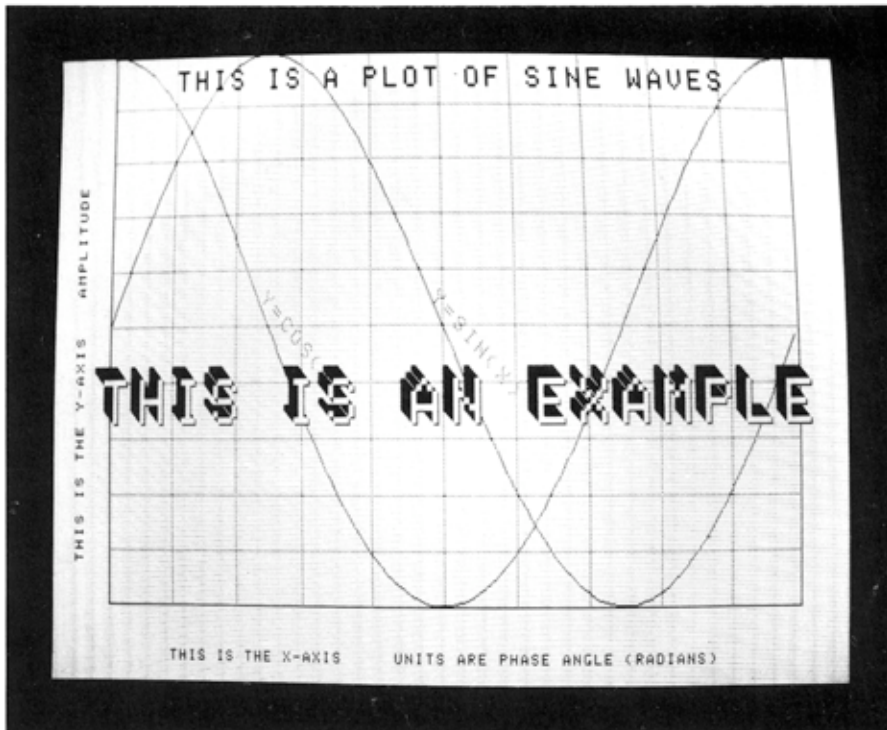
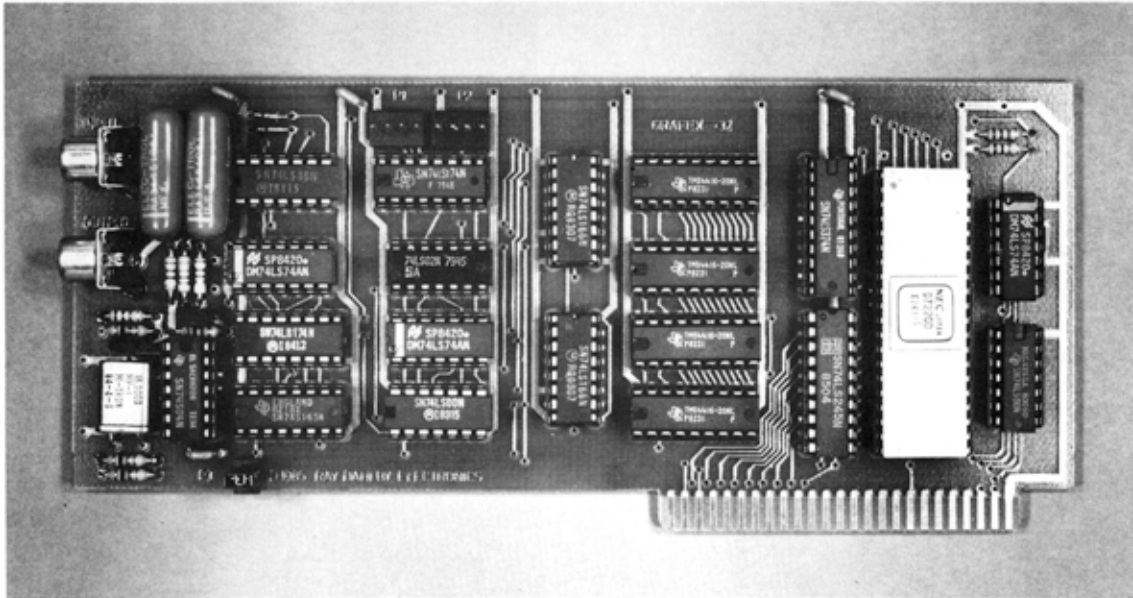


GRAFEX

THE 640 X 400 DISPLAY ADAPTER FOR THE APPLE II



RAY DAHLBY ELECTRONICS

GRAFEX

High Resolution Display Card for the Apple II

The GRAFEX card provides many different levels of graphics display expansion for Apple II and IIe computers. In its basic 32K configuration, a single GRAFEX card displays 640 horizontal pixels by 400 vertical pixels on a standard monochrome monitor. The display memory is contained on the GRAFEX card and a VLSI graphics processor draws characters, geometric figures, and vectors at a sustained rate of 500,000 pixels per second. This baseline level of performance exceeds that of the Apple Macintosh in both display resolution and drawing speed.

Unlike the Apple Macintosh, the GRAFEX system was designed with upgrade in mind.

Replacing four 64K RAM chips with 256K parts brings the addressable resolution of a single GRAFEX card to 640 by 1600 pixels. This upgrade provides enough on-board memory for four pages of graphics and the 640 by 400 display window can be smoothly scrolled through a 640 by 1600 "world".

Adding additional GRAFEX cards to the computer system allows 16 color RGB and 16 grey-level monochrome displays. Two GRAFEX cards will display 4 colors, three will display 8 and four will display 16 simultaneous colors or intensity levels per pixel.

A fast-scan kit generates non-interlaced 24.75 KHZ or 31.5 KHZ video for an absolutely flicker-free display on fast-scan RGB or monochrome monitors. This upgrade increases the VLSI graphics controller speed to 1,000,000 pixels per second.

From a basic 32K single-card GRAFEX system which trumps an Apple Macintosh, to a four-card, 512K, 1 million pixel/second RGB display system rivaling CAD/CAM workstations, GRAFEX should find a slot (or two) in your system.

Included with the GRAFEX card is an expansion cable (to hook up to your next GRAFEX card), a video cable, and complete technical documentation including schematics and theory of operation. To encourage software development, we are supplying subroutine entry points with GRAFEX - DIMENSIONS, an Assembly-language driver callable from APPLESOFT BASIC. DIMENSIONS adds about twenty high-level commands to APPLESOFT for plotting, character generation with multiple fonts, and screen dumps to dot-matrix printers. Application programs are being made available in the fields of color graphics, computer art, CAD/CAM, and Tektronix/VT100 terminal emulation.

