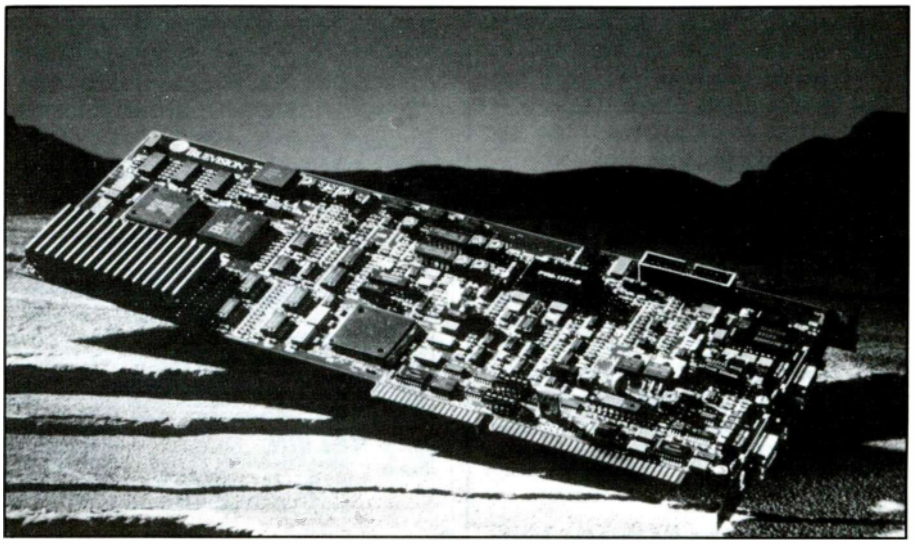
VGA To The Max
Part 1

A Look at Inexpensive Near-True Color Graphics and Windows Accelerators

You're probably aware by now of a quiet revolution—or evolution—spreading throughout the PC industry. It isn't *Windows*, but the long-awaited improvements in hardware and software that *Windows* 3.0 and other windowing graphical user interfaces (GUIs) have inspired. Integration gave *Windows* its sudden popularity. Long the exclusive desktop domain of the Apple Mac GUI, system integration under *Windows* simply means that all applications written for it essentially look and work alike. And integration goes all the way down to the hardware level.

Once *Windows* is configured for a particular PC, all applications for it follow suit. This is especially convenient with regard to the graphics controller being used. Set up *Windows* for 640 × 480 × 256-color resolution, and all applications within it adjust themselves accordingly. When you upgrade your graphics card, simply run the *Windows* Setup, install the appropriate driver, and the next time *Windows* is launched, everything appears in the new graphics mode. This means that *Windows*, by design, will take full advantage of a given graphics adapter, provided the appropriate software driver has been installed to support it.

To make things even more interesting, most graphics-intensive *Windows* applications like *PageMaker, Windows Paint, Ventura Publisher, Publisher's Paintbrush, ImagePrep, Excel,* etc., provide full support (display and editing) of 24-bit true color image files (originally, Truevision's 24- and 32-bit Targa formats).



Truevision's TARGA+ Graphics Engine.

"True color" refers to the fact that the human eye can't distinguish subtle differences among more than 256 shades of any given color. Each pixel within a 24-bit image is constructed from three eight-bit RGB (red, green and blue primary colors, each ranging in value from 0 to 256). This translates into a range of 16.7-million possible color combinations. The "possible" qualifier is used here because it would require a 24-bit resolution of 4,096 × 4,096 pixels to realize all these colors simultaneously. Images created and displayed in this pixel depth appear natural and lifelike.

The graphical PC cart is clearly ready, now what about an affordable horse to pull it?

This month, we discuss the latest trends in VGA technology. Next month, in the conclusion of this article, we'll present a brief but fairly comprehensive Glossary of Technical Terms commonly used in video display technology in general.

