, first on a new file and next on a conditioned file. The clock in the 4907 timed each test.

```
100 INIT
110 I0=-100
120 DIM A(30),A$(18),B$(18),L$(2)
130 DATA 1,2,3,4,5,6,8,10,12,15,20,25,30,40,50,60,75,100,120
140 DATA 150,200,250,300,375,500,600,750,1000,1500,3000
150 READ A
160 FOR I=1 TO 30
170 IF A(I)<I0+10 THEN 400
180 I0=A(I)
190 Z=0
200 N=A(31-I)
210 M=A(I)
220 KILL "TESTQ"
230 CREATE "TESTQ";M+0,N*10
240 DELETE B
250 Z0=MEMORY
260 DIM B(N)
270 B=999999.9999
280 Z=Z+1
290 OPEN "TESTQ";1,"F",A$
300 CALL "TIME",A$
310 FOR J=1 TO M
320 WRITE #1,J:B
330 NEXT J
340 CLOSE
350 CALL "TIME",B$
360 GOSUB 420
370 PRINT @51:USING "3X,7D,7D,7D.2D":M,N,H
380 IF Z<2 THEN 280
390 PRINT @51:"↓"
400 NEXT I
410 END
420 X0=0
430 H=0
440 X0=X0+1
450 L$=SEG(A$,17,2)
460 R=VAL(L$)
470 L$=SEG(A$,14,2)
480 R=VAL(L$)*60+R
490 L$=SEG(A$,11,2)
500 R=VAL(L$)*3600+R
510 H=R-H
520 A$=B$
530 IF X0=1 THEN 440
540 RETURN
```

The Results

Figures I and II show the results for the 4051 and 4052 respectively. Log-log axes uniformly distribute values on the X-axis. The X-axis graphs the number of writes used to transfer the 3000 values; the Y-axis graphs the time, in seconds, for the entire transfer.

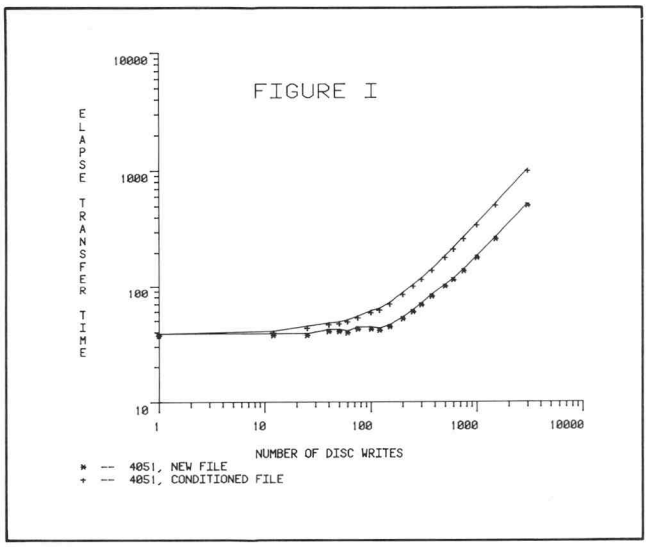


Fig. 1. The graph portrays the number of writes versus the time to transfer 3000 data values from a 4051 to a 4907.

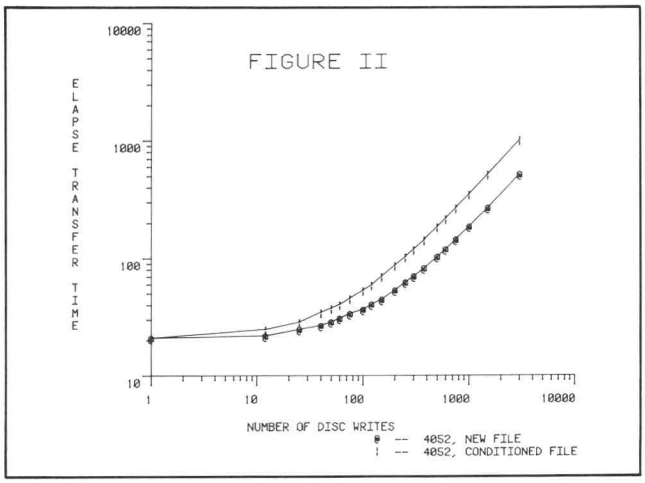


Fig. 2. The graph portrays the number of writes versus the time to transfer 3000 data values from a 4052 to a 4907.