The 32K GRAFEX card, documentation, and DIMENSIONS are available now for under \$250.

GRAFEX

Technical Specifications

A/ VLSI Graphics Processor

On-Board NEC 7220 graphics controller running at 2 MHZ
500,000 pixels per second drawing speed
16 MHZ pixel clock frequency
16 bit display data bus /8 bit microprocessor data bus
7220 executes high level drawing commands in hardware
13,000 transistor-equivalence

B/ Display RAM

32K bytes or 128K bytes of on-board display RAM (user-expandable)
Display RAM transparently accessed and refreshed by 7220

C/ Apple Interface

Slot-independent (works in all slots except slot 0)
Compatible with all Apple II, II +, IIe, and look-alikes
Requires no modifications or jumpers to the Apple computer
Requires just four addresses in the I/O area assigned to slot

D/ Video Input/Output

Generates NTSC standard 15.75 KHz 1V p-p into 75 ohms
Switchable 200/400 line video
Video changeover relays for software-controlled display
Dual-monitor capability for simultaneous Apple/ GRAFEX display
Standard RCA-type phono jacks for video I/O connections

E/ Electrical

Nineteen low power Schottky or CMOS chips plus VLSI controller
2.5 watts (approx) power dissipation from 5 V supply

F/ Mechanical

Epoxy-Glass double-sided card with gold-plated edge connector
7.1" length by 2.85" height exclusive of edge connector
125 grams (approx) card weight

G/ Expansion Connectors

Two expansion connectors allow chaining GRAFEX cards for multiplane color/gray-scale, external sync for RGB monitors, and future GENLOCK to external NTSC video sources.

H/ Warranty

Ray Dahlby Electronics warrants each GRAFEX card to be free of defects for a period of 1 year from the date of purchase. This warranty does not apply to kits. Defective cards will be repaired or exchanged at our discretion.

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GRAFEX - Dimensions
Version 2.00
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September, 1986

1/ Introduction to Dimensions Version 2.00

Dimensions is an Ampersand (&) extension to Applesoft basic allowing Basic programmers access to the increased display resolution of a GRAFEX card. It is assumed that the user is already familiar with Applesoft Basic and that a GRAFEX card is installed in his/her computer system. Dimensions commands work with either 32K or 128K of display memory installed on the GRAFEX card and any differences between command operation due to display memory sizing will be explained.

It is also assumed that the user has successfully run the demonstration program included on the Dimensions diskette to confirm proper operation of the GRAFEX card.

Dimensions adds commands to the Applesoft language by means of the Ampersand vector. This means that all Dimensions commands must be preceded by the Ampersand symbol. All commands must be separated from their parameters with commas, and multiple parameters must be separated from each other by commas.

To load Dimensions into your machine, type in "BRUN GRAFEX8" either from the keyboard or from a stored program. If this command is executed from a program, be sure to include the DOS control-D or chr\$(4) symbol. For example, the following program, when run, installs Dimensions:

```
10 PRINT CHR$(4);"BRUN GRAFEX8"
```

When this line is executed, Dimensions loads itself just below the current HIMEM address set by DOS 3.3 or Prodos, and resets the HIMEM pointer to prevent Applesoft application programs from using the memory area reserved by Dimensions. This memory space in the Version 2.00 software, is approximately 7K bytes in length and includes the GRAFEX8 driver, the printer driver, and one software character set. The workspace available for Applesoft programs can be found using the FRE function of Applesoft.

Dimensions version 2.00 includes several printer drivers for hardcopy Output of the graphics screens to dot matrix printers. The current drivers support all Epson MX, RX and FX and later printers and Grappler compatible printer interface cards. The Grappler card must be installed in Slot #1 of the computer and the Dip switches on the Grappler card set to enable the 8th bit. Consult your Grappler manual to determine which switch setting is appropriate. Other printer

drivers are in the works, and the next release will support the Apple Imagewriter printer, Apple super-serial card as well as the PKASO parallel card. Check Appendix A of this manual for information on installing the printer driver.

The source code for the Epson/Grappler printer driver is included with Dimensions and may help users to adapt the software to other printer / interface combinations.

This manual is intended to provide Applesoft programmers with enough information about Dimensions to use the enhanced text and graphics capabilities of the GRAFEX card in their programs. This manual refers to revision 2.00 of Dimensions only. Although as much effort as possible will be made to ensure source compatibility with future versions of Dimensions, no guarantee as such is made. If you encounter problems, please notify us so that corrections can be made for future releases.

2/ Dimensions Version 2.00 Command Summary

Dimensions commands may be invoked either directly from the keyboard in "immediate" mode, or through a stored Applesoft Basic program.

Version 2.00 of Dimensions adds 37 new commands to Applesoft Basic. These commands can be broken down into seven categories as detailed below. A BRIEF description of each command is included here and a detailed description appears in the "Dimensions Command Description" section of this manual.

A/ Initialization Commands

These commands do not write to or affect the graphics screen memory. They set flags or software switches and provide for initialization of the hardware.

- | | | |
|------------|----------|--------------------------|
| 1) &SLOT,N | N=1 to 7 | Sets the slot # |
| 2) &INIT | | Initializes hardware |
| 3) &RESET | | Restores defaults |
| 4) &MASTER | | Sets card as master |
| 5) &SLAVE | | Sets card as slave |
| 6) &FAST | | Fast drawing mode |
| 7) &SLOW | | Transparent drawing mode |

B/ Video Display Commands

Each of these commands directly affects the displayed image. None actually change the display bit-map but instead change the way in which the bit-map is presented on the screen.

