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Technical Product Summary

Professional/GX Workstations

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Table of Contents

Introduction **4**
Configuration Options **5**

Board Level Features
CPU 5
OverDrive™ Processor Socket
Memory 6
i486 Integrated Cache
Second Level Cache Option
DRAM Subsystem
FLASH EEPROM
SETUP Utility
Graphics Subsystem 9
Graphics Hardware / Software
SCSI Interface 13
Integrated Audio 14
Integrated I/O Devices 15
IDE Interface
Keyboard/Mouse Controller
Serial/Parallel Ports
Real Time Clock
CMOS Memory
Floppy Disk Drive

System Level Features
Chassis 18
Fans 18
Power Supply 18
AC Input and Output
DC Output and Current
Peripheral Carrier 20
Add-In Cards 20
Back Panel Connections 21

Appendices
A: Performance 22
B: Jumpers 23
C: Environmental Specifications 24
D: Reliability Specifications 25
E: Memory Map 25
F: Power Budget 25
G: I/O Map 26
H: CRT Parameters 27
I: Memory Upgrade Devices 28
J: Safety & EMI Certifications 29

Introduction

The Professional/GX is a powerful, highly integrated PC workstation which provides a unique combination of productivity-enhancing features for the professional PC user. Its CPU/Memory/Graphics core has been optimized to provide exceptional performance – performance that a user can *feel* – and ensures that users remain productive in today's and tomorrow's increasingly demanding computing environments. Integrated into this sleek machine is the power of accelerated local bus graphics, digital audio, and SCSI expansion, and the flexibility afforded by two EISA slots and one ISA slot. An innovative cableless chassis and power supply allow any system component, including the motherboard, to be field-replaced in minutes. A further benefit of high integration is the ease with which functions such as graphics, audio, and SCSI are configured via software, eliminating concerns about hardware compatibility and the need to deal with jumpers.

A choice of i486™ SX, DX, and DX2 CPUs, a highly efficient dynamic memory implementation, and two second level cache options offer a range of price-performance points today, while a second-generation OverDrive Processor Socket provides an upgrade path to the next generation of performance enhancing processors based on Intel's Pentium™ microprocessor technology. High performance I/O features such as local-bus accelerated graphics, EISA and SCSI-II buses ensure that the CPU and the user won't be constrained by the bottlenecks inherent in traditional PC designs. Integrated digital audio provides access to productivity-enhancing business audio capabilities available today in Windows 3.1, and forthcoming in future releases of other operating systems.

The heart of the Professional/GX is its tightly coupled CPU, memory, and local bus graphics core. Its SuperTuned™ memory features a 64 bit wide DRAM memory bus and custom DRAM controller. SuperTuned memory offers zero wait-state DRAM read and write cycles, allowing the i486 CPU to realize its peak performance potential. The graphics subsystem – built around the ATI 68800 and a linear frame buffer – is integrated onto a synchronous extension of the CPU local bus. The 68800 combines a state-of-the-art 8514/A compatible graphics accelerator with 100% IBM compatible VGA capabilities. High resolution modes up to 1280 x 1024 @ 74Hz allow flicker-free display of large spreadsheets, documents and drawings. Support for 24-bit TrueColor provides up to 16 million colors for working with photo-realistic images.

Additional integrated I/O capabilities include an IDE drive interface and floppy disk drive, as well as mouse, keyboard, serial, and parallel ports. The digital audio subsystem provides stereo 16-bit audio channels each supporting sampling rates between 8 and 44.1KHz. A Windows 3.1 driver allows sound objects from a microphone or other input device (such as tape or CD-ROM) to be embedded within files such as spreadsheets and other documents. Once embedded, these sound objects appear as icons which can be played simply by clicking the mouse pointer on them. Voice annotation of spreadsheets and documents is a proven productivity-enhancing technology which until now has required an add-in card.

I/O expansion opportunities are provided by two 32-bit EISA connectors and a SCSI-II subsystem. The FLASH BIOS and EISA Configuration Utility (ECU) allow systems to be easily updated and configured in the field. A half-length ISA slot accepts Intel EtherExpress™ or TokenExpress™ networking cards, providing access to 10Base-T, thick and thin wire Ethernet, or 4MB and 8MB per second Token Ring under all popular network operating systems.

The sleek, small-footprint chassis meets stringent FCC Class B EMI requirements, even when running in 1280 x 1024 graphics mode, an ability unique among PCs. Security features allow the system to be locked or cabled to an immovable object, and users can be restricted from writing to the floppy drive, running the SETUP utility, or updating the FLASH EEPROMs.

Configuration Options

Professional/GX systems are offered in 5 base configurations:

Product Code	*CPU*	*Memory*	*Graphics**	*Cache*
L486D2668FAH	i486DX2/66	8 MB RAM	High Resolution	64KB
L486DX338FAH	i486DX/33	8 MB RAM	High Resolution	
L486D2668FAS	i486DX2/66	8 MB RAM	Standard Resolution	64KB
L486DX334FAS	i486DX/33	4 MB RAM	Standard Resolution	
L486SX33FAS	i486SX/33	4 MB RAM	Standard Resolution	

Table 1. Professional/GX Configurations
*High Resolution supports 1280 x 1024 resolution, 1024 x 768, as well as lower resolutions
Standard Resolution supports up 1024 x 768 resolution. as well as lower resolutions
See Graphics Subsystem section for further details

A Cache Kit (L486CACHE128) is available for adding or upgrading any base configuration to a 128KB cache.

Board Level Features

CPU

The five base Professional/GX configurations encompass three CPU options:

- i486SX/33
- i486DX/33
- i486DX2/66

All i486 CPUs feature a 4-way set associative on-chip cache which can be disabled via software. A numeric coprocessor integrated on the i486DX/33 and i486DX2/66 components is backward compatible with i387DX and i387SX math coprocessors and complies with ANSI/IEEE standard 754-1985. The i486SX/33 CPU contains an on-chip cache but no numeric co-processor. The i486DX2/66 employs internal clock doubling technology, allowing the CPU to process instructions and access its internal cache at 66MHz while maintaining an external 33MHz interface. The system supports 25MHz operation although no base configuration is offered with those processors.

OVERDRIVE PROCESSOR SOCKET

Upgrading to higher performance computing is easy using the Professional/GX OverDrive Processor Socket. An OverDrive Processor for the i486/33 employs internal clock doubling and allows i486SX/33 and i486DX/33 systems to achieve significantly higher CPU and floating point performance. All Professional/GX systems support the next generation of OverDrive technology, which will be based on Intel Pentium microprocessor technology (write-through cache mode only). Table 2 lists the possible Base CPU and OverDrive component configurations:

Base CPU	*OverDrive Processor Socket Options*
i486SX/33	empty
	OverDrive Processor for the i486/33
	Next Generation OverDrive Processor
i486DX/33	empty
	OverDrive Processor for the i486/33
	Next Generation OverDrive Processor
i486DX2/66	empty
	Next Generation OverDrive Processor

Table 2. Possible Base CPU/Upgrade Configurations

SUPERTUNED MEMORY

To function efficiently, an i486 requires low latency access to code and data. The i486 integrated cache allows it to execute small instruction loops without having to go out to external memory. Large, complex applications and multi-tasking environments place greater demands on a memory subsystem than small single tasking applications, and will benefit from a second level cache external to the CPU. But no matter how much cache memory is available, a system inevitably must access its Dynamic RAM, and it is the DRAM subsection which limits CPU performance. This is especially true with DX2 CPUs which employ clock doubling technology, because each external wait state represents two wasted internal clock cycles.