Evolving Graphics

Remember MDA, CGA and EGA? The same thing appears to be happening to VGA, with the exception that instead of disappearing altogether, it's evolving again. Originally, IBM tried to give the PC true high-resolution analog RGB graphics with the professional graphics adapter (PGA). However, its acceptance was limited largely because it was never really a standard, it was expensive at around $2,000 and it was hardware-inefficient because it required two full-length expansion cards to implement.

A far better solution came with the video graphics array (VGA) for IBM's line of PS/2 computer systems. Promising a true analog graphics solution at reasonable cost, VGA quickly became an easily cloned standard that has been greatly enhanced over the past few years. Originally offering 256 on-screen colors, or "attributes," only in a very chunky 320 × 200-pixel resolution, chip makers quickly pushed this resolution up to 800 × 600 pixels SVGA (super-VGA) and beyond by increasing the video page buffer to 512K and then to 1M.

Although these extended-VGA modes were essentially proprietary with respect to a given graphics controller (these non-standards are quickly giving way to the new guidelines laid down by the Video Electronics Standards Association, or VESA), software drivers are shipped with these graphics cards to provide support for numerous popular applications packages. However, recent releases of programs like *Windows* and applications written for its environment are beginning to make 256-color VGA (pseudo-color) appear dated.

Unlike EGA, though, SVGA still has a lot of life left. Rather than discard SVGA in search of a new platform, innovative semiconductor houses are breathing new life into what has turned out to be a very versatile approach to PC graphics.

More Enhancements

One of the more-elegant and most-promising means of boosting the color performance of VGA graphics is HiColor, a registered trademark of its developer, Sierra Semiconductor. HiColor essentially permits existing VGA controllers to break the 256-color barrier via the exclusive HiColor line of color palettes (the more familiar term coined by Brooktree Corp. is RAMDAC).

Simply put, the VGA palette is a device with three on-chip D/A (digital-to-analog) converters and 256 bytes of RAM used for a color attribute look-up table that provide the RS-343A-compatible RGB outputs required to drive an analog color monitor.

Industry standard VGA palettes like Brooktree's BT471/476/478 series, with which HiColor is pin-for-pin compatible, can at best produce only eight-bit pseudo-color. Although VGA has 262,144 possible color combinations, it's restricted to displaying only 256 of these at any given time. To obviate this limitation, HiColor palettes cleverly bypass the look-up table to provide pixel depths of 15 and 16 bits, for 32K and 64K on-screen colors, approaching true-color output.

Often requiring little modification to an existing SVGA board design, other than a video BIOS upgrade and additional software drivers to support the available HiColor modes, the upward transition to HiColor for the graphics card OEM is a very easy one. This translates into an inexpensive upgrade path for consumers who want to obtain a perceived depth of color that approaches those of such prohibitively-expensive display adapters as the Truevision 1024-32.

As of this writing, HiColor boards are selling in the US for less than $200. Compare this with IBM's original 64 color EGA (false-color), which sold for $1,000-plus a just few years ago!

If you still aren't convinced of the merits of such enhancements, you probably haven't seen *Windows* or *AutoCAD* applications like *Renderman* and *AutoShade* running in HiColor mode.

Here's an experiment that stresses this point: If you currently use *Windows* in a 256-color SVGA mode, try opening two or more windows simultaneously with eight-bit (or greater) color images displayed within them. You'll be surprised to see all palette information for the inactive windows (those still visible but with tasks suspended) are temporarily discarded. Only the currently active window will appear to have its correct color information. This occurs because of that 256-attribute limitation of VGA.

Only one color map (virtually the entire contents of the 256-byte RAMDAC look-up table) can be assigned at any given time. If two or more different color images, each with its own unique color map, are to be displayed simultaneously, only one is given priority over the look-up table.

Interestingly, *Windows* seizes a few of the available color attributes for its own use when launched. These confiscated attributes are then used for coloring icons, window borders, etc., and are no longer made available to applications. Therefore, if *Windows* is running in, say, pseudo color mode, a number of those possible on-screen colors are lost. This isn't the case with HiColor because its viewable on-screen attributes aren't bound by VGA's 256-color limitation.