- | | | |
|--------------|-------------|--------------------------------|
| 1) &V200 | | Non-interlaced video 200 lines |
| 2) &V300 | | Scan-doubled 200 lines |
| 3) &V400 | | Interlaced video 400 lines |
| 4) &SCROLL,N | N=0 to 1151 | Scrolls the window N lines |
| 5) &PAGE,N | N=0 to 3 | Page scroll (N*384 lines) |
| 6) &VCNTR,N | N=0 to 45 | Centers screen vertically |
| 7) &HCNTR,N | N=0 to 10 | Centers screen horizontally |
| 8) &GDC | | Displays GRAFEX video |
| 9) &APPLE | | Displays Apple video |

C/ Drawing Set-Up Commands

These commands set parameters for the VLSI graphics display controller chip (the 7220) to do subsequent drawing operations. These parameters, once set, will stay in effect until re-programmed or until an &RESET command is issued

- | | | |
|--------------|---------------------------|--------------------------------|
| 1) &MODE,N | N=0 to 3 | Replace/Complement/Clear/Set |
| 2) &TYPE,N | N=0 to 65535 | Pattern for solid/dashed lines |
| 3) &MOVE,X,Y | X=0 to 639
y=0 to 1535 | Moves invisible cursor |
| 4) &MAG,N | N=0 to 15 | Magnification factor |
| 5) &DIR,N | N=0 to 7 | Drawing direction |
| 6) &SLANT | | Slant text mode |
| 7) ®ULAR | | Regular text mode |
| 8) &ROT,N | N=0 to 3 | Sets rotation for shapes |

D/ Drawing Commands

These commands cause the GDC chip to start drawing to the screen bit-map based on the set-up parameters currently in effect.

- | | | |
|--------------|---------------------------|--|
| 1) &DOT | | |
| 2) &LINE,X,Y | X=0 to 639
y=0 to 1535 | Draws a dot at cursor location
Draws a line from cursor |
| 3) &ARC,R | R=radius | Draws a 45 degree arc |
| 4) &CIRCLE,R | R=radius | Draws a circle of radius R |
| 5) &BOX,W,H | W=width
H=height | Draws a rectangle |
| 6) &DRW,N | N=shape # | Draws a shape |

E/ Block Drawing Commands (Bit-Bit)

- 1) `&CLS,P,N` P=0 to 4 Clears screen P to mode N
 N=0 to 3
- 2) `&TXT,A$` Draws text
- 3) `&CAPTURE,P,X,Y` P=0 to 1 : X=0 to 639 : Y=0 to 1535
 Moves an Apple HIRES image to GRAFEX

F/ Graphics Output Commands

- 1) `&RELEASE,X,Y,P` X=0 to 639 : Y=0 to 1535 : P=0 to 1
 Moves a GRAFEX image to a HIRES screen
- 2) `&HCPY,N` N=0 to 3 Dump page N to printer

G/ Memory Read/Write Commands

- 1) `&RD,M,S,L` Reads a range of GRAFEX into
memory into Apple memory into Apple memory
- 2) `&WR,N,S,L` Writes a *range* of Apple
memory into GRAFEX memory

3/ Dimensions Version 2.00 Screen Partitioning (Windows)

The GRAFEX card is capable of addressing up to 128K bytes of display memory. This is more than what is possible to display on a standard Apple-compatible video monitor at one time. The GRAFEX card will display 400 lines of video on the monitor with two display windows, each individually scrollable. Dot matrix printers such as the Epson MX/RX and FX series and the Apple Imagewriter have a vertical resolution of 72 dots per inch which limits an 11" page to 792 dots, or less than double the capability of a GRAFEX card. It was decided to partition the 400 line vertical resolution of GRAFEX into a 384 line display window and a 16 line status window, each of which can be individually written to and scrolled. In this way, two GRAFEX "pages" each 384 lines long, can be used to compose one printed page, 768 lines long. The printed page at 72 dots per inch yields a hardcopy image 10.67" high thus allowing for a border top and bottom for page serrations.

The status window, which is visible on the bottom of the screen as sixteen lines of text or graphics, will be available for program prompts, terminal-emulator status information, or it can be simply turned off. This status window appears stationary as the display window is scrolled and information displayed here is not included in the printed hardcopy of the screen Image. Version 2.00 of Dimensions has no facility to allow the user access to the

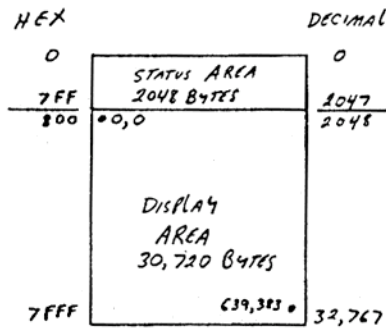
status area. It is planned that future versions will provide such commands.

Use care when drawing vectors, or other figures. not to overwrite the vertical boundary of your GRAFEX card. On a 32K card, if you address beyond y=383, the drawing will encroach upon the status area. On a 128K system, addressing beyond y=1535 will do likewise. To clear the status area, along with all the memory, execute an &CLS,4,0 command.

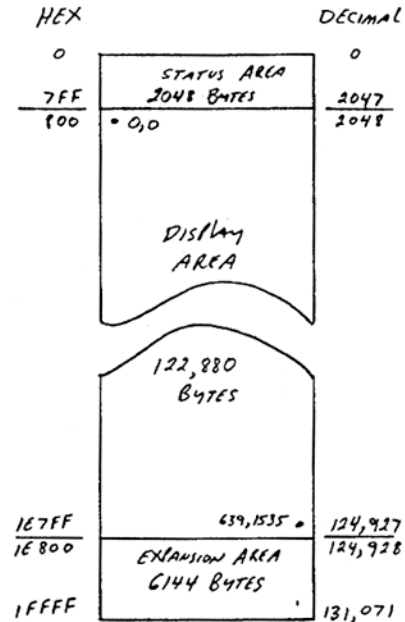
The following diagrams illustrate the global display memory addressable by Dimensions on both a 32K and a 128K GRAFEX card. The X and Y addressing convention puts the origin, 0,0 at the upper left corner of the screen to retain compatibility with the graphics commands of Applesoft Basic.

DISPLAY MEMORY PHYSICAL MAPS

32K GRAFEX

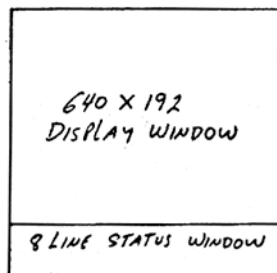


128K GRAFEX

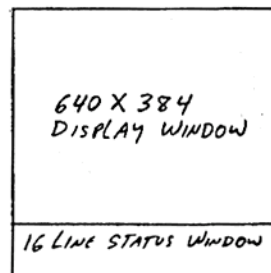


DISPLAY WINDOWS INTO MEMORY

V200/V300 MODES



V400 MODE



4/ Dimensions Version 2.00 Command Description

The following information provides a detailed description of each Dimensions command.

1) &SLOT,N

This command tells Dimensions which slot the GRAFEX card is in. The GRAFEX card must be installed in the slot specified by N and, even though a value of 0 is allowed, GRAFEX will not work in slot 0.