The Professional/GX SuperTuned memory is a three-tiered heirarchy consisting of the i486 internal cache, two optional second level external cache configurations, and a highly efficient page-mode DRAM subsystem built around a 64-bit memory bus and custom memory controller. This architecture is flexible enough to allow the right amount of cache memory for the task at hand and fast enough to ensure that the inevitable cache misses do not degrade overall CPU performance.

i486 INTEGRATED CACHE

At the top of the memory hierarchy is the 8KB cache integrated on the i486 component. This four-way set associative cache is organized as 512 16-byte cache lines, each capable of storing code or data. The CPU execution unit can access this cache with zero wait states and without generating any bus cycles external to the CPU. On i486DX2/66 machines, the integrated cache is accessed at the processor's internal 66MHz rate. Special bus cycles called burst cycles fill an internal 16 byte cache line from external memory in as few as five clock cycles.

Although cache hit rates vary with the application, the i486 internal cache typically will yield rates of 90% or better in DOS and Windows environments. In multi-tasking environments, such as UNIX and OS/2, and for compute-intensive applications such as CAD-CAM, there will be a reduction in the hit rate as the number of concurrent execution threads increases and as the complexity (and size) of the software routines increases.

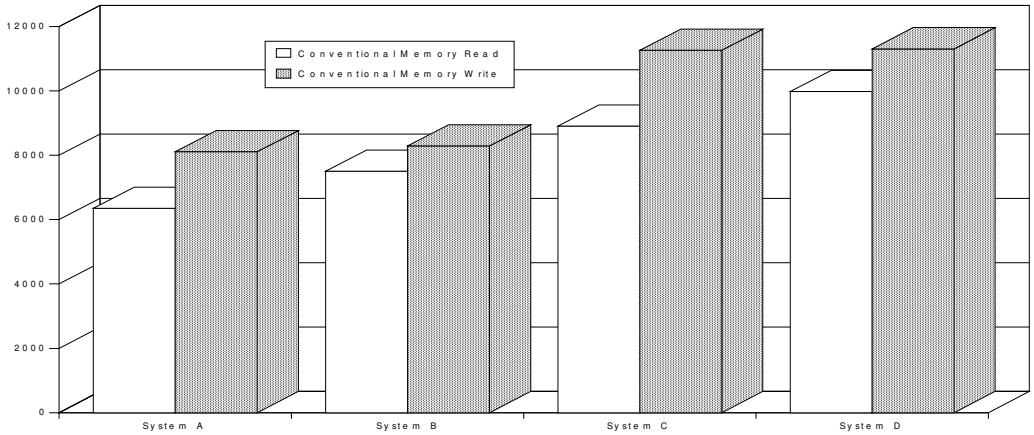
SECOND LEVEL CACHE OPTION

Large memory-intensive applications can realize a 10%-30% increase in performance by employing one of the Professional/GX second level cache options designed around the Intel 82485 cache controller and SIMM form factor static RAM (SRAM). Two base configurations ship with a 64KB cache, and all base configurations can be upgraded to a 128KB cache. Because these cache options are two-way set associative, they provide performance comparable to direct mapped caches twice their size. The cache is write-through and fully supports the i486 burst mode, allowing the CPU to fill an internal cache line in five clock cycles. Selected address ranges can be write-protected, so that frequently accessed BIOS code can remain in the cache. The Professional/GX second level cache options are totally transparent to software.

DRAM SUBSYSTEM

The i486 integrated cache and second level cache options provide a solid basis for high performance, but it is the underlying SuperTuned DRAM subsystem which allows the i486 CPU to reach its highest performance. Without a solid DRAM subsystem to support memory writes and cache-miss reads, the performance of any i486 based system will suffer. This is especially true in systems which employ DX2 or OverDrive processors, because each wait state incurred by the CPU while accessing external memory results in two wasted internal clock cycles during which the CPU could be doing useful work.

The Professional/GX DRAM subsystem is optimized for both read and write performance. A custom Application Specific Integrated Circuit (ASIC) interfaces the 64-bit DRAM bus to the 32-bit CPU bus. This highly efficient design optimizes performance when accessing DRAM within a 4KB DRAM page, allowing up to 16 bytes to be bursted onto the CPU bus – and into the i486's internal cache and optional second level cache – in as few as eight clock cycles with zero wait states. Writes to DRAM which fall within the current 4KB page boundary are posted with zero wait states. Figure 1 shows the results of the PC Labs 6.0 memory benchmarks run on a Compaq DX2/66 and a Professional/GX DX2/66. The fact that the Professional/GX with no second level cache outperforms the Compaq Deskpro/i with a 64KB cache highlights the relative importance of DRAM efficiency versus a second level cache.



System A: Compaq DeskPro/i, no second level cache
System B: Compaq DeskPro/i, 64K second level cache
System C: Intel Professional/GX, no second level cache
System D: Intel Professional/GX, 64K second level cache

Figure 1. PC Labs 6.0 Memory Benchmarks

The Professional/GX baseboard has four double-sided 36-bit SIMM sockets which accept 1, 2, 4, 8, 16 or 32MB SIMMs (70ns Fast Page Mode). The sockets are arranged as Bank A and Bank B, with each bank containing two sockets. Each bank provides a 64-bit wide data path and 8 parity bits to the DRAM control circuitry. On DRAM read cycles, the control circuitry accesses a 64-bit bank and then multiplexes either an odd or even double-word onto the CPU's 32-bit data bus. All memory size options implement a page size of 4KB. The number of clock cycles required to access DRAM depends on the type – read or write, burst or non-burst – and whether or not the access falls within the 4KB page last accessed (see Appendix A).

Each bank must hold a pair of like-sized SIMMs, and memory configurations between 2MB and 128MB are possible by using different sized pairs in Banks A and B. The amount of installed memory is automatically detected, eliminating the need to jumper the board for different memory configurations. All system configurations are shipped with Bank B empty. Tin-leaded DRAM should be used. See appendix I for details on DRAM upgrades.

BANK A / ***BANK B***	**2MB**	**4MB**	**8MB**	**16MB**	**32MB**	**64MB**
Empty	2	4	8	16	32	64
2MB	4	6	10	18	34	66
4MB	6	8	12	20	36	68
8MB	10	12	16	24	40	72
16MB	18	20	24	32	48	80
32MB	34	36	40	48	64	96
64MB	66	68	72	80	96	128

Table 3. On-Board Memory Sizes Supported

FLASH EEPROM

The organization of the run-time BIOS has been optimized to provide a contiguous 160KB area of DOS Upper Memory Blocks (UMBs), allowing memory managers to derive the most benefit from the available memory. This 160KB of free UMBs is maintained even when using the SCSI BIOS, since it is integrated into the System BIOS. See the run-time memory map in Appendix E for details.

The system BIOS is stored in two Intel 28F001B FLASH EEPROM devices providing a total of 256KB of program code space. The use of FLASH memory allows BIOS upgrades to be performed with a floppy diskette or over a network. A baseboard jumper provides recovery capability in the unlikely event that a BIOS update was interrupted before being completed (i.e.; due to a power failure). Another jumper can disable the update capability. For improved system performance, the BIOS is shadowed to allow execution from 32-bit write-protected DRAM instead of the slower 8-bit FLASH devices.

The FLASH EEPROMs contain:

- System BIOS (Phoenix Technologies 80486 ROM BIOS PLUS v1.0)
- Power-On Self Tests (POST)
- Video BIOS (ATI 68800)
- SCSI BIOS (Adaptec S1)
- EISA configuration memory
- EISA board identification strings
- SETUP utility
- FLASH update recovery code

Integrating all of this functionality into the FLASH EEPROMs requires more than the standard 128KB memory region traditionally reserved for system BIOS. A patent-pending paged memory scheme is employed which enables these enhancements while maintaining compatibility with standard PC architectures. Page registers, transparently operated under BIOS control, govern which two of four 64KB pages are available to the CPU at any given time. During normal operation, the 64KB page located at F0000-FFFFF swaps between one of three pages: POST, SETUP, and run-time system BIOS. The 64KB page located at E0000-EFFFF which contains the video BIOS is shadowed to C0000, and made available to memory managers.