The curves in Figure 1 and 2 are very similar: when all 3000 values are transferred in one large block, the elapsed time is the least; as the number of writes increases, the transfer time increases rapidly. Note the vast difference (10-40 times) in transfer speed between one write and 3000 writes. At the other extreme, these illutrations show a large difference (factor of 2) between writing into a new file (bottom curve) as opposed to writing into a conditioned file (top curve). Two conclusions may be reached:

1. An application program can save a great deal of time if all reads and writes to the disc are done in large blocks of data.
2. When you are recreating a file, it may be much faster to KILL and CREATE the file instead of reusing the old file; however, as the number of writes dimishes, so does the time difference between using new and conditioned files.

Figure 3 shows all four curves on the same graph. For large block sizes, the 4052 approaches a twofold speed increase over the 4051; as the block size dimishes, this speed difference disappears. For block sizes of 20 values or less the speed advantage is gone.

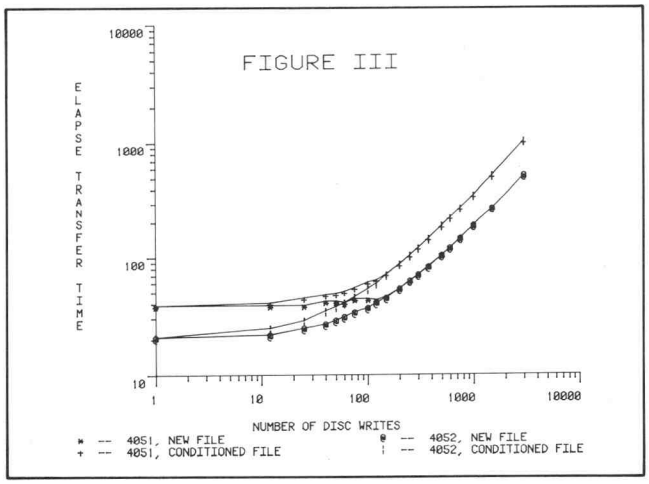


Fig. 3. Composite of Figures 1 and 2 compares 4051/4907 writes vs. time to 4052/4907 writes vs. time.

Conclusion

When using the 4907, performing reads and writes in blocks as large as possible, is the major factor that minimizes I/O time. To accomplish this, programs can be written to use the remaining 405X memory as an I/O buffer. These programs are often called "paging" techniques, and will be covered in a subsequent issue of TEKniques.

The second major speed increase can be gained by deleting and then recreating a file if it will be regenerated in its entirety. The illustrations show that writing to a new file is always at least as fast as, or faster than, writing to a conditioned file. Implementing this technique usually takes very minor changes to existing programs.

The following table summarizes the test data.

TABLE I

Tabular summary of transferring 3000 numeric values

#DISC * WRITES	4051 NEW FILE	4051 CONDITIONED FILE	4052 NEW FILE	4052 CONDITIONED FILE
1	39 sec	39 sec	21 sec	21 sec
12	39 "	41 "	22 "	25 "
25	39 "	45 "	25 "	29 "
40	42 "	48 "	27 "	35 "
50	42 "	49 "	29 "	38 "
60	41 "	51 "	31 "	41 "
75	44 "	55 "	34 "	46 "
100	44 "	61 "	37 "	54 "
120	43 "	64 "	41 "	60 "
150	46 "	72 "	45 "	71 "
200	54 "	87 "	54 "	88 "
250	62 "	104 "	63 "	104 "
300	71 "	121 "	71 "	121 "
375	84 "	146 "	83 "	145 "
500	104 "	187 "	104 "	188 "
600	120 "	221 "	121 "	221 "
750	145 "	271 "	146 "	271 "
1000	187 "	354 "	188 "	354 "
1500	271 "	521 "	271 "	522 "
3000	521 "	1021"	521 "	1021"

*The number of disc writes and the block size are inversely related.