2) &INIT

This command, which takes no parameters, does a hardware initialization of the GRAFEX card. After this command is issued, the GRAFEX card begins to produce NTSC standard video but the display memory is not initialized or cleared. This command should only be issued once, after power-up and after the Slot command has been sent.

3) &RESET

Reset, unlike the Apple reset button, is strictly a software initialization command. Reset restores all parameters to their default values and is handy when running Dimensions in immediate mode.

4) &MASTER (default)

This command sets up the addressed GRAFEX card to act as the master in a multiple-plane RGB or Grey-Scale system.

5) &SLAVE

Sets the addressed GRAFEX card to synchronize to the master GRAFEX card for color and grey-scale work.

6) &FAST

This command sets up the GRAFEX card to allow the VLSI graphics processor unlimited access to the display memory for maximum drawing speed. The side-effect of allowing the 7220 access to the display memory at any time is a "snow" effect or otherwise disturbed screen display while the GDC is drawing. Applesoft Basic is the bottleneck for speed so this command results in a very small speed increase compared to the Slow command described below.

7) &SLOW (default)

The complement to Fast, execution of this command restricts the 7220 accesses to display memory to the invisible retrace blanking intervals of the video timing. The result is completely transparent screen accesses which users of the Apple II are already familiar with. This is the preferred mode as the speed penalty is almost negligible when running under Applesoft.

8) &V200

Sets up the video display registers of the 7220 to generate a non-interlaced, 200 line video image. The screen image is updated at 60 times per second so no visible flicker is apparent on any standard monitor. The display window is 192 lines and the status window is 8 lines.

9) &V300

No, not 300 line resolution! This mode displays 200 lines of vertical resolution in a 400 line frame by a technique known as scan-doubling. This mode displays the same information as the V200 mode but it fills in the black spaces between horizontal lines by replication. Each horizontal line in V200 mode is displayed as two parallel lines very close together, with a much smaller inter-line gap. This mode can result in a smoother, easier to read display, but some flicker may be observed at high display brightness levels.

10) &V400

This is the true 400 line interlaced video mode. This mode can flicker depending on the video monitor phosphor, brightness level, and the type of display on the screen. Conversely, this mode doesn't flicker at all with the right choice of monitor, display brightness, and image. Displays that have lots of parallel horizontal lines tend to flicker most. The display window is 384 lines and the status window is 16 lines.

11) &SCROLL,N

The word "scroll" conjures images of early rolled writing parchment. Like the parchment scrolls, this command allows the display memory to be rolled past the display window creating an impression that the text and graphics are actually in motion, past the observers view. The display window is either 384 lines or 192 lines in length depending on whether interlaced or non-interlaced modes have been selected. The display memory, on the other hand, can be considerably longer than what can be seen at one time. With

a 32K GRAFEX card, the display memory actually matches the display and status window size so the scroll command would only be useful in non-interlaced, 192 line modes to see the complete, 384 line range. With a 128K GRAFEX card, the display memory holds 1536 lines so scrolling is needed to move this range back and forth past the display window.

The parameter, N, refers to the number of lines to be scrolled, with a value of 0 being the default. Scrolling past the edge of the display memory will result in an interesting, if not very useful effect of seeing the display replicated with a horizontal displacement. This effect is because the displayed screen size does not fall on a power of two like the length of the actual display memory.

12) &PAGE,N (n=0 is default)

This command is a macro to the Scroll command explained above. When Page is executed it multiplies the parameter N by 384 and jumps to the Scroll subroutine so that one complete page is instantly scrolled into view. This is similar to page flipping. N is restricted to 0 for 32K GRAFEX cards and can range from 0 to 3 for 128K cards.

13) &VCNTR,N

To accommodate different video monitors, this command allows the image to be moved up and down on the screen. It programs the video timing registers of the 7220 graphics chip and has no effect on the display or status windows into display memory. The value of N can range from 0 to 45 and is the number of video lines moved. A small value of N positions the screen downwards while a large value positions the screen upwards.

14) &HCNTR,N

The screen can be moved right and left to allow centering on different monitors. The value of N can range from 0 to 10 with small values positioning the screen to the right, and larger values to the left. The units are in 16 pixel increments.

15) &GDC

GDC stands for Graphics Display Controller and this command switches the video changeover relay to display video from the GRAFEX card. When this command is issued, the GRAFEX signal appears on the OUTPUT video connector, J2.

16) &APPLE

This command switches the video changeover relay to connect the video signal appearing on connector J1 of the GRAFEX

card to a video monitor connected to 32. Normally J1 carries the Apple video signal so this command puts the system in "Apple mode". This is the default mode on power-up or reset.

17) &MODE.N

Mode tells the *graphics* processor to perform one of four basic pixel-changing operations on the bitmap. An understanding of these four operations is important to successfully use Dimensions from within your program. The four modes are as follows:

&MODE,0

This is the REPLACE mode of operation. All drawing subsequent to this command will both set and clear bits on the screen as necessary. This mode will draw legible text over both black and white backgrounds.

&MODE,1

This is the COMPLEMENT or "exclusive-or" mode. Similar to the XDRAW command in Applesoft, this mode sets and clears bits to the reverse of the background pattern, allowing transparent drawing over a background image. Very useful for moving an object around without disturbing the background, it also provides a convenient and fast way to subtract two binary images from each other.

&MODE,2

The CLEAR operation, this mode provides only for clearing of bits, not setting them. If a background is primarily set, (white background), this mode will draw lines, dots, and text as black. If the background is primarily clear, (black background), this mode will not draw much. Think of this mode as the color black. Drawing with black on black will not be visible.

&MODE,3

You guessed it, the SET operation, or the color white. This mode will not clear bits, only set them, so it's best used over an already cleared background to draw in white...or green...or amber, depending on your display monitor. This is the default mode.

For more information about how to initialize the background "color", see the command "&CLS,P,N"

18) &TYPE,N

This command sets a pattern for line, rectangle, arc and circle drawing so that solid or different patterns of dashed and dotted lines may be drawn. This command is not in effect for text and other block drawing operations. The parameter, N, can range from 0 to 65535 and the pattern used for drawing is the binary bit image of N with the LSB displayed first and the MSB displayed last. For example, a value of 65535 displays a solid figure, while a value of 255 will display a dashed line with a solid first eight pixels and a cleared second eight pixels. A value of 0 draws blanks. The default type is 65535.

