Graphix Plus II™
Users Manual
Preliminary
Rev 0.3

STB Systems, Inc.
601 North Glenville
Richardson, Texas 75081
(214) 234-8750

What is a Graphix Plus II?

The STB GRAPHIX PLUS II ™ is a universal video adapter board for the IBM Personal Computer, the IBM Personal Computer model XT, the Portable Personal Computer (™ International Business Machines, Inc.), and most IBM hardware compatible computers. The STB GRAPHIX PLUS II is used to connect the computer to a variety of **video display monitors and printers.** The board also contains provisions for an **optional battery operated time-of-day clock/calendar.**

Features

- Supports **both** RGB color and monochrome displays on a *single* STB GRAPHIX PLUS II. Automatically switches display to appropriate monitor.

- Configurable as a Color Graphics and/or a Monochrome/Printer Adapter. Hardware and software compatible with the IBM display adapters.

- Flicker free scrolling in all display modes. No snow on picture when screen RAM is accessed, allows high speed screen updates and scrolling.

- 32Kb of display RAM available in all text and graphics modes.

- Supports high resolution display modes with appropriate software drivers:

  320 x 200 x 16 color graphics
  640 x 200 x 4 color graphics
  640 x 350 monochrome FULL SCREEN graphics
  80 x 44 monochrome text

- Parallel printer port is standard. Port is switchable between "Centronics" style printer interface or SASI/SCSI hard disk controller interface.

- User-installable battery operated time-of-day clock/calendar option.

- Can be used with a second display adapter card for simultaneous display of text and graphics on two monitors.

- Customizable video monitor driver chip allows use with most standard video monitors. Customized versions for special monitors are available.

- Supports graphics on many monochrome text display monitors without special software drivers.

- True grey scale display on composite video monitors. Does not support composite color displays.

- Includes **PC Accelerator™** printer buffer and electronic RAM disk utility program. Supports up to two 360Kb "disk drives" and a 64Kb printer buffer.

What Does a Video Monitor Do?

A **monitor** is a computer's "television set." Instead of moving pictures and commercials, monitors are designed for displaying a computer generated picture, with all of the intricate patterns of dots and fine details intact.

There are three basic types of monitors available. In order to choose what type of monitor best suits your situation you must first determine what types of programs you intend to use.

Some software packages require a particular type of monitor before they will operate. Other programs work better with one type of monitor than they would with another. The STB GRAPHIX PLUS II combines both an **enhanced feature Color Graphics Adapter and a Monochrome Display/Printer Adapter** onto a single circuit card. It can be configured to operate in many different ways and with most standard and special video monitors.

Composite Video Monitors

Generally, the least expensive type of monitor is a **composite video monitor**. These monitors are suitible for both text and graphics applications.

Composite video monitors operate very much like a standard television set. Because of this they are somewhat limited in their ability to display a finely detailed image. Overall, composite monitors provide an image that is suitable for casual use. Characters do not appear as sharp as those on a monitor designed for word processing use.

Composite monitors come in both **color** and **monochrome** styles. *Monochrome* is a fancy way of saying "one color" or "black and white". Monochrome monitors for computer use generally show a green or amber picture instead of black and white. The choice of screen color usually comes down to personal preference, but some governments require the use of the amber screen. Its higher contrast image is said to reduce eye strain over long periods of uninterruped use. Amber monitors are usually 10-20% more expensive than green monitors. The lack of color can be a problem with some programs. Check with your dealer when in doubt.

Composite color monitors and television sets connected to computers via little transmitters called **modulators** are not very well suited to computers. The television-like signal required by these devices cannot carry enough information to show the fine details in computer generated images. Fine details and closely spaced colors appear blurred or distorted. This can be fine for games and home use but text is usually limited to 40 columns or less. A few programs, such as the popular *Microsoft Flight Simulator,* " have been able to use some of these effects to get extra colors that are not otherwise available.

The Graphix Plus II board produces a 15 level "grey scale" signal for use by composite video type monitors. This means it will display black and white images in 15 shades of grey on a composite color monitor. The Graphix Plus II does not generate a color burst signal. Text characters should not show a fringe of colors that the color burst signal would otherwise produce.

RGB Color Monitors

Most color monitors for computer usage, such as the IBM Personal Computer Color Display, are of the **RGB** variety. This stands for **R**ed, **G**reen, **B**lue. These are the three colors that a computer display combines together to produce one of eight basic colors. The computer sends signals for each color and the horizontal and vertical hold pulses to an RGB monitor on individual wires. This enables it to produce a much more detailed picture than a composite color monitor which has to extract all this information from a single signal. Most RGB monitors produce eight colors in one or two brightness (Intensity) levels.

Typically, a color monitor will cost 2-3 times as much as a monochrome monitor. RGB monitors vary in cost depending upon the **resolution** of the picture tube used to display the image. Color monitors show a color image by lighting up tiny colored dots on the screen. A computer draws characters as an array of tiny dots. The more dots that build up a character, the sharper it will appear.

The spacing of these dots determines how sharp the image will be. Most RGB monitors for computer use have a resolution around 0.40mm (millimeters). This is adaquate for charts, graphs, and games but text will appear a bit coarser than on a composite monochrome monitor. Higher resolution monitors have a resolution around 0.32mm. Some premium monitors have tubes with resolutions below 0.25mm. The image produced by these high resolution tubes rivals the best composite video monitors in clarity of details.

Monochrome Display Monitors

Although composite video and RGB color monitors can be used for word processing and spreadsheet programs, the image that they produce is limited in its resolution. Business programs involving mainly letters and numbers are best served by a special type of monitor called a **monochrome display** (not to be confused with the composite monochrome monitor discussed above). This type of monitor is designed to produce a very sharp text image composed of characters built with a dense array of dots.