1/A/20

Easy Curves Revisited

by P. K. Wong
Department of Mathematics
Michigan State University
East Lansing, MI

In reference to the "Easy Curves" programming tip in the June 15, 1979, issue of TEKniques, the following examples illustrate some difficulties:

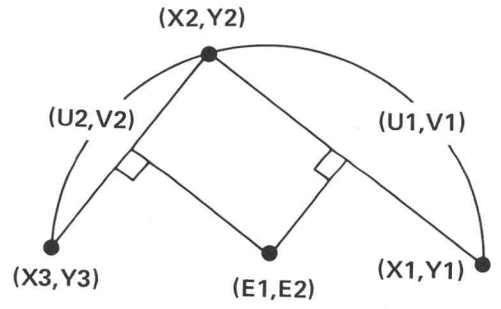
	(X1,Y1)	(X2,Y2)	(X3,Y3)	Problem
1.	(70,50)	(60,60)	(50,50)	SIZE ERROR ON LINE 450
2.	(50,50)	(60,60)	(50,70)	size error on line 720
3.	(50,50)	(60,50)	(70,50)	SIZE ERROR ON LINE 450
4.	(50,50)	(50,60)	(50,70)	SIZE ERROR ON LINE 520
5.	(50,50)	(60,59.9)	(70,70)	Wrong angular sweep

The size errors arise mainly due to division by zero in the lines indicated. A conceptually more direct way of finding the center and radius of the arc is to locate the intersection point of the perpendicular bisectors of the two cords joining the three given points. The listing for such a routine follows.

```
290 REM *** FIND MIDPOINT OF CORDS
300 U1=0.5*(X1+X2)
310 V1=0.5*(Y1+Y2)
320 U2=0.5*(X2+X3)
330 V2=0.5*(Y2+Y3)
340 REM *** M1 & M2 ARE SLOPES OF PER. BISECTORS OF CORDS
350 IF Y1=Y2 THEN 440
360 M1=(X2-X1)/(Y1-Y2)
370 IF Y2=Y3 THEN 490
380 M2=(X3-X2)/(Y2-Y3)
390 IF M1=M2 THEN 1030
400 REM *** LOCATE CENTER (E1,E2) OF ARC
410 E1=(V2-V1+M1*U1-M2*U2)/(M1-M2)
420 E2=M2*(E1-U2)+V2
430 GO TO 520
440 E1=U1
450 IF Y2=Y3 THEN 1540
460 M2=(X1-X2)/(Y2-Y1)
470 E2=M2*(E1-U2)+V2
480 GO TO 520
490 E1=U2
500 E2=M1*(E1-U1)+V1
510 REM *** FIND RADIUS
520 R=SQR((E1-X1)*(E1-X1)+(E2-Y1)*(E2-Y1))
530 REM

1030 PRINT "THE THREE POINTS ARE COLINEAR."
```

I have not tried to make all the necessary changes in the Easy Curves program. However, this routine will produce the correct center and radius without using sines and cosines.



One File Sort on the 4907

by Chuck Eng
Tektronix, Inc.
Beaverton, OR

The following routine* sorts string data on the 4907 disc into ascending order. Because it doesn't require that all data to be sorted reside in memory, you can sort a random file containing any number of records of any length. Furthermore, only three variables need to be defined before a file can be sorted: the number of records in the file plus 1 (R in statement 120), their length (F in statement 110) and the name of your data file (statement 140). When you are finished sorting, the sorted records remain in the original file.

```
100 REM START SORT
110 F=36
120 R=698
130 DIM A$(F),B$(F),C$(F),D$(F),E$(F),F$(F)
140 OPEN "SORTDATA";1,"F",A$
150 PRINT "LSORTING!"
160 PRINT "JJPLEASE WAIT"
170 REM
180 REM                 ******START OF ONE FILE SORT******
190 DELETE B3
200 DIM B3(24)
210 IF R<=1 THEN 810
220 B4=0
230 B1=1
240 B2=R-1
250 IF B2<=B1 THEN 760
260 A5=0
270 IF B2-B1<1 THEN 710
280 IF B2-B1>1 THEN 360
290 READ #1,B1:C$
300 READ #1,B2:D$
310 IF C$<=D$ THEN 710
320 A$=C$
330 WRITE #1,B1:D$
340 WRITE #1,B2:A$
350 GO TO 710
360 A5=1
370 B5=INT(0.5*(B1+B2))
380 READ #1,B5:E$
390 B$=E$
400 READ #1,B1:C$
410 WRITE #1,B5:C$
420 B6=B2
430 A4=B1
440 A4=A4+1
450 IF A4>B6 THEN 600
460 READ #1,A4:G$
470 IF G$<=B$ THEN 440
480 IF B6<A4 THEN 600
490 READ #1,B6:F$
500 IF F$<B$ THEN 530
510 B6=B6-1
520 GO TO 480
530 READ #1,A4:G$
540 A$=G$
550 READ #1,B6:F$
560 WRITE #1,A4:F$
570 WRITE #1,B6:A$
580 B6=B6-1
590 GO TO 440
600 READ #1,B6:F$
610 WRITE #1,B1:F$
620 WRITE #1,B6:B$
630 IF B6+B6<=B1+B2 THEN 680
640 B7=B1
650 B8=B6-1
660 B1=B6+1
670 GO TO 710
680 B7=B6+1
690 B8=B2
700 B2=B6-1
710 IF A5<=0 THEN 760
720 B4=B4+2
730 B3(B4-1)=B7
740 B3(B4)=B8
750 GO TO 250
760 IF B4<=0 THEN 810
770 B1=B3(B4-1)
780 B2=B3(B4)
790 B4=B4-2
800 GO TO 250
810 END
820 REM                 ******END OF ONE FILE SORT******
```