19) &MOVE,X,Y

This is the cursor position command. The cursor is an invisible point which can take up any pixel location on the 640 by 1536 GRAFEX WORLD. It is used to position text, put up dots at the cursor location, draw lines, and otherwise specify an absolute location in the bitmap for operations to proceed from. Very useful.

20) &MAG,N

Mag stands for magnification factor and can range from 0 to 15. It has an effect on text drawing and block drawing only. See the &TXT and &CAPTURE command description for more information. A MAG factor of 0 is the default.

21) &DIR,N

Dir stands for direction and can range from 0 to 7. It is used for text drawing as well as for arc and box drawing. The default value is 0.

22) &SLANT

This command sets the drawing processor to draw text characters in a backwards slant orientation.

23) ®ULAR

This command sets the drawing processor to draw text characters normally.

24) &DOT

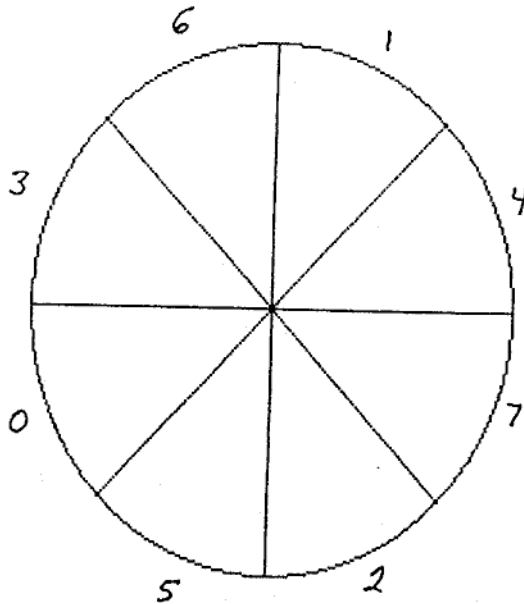
Causes a single pixel to be set, reset, or complemented at the current cursor position. Depending on the current MODE and TYPE setting, as well as the background "color", a dot may or may not be actually seen. When this command has executed, the cursor is left at its original position.

25) &LINE,X,Y

This is the vector draw command and it draws a straight line from the current cursor position to the point addressed by <the X and Y parameters. This command also is affected by the status of the NODE and TYPE parameters, as well as background. The execution speed of vector drawing is very fast thanks, in part, to the hardware assistance from the 7220 graphics controller chip. X can range from 0 to 639 and Y from 0 to 1535. The cursor is left at the end point of the vector to allow vector-chaining.

26) &ARC,R

Draws a 45 degree arc with radius R. This command uses the cursor position and the DIR values to draw one eighth of a circle. The cursor is left at its original position, at the center of the circle, when this command is executed. The 8 directions which define which octant of the circle will be drawn, are illustrated below:



DIR, 0
&ARC, 100

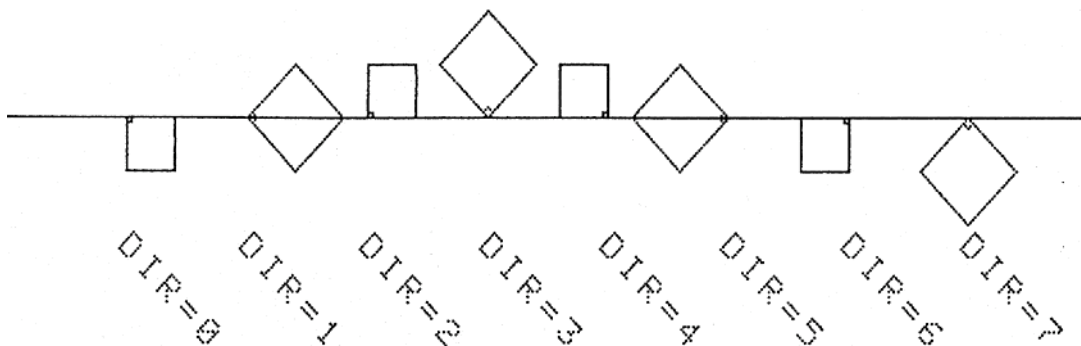
27) &CIRCLE

This command draws a circle by drawing eight octants, or 45 degree arcs, with a radius of R and the center at the cursor position. When this command executes, it leaves the cursor position unchanged. The circle drawn is "circular" in the bit map, but appears slightly oval on the CRT screen. This is because the aspect ratio of the display (640 by 384) and the monitor (4 to 3) does not quite match. If your monitor has a width control, you might find that by adjusting it, you can get rounder circles~

The circle drawing capability of the NEC 7220 chip is much faster than implementations done in software. Compare, if you can, the speed of an IBM PC drawing a circle to your Apple II/GRAFEX system. The difference is amazing. To really explore the 7220's power, I suggest you program it in Assembly language. If you look closely on the Dimensions diskette (both Dos 3.3 and Prodos sides), you might find some source code I've left there for adventurous programmers.

28) &HOX,W,H

The box command draws a rectangle with a width of W pixels and a height of H pixels. Eight drawing directions are possible, depending on the programmed value of the &DIR,N command, and the results of the different directions are shown below. The box command is more convenient, in many cases, than drawing four line segments. For one thing, the dimensions of the box are expressed in relative terms and the user doesn't have to calculate absolute pixel end-point locations in the bit map. When drawing boxes at 45 degrees of rotation, the user again is spared some trigonometry. The box command also executes with blinding speed compared to drawing four vectors.



29) &CLS,P,N

This is the clear screen command. P is the page variable and can range from 0 to 4. A value of 0 will address the first page of display memory, Y=0 to Y=383. With a 32K GRAFEX card, this is the only page addressable. With a 128K GRAFEX card, a total of four pages are addressable with Y going from 0 to 1535. A page value of 1 will address the second page starting at Y=384 and ending at Y=767. Similarly, page values of 2 and 3 will address the last two pages.

The page variable can take on a special value of 4 if it is desired to clear all pages in a single command, for instance, just after the GRAFEX card has been &INITIALIZED and all memory is to be cleared. A page variable of 4 is special because it is the only value which also clears the 16 line status area on the bottom of the screen.

The mode variable, N, like the &MODE,N command, sets the graphics controller to perform the desired operation on the bit-map. A value of 0 or 2 will clear the screen memory to zeroes, or black, while a mode value of 3 will set the screen memory to ones, or white. A mode value of 1 is interesting because it performs an exclusive-or, or complement operation on the screen, turning all white areas to black, and all black areas to white. This mode value is useful to instantly reverse the screen for visual emphasis or for preparing a digitized image for printing.