Can I Show Graphics On a Monochrome Display Monitor?

Monochrome display monitors were originally designed with only text applications in mind. There was no way to produce graphics on them using standard IBM equipment. With the STB Graphix Plus II, you can produce full screen, 640 x 350 resolution, pictures on all standard monochrome displays. A program that uses this feature must provide for the use of special "driver" routines that customize the program for the extra resolution. Check with your dealer or software manufacturer for availability of driver routines for programs of interest.

Unfortunately, many software packages and games do not allow for customization with software driver routines. With some models of monochrome display monitors, the Graphix Plus II will allow you to use graphics programs that do not allow for special drivers. Most monochrome displays are set up to show an image with 350 lines of resolution. Since the IBM standard color graphics images are 200 lines tall, they will occupy about 2/3 of the monochrome display's screen the software does not use a full screen graphics driver routine.

A display suitable for this application must be able to lock onto the Graphix Plus II's video synchronizing signals without causing the picture to roll or tear. Monitors for this application should be able to lock onto a HORIZONTAL sync signal of 15,750-18,432 Hz and a VERTICAL sync signal from 60-50 Hz. Ask your dealer or monitor manufacturer if in doubt.

What Kind of Monitor Should I Buy?

The monitor or monitors that you need should be chosen to match your budget, applications and even desk top space. An RGB color monitor is well suited for displaying graphs, charts and games. It is probably the ideal single monitor for all around use.

Although an RGB monitor is fine for text displays, characters appear coarser than those on a monochrome display monitor. The benefits that a color image can provide often more than compensate for the coarser characters. Only those few software packages that require a Monochrome Adapter will not work with it.

The combination of both monitors on one system provides maximum flexibility and ease of use. A composite video monitor is a low cost alternative for casual use. With the STB Graphix Plus II, you can easily change your monitor or add another one without having to purchase another display adapter board.

How Close Can I Place Two Video Monitors?

If you have two monitors placed too close to each other, they may cause interference with each other's image. This usually shows up as a "swimming" motion to the picture on the screen. It does not hurt the monitors, but is quite annoying. About the only cure for this effect is to change the position of the monitors. Try moving them farther apart. Some monitors are more sensitive than others.

Should I Keep Diskettes Away From Monitors?

Most color televisions and monitors contain a built in magnetic field eraser called a degausing coil. Its purpose is to rid the monitor of any magnetic fields it may pick up in shipping or general use. These fields might otherwise cause the colors or picture to appear distorted. Unfortunately,

data on a nearby diskette can also be erased by the degausing coil. The coil is momentarily activated every time the monitor is turned on. Some monitors have a manual DEGAUSS switch instead of an automatic switch. Most monochrome monitors do not have a degausing coil. Just to be safe, keep diskettes away from all monitors.

Switching Between Video Monitors

If you have two video display monitors connected to the Graphix Plus II, the board switches the picture to the monitor that the software is accessing. Most programs that use graphics will automatically switch to the RGB monitor whenever a picture is being displayed and switch back to the monochrome monitor when text is being used.

The DOS 2.0 and later version "MODE" command can be used to tell the operating system which monitor it should be using. To switch to the RGB color and composite video monitors use the DOS command:

A>**MODE COLOR**

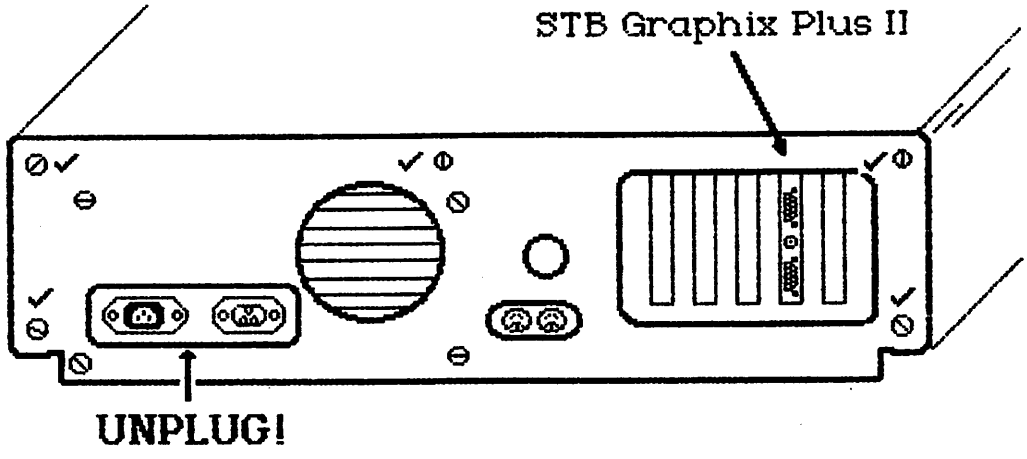
To return to the monochrome display, use the command:

A>**MODE MONO**

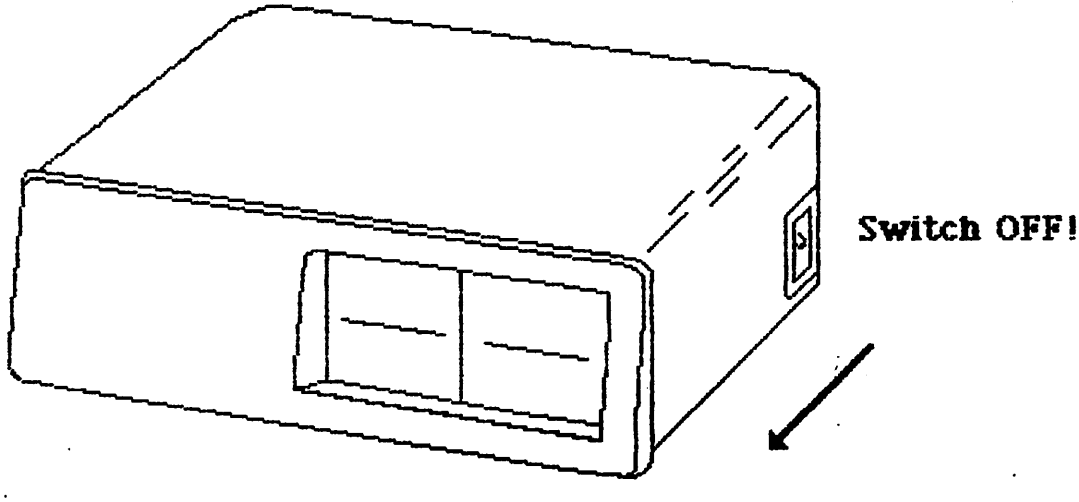
Many programs will change their operating modes or features depending upon the adapter DOS was using when the program was started. As an example, the BASIC color/graphics commands are not available unless the color/graphics adapter was active when BASIC was started.

Installing the Graphix Plus II

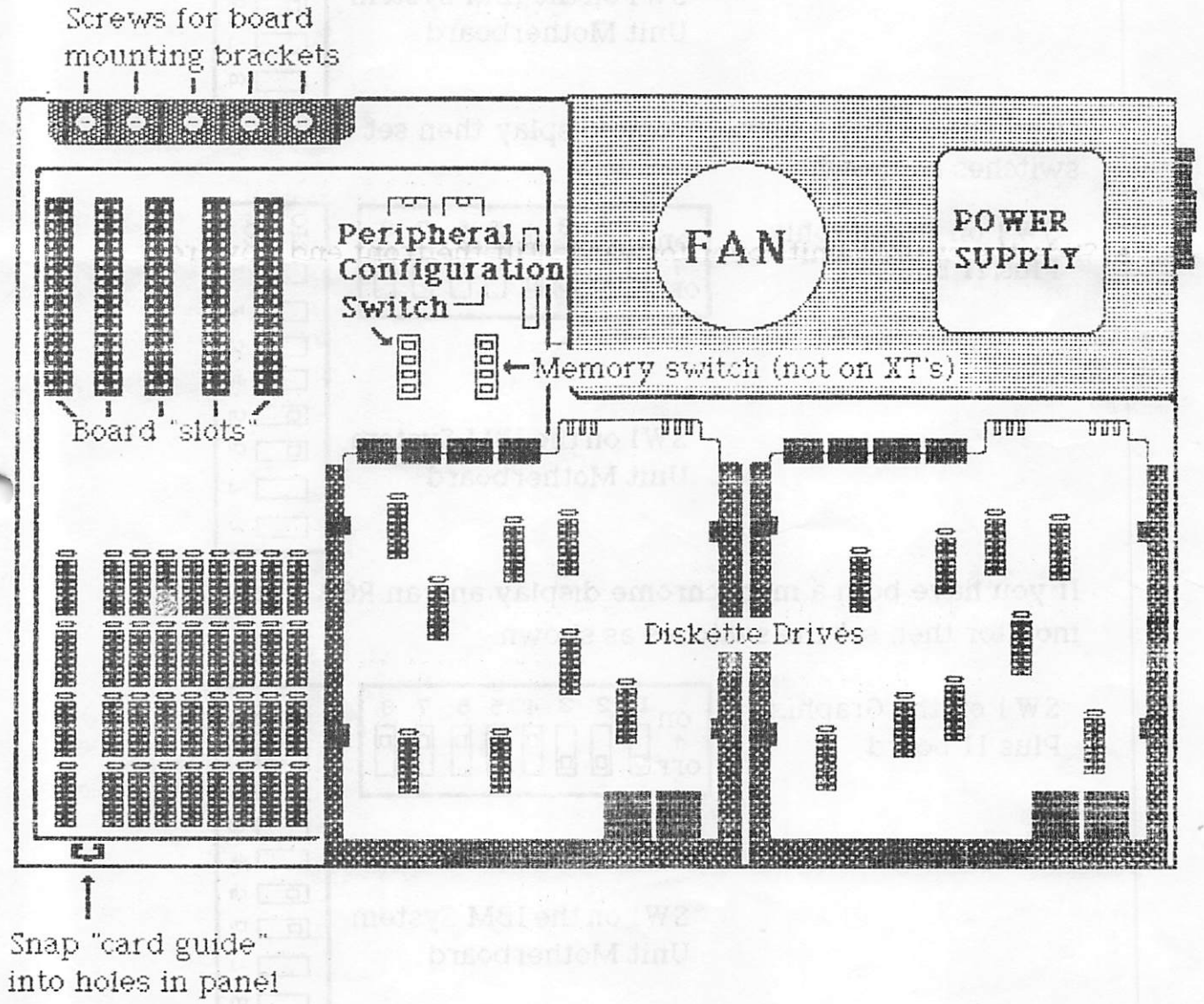
- **Unplug System Unit and all attachments**
- Remove screws marked with a ✔
  (some systems have only the bottom screws)



- Slide the system unit cover forward. Tilt the front end upward and lift the cover off.



- **Set positions 5 & 6 of the peripheral configuration switch as shown in the examples.**
- Remove screw holding cover plate over slot opening
- Remove cover plate.
- Snap "card guide" into holes in front panel
- Insert Graphix Plus card into desired slot. Make sure it is firmly and evenly seated in the connector. Back of card should be held by the card guide.
- Route printer cable, if used, to an unused slot cover or through board mounting bracket if no unused slots.
- Replace screw through board hole in board mounting bracket.
- Double check your work, replace the system unit cover, and replace the screws in the rear panel.