SETUP UTILITY

One of the advantages of the high level of integration in the Professional/GX is the ease with which functions such as graphics, SCSI and audio support are configured, without having to manage available interrupts, DMA channels, upper memory blocks, I/O space, or configure jumpers. The SETUP utility provides a subset of the EISA Configuration Utility (ECU). Users may access SETUP by pressing the F1 key after POST completion and before the system boots. SETUP can be used to set drive types and to enable or disable drive interfaces and the major hardware blocks such as graphics, audio, SCSI, COM ports, etc. Pressing the F2 key from within the SETUP utility accesses information on interrupts and DMA channels being used by the integrated hardware. Complete control of these configurable features is available through the ECU. As a security measure, access to SETUP can be disabled through the ECU.

A Flash Language Update Program (FLUP) is available which allows the SETUP utility to be configured for English, French, German, Italian, or Spanish.

GRAPHICS SUBSYSTEM

The advent of Graphical User Interface (GUI) operating environments such as Microsoft Windows, OS/2, and X-Windows has placed greater and greater demands on the PC's graphics subsystem. Graphics tasks represent an increasingly greater percentage of the overall application task mix, and the amount of pixel data to be manipulated increases exponentially with greater monitor resolution and color depth. The weak link in traditonal PC graphics subsystems is the relatively slow ISA or EISA bus, over which the CPU must move pixel data to a graphics card. There are two avenues available for overcoming this graphics bottleneck:

- Utilizing a graphics accelerator so the CPU does not have to move graphics data as often
- Locating the graphics subsystem on the CPU local bus so that when the CPU must move graphics data it can be done efficiently

The Professional/GX employs both optimizations.

GRAPHICS HARDWARE

The Professional/GX features an ATI 68800 graphics accelerator and a Video RAM (VRAM) linear frame buffer which reside on a 32-bit synchronous extension of the CPU local bus. Locating the graphics subsystem on the CPU local bus allows bit-mapped images to be delivered to the display memory at the 33MHz local bus speed instead of the 8MHz speed of the relatively slow I/O bus.

The ability to move data efficiently to the video display memory becomes increasingly important with multimedia applications such as Video For Windows. In these applications the displayed image is constantly changing (as opposed to being manipulated) requiring large amounts of data to be constantly moved from system memory to display memory. These applications benefit from the high available bandwidth and the speed of the Professional/GX local bus VRAM linear frame buffer.

More traditional windowed applications such as word processors, spreadsheets, and drawing programs
benefit from the accelerated compute and data-movement capabilities of the Professional/GX. These applications manipulate a relatively constant set of graphics data – a document, spreadsheet, or drawing – by scrolling, re-sizing, and moving the windowed images. In non-accelerated VGA or Super VGA systems, this places a tremendous burden on the CPU which must maintain and manipulate the video image in system memory and transport the pixel data to the video display memory over the slow I/O bus. The Professional/GX performs graphics functions such as Bit Block Transfers (BitBlts), point to point line draws, polygon fills, and clipping in the hardware, providing a dramatic performance advantage when running graphic intensive software, such as Microsoft Windows, OS/2, or AutoCad.

Running in 1024 x 768 x 256 color mode, the Professional/GX performs ***over 30 million Winmarks*** (Winbench version 2.5). This is more than 700% faster than the 4.3 million Winmarks available from the Intel Professional Workstation using the Western Digital WD90C31 graphics controller.

The use of high-quality Video RAM instead of DRAM in the Professional/GX graphics subsystem allows high refresh rates when operating in high

resolution and high-color modes. High refresh rates result in less screen flicker and less eye strain than low refresh rates. DRAM also is single ported, meaning that pixel data can not be written into it at the same time that pixel data is being transferred from the video memory to the monitor. As resolution and color depth increase on a DRAM-based system, there is a degradation in performance and the ability to provide high refresh rates. This is because the part of the system that is putting information into the DRAMs is competing with the part which is taking information out of the DRAMs. Video RAM is dual ported, meaning that pixel data can be written to it (by the CPU or the 68800) at the same time that pixel data is transferred out to the monitor. High refresh rates are available even as screen resolution and color depth increase. The linear frame buffer maps the entire range of VRAM within a contiguous area, negating the need for costly page manipulations when accessing the frame buffer.

Not all applications require the same level of graphics capabilities. In recognition of this, there are two graphic hardware options available within the five Professional/GX base configurations. The difference between the two options is the RAMDAC and amount of VRAM used. The standard resolution versions of the Professional/GX are equipped with an ATI 68830 RAMDAC and 1MB of VRAM. These systems provide up to 1024 x 768 resolution. The high resolution versions of the Professional/GX are equipped with a TI 34075 RAMDAC and 2MB of VRAM, and will provide up to 1280 x 1024 resolution. Both standard and high resolution modes are certified FCC and VDE class B, even at the highest resolutions and refresh rates.

Resolution and color depth depend on the amount of VRAM and the type of RAMDAC. Tables 4a and 4b summarize the available resolution and color depth combinations for the standard and high resolution systems. Appendix H provides complete information on graphic output parameters.

Resolution	*Displayed Colors*	*Bit Planes*	*Max. Refresh*
640 x 480	65,536	16	72 Hz.
800 x 600	256	8	76 Hz.
1024 x 768	256	8	76 Hz.

Table 4a. Standard Resolution Configurations: Maximum Resolution/Colors

Resolution	*Displayed Colors*	*Bit Planes*	*Max. Refresh*
640 x 480	16,777,216	24	72 Hz.
800 x 600	16,777,216	24	76 Hz.
1024 x 768	65,536	16	72 Hz.
1280 x 1024	256	8	74 Hz.

Table 4b. High Resolution Configurations: Maximum Resolution/Colors

The standard resolution version is not field upgradable to high resolution, however it contains sockets which allow it to be upgraded to 2MB of VRAM. This does not increase the maximum resolution, but does allow greater color depths at the available resolutions. It also allows a full 1MB of VRAM to be dedicated to 8514/A functionality when running software which uses both 8514/A and VGA modes, but which is not capable of sharing memory between the two modes (such as OS/2). The Graphics Software section contains further details on 8514/A mode considerations.

Graphics EEPROM

The Professional/GX contains an Electrically Erasable PROM (EEPROM) which is dedicated to storing parameters affecting graphic output such as refresh rates for each possible resolution. This EEPROM is programmed using the graphics setup software provided with each system, and allows the graphic output to be tuned for any monitor connected to the system.

Video Connector

The Professional/GX has a standard PS/2 15-pin analog VGA connector located on the back panel. On-board graphics can be disabled using a baseboard jumper, allowing the use of add-in video adapter cards.

VESA Feature Connector

A VESA compliant 8514/A feature connector is provided on the baseboard. The feature connector can drive graphics data from the integrated graphics subsystem onto an external video add-in card (such as a DVI card). When using the video feature connector, jumper E0810 must be installed to allow propagation of RAMDAC write signals over the I/O bus to the add in card.

GRAPHICS SOFTWARE

ATI Video BIOS

The ATI 68800 Video BIOS is incorporated into the system BIOS EPROM. The video BIOS supports normal VGA modes and also is compatible with EGA, CGA, MDA and Hercules display modes. It resides in FLASH EPROM from E0000 to E7FFF, and is automatically shadowed to RAM at runtime. The default configuration shadows it to address C0000, and frees RAM located between E0000 to E7FFF to be used by memory managers. An ECU option allows the video BIOS to be shadowed between E0000 and E7FFF, in which case RAM located between C0000 and C7FFF is available to be used by memory managers.

Setup Utility

A Setup utility shipped with every system configures the 68800, installs enhanced DOS application drivers, and can be used to test the graphics subsection. Configuring the 68800 allows the system to be tuned for whatever monitor might be connected to it, ensuring that the highest possible refresh rates can be used for every resolution, for any given monitor.

Graphics Drivers

A graphics implementation must be backed by broad driver support to be useful in diverse computing environments. The ATI 68800 based graphics subsystem in the Professional/GX enjoys backward compatibility with a large number of graphics standards and drivers in addition to driver which deliver the highest levels of graphics performance.