30) &TXT,AS

This is the text output command. Text characters are drawn from a software-resident character set located in the top 1024 bytes of system RAM. Since the character set is located in RAM, different fonts may be loaded for special applications. The character set included with Dimensions allows a full 128 character upper and lower case with control symbols ASCII standard display.

TXT must be called with a string variable as the parameter. String literals and functions evaluating to strings are not acceptable. If in doubt, assign a string literal or expression to a variable, such as AS, and then use it as the parameter for TXT.

TXT draws a character in an 8 by 8 pixel box downwards from the cursor location. To draw a text character at the upper left corner of the screen, the cursor should first be positioned using the &MOVE,X,Y command to X=0 and Y=0. If the drawing direction is 0 (default) then after the text character has been drawn, the cursor is repositioned 8 pixels to the right of the last position to allow the next character to be drawn. Multiple characters and strings can

be drawn without repositioning the cursor. TXT does not watch for the screen boundaries so it is up to the programmer to ensure that text output does not over-write the screen borders. If this is allowed to happen, a wrap-around takes place and text will begin overwriting itself at the opposite side of the screen.

Text can be drawn in one of 16 sizes and 8 rotations, depending on the parameters set with the &MAG,N and &DIR,N commands. An Applesoft program called "DIFFERENT DIRECTIONS" is included on the Dimensions diskette to illustrate the effect of the &DIR,N command.

TXT also is affected by the &MODE,N command and special effects are possible by drawing a text string and then shifting the X and Y starting position by 1 or 2 pixels and re-drawing the same text string with the MODE set to complement. The section of the DEMO program which draws and labels a sinewave plot illustrates this technique. Complement mode performs a binary subtraction on the bit-map of the original text string and the shifted string.

The character set included with Dimensions is in a binary file called "CHARACTER.SET". When additional sets are available, they can be called up from diskette simply by executing the following:

```
10 PRINT CHR$(4);"BLOAD CHARACTER.SET"
```

A program on the Dos 3.3 side of the Dimensions diskette called "CONVERT", lets you use any of the DOS-TOOLKIT fonts with Dimensions. Blippo Black Set was already converted using this utility, and appears on the Dos 3.3 side of Dimensions with a new name "ALT.CHR.SET". Not such an imaginative name but easy to remember.

```
31) &CAPTURE,P,X,Y
```

This command moves an Apple HIRES screen, referred to by the page variable P, to the X and Y location on the GRAFEX screen. P can only be 0 or 1, with 0 referring to the Apple HIRES screen 1 (HGR) and 1 referring to Apple HIRES screen 2 (HGR2). X can range from 0 to 639 and Y from 0 to 1535.

Since an Apple HIRES screen is composed of 280 horizontal pixels by 192 vertical pixels, be careful not to overwrite the GRAFEX screen boundaries by choosing X and Y starting locations that are too large.

The HIRES screen is moved to the GRAFEX screen using the &MODE,N parameter in effect at the time of the transfer. Using a mode value of 0 will result in a direct transfer with the HIRES image, overwriting whatever was previously

displayed in the 280 by 192 block of the GRAFEX screen. A mode value of 1 will perform a binary subtraction of the GRAFEX screen area and the HIRES image. Mode values of 2 and 3 will respectively clear and set pixels as defined in the &MODE,N command description.

An interesting form of Image analysis called "auto-correlation" can be performed on an image by transferring it to a cleared GRAFEX screen area, and then subtracting a spatially shifted version from itself. This operation can be effected by the following sequence of commands:

```
10 &MODE,0          (sets mode to replace)
20 &CAPTURE,0,0,0    (moves NCR to GRAFEX at X=0,Y=0)
30 &MODE,1          (sets mode to complement)
40 &CAPTURE,0,2,2    (subtracts shifted image from itself)
```

Try this operation with different digitized photographs and different spatial shifts. A couple of digitized photographs are included on the Dimensions diskette in a file called "PIX". Load the two pictures into the two Apple HIRES screens by using the command BLOAD FIX.

Capture was written as a page-composition tool. With it, application programs such as paint, cad/cam, and font generators, can be used to compose a small part of a larger document. Each part of the larger document can be moved to the GRAFEX screen as a paste-up, and when the final document is ready, it can be printed as a whole.

capture works with an &MAG,N setting of 0 or 1. with a MAG setting of 0, an Apple HIRES screen is moved to a 280 by 192 pixel area of the GRAFEX screen. With a MAG factor of 1, the Apple HIRES area is moved to a 560 by 384 area of GRAFEX. This process of magnification takes place by replicating pixels in both the horizontal and vertical direction so each Apple HIRES pixel becomes four GRAFEX pixels.

32) &RELEASE,X,Y,P

This command is the complement of the &CAPTURE command. A 280 by 192 pixel area of the GRAFEX bit-map pointed to by the X and Y parameters, is moved to the Apple HIRES screen referred to by the page variable, P. X and '1 can range from 0 to 639 and 0 to 1535 but again, care must be taken to avoid addressing beyond the display memory boundaries of the GRAFEX card.

An interesting effect can be had by capturing an Apple HIRES image to the GRAFEX screen at a MAG factor of 1, and then releasing a quarter of it back to the Apple HIRES screen. The Apple screen then holds a quarter of the original image magnified by a factor of four. This operation may be

performed several times until the Apple screen holds only a single pixel of the original image, magnified to fill the entire screen.

If a color picture is captured to the GRAFEX screen and then released back to the Apple, some color loss will be evident. On monochrome monitors, however, the image will be identical. This effect is due to the fact that the 8th bit of each byte composing an Apple HIRES screen is not shown as a pixel, but used to convey color information. The &CAPTURE and &RELEASE commands transfer only the pixel bits of the image, and the 8th bit is thus lost.

33) &HCPY,N

This command is the HARDCOPY output command and is used to perform a screen dump to a dot matrix printer. The page variable, N, can range from 0 to 3 and refers to the GRAFEX screen page to be printed. Each screen page is 384 lines long so a 32K GRAFEX card supports only a value of 0 for N. Multiple &HCPY commands may be executed in sequence to dump multiple pages to the printer without any intervening gaps. For example, the following sequence will print a 640 by 768 image to the printer, composed of GRAFEX lines 0 through 767

```
10 &HCPY,0: &HCPY,1
```

Appendix A of this manual explains the supported printers and interface cards. A text file of the source code for a typical printer driver is included on the Dimensions diskette for those users who may want to try customizing it to support different printer and interface card combinations. This file, called "DRIVER80.SRC", is compatible with the DOS TOOL-KIT Editor /Assembler or the PRODOS Assembler.