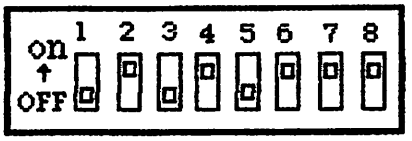


Example Switch Settings

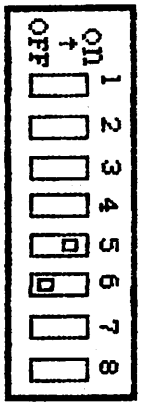
These switch settings assume that the Graphix Plus II is the only display adapter installed in the computer.

If you have only a composite video display or an RGB color display then set the switches as shown:

SW 1 on the Graphix Plus II board

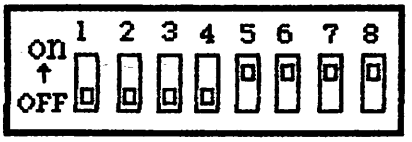


SW1 on the IBM System Unit Motherboard

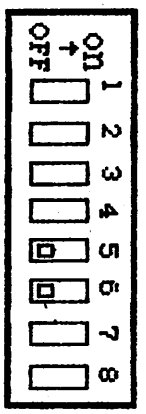


If you have only a monochrome display then set the switches as shown:

SW 1 on the Graphix Plus II board

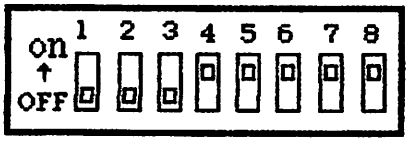


SW1 on the IBM System Unit Motherboard

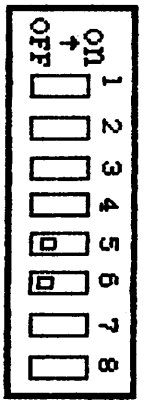


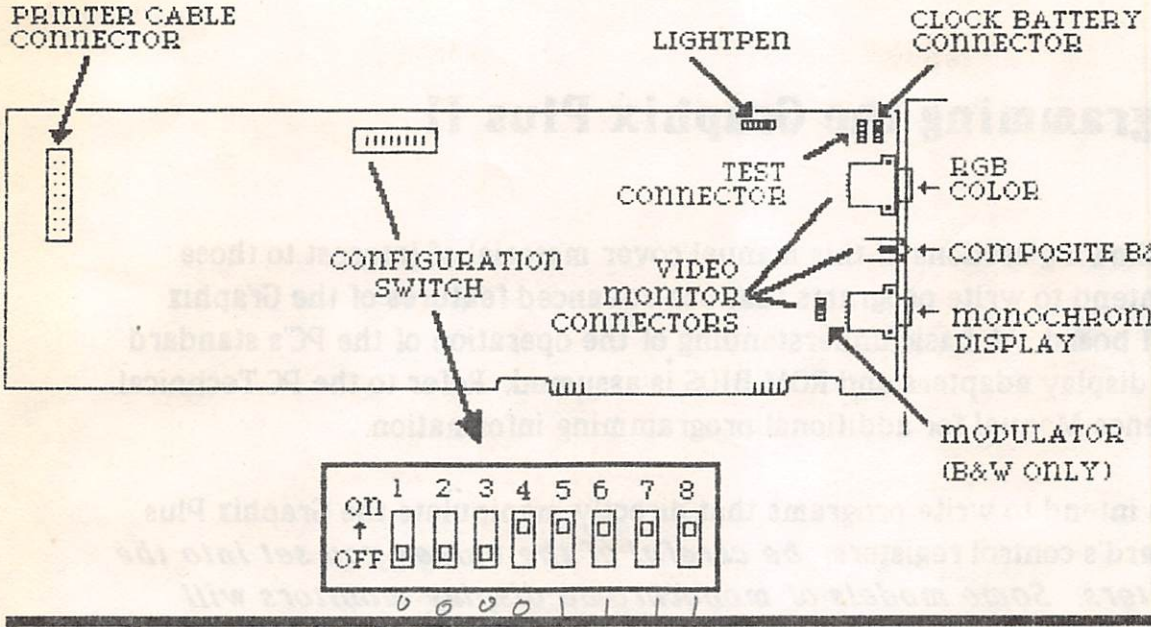
If you have both a monochrome display and an RGB color monitor then set the switches as shown.

SW 1 on the Graphix Plus II board



SW1 on the IBM System Unit Motherboard





1	OFF	Parallel port is a PRINTER port.
	On	Parallel port is SASI/SCSI port.
2-3	OFF-OFF	Board responds as BOTH MONOCHROME and COLOR adapter cards. Automatic monitor switch.
	OFF - On	Monochrome display adapter only.
	On - OFF	COLOR/GRAPHICS adapter only.
	On - On	Board responds the same as the GRAPHIX PLUS I board in monochrome graphics mode
4	On	Video output signals switch automatically to the monitor currently in use by the software
	OFF	All video signals (including graphics) are sent ONLY to the monochrome display connector
5	On	Disable Monochrome Video when the Monochrome Display is OFF
	OFF	Monochrome Video always enabled
6, 7 8		These three switches control which colors are sent to the monochrome display (6=RED, 7=GREEN, 8=BLUE). On sends the color, OFF blocks it.

Programming the Graphix Plus II

The following sections of this manual cover material of interest to those who intend to write programs that use advanced features of the Graphix Plus II board. A basic understanding of the operation of the PC's standard video display adapters and ROM BIOS is assumed. Refer to the PC Technical Reference Manual for additional programming information.