Backward Compatibility: The ATI 68800 is 100% register-level VGA and IBM 8514/A compatible. This means that basic graphics support is available by using the standard VGA and 8514/A drivers widely available in most operating environments and applications, such as SCO UNIX, Interactive UNIX, and OS/2. The Professional/GX can also use drivers written for the 8514/A Adapter Interface (AI), VESA Super VGA, and the ATI MACH 8 card (other names for the MACH 8 drivers are 8514-ULTRA and Graphics Ultra). Most drivers for the ATI VGA Wonder+ cards also can be used. These drivers differ in the degree of graphics acceleration, resolution, and color depths they support.

Enhanced Performance: For the highest possible graphics performance, *mach32* drivers take full advantage of all of the ATI 68800's acceleration features. Included with each system are *mach32* drivers for Windows which support 16,256 and 65,536 colors. A follow-on driver release will support 24-bit color (16,777,216 colors) for the high resolution systems. The enhanced *mach32* Windows drivers are Virtual Display Drivers, meaning that they can be used only when running Windows in Enhanced mode. Windows can be run in standard mode using Window's default 8514/A driver.

Other Drivers: Enhanced drivers also are shipped for these DOS 5.0 applications:

• Lotus 1-2-3	Ver. 2.0/2.01/2.1/2.2
• Lotus Symphony	Ver. 1.1
• WordPerfect	Ver. 5.0/5.1
• MS WORD	Ver. 5.0
• Ventura	Ver. 1.0/1.1/2.0/3.0
• AutoCAD	Ver. 10/11/12
• AutoDesk 3D	
• AutoShade	
• GEM	
• OS/2 P.M	Ver. 2.0

Enhanced drivers also are available for the following operating systems:

SCO UNIX V.3.2 R4/ODT 2.0	Enhanced graphics support will be integrated into SCO.
INTERACTIVE UNIX V.3.2	Enhanced graphics support (8514A) is integrated into the OS.
IBM OS/2 2.0	Enhanced drivers shipped with system; will be integrated into future release of OS/2.

8514A Considerations

Both the standard and high resolution versions of the Professional/GX are compatible with 8514/A drivers. However, the ways in which 8514/A drivers are used must be taken into consideration on the standard resolution systems, which ship with 1MB of VRAM (compared to the high resolution systems which ship with 2MB of VRAM). The 8514/A specification calls for an entire megabyte of VRAM to be available for the driver's use. Operating systems which simultaneously mix 8514/A and other modes of operation can run into difficulty due to their inability to arbitrate between the conflicting needs of 8514/A and the other modes. An example is OS/2, which can run Windows applications in 8514/A mode. These applications can monopolize all of the VRAM, leaving none for the OS/2 presentation manager. To prevent this type of problem, it is recommended that OS/2 be run only on high resolution systems or on standard resolution systems which have been upgraded with an additional megabyte of VRAM. This also applies to other operating environments which may run partially in 8514/A mode.

SCSI INTERFACE

A SCSI-II subsystem provides I/O connectivity to a wide range of *external* peripheral devices (the internal drive bay supports only IDE). The SCSI interface consists of an Adaptec 6260 SCSI controller, associated SCSI bus terminators, and a fine-pitch 50-pin SCSI-II connector mounted on the back of the chassis. External devices can be attached using a single-ended SCSI "A" cable meeting the ANSI X3T9, X3.131-1991 specification. The maximum cable length is 6 meters and the maximum number of attached peripherals is limited to 7. The Professional/GX occupies SCSI ID 7. The Adaptec 6260 device provides 5MB/sec of bandwidth (synchronous transfer) between itself and SCSI peripherals.

The SCSI subsystem is driver-compatible with the Adaptec AHA-1520/1522 SCSI host adapter. Access to SCSI is supported via a SCSI BIOS, embedded within the system BIOS F0000-FFFFF address range, and by ASPI drivers provided with the system. The SCSI BIOS and SCSI drivers use 16-bit programmed I/O string move commands to transfer SCSI data from the 6260 through the CPU to main memory. Analysis has demonstrated that programmed I/O mode data transfers provide higher performance than DMA-based data transfers with the 6260.

Enabling of the SCSI BIOS is accomplished with the SETUP and ECU utilities. If the on-board SCSI option is selected in the BIOS setup page, the SCSI BIOS is shadowed within the F0000h to FFFFFh range of the system BIOS. The SCSI BIOS is shadowed and executed only if the SCSI option is enabled. While it is acceptable to disable access to SCSI using only the SETUP or ECU utilities, a baseboard jumper is provided to electrically disable the Adaptec 6260 hardware. The jumper should be used only if there is an I/O address (340-35F) conflict between the 6260 and an add-in card.

The SCSI bus must be terminated at each end. On the baseboard, the bus is terminated near the Adaptec 6260 chip with 220 ohm pullups to TERMPWR and 330 ohm pulldowns to ground. The SCSI bus signal TERMPWR is provided through a Polyfuse, which limits current to a maximum of 1.5Amps, and a Schottky diode, which prevents reverse current if another SCSI device is also supplying TERMPWR (TERMPWR is +5 volts, which can be used to power the active termination on SCSI peripherals).

The following SCSI drivers ship with the Professional/GX, and are installed via automated utilities:

DOS 5.0: Hard disk, ASPI Interface, CD-ROM , and AFDISK

Windows: ASPI interface for Windows. The Windows CD-ROM driver, MSCDEX.EXE, may be obtained from the CD-ROM vendor, Microsoft, or Intel, but is not shipped with the system.

Compatible SCSI drivers available from OS vendors:

IBM OS/2 2.0
SCO UNIX V.3.2 R4/ODT 2.0
INTERACTIVE UNIX V3.2

INTEGRATED AUDIO

The Professional/GX has integrated digital audio capabilities providing high quality sound for business applications. A driver shipped with the Professional/GX supports the Windows wave audio standard, and can be used to embed sound objects in OLE-capable Windows applications. Third party applications are available which support text-to-voice using wave audio, and these applications will run on the Professional/GX without the need for any additional hardware. Future wave audio applications will support voice recognition and voice piloting, which will allow the computer's input to be controlled via voice.

An audio volume application shipped with each system allows both the input and output volume levels to be set. By default, the audio output will play through the system's internal speaker. A jack is provided to allow the use of external speakers or headphones. Input can come from an external jack which supports microphone levels and line-in levels, or from digital data such as embedded sound objects.

Two 3.5mm stereo "mini" jacks are provided for audio input and output. One jack accepts stereo line-in or mono microphone input. The second jack provides a stereo line-out. A built-in leaf switch automatically disables audio from the internal speaker when a cable is plugged into the audio output jack. However, standard PC "beeps" are still heard through the internal speaker; and are not sent to the output jack. If nothing is plugged into the output plug, both standard PC "beeps" and audio output can be heard from the internal speaker.

The Professional/GX audio section is composed of a custom ASIC and a stereo audio Codec chip. The Codec contains stereo 16-bit A/D and D/A converters and supports audio sampling rates from 8KHz to 44.1KHz (the compact disc standard). Sampling rates, sample size of 8 bit or 16 bit, and stereo/mono sampling all affect the quality of the sound, as well the amount of storage required for the digitized sound. The ability to set sampling rates, size, and mono/stereo is defined by the wave audio API (Application Programmatic Interface) and is dependent on the given application.

The stereo audio Codec has a built-in analog multiplexer to select between stereo line-in versus mono microphone input. Since microphones require more gain than line-in signals, an additional Op-Amp stage is used to increase microphone signal levels. The LM386's provide about 500mV rms of audio drive into a 16 ohm load. A dynamic or self powered microphone should be used. The microphone input does not provide the "phantom voltage" required by many electret microphones.