The sorting of 697 records consisting of 36 characters each took 6 minutes 24 seconds on a 4051/4907 system.

**The routine is adapted from the "Quicker Sort" subroutine, contained in the TEKTRONIX PLOT 50 General Utility Programs Volume 1, which sorts a linear array of numeric data.*

Use 4052/4054 to Recover Damaged Tapes

By Ed Mitchell

A feature of the new 4050 Graphic Systems product line allows you to partially recover accidentally marked tapes* or tapes with bad spots. This feature, CALL "HEADER", locates the next good file after the "LAST" file or a damaged spot.

How it Works

Insert the tape you are recovering. First, do a TLIST to find the file number of your last legible file, then FIND this last file. Now eject the tape and manually move the tape forward a few inches and re-insert it into the tape drive. Since the 4052 or 4054 doesn't automatically rewind your tape to file 0, you can locate the tape position by typing in CALL "HEADER". The system will search for the next header and will print out its description: file number, type, etc. You can now back the tape FINDing the files in decreasing sequence until you locate the first good file after the damaged spot. Access the files normally (OLD or CALL "BOLD") and transfer the program(s) to another tape.

**When you mark over an existing file, at least eight 256 byte records will be lost to each new file and four 256 byte records for the new LAST file. Add these to the length of your newly marked file(s) and you'll have some idea of what's gone.*

Truncation and 4050 INT Function

by Phil Somerset
Tektronix, Inc.
Rockville, MD

The INT function on the 4050 Series does not simply truncate numbers at the decimal point, but rather produces the largest integer less than or equal to that number. For example, INT(1.1) is, in fact, 1; but INT(-1.1) returns -2!

If your application requires that numbers, whether positive or negative, be truncated at the decimal point, then define and use the following function:

```
DEF FNT(X)=SGN(X)*INT(ABS(X))
```

4050 Series Applications Library Program Abstracts

Order

Documentation and program listings of each program are available for a nominal charge. Programs will be put on tape or disc for a small recording fee per program plus the charge for the tape cartridge or flexible disc. One tape/disc will hold several programs. Programs will be recorded on like media only, i.e., programs on tape cannot be sent on disc and vice versa unless so noted in the abstract.

(The program material contained herein is supplied without warranty or representation of any kind. Tektronix, Inc. assumes no responsibility and shall have no liability, consequential or otherwise, of any kind arising from the use of this program material or any part thereof.)

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Documentation and listings	*$ 20 per program*
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Contribute one program to the Library and receive three in exchange. Send in the membership card from your 4050 Series Graphic System Reference Manual to get the details. Or call us (503) 682-3411, ext. 2618.

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Please use the Applications Library Order Form. Order forms are included in the Membership Packet and are available from your local Tektronix Sales Engineer.

Outside U.S.

Program contributions or orders outside the U.S. must be processed through the local Tektronix sales office or sent to one of the Libraries serving your area. See Library Addresses section.

ABSTRACT NUMBER: 51/00-9536/0

Title: **SYMBOLGEN**
Author: E.J. Moran
GTE AE Laboratories
Northlake, IL
Memory Requirement: 16K
Peripherals: 4952 Option 2 Joystick
Option 1 Data Communications Interface
Statements: 359
Files: 1 (Requires additional data file)

SYMBOLGEN converts symbols "digitized" on the 4051 graphic screen to x,y coordinates, encodes these coordinates in TEKTRONIX PLOT 10 graphic language "calls," and affixes a preamble to the calls. This forms a complete PL/I procedure which is sent to the IBM 370 (303X) host over the 4051 Option 1 Data Communications Interface. The program is now ready to be called by a PL/I main procedure for drawing and for digitizing drawings made up of the sketched symbols.