Under the Rainbow

Viewing a Targa image (or any 16-, 24- or 32-bit graphics file format) in HiColor mode is a real treat. Edges and color gradations within an image appear smooth and realistic (a sort of "anti-aliasing") when compared to the jaggies apparent in pseudo-color modes, with a depth that 256-color VGA can't begin to approach.

Also gone is the obvious "banding" that's apparent with pseudo-color when viewing true-color images under HiColor. Banding is an inability to smoothly gradate between light to dark adjacent shades of a given color. Images with large areas of like shades, such as blue skies and water, readily display this anomaly as strips or "bands" of stepped colors, instead of a more realistic, smooth transition from light to dark shades.

Although some color/detail-complex eight-bit graphics images can look quite good, they quickly pale next to 16- and 24-bit formats with which you can work under a HiColor-enhanced video system.

Proof of the increasing popularity of HiColor is evidenced by its support in the shareware arena with Version 4.6 of Bob Montgomery's perennial VPIC. Originally a GIF image-only (Compuserve's Graphics Interchange Format) viewing program, VPIC is now configurable for HiColor cards that utilize the Tseng Labs ET4000 controller and supports a broad range of image formats. VPIC Version 4.6 lets you view and manipulate 16- and 24-bit Targa files on your PC in 32K HiColor mode, while maintaining support for lesser graphics platforms.

If there's a down side to HiColor, it's the fact that it can marginally slow down graphics throughput. This is because there's a lot more color information to be processed when compared to 256-color graphics. Just how great the slowdown will be depends on the graphics controller you use with the HiColor palette. It's applicable when in HiColor mode. In all other modes, display speed is unaffected. If the graphics card in question makes use of VRAM (dual-port DRAMs), the slowing effect of HiColor is virtually nil when compared to 256-color modes at the same resolution.

HiColor a Standard?

If imitation is the sincerest form of flattery, copying the other guy's chip means you have a sure winner. Such is the case with HiColor. As of this writing, at least one semiconductor house (Music Semiconductor, a Dutch company with a sales and marketing office in Colorado) has announced a color palette (MU9C1715) claiming 8-, 16- and 18-bit color support. It seems targeted at Sierra's HiColor market. It remains to be seen if this new chip will succeed.

The MU9C1715 is available only in a 44-pin plastic leadless chip carrier (PLCC) package (industry standard palettes are packaged almost exclusively in 28-pin DIPs) and requires additional "glue" logic to implement on existing SVGA designs. Such shortcomings aren't suffered by HiColor.

VGA On Steroids

Windows and other GUIs make the most of a given hardware installation by pushing a system to its performance limits. Minimal system memory, slow hard disks and inefficient graphics controllers can all add bottlenecks to *Windows,* making it agonizingly slow to respond to your input.

I've seen 33-MHz 386DX-based PCs running *Windows* with a poorly designed SVGA system and it was nearly comedic (or tragic, depending on how you look at it). Opening or closing a window in 1,024 × 768 × 256-color mode was akin to using venetian blinds. You could actually see individual strips of each window being drawn! Although the software driver was probably just as much at fault as the controller chip itself, this was an object lesson in how power-hungry *Windows* truly is.

On the other side of the coin, there are truly speedy VGA controllers like the Tseng Labs ET4000/AX. Arguably the fastest non-coprocessed VGA controller available, the ET4000/AX performs exceptionally well with HiColor under *Windows*. Even without the added advantage of VRAM, an ET4000/AX is capable of driving noninterlaced 1,024 × 768 × 256 displays by accessing normal DRAM memories in zero wait-states and providing full support of faster throughput VRAM memories if incorporated into the board design.