If you intend to write programs that directly manipulate the Graphix Plus II board's control registers, ***be careful of the values you set into the registers. Some models of monochrome display monitors will blow their fuses or otherwise be damaged if the display's sync signals are set improperly.***

The Graphix Plus II board can be divided into 5 major sections:

- Video mode switch
- 6845 CRT Controller Chip (CRTC)
- Control and Status registers
- 32Kb video display memory
- Parallel Printer/Clock

Video Mode Switch

Depening upon the settings of the Graphix Plus II's configuration switches (SW1-2 & 3) the Graphix Plus II can be configured as a monochrome (text only) adapter, a color/graphics adapter, or as both.

SW1		
2	3	Mode
OFF	OFF	Both adapters. Software controls adapter mode.
OFF	ON	Monochrome/printer adapter only
ON	OFF	Color/graphics adapter only
ON	ON	Special purpose color adapter

In color/graphics mode the RGB color monitor and composite video monitor connectors will receive the Graphix Plus II's picture. The monochrome display connector will be turned off.

In monochrome/printer adapter mode, the board will send the video to the monochrome/display connector only. The RGB and composite video connectors are turned off.

If the Graphix Plus II is set to respond as either adapter, any I/O accesses at the monochrome/printer adapter's 6845 CRTC register addresses will switch the board into ***monochrome/printer adapter mode*** and any accesses to the color/graphics adapter's CRTC registers will place the board into ***color/graphics adapter mode.***

The Graphix Plus II has a single 6845 CRTC controller. The CRTC's display and sync control registers must always be reset to match the monitor that is selected. Appendix A of this manual gives typical register setup values for common display modes.

If SW1-4 on the Graphix Plus II is turned OFF, all video (including graphics) will be sent to the monochrome display monitor and the RGB monitor connector will be turned off. This switch setting is needed if graphics are to be displayed on a monochrome display monitor. In this mode no video is sent to the RGB color monitor connector.

Throughout the rest of this manual, I/O control register addresses are given as two hex numbers in parentheses:

(MON/COL)

The first number is the address that monochrome/printer adapter responds to and the second number is the color/graphics adapter address. Individual register bits are referred to as a 2 hex digit a "bit-mask."

CRT Controller Chip

The 6845 CRT Controller Chip (CRTC) is the main control circuit of the Graphix Plus II board. It produces all the timing, control, synchronization, and display addresses for the board.

CRTC Address Register (3B4/3D4)

The CRTC contains 18 control registers. These registers control the timing position and width of the monitor sync pulses, display, text cursor, and light pen. The registers are accessed by first outputting the number of the register to be accessed (0-17) into the CRTC Address Register. This register is write-only. Its value cannot be read back by software.

CRTC Data Register (3B5/3D5)

Once the CRTC address register has been set to the number of the CRTC register to be accessed (0-17), the register's data value is written or read via this I/O address. The registers are described briefly below. For a full description refer to a 6845 CRTC data sheet.

6848 CRTC Register Definitions

Reg	R/W	FUNCTION
0	Write	HTOTAL - Total number of character cells per scan line minus 1. The MODE register clock rate control bit (01) sets the timing of each character cell on the scan line This register thus determines the frequency of the horizontal sync pulses and scan lines.

1	Write	HDISP - Total number of characters displayed per character row. Display memory WORDS from 0 to HDISP-1 are displayed. Cells from HDISP to HTOTAL-1 used for sync pulses and screen border area. HDISP is added to the video RAM display address after each character row has been displayed. In graphics applications each SCAN LINE within the character row temporarily increments the display address 8192 bytes.
2	Write	HSPOS - contains the character cell location of the start of the horizontal sync pulse. As this register is increased in value the picture is shifted left on the screen.
3	Write	WIDTH - the lower four bits of this register determine the width of the horizontal sync pulse. Its value may range from 0-15 character cells. The character cell time is detemined by bit 01 in the MODE register. The upper four bits should be set to 0's.
4	Write	VTOTAL - This register is set with the total number of character ROWs (0-127) per frame of video. This register together with the MAXSCAN register (R9) determine the coarse frequency of the vertical sync pulse.
5	Write	VADJ - This register sets the number of extra scan lines to add to each video frame (0-31). It is used to "fine-tune" the frequency of the vertical sync pulse.
6	Write	VDISP - This register determines the number of character ROWS (0-127) that are shown on the screen.

7	Write	VSP - This register contains the character row number of the start of the vertical sync pulse (0-127). Increasing the value of this register will move the picture UP on the screen.
8	Write	INTERLACE - For normal, non-interlaced use set this register to the value "2".
9	Write	MAXSCAN - This register is set with how many scan lines tall each character row is minus 1.
10	Write	CURSOR START - The lower 5 bits of this register should be loaded with the scan line number of the character cell where the text cursor should start (0-31). If the upper three bits of this register are set to "001XXXXX" then the cursor is turned off.
11	Write	CURSOR END - This register is loaded with the number of the last scan line of the text cursor (0-31). By changing the values in register R10 and R11 the shape of the text cursor can be changed from an underline to a block, dash, etc.
12 13	Write	START ADDRESS - These two registers contain the number of WORDS in the display RAM buffer to skip before starting the display. R13 is the lower 8 bits of the WORD (2 byte) count. R12 is the upper 6 bits.
14 15	Rd/Wrt	CURSOR ADDRESS - These two registers contain the WORD offset of the character/attribute word in display RAM where the flashing text cursor should appear. R15 is the lower 8 bits of the WORD count. R14 is the upper 6 bits.
16 17	Read	LIGHTPEN ADDRESS - These registers contain the 14 bit WORD offset of the character location in display RAM where the light pen detected a "hit". R17 is the lower 8 bits of the WORD count. R16 is the upper 6.