The Professional/GX audio design does not provide hardware frequency synthesis and, as such, is not hardware or register compatible with popular "game" sound cards. However, software can be written to utilize the power of the i486 CPU, allowing the Professional/GX to playback the synthesized sound effects typically used in game software.

Windows MIDI drivers should be available from Intel in 1993.

INTEGRATED I/O DEVICES

IDE INTERFACE

Professional/GX Workstations support one 3.5" third-height (1" thick) IDE disk drive using the integrated IDE interface. CAM specification type 2 IDE drives or faster are supported. The IDE interface may be enabled/disabled using the SETUP and ECU utilities. The drive bay, containing the IDE drive and a floppy drive, pops in and out without screws once the system cover is off.

KEYBOARD/MOUSE CONTROLLER

The Professional/GX includes a Phoenix Technologies PS/2 compatible keyboard/mouse microcontroller which supports Power-On/Reset (POR) and keyboard password protection. If keyboard password protection is enabled, a password is required to access the SETUP utility or boot the system. A jumper on the baseboard can disable the password if it is forgotten (access to the jumper can be restricted by locking the system).

PS/2 style keyboard and mouse connectors are located on the back panel. These connectors supply +5 volts through a Polyfuse that limits current to 1 Amp. Unlike standard fuses, the Polyfuse device is self-healing and does not require replacement after an over-current condition. The mouse port can be enabled/disabled via the SETUP utility or ECU. Disabling the mouse port makes Interrupt 12 available.

Pin	*Signal*	*Description*
1	KEYDAT	Keyboard Data
2	(NC)	
3	GND	Ground
4	FUSED_VCC	Current limited +5Volts
5	KEYCLK	Keyboard Clock
6	(NC)	

Table 5. Keyboard Connector Pin-Out

Pin	*Signal*	*Description*
7	MSEDAT	Mouse Data
8	(NC)	
9	GND	Ground
10	FUSED_VCC	Current limited +5Volts
11	MSECLK	Mouse Clock
12	(NC)	

Table 6. Mouse Connector Pin-Out

SERIAL PORTS

A 16C452 device provides two nine-pin serial ports, each of which can be enabled/disabled by the SETUP and ECU utilities. Each serial port can be set to accommodate one of four different communications ports (See the I/O address map in Appendix G).

Pin	Name	Description
1	DCD	Data Carrier Detected
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request to Send
8	CTS	Clear to Send
9	RIA	Ring Indication Active

Table 7. Serial Port Pin-Out

PARALLEL PORT

The 25-pin AT compatible parallel port can be mapped to LPT1, 2, or 3 using the SETUP utility. When the parallel port is disabled, Interrupt 7 is available to add-in cards.

Pin	Name	Pin	Name
1	STROBE*	**14**	AUFDXT*
2	D0	**15**	ERROR*
3	D1	**16**	INIT*
4	D2	**17**	SLCTIN*
5	D3	**18**	GND
6	D4	**19**	GND
7	D5	**20**	GND
8	D6	**21**	GND
9	D7	**22**	GND
10	ACK*	**23**	GND
11	BUSY	**24**	GND
12	PE	**25**	GND
13	SLCT		

Table 8. Parallel Port Connector Pin-Out

REAL TIME CLOCK

The real time clock (RTC) is a Dallas DS1287 or equivalent. The DS1287 contains a battery within the package so an external battery is not required. Data will be retained for more than 10 years in the absence of power. The DS1287 is accurate to ±1 minute/month @25°C. The RTC device is socketed at location U0111, allowing for replacement if the RTC battery fails.

CMOS MEMORY

The industry standard 64 bytes of CMOS memory is provided within the real time clock component. Additionally, 8KB of FLASH memory is used to support EISA configuration data.

FLOPPY DISK

The on-board floppy interface utilizes the Intel 82077AA-1. The floppy interface supports media densities of 720KB, 1.44MB and 2.88MB, but does not currently support software detection of media density[1]. The interface may be enabled/disabled using the SETUP and ECU utilities. The floppy controller uses IRQ6, which is available for add-in cards with the floppy disabled. A baseboard jumper is provided that forces the floppy to always be write-protected. This jumper is provided for customers wanting additional data security.

[1] 5.25" floppys are electrically supported, however these drives will not fit in the chassis nor are they configurable via SETUP.

3½"	720KB
	1.44MB
	2.88MB

Table 9. Floppy Drive Support

Pin	*Name*	*Function*
1	(NC)	Docking drive only, usually GND
2	HD_In	High Density In
3	(NC)	Docking drive only, usually GND
4	(NC)	Docking drive only, usually GND
5	(Keyed)	
6	ED_In	Extended Density In
7	+5V	Docking drive only, usually GND
8	INDEX*	L = Beginning of track
9	+5V	Docking drive only, usually GND
10	MOTENA*	Motor A select
11	+5V	Docking drive only, usually GND
12	DRVSELB*	Drive B select
13	GND	
14	DRVSELA*	Drive A Select
15	GND	
16	MOTENB*	Motor B Select
17	GND	
18	DIR*	Head Move to Center
19	GND	
20	STEP*	Step (Supplies step pulses)
21	GND	
22	WRDATA*	Write Data
23	GND	
24	FLPYWE*	Enable Head to Write
25	GND	
26	TRACK0*	Indicates Head on Track 0
27	GND	
28	WP*	Write Protected
29	ED_Out	Extended Density Out
30	RDDATA*	Read Data
31	GND	
32	HDSEL*	Head Select side 1
33	HD_Out	High Density Out
34	DSKCHNG*	Disk Changed

Table 10. Floppy Drive Connector Pin-Out

System Level Features

CHASSIS

A sleek, low profile sheet metal chassis houses the system board, power supply, peripheral drive bay, and expansion slots. The cover is integrated with the front panel and provides access to a 3½" floppy drive, Power-On and Reset switches, Power-On and Hard Drive Access LEDs. The chassis dimensions are 15½" x 15¼" x 3" (39.37cm x 38.735cm x 76.2mm). Access to the system interior is obtained by removing three screws on the back panel and lifting up the chassis cover to expose the drive carrier and power supply (Figure 2).

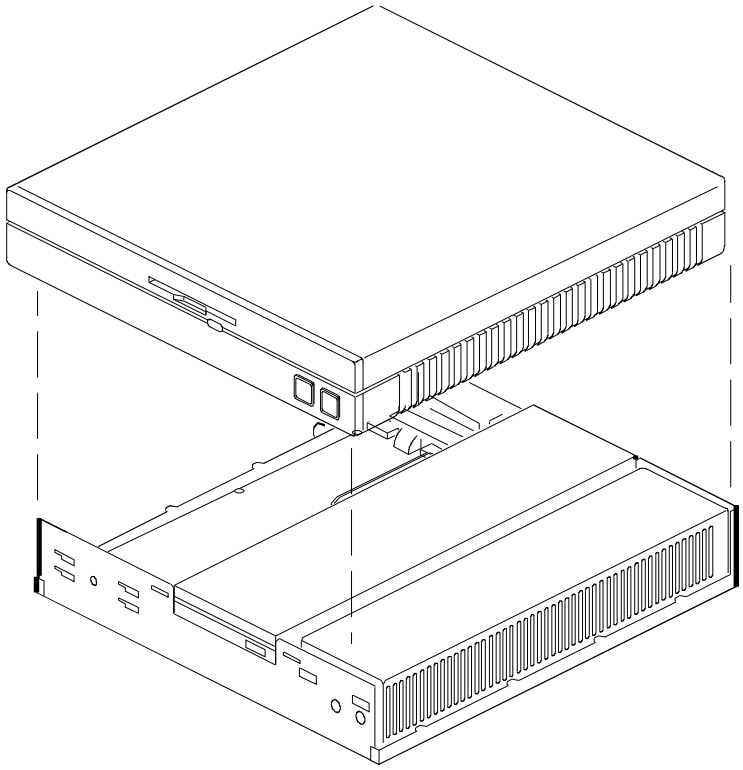


Figure 2. Removal of Chassis Cover

FANS

The system is cooled by thermostatically controlled twin fans integrated inside the power supply module. Fan speed is regulated in accordance with ambient air temperature, allowing fan speed (and noise) to rise only when ambient temperature rises. When operating at the maximum specified ambient temperature of +40°C (+104°F), acoustic noise will be no more than 35dBA at one meter.