34) &RD,M,S,L

RD stand for READ and what it does is move a block of memory from the GRAFEX card, into the Apples memory. This command, along with the &WR command described later, allows the 32K or 128K of memory on a GRAFEX card to be used as a temporary storage buffer for programs or data, when the card is not being used for graphics. These two commands could be used from another program to emulate a RAM disk. They are useful right now for stashing hires pictures, binary programs, and also to save or recall GRAFEX images on the Disk II system.

IMPORTANT!...The GRAFEX card must be initialized before any commands, including &RD and &WR are issued.

The three parameters, M,S,and L refer to respectively, the MEMORY location in the Apple where you want to put the

GRAFEX data, the START page of the GRAFEX memory, and the LENGTH in pages, of the data. All parameters must be expressed in DECIMAL and a page refers to 256 bytes of data, not a screen page. The M parameter can range from 0 to 65535, but the user is left responsible for any dire consequences of reading into page 0 or 1 or the C000 areas of the Apple's memory map

The S and L parameters can range from 0 to 127 for a 32K GRAFEX card and from 0 to 511 for a 128K card. If you refer to the section of this manual which deals with the GRAFEX memory map, you will see that the display starts at logical page 08 so to move a 640 by 384 Image into the Apple's memory, you would specify an S parameter of 8, and an L parameter of 120. (30720 bytes/256= 120)

35) &WR,M,S,L

This command is very easy to explain after going through the RD command. In fact, I won't say anything at all about it except that it writes to the GRAFEX memory from the Apple's memory. Oh yes, before this command executes, it automatically clears the range in the GRAFEX memory, before writing. Due to oddities within the NEC 7220 chip, the &WR command is much slower than the &RD command.

36) &ROT,N

Sets the rotation factor for shape drawing. This command is similar to the Applesoft ROT command, but only four rotation values are allowed, 0 - 3. The rotation factor wraps around if larger values are passed. Four rotation values should not be a limitation because shapes do not usually look good at other than 90 degree rotations.

37) &DRW,N

This is the shape draw command, and it uses the mode, type, mag, and rot values in effect at the time of execution. It is equivalent to the Applesoft Draw command. Xdraw can be emulated by first setting the mode to 1 (complement mode), and then issuing the Drw command.

To draw shapes, first a shape table must be loaded somewhere into the Apple memory, and the shape table pointer (\$E8 and \$E9 decimal 232 and 233) must be set to the address of the table.

The Dimensions Version 2.00 diskette has on it a file called "SHAPES" which contains plotting symbols and a character set. To load this table, type in "BLOAD SHAPES", and set the shape pointer to the starting address, which is \$2000 or decimal 8192. From Basic, you can poke the shape pointer locations by executing the following:

```
10 PRINT CHR$(4); "BLOAD SHAPES"  
20 POKE 232,00 POKE 233,32
```

To draw a shape, first set up the rot, mode, mag, and type parameters, then position the cursor, using &MOVE to where you want to start drawing. Finally, issue the &DRW,N command, where N is the shape number you wish to draw.

The Rot and Drw commands were included with Dimensions to allow the easy conversion of Applesoft programs which use shape tables for putting up text and symbols on a hi-res screen. Using other commands of Dimensions, notably TXT, ARC, CIRCLE, and BOX, you will achieve a much faster execution speed than if you use DRW. However, you may find it more convenient to simply use shape tables. The choice is yours. With the addition of these two commands, Dimensions should be 100% compatible with existing Applesoft programs.

Many thanks to Mr. Cyrus Roton, who contributed the shape table extensions to us for inclusion into Rev. 2.00 of Dimensions.

GRAFEX Dimensions Version 2.00
Appendix A
Supported Printers

Dimensions Version 2.00 supports only Epson-compatible dot matrix printers and Grappler-compatible parallel interface cards. The Grappler card MUST be in slot 1 of the Apple and have its DIP switches set to allow the transmission of 8-bit data. All Epson printers from the MX-80 and MX-100 up to the newer FX, RX, and LX Spectrum, will work with the current software.

There are three printer drivers on the DimenSions diskette. They are called DRIVER60, DRIVER80, and DRIVER120, with the difference being the horizontal dot density of 60, 80 or 120 dots per inch. The older Epson XX series supports only the 60 and 120 dots per inch modes., while newer printers support the optimum (from Dimensions point of view), 640 dot horizontal, 80 dot per inch mode.

GRAFEX and Dimensions display 640 dots on each horizontal line. With a paper width of 8 inches, a dot density of at least 80 DPI is necessary. Owners of MX80 printers should use the 12.0 DPI driver while owners of the wider carriage, MX100 can use either the 120 DPI or 60 DPI drivers.

A dot density of 80 DPI is considered optimum as it offers the closest approach to a 1:1 aspect ratio between the horizontal and vertical dot densities. The vertical dot spacing on all Epson printers is 72 DPI.

Although Epson printers have been mentioned exclusively in this discussion, there are many others which are Epson-compatible. Among those that have been tested with Dimensions are the Panasonic 1080, 1091 and 1092, as well as the Roland PR 1011, 1111, and 1212 printers.

To install one of the printer drivers, please refer to Appendix B of this manual.

We are working on supporting other printers and interface cards. Future versions of Dimensions will support the Apple Imagewriter and Apple Super Serial Card, as well as the PKASSO parallel card. Please let us know your printer and interface card requirements so that we can add it to the list.

Dimensions Version 2.00
 Appendix B
 User-Configuration of the Dimensions system

I/ Introduction

The Dimensions diskette is double-sided with Prodos files appearing on the first side, and Dos 3.3 files appearing on the flip side.

The Prodos and Dos 3.3 catalog listings appear here and a discussion of what is in each file follows.