Mode Control Register (3B8/3D8)

The MODE register is a 6 bit register that controls the basic operating mode of the Graphix Plus II board. This register is a write only register. The value stored in the register cannot be read back.

BIT	FUNCTION
01	Video Clock Rate Control - when set to a "0" the video data is shifted out at a 7.15909 Mhz dot (pixel) rate. The character CRTC character clock rate is 1.12 microseconds/char. This is used for 40 column text displays and the standard IBM graphics modes. When set to a "1" the dot clock rate is 14.31818 Mhz and the character rate is 0.560 microseconds/char. This is used for 80 column text displays and the high resolution 16 color and 4 color graphics modes.
02	Graphics Enable - When set to a "0" the board is in TEXT mode and the video display is produced via the CHARACTER GENERATOR read-only-memory. When set to a "1" the video display is produced by the bit-mapped GRAPHICS generator circuitry. If software operates the board at the Monochrome Display addresses, this bit is ignored and the display is forced into TEXT mode.
04	This bit is only used in the 4-color graphics modes. It should normally be set to a "0". If set to a "1" the CYAN/MAGENTA/WHITE pallette is changed to CYAN/RED/WHITE.

08 Video Enable - When set to a "0" the video displays are turned off. The monochrome display SYNC signals are set to the "OFF" state and all video outputs are turned OFF.

When set to a "1" the video display is sent to the active video monitor.

The setting of this bit is forced to a "1" whenever software configures the board for 80 column text displays in COLOR/GRAPHICS adapter modes.

10 640 Dot Graphics Enable - When set to a "0" the graphics display circuitry is set to display a picture with 320 dots/line. Setting this bit to a "1" produces a 640 dot display. This bit is used only when the GRAPHICS bit (02) is set to a "1".

20 Blink Enable - When set to a "0" text characters cannot blink, but can be shown with up 16 different background colors. When set to a "1" the character background color intensity for all characters is determined by bit 10 of the COLOR register described below and BACKGROUND INTENSITY bit (80) of the display RAM character attribute byte will control the blinking of the character (if set, the character will blink).

This bit is used only when the GRAPHICS bit (04) is set to a "0".

Color Control Register (3B9/3D9)

This register is a 6 bit write-only register that controls the color processing circuitry.

BIT	FUNCTION
01	BLUE
02	GREEN
04	RED
08	INTENSITY - In TEXT modes these four bits control the color of the screen border area. In 4 color GRAPHICS modes they control the color of the BACKGROUND color (00) pixels.
10	In TEXT modes this bit controls the character background intensity of all the characters on the screen if the BLINK bit (20) is set in the MODE register. In 4-color GRAPHICS modes this bit controls the INENSITY of the foreground color set. A "1" selects high intensity colors, a "0" selects normal.
20	In 4-color GRAPHICS modes this bit selects which of two color "pallettes" is displayed. When set to a "0" the available colors are BACKGROUND/GREEN/RED/BROWN. A "1" selects BACKGROUND/CYAN/MAGENTA/WHITE. This bit is ignored in all other modes.

STATUS Register (3BA/3DA)

This is a 4 bit read only register that software can check to determine various information about the display.

When read at the MONOCHROME Adapter address (3BA) the following information is returned:

BIT	FUNCTION
01	HSYNC - The current state of the display monitor horizontal sync pulse can be monitored here. A "1" indicates the pulse is active.
02	Always "0".
04	Always "0".
08	VIDEO DOTS - When read as a "1" the display is showing a lighted pixel. When read as a "0" the display is showing an unlighted pixel. This information helps diagnostic programs test the operation of the board.

When this register is read at the COLOR/GRAPHICS address (3DA) the following information is returned:

BIT	FUNCTION
01	DISPLAY INACTIVE - Set to a "1" when the display beam is in the SYNC or BORDER areas of the display. This bit is a "0" during the active portion of the display. Note that the GRAPHIX PLUS II display memory can be accessed at any time without causing "snow" to appear in the picture. Programs that wait for this bit to be set before accessing the display memory will run much faster if they are modified to NOT wait on this bit.

02 LIGHT PEN "HIT" - When this bit is a "1", the light pen circuitry has detected a "hit" where the display beam has passed under the pen's light sensor. The location of the hit on the screen can be calculated from the values in CRTC registers **R16** and **R17**. After reading the CRTC registers the light pen data latch must be cleared. See the next section for details.

04 LIGHT PEN SWITCH - While this bit is a "1", the light pen trigger switch is OPEN. While this bit is a "0", the switch is CLOSED (pressed).

08 VSYNC - While this bit is a "1", the display beam is within the vertical sync area. This information is useful for special animation effects, etc.

Clear Light Pen Hit (3BB/3DB)

Accessing this I/O location will clear the light pen "hit" latch. The register must be either read or written after any light pen hit before another hit can be detected. The data value read or written is not used for anything.

Force Light Pen Hit (3DC)

Accessing this I/O location will set the light pen "hit" latch, simulating a pen "hit". This register is used by diagnostic software for checking out the board when no light pen is connected. The actual data value read or written is not used for anything. Note that this register is not available if software has the Graphix Plus II set to Monochrome Display/Printer Adapter mode.

Printer Data Register (3BC/278*)
Printer Status Register (3BD/279*)
Printer Control Register (3BE/27A*)
Clock Control Register (3BF/27B*)

* Addresses used if SW1 is set for color/graphics only

Video Display Memory

The Graphix Plus II board has 32 kilobytes (Kb) of dual-ported video display memory shared between the PC's expansion bus and the 6845 CRTC video display controller. The bus may access the video memory at any time without causing any "snow" to appear in the picture. The board may generate 0-2 wait states depending upon the timing of the memory request. The video display memory supports DMA (direct memory access controller) requests.