POWER SUPPLY

A custom 142 Watt auto-ranging power supply module contains the fans, all AC inputs, AC outputs, power switch, front panel indicators (hard disk activity and power) and a reset switch. A custom connector eliminates the need for power cables. The power supply can be removed by sliding it away from the connector and lifting it out. The procedure for insertion is the reverse of removal.

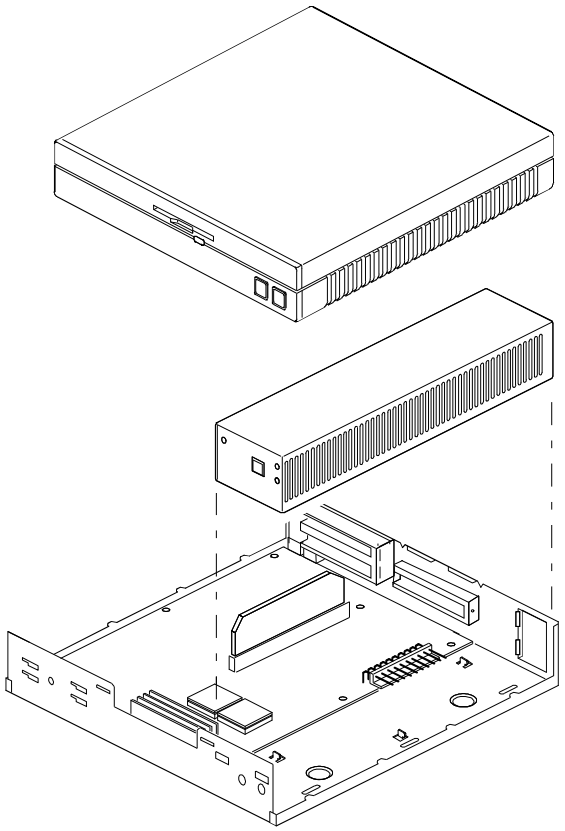


Figure 3. Power Supply Module

AC INPUT AND OUTPUT

AC input current requirement	8A @ 100-120 VAC 5A @ 200-240 VAC
AC input voltage select	Auto-ranging
AC outlet capacity	5A @ 100-120VAC 3A @ 200-240VAC

The AC Output socket is switched on/off by the system power switch.

DC OUTPUT AND CURRENT

Power Supply	+5V	+12V	-12V	-5V	Notes
	18.00A	3.00A	0.40A	0.40A	142W

Table 11. DC Outputs and Current

PERIPHERAL CARRIER

Both the floppy and hard disk drives are mounted in a removable carrier, located in the center of the chassis. The carrier accepts a 1" (25.4mm) high floppy disk drive with front panel access, and a 1" high IDE drive which mounts to the rear of the carrier. The carrier bay drops into inter-locking taps/slots in the chassis base, and can be removed/inserted without removing any screws other than the three required to remove the chassis cover. A peripheral riser card carries power and all floppy and IDE signals between the peripherals and the baseboard, eliminating all cables.

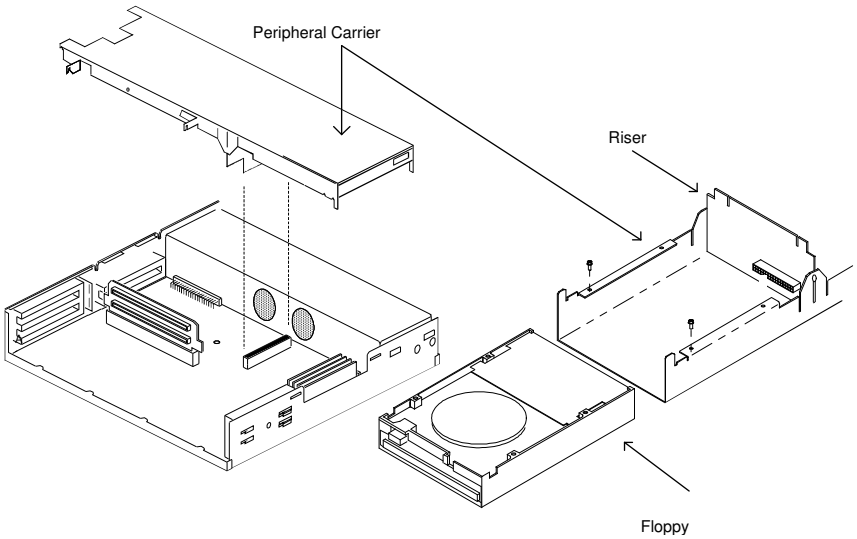


Figure 4. Peripheral Carrier and Riser Card

ADD-IN CARDS

A connector on the system motherboard hosts a riser card which allows three expansion cards to be mounted horizontally. The riser contains two slots for standard EISA cards on side A and a single ISA slot on side B. The ISA slot is slightly under 3/4 length and has limited access to the back panel. Although it is intended for hosting an Intel EtherExpress network card, the slot will accept any ISA card which fits into its mechanical constraints.

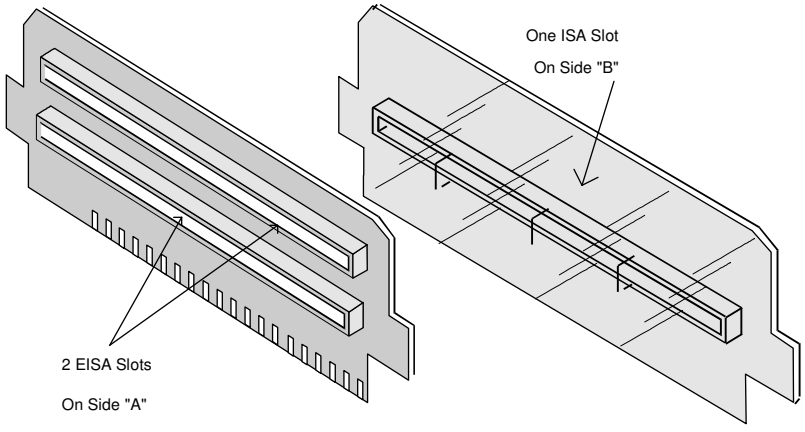
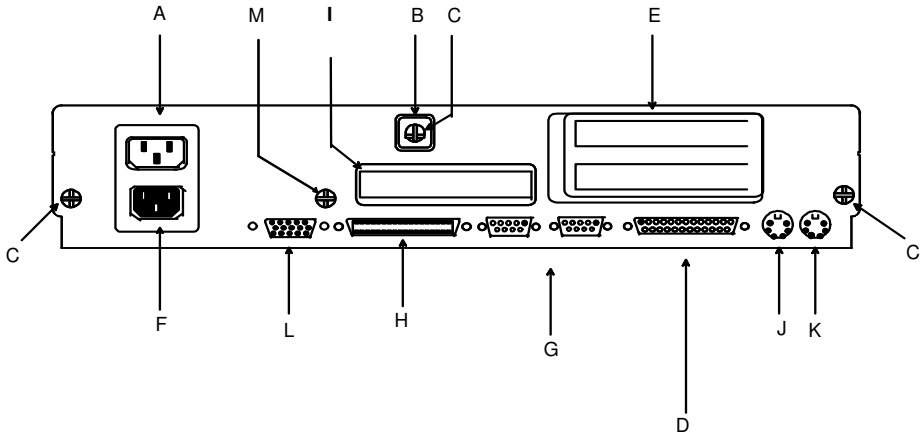


Figure 5. Professional/GX Riser Card

BACK PANEL CONNECTIONS



A - Auxillary Port
B - Case Lock
C - Top Cover Screws
D - Parallel Port
E - EISA Slots
F - AC Power in
G - Serial Ports
H - SCSI Port
I - ISA Slot
J - Mouse
K - Keyboard
L - Monitor Port
M - ISA Slot Screw

Figure 6. Back Panel Connections

Appendix A – Performance

CPU TO CACHE

Cache read hits at the secondary cache result in zero wait state burst read cycles (2-1-1-1).