Getting Ergonomic

Although a *Windows* driver alone won't automatically enable a noninterlaced 1,024 × 768 display, most of these boards are bundled with controller-specific utilities that sense when 800 × 600 or 1,024 × 768 display resolution has been invoked. They then take appropriate action to enable noninterlacing by increasing the rate at which the screen refreshes.

Pushing VGA performance even further are the new generation of *Windows* accelerators. Unlike true coprocessed graphics engines like those that incorporate a dedicated RISC processor or the Texas Instruments' TI34010 and TI34020 vectored-graphics processors (TIGA) familiar to high-end CAD workstations (that require a separate, standard VGA controller to maintain boot-up VGA compatibility), the new *Windows* accelerators are targeted specifically at GUIs.

Lacking the vector processors mentioned above, these latest controllers are essentially built around superset VGA cores with on-chip engines to perform rectangular bit-block transfers (BitBlts) and line draws, which are the two most CPU-intensive graphics calls in *Windows* and similar GUIs.

Surprisingly, these accelerators can often outperform the TIGA cards when it comes to running *Windows*. This can likely be attributed to the fact that both approaches differ greatly in design philosophy and target markets. While the TIGA or RISC-based platforms are optimized for the vectored graphics world of CAD, *Windows* accelerators are optimized for the raster-

WHEN YOU'VE FINISHED YOUR ESSAY, PUT YOUR NAME ON YOUR FLOPPY DISK AND PASS THEM FORWARD.

based, bit-map world of GUIs.

By relieving the host CPU of such mundane tasks as redrawing a window (BitBlts) and its border (linear line draws), perceived graphics speed and overall system throughput is markedly increased. One of the hotrods in this rapidly expanding field comes from a company called S3 (pronounced S-cubed), which supports HiColor.

I recently had the opportunity to witness an impressive "*Windows*" demo of an S3 Carrera-based graphics card (sans HiColor) given by a marketing team that really showed what these chips can do. Performing in 1,024 × 768 × 256 noninterlaced mode, this single-chip controller (the demo board, looking like any typical SVGA card, with no 8514/A processor) was literally snapping windows open and slamming them shut. Even text writes within *Windows* were nearly instantaneous. A platform like this equipped with HiColor would make using *Windows* a very pleasurable experience indeed.

The first of these S3-based graphics accelerators to become commercially available is the Fahrenheit 1280 graphics card from Orchid Technology ("1280" presumably refers to the 1,280 × 1,024 × 16 *Windows* 3.0 driver under development). Priced at less than $500 (with a HiColor upgrade to be made available), the 1280 is definitely worth considering.

Another hot contender to watch for is the recently announced ET4000/X32 graphics engine from Tseng Labs. These chips are a superset of the existing ET4000/AX controller with BitBlts in hardware (up to 30 times faster than block transfers performed in software, according to Tseng Labs), hardware line drawing, area fills and more. The new controllers will also support 2M of video RAM, providing 1,024 × 768 XGA (64,000 colors) and 800 × 600 24-bit true-color (16.7-million colors) resolutions.

Other VGA controller manufacturers, like Weitek Corp. with its recently released W5086 engine, are currently planning their own graphics accelerators, or are already in production.

Unfortunately, monitor technology hasn't kept up with the current price-versus-performance pace of graphics cards. To take the fullest advantage of these cards requires relatively expensive multi-frequency analog monitors that can display 1,024 × 768 (or greater) noninterlaced resolutions with dot pitch (space between pixels) of 0.28 mm and smaller. If you plan to run *Windows* at this resolution, don't even think about diagonal screen sizes smaller than 16″. On a 14″ screen, for example, those cute little icons become unrecognizable at 1,024 × 768. And forget *Windows* word processing. Even with the aid of something like Adobe *Type Manager* or Bitstream's *Facelift*, word processing under *Windows* on a 14″ monitor at 1,024 × 768 resolution is like reading a newspaper at arm's length.