Software using the monochrome display/printer adapter accesses the 32Kb of video display memory at **segment address B000**. Color/graphics adapter software accesses the 32Kb of memory at **segment address B800**.

If the Graphix Plus II is set to respond as both a monochrome and color adapter the 32Kb of memory shows up at both segment addresses, however the memory appears to the system as a pair of contiguous16Kb blocks (A and B) at the following segment addresses:

Segment Address	Memory Block
B000	A
B400	B
B800	B
BC00	A

This arrangement keeps the IBM standard monochrome and color/graphics video display memory addresses in different 16Kb blocks. The color/graphics data overwrites the monochrome adapter data only when the extended resolution display modes are used.

The standard IBM Color/Graphics Adapter memory appears to the system as a single16Kb block of memory duplicated at segments B800 and BC00. The Graphix Plus II has independent 16Kb memory blocks at these segments. *Software that expects the same data to appear in both 16Kb segments may need to be modified to work with the Graphix Plus II's extra memory.*

The CRTC sequentially accesses the video display memory, fetching and displaying a16-bit word of data every 560 or 1120 ns, depending upon how the CLOCK RATE bit (01) of the MODE register is set. The MODE register also determines how this word of data will appear on the screen.

The Graphix Plus II has two basic modes of displaying the video memory word, **Text** and **Graphics**. Bit 02 of the MODE register determines the mode.

Text Mode

If bit 02 of the MODE register is low, the board is in TEXT mode and the word of video data is sent to the CHARACTER GENERATOR logic.

The even byte of each word contains the number of the character to display. The IBM standard character set contains 256 unique characters numbered from 0-255.

The odd byte (attribute byte) determines the color or shade of the character dots and their surrounding background. The lower four bits contain the color code of the character's dots. The upper four bits determine the color of the dots in the character matrix that surround the character outline.

Even Byte - Character Code	**Odd Byte - Character Color**
Bits 7 6 5 4 3 2 1 0	**Bits 7 6 5 4 3 2 1 0**
character code 00 - FF	**I* R G B** **I R G B**
	BACKGROUND **FOREGROUND**

Sixteen unique colors are available for the foreground or background colors. These colors are formed by combining the the basic colors Red, Green, and Blue along with an optional Intensity bit.

Available Colors

COLOR CODE	SCREEN COLOR
0	Black
1	Blue
2	Green
3	Cyan (pale blue)
4	Red
5	Magenta (purple)
6	Brown (yellow)
7	White
8	Dark Grey
9	Bright blue
10	Bright Green
11	Bright Cyan
12	Bright Red
13	Bright Magenta
14	Bright Yellow
15	Bright White

- Some color monitors ignore the Intensity signal and colors 8-15 appear the same as 0-7.

- Composite monitors show the colors as 15 increasingly bright shades of grey (color 8 is about the same shade as color 1)

- Monochrome display monitors show only 3 colors (OFF, NORMAL, and BRIGHT). Color 1 produces an UNDERLINE on scan line 12 of the character if the CRTC MAXSCAN register is set to 13 or above.

- By properly combining foreground and background colors special effects such as reverse video, hi-lighting, and hidden text can be obtained.

Blinking Text

The background intensity bit (80 or ODD bytes) in the video display word is shared with the character BLINK logic. If bit 20 of the MODE register is a "0", then all 16 colors are available for character backgrounds. If the bit is set to a "1", the background intensity bit (80) is changed to be a "BLINK CHARCTER" bit and the background intensity for ALL characters is supplied from bit 10 of the COLOR register.

Character Generator ROM

The patterns of dots that make up the characters that the STB Graphix Plus II displays in text modes are stored in a computer chip called a read-only-memory or ROM. The character generator ROM actually contains the patterns for TWO sets of 256 characters. The first 256 characters (4096 bytes) contains the color graphics adapter characters. The next 256 characters (4096 bytes) are the monochrome display adapter characters. *The board automatically switches between the character sets based upon how the 6845 CRT controller chip MAX SCAN LINE register (R9) is programmed. Values less than 10 will select the color graphics set. Values of 10 or above will select the monochrome display set.*

The color graphics adapter set shows characters as an 8 by 8 matrix of closely spaced dots. The monochrome character set is formed in an 8 by 14 matrix. Each byte in the EPROM contains one scan line of 8 dots for a character. Each character is stored in the EPROM as a 16 byte block; the patterns for each character are aligned in the first 8 or 14 bytes of the 16 byte blocks. Since there is no spacing between adjacent character cells on the screen, continuous line and block graphics characters are easily made.

The contents of the standard ROM supplied with the boards cannot be changed. For applications that require a different or customized character set the standard ROM chip (the 28 pin device on the Graphix Plus II board labeled **STB CGEN**) may be replaced by a user programmable part called an EPROM (Erasable Programmable Read Only Memory). The EPROM used

on the Graphix Plus boards is an indutry standard 2764 type device with an access time of 450nS (nanoseconds) or faster. This type of device contains 8K bytes of data. The contents of an EPROM may be erased by exposing it to ultraviolet light. A device called an EPROM Programmer may be used to write new data into an erased EPROM.

Graphics Modes

If bit 02 of the MODE register is set to a "1" and the Graphix Plus II board is operating as a Color/Graphics adapter, then the video display words are shown on the screen as a series of independently colored dots. Depending upon the settings of the 640 GRAPHICS (10) and CLOCK RATE (01) bits in the MODE register , the Graphix Plus II will show these 16 bits in one of 4 basic ways:

MODE Reg Bit 10	01	Graphics Resolution	
1	0	16 pixels of 2 colors	(640 x 200/352 x 2 color)
1	1	8 pixels of 4 colors	(640 x 200 x 4 color) *
0	0	8 pixels of 4 colors	(320 x 200 x 4 color)
0	1	4 pixels of 16 colors	(320 x 200 x 16 color) *

* Modes not available on the standard IBM Color/Graphics Adapter. These modes use all 32Kb of the display RAM. The standard IBM modes use16Kb.