How it works on the 4051: SYMBOLGEN displays a 10 x 10 grid (100 points) on the 4051 graphic screen. Using the 4952 Option 2 Joystick and a menu of commands, the designer sketches the symbol on the screen. When the sketch is completed, the user is prompted for the textual information to define the procedure name, and for any other appropriate data which may be fixed when the program is called to draw the symbol.

Menu of commands:

m: Move to the pointed-to location from the last pointed-to location without drawing a line.

d: Draw to the pointed-to location from the last pointed-to location.

```
 SYMBOLS.PLI(TRANSIS)
00010  TRANSIS :PROC (X_START,Y_START);
00020  DCL TSEND ENTRY EXTERNAL OPTIONS(FORTRAN);
00030  DCL DRAWR ENTRY(FLOAT DEC(6),FLOAT DEC(6)) OPTIONS(FORTRAN);
00040  DCL MOVER ENTRY(FLOAT DEC(6),FLOAT DEC(6)) OPTIONS(FORTRAN);
00050  DCL REL2AB ENTRY(FLOAT DEC(6),FLOAT DEC(6),FLOAT DEC(6),
00060  FLOAT DEC(6)) OPTIONS(FORTRAN);
00070  DCL MOVEA ENTRY(FLOAT DEC(6),FLOAT DEC(6)) OPTIONS(FORTRAN);
00080  DCL 1 TEXTDATA,
00090       2 SYMBOL ENTRY,
00100       2 GENERIC_NAME CHAR(8),
00110       2 LABEL,
00120         3 IDENTIFIER CHAR(8),
00130         3 COORDINATES,
00140           4 X FLOAT DEC(6),
00150           4 Y FLOAT DEC(6);
00160  DCL TRUNC BUILTIN;
00170  DCL (X9,Y9) FLOAT DEC(6);
00180  DCL SET_VALUES BIT(1);
00190  DCL (IX,IY) FIXED BIN(31);
00200  DCL(X_START,Y_START,X_CTR,Y_CTR,BASE) FLOAT DEC(6);
00210  DCL NULL BUILTIN;
00220  /* DRAW ONLY */
00230  CALL MOVEA(X_START,Y_START);
00240  TEXTDATA.GENERIC_NAME='TRANSIST';
00250  TEXTDATA.SYMBOL=TRANSIS;
00260  TEXTDATA.LABEL.IDENTIFIER=' ';
00270       CALL MOVER( 0., 55.);
00280       CALL MOVER( -5., 0.);
00290       CALL DRAWR( 5., 5.);
00300       CALL DRAWR( 5., -5.);
00310       CALL DRAWR( -5., -5.);
00320       CALL DRAWR( -5., 5.);
00330       CALL MOVER( 5., 0.);
00340       CALL DRAWR( 56., 0.);
00350       CALL DRAWR( 0., 33.);
00360       CALL DRAWR( 14., 0.);
00370       CALL DRAWR( 0., -66.);
00380       CALL DRAWR( -14., 0.);
00390       CALL DRAWR( 0., 33.);
00400       CALL MOVER( 14., 11.);
00410       CALL DRAWR( 42., 22.);
00420       CALL DRAWR( 0., 22.);
00430       CALL MOVER( 0., 0.);
00440       CALL MOVER( -5., 0.);
00450       CALL DRAWR( 5., 5.);
00460       CALL DRAWR( 5., -5.);
00470       CALL DRAWR( -5., -5.);
00480       CALL DRAWR( -5., 5.);
00490       CALL MOVER( 5., 0.);
00500       CALL MOVER( -42., -66.);
00510       CALL DRAWR( 42., -22.);
00520       CALL DRAWR( 0., 11.);
00530       CALL DRAWR( -14., -11.);
00540       CALL DRAWR( 14., 0.);
00550       CALL DRAWR( 0., -22.);
00560       CALL MOVER( 0., 0.);
00570       CALL MOVER( -5., 0.);
00580       CALL DRAWR( 5., 5.);
00590       CALL DRAWR( 5., -5.);
00600       CALL DRAWR( -5., -5.);
00610       CALL DRAWR( -5., 5.);
00620       CALL MOVER( 5., 0.);
00630  CALL TSEND;
00640  END TRANSIS;
READY
```

t: Draw a "terminal" (small diamond) around the pointed-to location.

a: Draw an arc of specified segment lengths (in degrees) and radius, starting at the pointed-to location from a given angle to a second given angle.

l: Locate the coordinates of a "label" at the pointed-to location and enter a single character prefix for the label.

e: End the sketch; fetch the required procedure textual data and send the PL/I program to the host computer.