A resolution of 800 × 600 is bare minimum for seeing the full width of a standard page of text under *Windows*. Seeing even half the length of that same page puts you back at 1,024 × 768, something that's definitely 16″ territory to be usable over extended viewing sessions.

Prices for quality 16″ monitors are still hovering at around $1,000. Is it worth it? When you consider the significant reduction in eyestrain and fatigue and increase in productivity via true WYSIWYG displays that larger monitors offer (all items that should be of major concern to corporations), I'd have to say "yes." Unless you are on a really modest budget, don't even consider less than HiColor-equipped VGA for your next graphics card. For just a little more money, you can obtain a HiColor-ready *Windows* accelerator capable of meeting or beating the performance of those very expensive TIGA and RISC-based systems for bit-mapped GUIs.

Tune in next month, when we'll conclude with our Computer Graphics Glossary of Terms. ■

Companies Mentioned

Sierra Semiconductor
2075 N. Capitol Ave.
San Jose, CA 95132

Tseng Laboratories Inc.
10 Pheasant Run
Newtown Commons
Newtown, PA 18940

VPIC Version 4.6, $20
Bob Montgomery
543 Via Fontana No. 203
Altamonte Springs, FL 32714

Brooktree Corp.
9950 Barnes Canyon Rd.
San Diego, CA 92121

Truevision
7340 Shadeland Sta.
Indianapolis, IN 46256

S3 Inc.
2933 Bunker Hill Lane
Santa Clara, CA 95054

Orchid Technology
45365 Northport Loop W.
Fremont, CA 94538

PC-Generated Printed-Circuit Boards: Experiences With "PCBoards" Software

Dozens of programs on the market let you design printed-circuit boards directly on a PC/compatible computer. *PCBoards* ($99 postpaid) by Ralph A. Lindstrom may not be the most sophisticated or advanced, but it has about everything needed to produce professional-quality artwork that can be used directly to fabricate at home pc boards of professional quality.

Before looking at what *PCBoards* can do, let's review its limitation in its latest release. Because it doesn't permit pad spacing of less than 0.1", it can't be used to design a board that contains surface-mount ICs that have 0.05" pin spacing. Additionally, board size is limited to 6.05" × 13" maximum. Since the program doesn't do overlays, you must generate component-mounting guides by hand or with a separate general-purpose CADD program.

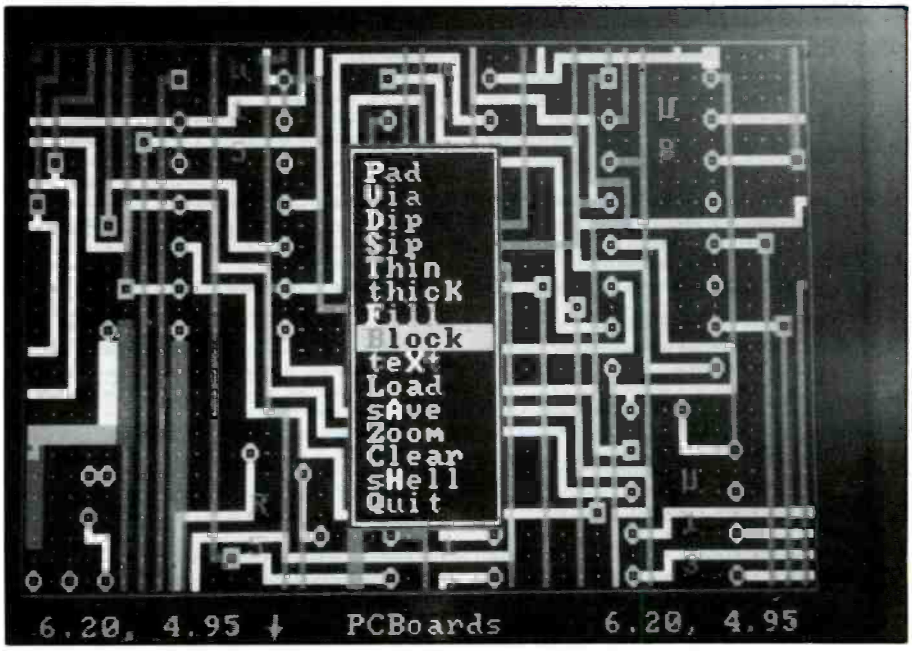
PCBoards doesn't come with a printed manual; it's a file on-disk. What it does have is an intuitive, game-like genius. It's good-natured and enjoyable to work with. It's one of those well-thought-out, simple programs that boosts your ego by turning you into an expert in half a day!