CPU TO MEMORY

Cycle Type	*Clocks*
Read page hits	4-1-2-1
Read page miss	7-1-2-1
Read precharged page	6-1-2-1
Write page hits-sustained	2-2-2-2...
Write page miss-sustained	2-5-6-6...
Write precharged page	2-4-2-2...

Table A-1. Memory Clock Counts

CPU I/O BANDWIDTH

Cycle Type	*Typical Cycle Time (@ 33MHz)*	*MB/Second (@ 33MHz)*
CPU to local graphics bus	150 nSec (writes)	26
CPU to 32-bit EISA slave	360nSec	11
CPU to 16-bit ISA slave	480nSec	3.7

Table A-2. CPU I/O Bandwidth

EISA/ISA MASTER

On-board memory supports 33MB/sec EISA Master Burst cycles and standard 3 clock (5.55 MB/sec) ISA master 16-bit cycles.

PERFORMANCE BENCHMARKS

For a complete discussion of system performance, see the Professional/GX Benchmark Report.

APPENDIX B – Jumpers

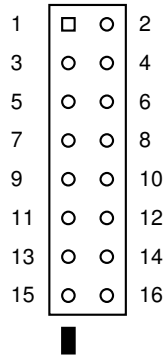


Figure B-1.
Jumper Block
Layout

JUMPER BLOCK E0160		
FUNCTION	*NORMAL*	
On-board video enable (VE)	1-3	2-4 disable on-board video
On-board SCSI enable (SE)	5-7	6-8 disable on-board SCSI
Floppy write enable (FE)	9-11	10-12 write protect floppy
Audio secondary address (AO)	13-15	14-16 secondary audio address

Table B-1. Jumper Block E0160

JUMPER BLOCK E0161		
FUNCTION	*NORMAL*	
Clear CMOS (CM)	1-3	2-4 force CMOS defaults
Clear Password (PW)	5-7	6-8 clear password
Recovery BIOS (RV)	9-11	10-12 enable recovery BIOS
BIOS write protect (BW)	13-15	14-16 disable flash updates

Table B-2. Jumper Block E0161

JUMPER BLOCK E0480		
FUNCTION		
Primary CPU type (DX)	1-3 DX CPU	2-4 SX CPU
CPU speed (SP)	5-7 33 MHz	6-8 25 MHz
Cache size (128)	9-11 128Kbyte	10-12 64Kbyte
Cache size (128)	13-15 128Kbyte	14-16 64Kbyte

Table B-3. Jumper Block E0480

JUMPERS E0810, E0811		
FUNCTION	*Not Installed*	*Installed*
RAMDAC write control	RAMDAC writes do not propagate to EISA slots. This is the standard setting and results in the best on-board video performance.	RAMDAC writes propagate to EISA slots. This setting should be used only if another video card is connected to the VESA connector.

Table B-4. Jumpers E0810, E0811

APPENDIX C – Environmental Specifications

The Professional/GX system meets the Board level Specifications as specified in the Intel Systems Environmental Limits Specification 112000 Rev H. The following summarizes the system environmental limits.

TEMPERATURE

Non-Operating	-40^{O}C to 70^{O}C
Operating	+10^{O}C to +40^{O}C

HUMIDITY

Non-Operating	92% RH at +36 ^{O}C
Operating	80% RH at +36 ^{O}C

VIBRATION

Non-Operating	Random input, 0.001 g^2/Hz at 5Hz, sloping to 0.01 g^2/Hz at 20Hz, and maintaining 0.01 g^2/Hz from 20Hz to 500Hz.

SHOCK

Non-Operating	Amplitude of 30g, trapezoidal waveform
Operating	Amplitude of 2G, 11 msec, 1/2 sine waveform

ALTITUDE

Non-operating	50,000 feet (pressure altitude)
Operating	10,000 feet (pressure altitude)

ESD

Operating	0-2.5Kv	No Errors
	5Kv	5% soft errors, 0% hard errors, 0% physical damage
	7.5Kv	10% soft errors, 0% hard errors, 0% physical damage
	10Kv	25% soft errors, 5% hard errors, 0% physical damage
	12.5Kv	50% soft errors, 10% hard errors, 0% physical damage
	15Kv	100%soft errors, 25% hard errors, 0% physical damage
	25Kv	100% soft errors, 100% hard errors, 0% physical damage

EMI

Certified FCC B, comply to VDE/CISPR B and VCCI class 2

APPENDIX D – Reliability Specifications

The following table lists the "hard" MTBF for the Professional/GX system. The term "hard" refers to the type of failure. A hard failure indicates a permanent or repeatable failure which can be remedied by replacing the faulty part with a good part.

Product Code	*Mean Time Between Failure*
L486D2668FAH	23,630
L486DX338FAH	Not Available at time of publication
L486D2668FAS	25,485
L486DX334FAS	24,729
L486SX334FAS	24,729

Table D-1. System MTBF

APPENDIX E – Memory Map

Address Range	*Amount*	*Function*
7A100000h or 7A200000h to FFFFFFFFh	2.142 or 2.143 GB depending on configuration	Extended Memory
7A000000H to 7A0FFFFFh or 7A1FFFFFh	1 or 2 MB depending on configuration	Linear Frame Buffer (VRAM)
100000h to 7A000000h	1.952 GB	Extended Memory
F0000h to FFFFFh	64 KB	System BIOS (shadowed)
E0000h to EFFFFh	64 KB	Free for EMM *
0C8000h to 0DFFFFh	96KB	Free for EMM, cards
0C0000h to 0C7FFFh	32 KB	Video BIOS (shadowed)
0A0000h to 0BFFFFh	128 KB	Video display controller RAM
80000h to 9FFFFh	128 KB	Base memory enabled in Setup
0h to 7FFFFh	512 KB	Base memory

Table E-1. Run TIme Memory Map

* This area contains configuration and initialization code which is not used during run time and is available for use by extended memory managers. However, add in cards should not be mapped to this area to avoid conflicts during system initialization.

APPENDIX F – Power Budget

The power budget assumes a 65% derating of worst case board power consumption.

Power Supply	+5V	+12V	-12V	-5V
	18.00A	3.00A	0.40A	0.40A

Table F-1. DC Outputs and Current

	+5V	*+12V*	*-12V*	*-5V*
Baseboard	7.3 Amps	0.38 Amps	None	None
Floppy	0.50 Amps	None	None	None
Total	**7.8 Amps**	**0.38 Amps**	None	None
Available for IDE drive and expansion slots	**10.2 Amps**	**2.62 Amps**	**0.40 Amps**	**0.40 Amps**