NAME	TYPE	BLOCKS	MODIFIED	CREATED	ENDFILE	SUBTYPE
*PRODOS	SYS	30	25-SEP-86	0:00	25-SEP-86	14848
*BASIC.SYSTEM	SYS	21	25-SEP-86	0:00	25-SEP-86	10240
*SHAPES	BIN	5	25-SEP-86	0:00	25-SEP-86	1648 A=\$2000
*GRAFEX8	BIN	11	25-SEP-86	0:00	25-SEP-86	4675 A=\$7E00
*DRIVER80	BIN	1	25-SEP-86	0:00	25-SEP-86	235 A=\$9080
*DRIVER60	BIN	1	25-SEP-86	0:00	25-SEP-86	235 A=\$9080
*CHARACTER.SET	BIN	3	25-SEP-86	0:00	25-SEP-86	1024 A=\$9200
*DRIVER120	BIN	1	25-SEP-86	0:00	25-SEP-86	235 A=\$9080
*STARTUP	BAS	1	25-SEP-86	0:00	15-SEP-86	10:00 139
*DEMO	BAS	12	29-SEP-86	0:00	15-AUG-86	10:00 5626
*DRIVER80.SRC	TXT	6	25-SEP-86	0:00	25-SEP-86	0:00 2184
*PICS	BIN	33	<NO DATE>	0:00	15-AUG-86	10:00 16384
*GRAFEX8.SRC	TXT	55	<NO DATE>	0:00	<NO DATE>	27526
*DRIVER60.SRC	TXT	6	<NO DATE>	0:00	25-AUG-86	0:00 2184
*DRIVER120.SRC	TXT	6	<NO DATE>	0:00	25-AUG-86	0:00 2185

BLOCKS FREE: 81 BLOCKS USED: 193 TOTAL BLOCKS: 280

```

*A 002 HELLO
*A 024 DEMO
*A 003 CONVERT
*B 020 GRAFEX8
*B 006 CHARACTER.SET
*B 002 CONV.OHJO
*B 010 SHAPES
*B 002 DRIVER80
*B 002 DRIVER60
*B 002 DRIVER.120
*B 066 PICS
*T 006 CONV
*B 006 ALT CHR.SET
*T 109 GRAFEX8.SRC
*T 010 DRIVER60.SRC
*T 010 DRIVER80.SRC
*T 010 DRIVER120.SRC
*A 004 DIFFERENT DIRECTIONS
  
```

- 1) The STARTUP file on the Prodos side, and the HELLO file on the Dos 3.3 side, are Basic programs which print the revision number of the software and the copyright notice.
- 2) GRAFEX8 is the Ampersand sub-interpretter and Assembly-language routine library which makes up the Dimensions command set. This file does not include a character set or printer driver. GRAFEX8, when loaded, occupies the memory space from \$7E00 to \$907F. When this program is run, it resets HIMEM to \$7A00 to allow room for a 1024 byte Prodos buffer.
- 3) CHARACTER.SET is the binary file containing the character set image. This file is 1024 bytes in length which is sufficient to hold 128 characters formed in an 8 by 8 pixel matrix. This file, when loaded, occupies \$9200 to \$95FF.
- 4) DRIVER60, DRIVER80, DRIVER120. These files contain the printer drivers for Epson printers and Grappler interface cards. 60/80/120 refers to the horizontal dot density. The printer driver, when loaded, occupies \$9080 to \$91FF, a 384 byte space.
- 5) PICS, DEMO, and DIFFERENT DIRECTIONS are all part of the demo portion of this diskette. PICS is a binary HIRES image file, DEMO is the Applesoft Basic demonstration program, and DIFFERENT DIRECTIONS is an Applesoft demo of text drawing. It is suggested that the Basic programs be listed and used as examples of Dimensions command usage. Please don't use them as examples of good programming style!
- 6) All files with a .SRC suffix. These are Assembly language source code files. The source files on the Prodos side of the Dimensions diskette are compatible with the assembler which comes with the Prodos Assembler Tools package from Apple Computer Inc. Those on the Dos 3.3 side of the diskette are compatible with the EDASM assembler which was distributed by Apple Computer Inc. on the Dos Tool Kit package.

We recommend that programmers use Prodos for any serious development work with Dimensions files. Loading, saving and assembling files the size of GRAFEX8.SRC are at least a factor of 10 times faster with Prodos, and the Prodos Assembler Tools package includes a good debugger as well. It is also suggested that the interested programmer thoroughly read through the NEC documentation on the 7220 Graphics Display Controller chip before attempting to modify any of the GRAFEX8 routines. This is a complex part with many subtle modes and idiosyncrasies. Overall, though, the programmer will be well paid for his efforts by gaining tremendous speed advantage over graphics code that does not

fully utilize the 7220 chip. (One area in GRAFEX8 which could be re-coded for speed is the DRW command.)

II! Configuring the system

GRAFEX8, CHARACTER.SET, and DRIVER80 can be loaded and saved as one large contiguous file if desired. First, load the three files from the Dimensions diskette, and then save them under a new filename (or pathname) to the disk. The following sequence will load the three components and save them to the filename "DIMENSIONS" so that you can then install the complete package by simply executing the statement: BRUN DIMENSIONS.

```
BLOAD GRAFEX8
BLOAD CHARACTER.SET (or ALT.CHR.SET)
BLOAD DRIVER.80 (or whatever)
BSAVE DIMENSIONS, A$7E00, L$1800
```

GRAFEX-32
Installation Instructions
January, 1986

The GRAFEX card can be installed in any slot, except slot 0 of an Apple II+ or IIe computer. Many software packages including Dimensions, require that a printer interface card be installed in Slot 1, so it is a good idea to reserve slot 1 for that purpose.

Before installing the GRAFEX card, check to see that a jumper is in place on 23. This is the 2-pin connector close to the bottom of the card. A jumper is a small rectangular piece of plastic which slips onto 23 and electrically connects the two pins together. The purpose of this jumper is to designate the GRAFEX card as a MASTER, which is necessary when only one GRAFEX card is installed in the system.

At the left of the GRAFEX card, you will notice two RCA-type phono jacks, similar to those found on most stereo equipment. The upper one, marked on the board as "INPUT" connects to the Apple II or IIe computer's video output jack, at the back of the machine. The lower connector, marked "OUTPUT", connects to the video monitor. You will probably find it easier to make these connections before plugging the GRAFEX card into the expansion slot.

Never open the case of the Apple or make connections with the power on. Please turn the power off before attempting the installation of your GRAFEX card.

When the card is installed, insert the Dimensions diskette in Drive A of your machine and turn on the power. To test the GRAFEX card, type in "RUN DEMO" after the revision number and copyright notice have been displayed.

If you notice any problems, such as loss of video display, turn off the power to the computer and try to locate the cause before re-applying power. The GRAFEX card has been thoroughly tested in many different machines and it is unlikely that you will have any trouble getting it to work in yours. If you do have a problem that can't be resolved, feel free to contact us. If it is necessary for you to return either the GRAFEX card or the Dimensions diskette, you must contact us for instructions and the proper mailing address. Returns which have not been pre-authorized or returns sent to our correspondence-only addresses will not be accepted.