In **two color mode**, each bit in the word produces one dot on the screen. The dot is always black if the bit is a "0". Bits set to a "1", produce dots of the color indicated by the BACKGROUND bits (08, 04, 02, & 01) of the COLOR register.

	Even Byte								Odd Byte							
Bit:	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	C0	C0	C0	C0	C0	C0	C0	C0	C0	C0	C0	C0	C0	C0	C0	C0

Sixteen color mode divides each 16 bit word into 4 "nibbles" of 4 bits each. The four bits of each nibble represent the color number (0-15) as

shown in the color table in the TEXT section above. This arrangement is the same as the PCjr's 320x200x16 color mode.

	Even Byte								Odd Byte							
Bit:	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	C3	C2	C1	C0	C3	C2	C1	C0	C3	C2	C1	C0	C3	C2	C1	C0

The **four color modes** treat each word as 8 pixels of 2 adjacent bits (C1 and C0). Each pair of bits produce a dot that can be one of four colors. Bit 20 in the COLOR register and bit 04 in the MODE register select one of three available "pallettes" of four colors. Setting bit 10 in the COLOR register will intensify all the foreground colors on the screen.

	Even Bytes								Odd Bytes							
Bit:	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	C1	C0	C1	C0	C1	C0	C1	C0	C1	C0	C1	C0	C1	C0	C1	C0

Register Bits		Pixel	
COLOR	MODE		
20	04	C1 C0	COLOR
0	0	0 0	COLOR Reg BACKGROUND bits
or		0 1	Green
0	1	1 0	Red
		1 1	Brown
1	0	0 0	COLOR Reg BACKGROUND bits
		0 1	Cyan
		1 0	Magenta
		1 1	White
1	1	0 0	COLOR Reg BACKGROUND bits
		0 1	Cyan
		1 0	Red
		1 1	White

In all graphics modes, the CRTC chip should be programmed to display either 100 character rows of 2 scan lines per row (for IBM standard

resolutions of 320 x 200 x 4 color and 640 x 200 x 2 color), or 50 character rows of 4 scan lines per row (for the extra modes of 320x200x16 color and 640x200x4 color).

The 640x352x2 color full screen monochrome graphics mode requires 88 character rows of 4 scan lines per row, with the MODE and COLOR registers programmed the same as for the IBM standard 640x200x2 color mode. This mode is only available if the Graphics Plus II configuration switch SW1-4 is set to OFF, sending the color/graphics adapter's picture to the monochrome display monitor. You cannot use a composite video monitor or RGB color monitor with this switch turned OFF.

The CRTC chip produces a series of sequential addresses as it fetches display words for each scan line of the picture from video memory. Note however that each scan line within every character row is offset in the video memory 8192 bytes (2000 hex) from the preceeding scan line of the character row.

Character Row Scan Line No.	Offset from start of buffer
00	&H0000
01	&H2000
02*	&H4000
03*	&H6000

* These higher resolution modes require all 32Kb of video display memory. The monochrome adapter screen memory block is used to store the extra graphics data.

This arrangement of scan line address offsets is compatible with both the regular PC graphics and the PCjr high-resolution graphics modes.

Graphix Plus II - Typical Register Values

Resolution: / Adapter Mode: / Text/Graphics:	80 x 25 Monochrome Text	80 x 44 Monochrome Text	640x352x2 Monochrome Graphics	40 x 25 Color Text	80 x 25 Color Text	640x200x2 Color Graphics	320x200x4 Color Graphics	640x200x4 Color Graphics	320x200x16 Color Graphics
R0 - HOR TOTAL	61	61	31	38	71	38	38	71	71
R1 - HOR DISP	50	50	28	28	50	28	28	50	50
R2 - HSYNC POSN	52	52	29	2D	5A	2D	2D	59	59
R3 - HS WIDTH	0F	0F	08	0A	0A	0A	0A	0C	0C
R4 - VERT TOTAL	19	2E	5C	1F	1F	7F	7F	3F	3F
R5 - VERT ADJ	06	06	06	06	06	06	06	06	06
R6 - VERT DISP	19	2C	58	19	19	64	64	32	32
R7 - VSYNC POSN	19	2C	58	1C	1C	70	70	38	38
R8 - INTERLACE	02	02	02	02	02	02	02	02	02
R9 - MAX SCAN	0D	07	03	07	07	01	01	03	03
R10-CUR START	0B	06	06	06	06	06	06	06	06
R11-CURSOR END	0C	07	07	07	07	07	07	07	07
R12-START (H)	00	00	00	00	00	00	00	00	00
R13-START (L)	00	00	00	00	00	00	00	00	00
R14-CURSOR(H)	00	00	00	00	00	00	00	00	00
R15-CURSOR(L)	00	00	00	00	00	00	00	00	00
MODE REG	29	29	1E	2C	2D	1E	2A	1B	2B
COLOR REG	30	30	2F	30	30	3F	30	30	30

Notes:

* All values given are in HEX

* For monochrome TEXT modes use CRTC I/O addresses 3B4(R#) and 3B5(value)
  MODE reg I/O addr of 3B8
  COLOR reg I/O addr of 3B9

* For color text and ALL graphics modes use CRTC addr 3D4(R#) and 3D5(value)
  MODE reg addr of 3B8
  COLOR reg addr of 3B9

Cntrl alt esc
= Setup