Table F-2. Available Power Outputs

APPENDIX G – I/O Map

Port	*Bits*	*Function*	*Alias (#'s refer to Port)*
0000-000F		ISP -- DMA	0000 000x ####
0020-0021		ISP -- Interrupt Controller 1	0000 001x xx##
0026-0027		CLASIC -- CIR/CDR	None
0040-0043		ISP -- Timer 1	0000 010x ####
0048-004B		ISP -- Timer 2	0000 010x ####
0060		Keyboard Controller - data byte	0000 0110 00x0
0061		ISP -- NMI, speaker control	None
0064		Keyboard Controller - command & status byte	0000 0110 01x0
0070	7	ISP -- Enable NMI	0000 0111 0xx0
0070	6:0	Real Time Clock (Addr)	0000 0111 0xx0
0071		Real Time Clock (Data)	0000 0111 0xx1
0074-0077		Reserved for future INT-15 access to Dallas 1387 extended CMOS.	
0078		Clasic BIOS Timer	None
0080-008F		ISP -- DMA	None
0092		Clasic System Control Port A	None
00A0-00A1		ISP -- Interrupt Controller 2	0000 101x xx##
00C0-00DE		ISP -- DMA	0000 1100 ###x
00F0		Reset Numeric Error	None
100-105		GRAPHICS - ATI68800	None
01F0-01F7		IDE	None
220-22F		Audio default address	
0278-027B		Parallel 3 (PS2) or Par. 2 ISA	0010 0111 1x##
02E8-02EF		Graphics - ATI68800	* See note
02F8-02FF		Serial 2	None
340-35F		SCSI	None
0378-037F		Parallel 2 (PS2) or Par. 1 ISA	0011 0111 1x##
03B0-03BB		MDA/CGA/EGA/VGA/Paradise	None
03BC-03BF		Parallel 1 (PS2)	None
03BF-03DF		3BF is a write-only port in the 16C552. Not used by 16C452.	
03E8-03EF		Serial 3	None
03F0-03F5		Floppy	None
03F6		IDE	None
03F7	7:0	Floppy (Write)	None
03F7	7	Floppy (Read)	None
03F7	6:0	IDE (Read)	None
03F8-03FF		Serial 1	None
0400-040B		ISP -- High DMA	None
040C-040F		ISP -- Control/Test	None
0461-0464		ISP -- Extended NMI	None
0464-0465		ISP -- Bus Master	None
0480-048F		ISP -- High DMA	None
04C2-04CE		ISP -- Extended DMA	None
04D0-04D1		ISP -- INTR Edge/Level	None
04D2-04FF		ISP -- Extended DMA	None
06E8-06EF		Graphics - ATI68800	* See note
0800-083F	3:0	Emerald CONFIGURATION REGS	
0C02		Clasic Control Port B - Gen. Purpose Outputs	None
0C03		Clasic Control Port C - Gen. Purpose Inputs	None
0C04		Clasic Control Port D	None
0C80-0C83		Clasic Baseboard EISA ID, bytes 0 - 3	None
*		ATI	
5050-505F		Sapphire Audio Chip	None

Table G-1. Professional/GX I/O Map

* The ATI 68800 chip decodes every ISA bus alias of addresses 2E8 and 2EE for additional control registers. For example, 06E8, 06EE, 0AE8, 0AEE, 0EE8, 0EEE, 12E8, 12EE, 16E8, 16EE, 1AE8, 1AEE, 1EE8, 1EEE .... FEEE. These ISA aliases are trapped by the ATI 68800 and are not propagated to the ISA bus. Refer to the ATI document "Programmer's Guide to the *mach32* Registers, Rel 1.0" for details regarding these registers.

APPENDIX H – CRT PARAMETERS

The selected resolution and vertical refresh rate will determine whether an interlaced CRT is required. The following table summarizes the CRT requirements for each configuration. An "i" following a vertical frequency number indicates interlaced operation.

Resolution	*Color Depth*	*Vertical Frequency (Hz)*	*Horizontal Frequency (Khz)*	*Standard Resolution*	*High Resolution*
640 x 480	8	60	31.5	YES	YES
	8	72	37.0	YES	YES
	8	72	44.6	YES	YES
	16	60	31.5	YES	YES
	16	72	37.0	YES	YES
	16	72	44.6	YES	YES
	24	60	31.5	NO	YES
	24	72	37.0	NO	YES
	24	72	44.6	NO	YES
800 x 600	8	89i	31.5	YES	YES
	8	95i	33.8	YES	YES
	8	56	35.2	YES	YES
	8	60	37.9	YES	YES
	8	70	44.5	YES	YES
	8	72	48.0	YES	YES
	8	76	52.4	YES	YES
	16	89i	31.5	NO	YES
	16	95i	33.8	NO	YES
	16	56	35.2	NO	YES
	16	60	37.9	NO	YES
	16	70	44.5	NO	YES
	16	72	48.0	NO	YES
	16	76	52.4	NO	YES
	24	89i	31.5	NO	YES
	24	95i	33.8	NO	YES
	24	56	35.2	NO	YES
	24	60	37.9	NO	YES
	24	70	44.5	NO	YES
	24	72	48.0	NO	YES
1024 x 768	8	87i	35.5	YES	YES
	8	60	48.4	YES	YES
	8	66	53.9	YES	YES
	8	70	56.1	YES	YES
	8	72	57.9	YES	YES
	8	76	61.4	YES	YES
	16	87i	35.5	NO	YES
	16	60	48.4	NO	YES
	16	66	53.9	NO	YES
	16	70	56.1	NO	YES
	16	72	57.9	NO	YES
1280 x 1024	4	87i	50.0	NO	YES
	4	97i	50.0	NO	YES
	4	60	64.0	NO	YES
	4	70	74.6	NO	YES
	4	74	81.1	NO	YES
	8	87i	50.0	NO	YES
	8	97i	50.0	NO	YES
	8	60	64.0	NO	YES
	8	70	74.6	NO	YES
	8	74	81.1	NO	YES

Table H-1. CRT Parameters.

APPENDIX I – Memory Upgrade Devices

DRAM

The Professional/GX can be upgraded with 36-pin single sided or 72-pin double sided, fast-page 70ns 1, 2, 4, 8, 16, or 32MB SIMMs. To prevent electrolytic action, tin leaded modules should be used and gold leaded modules should be avoided. The following table lists the SIMM modules which Intel has qualified for use in the Professional/GX.

2MB (512KX36,FP,70ns)	
TOSHIBA CORP	THM365120AS-70
SAMSUNG CORNING CO.,LTD	KMM536512B-7
TEXAS INSTRUMENT	TM512LBK36B-70
NEC ELECTRONICS INC	MC42412A36F-70
SAMSUNG CORNING CO.,LTD	KMM536512C-7
4MB (1MX36,FP,70ns)	
TOSHIBA CORP	THM361010AS-70
SAMSUNG CORNING CO.,LTD	KMM5361000A-7
HITACHI AMERICA LTD	HB56D136SBS-7A
MICRON TECHNOLOGY	MT9D136M-7
TEXAS INSTRUMENTS	TM124MBK36A-7
TEXAS INSTRUMENTS	TM124MBK36B-7
8MB (2MX36,FP,70ns)	
TOSHIBA CORP	THM362040AS-70
SAMSUNG CORNING CO.,LTD	KMM5362000B1-7

Table I-1. Qualified SIMM Modules

SECOND LEVEL CACHE

A second level cache kit (L486CACHE128) is available for adding a 128KB two-way set associative cache to any base configuration. The kit contains a 128KB SRAM SIMM module and an Intel 82485-33 cache controller chip.

VIDEO RAM

The two standard resolution system configurations (which have 1MB of VRAM installed at the factory) can be upgraded to 2MB of VRAM by installing eight 256K X 4, 80ns VRAM SIMMs into the provided sockets.

Appendix J – Safety & EMI Certifications

SAFETY CERTIFICATIONS

Underwriters Laboratories	UL1950	Listed
Canadian Standards Assn.	CSA C22.2 No.950-M89	Certified
TUV Rheinland of N.A.	EN 60 950-1988 + A1/A2	Certified
NEMKO (Norway) (includes SEMKO, Sweden, SETI, & Finland Certifications)	EN 60 950-1988 + A1/A2	Certified

EMI CERTIFICATIONS

Federal Communications Comm.	CFR 47, Parts 2 and 15 Class B	Authorized
German Post Office	CISPR 22, Class B	Registered to Vfg. 243/1991
Canadian Dept. of Comm.	C.R.C., c.1374, Class B	Compliant
Voluntary Control Council	Class 2 I.T.E.	Registered
VDE (Germany)	VDE 0871 Class B	Tested/Compliant
NEMKO (Norway) (includes SEMKO, Sweden, SETI, & Finland Certifications)	EN 55 022, Class B	Certified