Despite its limitations, what *PCBoards* does provide for the design of most pc boards is more than enough. This program is capable of producing excellent art on a Hewlett Packard LaserJet II or compatible laser printer and can be used to design virtually any single- and double-sided pc boards you might require.

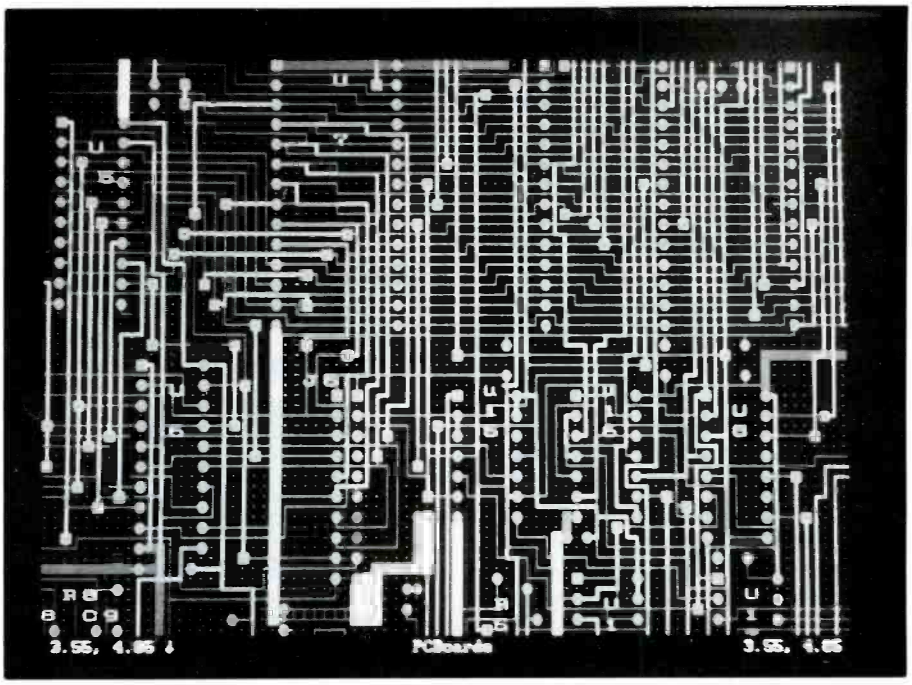
To run *PCBoards*, you need an IBM PC or compatible system with at least 384K of RAM and CGA or VGA graphics. DOS version 3.0 or later is recommended for use with the Shell option. While it isn't listed as a requirement, it seems foolish to run *PCBoards* without a color display. A mouse is nice, too, but it isn't required.

The latest version of *PCBoards* permits use of either CGA or VGA. I designed the MAG-11 single-board computer that appeared as a build-it-yourself project in the February issue of *ComputerCraft* using Version 1.65 of *PCBoards*, which supported only CGA. With VGA supported in the later Version 1.7, it should be even easier to do because more of the board will fit on the screen.

Its obvious I like *PCBoards*. I'm not completely smitten by it, though. While using this program, I discovered a few things I didn't like. One had to do with the



The PCBoards printed-circuit design package has a fairly rich lineup of commands from which to choose, as shown here in menu at center of screen.



A wide range of single- and double-sided pc layout patterns can be generated with PCBoards, from very simple designs to the fairly complex example shown here.