Applications: SYMBOLGEN was used to generate a set of 24 symbol routines for graphic symbols used in constructing an analog electronic circuit schematic drawing. SYMBOLGEN was also used to generate block letters for title pages of some applications programs in PL/I. With revision, the program can be made to produce FORTRAN or other language symbol drawing routines.

ABSTRACT NUMBER: 51/07-3302/0

Title: **Telephone Cable Layout**
Author: Len Olson
Tektronix, Inc.
Rockville Field Office
Memory Requirement: 32K 4051 or 4052 or 4054
Peripherals: 4907 File Manager
4956 Graphic Tablet
4663 Plotter
4641 Printer
Optional—4631 Hard Copy
Files: 41
Statements: 4500

Available on Disc Only

A unique package allows the user to 1) draft telephone cable staking sheets, and 2) inventory parts for the resulting cable network.

The staking sheets are composed and edited by adding or deleting discrete elements rather than inserting or deleting moves and draws within the plot. A Baisc Road Library and Symbol Library constructed by the user provide a reservoir of standard road segments and constant symbols. Meter location details, variable symbols, cable layout and annotations complete the staking sheet elements.

The graphic input may come from the 4956 Tablet or the 4663 Plotter. Graphic output may be sent to the 4050 Series graphic screen or 4663 Plotter. The user may choose one of four colors for each element. The parts inventory list is sent to the 4641 Printer.

Four programs help the user do the job. The **Digitizer Program** initiates the 4956 Tablet and helps the user construct the Basic Road Library and Symbol Library. The Basic Road Library is a collection of basic roads digitized in centerline format (alternating arcs using three points) and straight line segments. The program calculates the curb lines and rights-of-way lines which are stored along with the road sections in the Library. The Symbol Library contains digitized and named relocatable symbols or subpictures. They are stored as sequences of relative moves and draws. The basic road segments or symbols may be deleted as well as added to their respective libraries.

Once the two Libraries are set up, through 48 commands the user interacts with the **Edit Program** to compose, edit and display staking sheets. The user chooses a basic road section and locates it on the plotter/screen. The program will prompt for meter-location information.

side roads

meter location of intersection of center lines
intersection angle
whether road is above only, below only, or both

symbols

meter location
"Y" location
symbol name
angle w.r.t. center line

pedestals

meter location
pedestal symbol type
location relative to right-of-way lines

variable symbols

start and end (fences, etc.)

These four types of entries may be deleted or moved during this phase.

The compass symbol with orientation is displayed, and curb lines for side roads are drawn. Editing may be done at this point.

Cable layout and nonsymmetric landmarks such as rivers are digitized from the 4956. When annotation is keyed in, the information is complete. A final editing may be done and the plot completed on the 4663 along with the title block. Partially completed staking sheets may be edited also.

Each job has a Master Parts List and a Master Cable List. The Information Entry Program allows the user to add part names, cable type, and construction units. Information for individual staking sheets such as Designation Standards, Meter Reading of Pedestals, and construction units and lengths of cables may be input also.

The Summary Report Program generates a report of the part names and quantities, the cable types and lengths, for all sheet numbers or a given sheet number of a given job. Output may be to the graphic screen or the 4641 Printer.

4050 Series Graphic System Publications

The following table contains a summary of all current manuals related to the 4050 series Graphic Systems. The correct nomenclature, latest published date, and Tektronix part numbers are included. This list contains all manuals published up to December, 1979.

Contact your local Tektronix office for prices, availability, and to order any of these publications.

4050 SERIES and RELATED PERIPHERAL MANUALS

Manual	Publication Date	Part No.
STANDARD		
4050 Series Graphic Computing System Operator's	JUN 79	070-1940-01
4050 Series Graphic System Reference	JUN 79	070-2056-01
Reference Guide to 4050 Series BASIC	SEP 79	070-2142-01
PLOT 50: Introduction to Programming in BASIC	JUL 79	070-2058-01
PLOT 50: Introduction to Graphic Programming in BASIC	JUL 79	070-2059-01
OPTIONS		
4054 Option 30 Dynamic Graphic Operators	OCT 79	070-2289-00
4054 Option 30 Dynamic Graphics Reference	SEP 79	070-2586-00
4052 F02 Four Slot ROM Backpack Instruction Sheet	AUG 79	070-2987-00
SERVICE		
4051 Graphic System Service Vol. 1	OCT 79	070-2065-00
4051 Graphic System Service Vol 2	OCT 79	070-2286-01
#067-0746-00 System Test Fixture	JUN 77	070-2304-00
4052 Graphic System Parts and Schematics Service	AUG 79	070-2829-00
4054 Graphic System Parts and Schematics Service	JUL 79	070-2839-00
4052/4054 Graphic System Technical Data Service	SEP 79	070-2840-00
067-0962-00 4051 Service ROM Pack	AUG 79	070-2988-00
067-0969-00 Tape Head Alignment Module	OCT 79	061-2225-00
ROM PACK		
4051 R01 Matrix Functions	MAY 79	070-2127-00
4051 R06 Editor	FEB 77	070-2170-00
4051 R05 Binary Program Loader	AUG 79	070-2171-00
4051 E01 ROM Expander Instruction	DEC 76	070-2215-00
4050 Series R07 Signal Processing ROM Pack No. 1 Instruction	MAY 79	070-2557-00
4050 Series R08 Signal Processing ROM Pack No. 2 (FFT)	JUL 79	070-2841-00

4662 Interactive Digital Plotter User's Reference Card	MAR 78	070-2556-00
#067-0829-00 4662 Test Tape Operator's	JUN 79	070-2366-00
4662 Diagnostic Test Fixture Instruction	APR 78	070-2564-00
4907		
4907 File Manager Operator's	FEB 79	070-2380-01
4907 File Manager Operator's Pocket Reference Card	APR 79	070-2381-01
4907 File Manager Service	JAN 79	070-2405-00
4907 Installation Guide	APR 79	070-2493-00
119-0977-00 Flexible Disc Drive Installation	MAY 78	070-2504-00
4924		
4924 Digital Cartridge Tape Drive Operator's	JUL 79	070-2128-00
4924 Digital Cartridge Tape Drive Service	JUN 79	070-2131-00
4924 Reference Guide	MAR 77	070-2302-00
4952		
4952 Joystick Option 2	OCT 79	070-2098-00
4956		
4956 Graphics Tablet Operator's	OCT 79	070-2210-00
4956 Graphics Tablet Service	FEB 77	070-2211-00
7912		
7912AD Programmable Digitizer	AUG 78	070-2689-00

MODIFIED 4051 and RELATED MODIFIED PERIPHERAL MANUALS

Manual	Publication Date	Part No.
4051		
4051 (Option 1) Mod AA Half-Duplex BASIC I/O	JUN 78	061-1843-00
4051 Mod AB (with XYZ Output) Scan Converter I/F	APR 78	061-1807-00
4051 Mod SA Current Loop Backpack I/F	SEP 78	061-1842-00
PERIPHERAL		
(CM020-0198-00) 4051 Auto-Start ROM Pack	MAR 78	061-1147-00
(CM021-0211-01) 4051 General Purpose Output Interface	MAY 78	061-1803-00
(CM021-0212-01) 4051 General Purpose Input Interface	MAY 78	061-1804-00

INTERFACE

4051 Option 1 Data Communications Interface	DEC 79	070-2066-01
4050 Series Option 10 RS-232 Printer Interface	AUG 79	070-2908-00
4051 GPIB Hardware Support	MAR 77	070-2270-00
4051 GPIB Application Support	JAN 79	070-2307-00
4051 C01 Synchronous Communications Interface	AUG 79	070-2436-00
021-0206-00 P7001/IEEE Interface Instruction	JUL 78	070-2623-00

SOFTWARE

4050A01 PLOT 50 Statistics Vol. 1	JAN 79	070-2809-00
4050A02 PLOT 50 Statistics Vol. 2	NOV 79	070-2810-00
4050A03 PLOT 50 Statistics Vol. 3	JUN 79	062-1856-00
4050A04 PLOT 50 Mathematics Vol. 1	JAN 79	070-2776-00
4050A05 PLOT 50 Mathematics Vol. 2	OCT 79	070-2777-00
4050A06 PLOT 50 Electrical Engineering Vol. 1	DEC 75	062-2280-00
4050A07 PLOT 50 Graph Plot	NOV 79	070-2288-01
4050A08 PLOT 50 General Utilities Vol. 1	FEB 79	070-2287-01
4050A09 PLOT 50 Business Planning and Analysis	FEB 79	070-2226-01
4050A10 PLOT 50 Statistics Vol. 4	MAR 79	070-2214-00
4050A11 PLOT 50 Business Planning and Analysis Vol. 2	MAY 79	070-2290-00
4050A12 PLOT 50 Business and Analysis (Disc Version) User's	OCT 79	070-2888-00
4051B01 Modeling and Reporting User's	APR 78	070-2544-00
4051B01 Modeling and Reporting Opt 5 Flexible Disc User's	SEP 78	070-2673-00

PERIPHERAL

4631

4631 Hard Copy Unit User's	SEP 79	070-1830-01
4731 Hard Copy Unit Service	NOV 79	070-1831-01

4641

4641/4641-1 Character Printer Operator's	SEP 79	070-2110-00
4641/4641-1 Printer Service	NOV 76	070-2111-00

4642

4642/4642-1 Printer Operator's	SEP 79	070-2486-01
4642/4642-1 Printer Service	JAN 79	070-2489-00

4662

4662 Interactive Digital Plotter User's	MAY 79	070-1932-01
4662 Interactive Digital Plotter Service	AUG 79	070-1933-00

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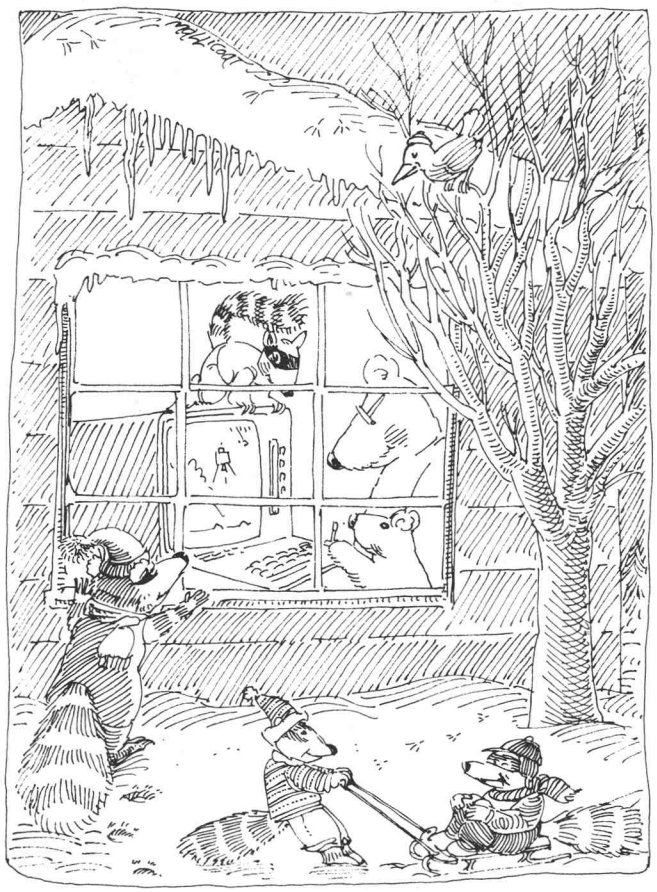

4050 Series Applications Libraries

Africa, Europe, Middle East

Contact local sales office

Australia

4050 Series Applications Library
Tektronix
Australia Pty. Limited
Sydney
80 Waterloo Road
North Ryde, N.S.W. 2113

Canada

4050 Series Applications Library
Tektronix Canada Ltd.
P.O. Box 6500
Barrie, Ontario
Canada L4M 4V3

Caribbean, Latin America and Far East (excl. Japan)

IDD Group
Export Marketing
Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077
U.S.A.

Japan

4050 Series Applications Library
Sony/Tektronix Corporation
9-31 Kitashinagawa-5
Tokyo 141 Japan

United States

4050 Series Applications Library
Tektronix, Inc.
Group 451
P.O. Box 500
Beaverton, Oregon 97077