3Dlabs®

PERMEDIA® 2

Architecture Overview

PROPRIETARY AND CONFIDENTIAL INFORMATION

Issue 2

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Change History

Document	Issue	Date	Change
147.3.0	1	24 Feb 97	Issue.
147.3.0	2	27 Nov 97	Change input FIFO depth to be 256 entries. Minor typographical corrections.

Contents

1. Introduction

PERMEDIA 2 is a high performance PCI/AGP graphics processor that balances high quality 3D polygon and textured graphics acceleration, windows acceleration and state-of-the-art MPEG1/MPEG2 playback with a fast integrated SVGA core, integrated RAMDAC and video ports. This document provides a high level overview of the architecture of the PERMEDIA 2 graphics processor and is intended as an introduction for design engineers and project managers planning the implementation of PERMEDIA 2 based systems.

1.1 PERMEDIA 2 Key Features

- Full support for Intel's Accelerated Graphics Port (AGP) and PCI
  - 66 MHz operation
  - DMA and Execute mode support
  - Sideband addressing
- Enhanced 3D graphics features and performance (at 83MHz)
  - 83M perspective correct, bilinear filtered, texture mapped pixels/sec
  - 42M perspective correct, bilinear filtered, texture mapped, depth buffered pixels/sec
  - 800K texture mapped polygons/sec
  - True-color 3D graphics
  - Polygon based with Z buffer
  - Texture decompression
  - Full scene anti-aliasing
- Enhanced GUI acceleration
  - Ultra-fast BLT engine and 2D rasterizer
  - Stretch BLTs, monochrome/color expansion and logic ops
  - 8, 16, 24 and 32-bit packed framebuffer
- MPEG2 compatible Video playback acceleration
  - YUV 4:4:4, YUV 4:2:2 and YUV 4:2:0 (native MPEG2 format)
  - Unlimited multiple playback windows (occluded)
  - Independent XY scaling and mirroring
- Integrated geometry pipeline set-up processor
- Integrated true-color 230 MHz RAMDAC
  - DPMS, DDC1 and DDC2AB+
  - Clock synthesizer and Hardware cursor
  - 320x200 to 1600x1200 Screen Resolutions
- Multi-mode video streams
  - Simultaneous input and output video
  - Optional scaling and filtering
  - Optional color space conversion and gamma correction
- Fast on-chip SVGA

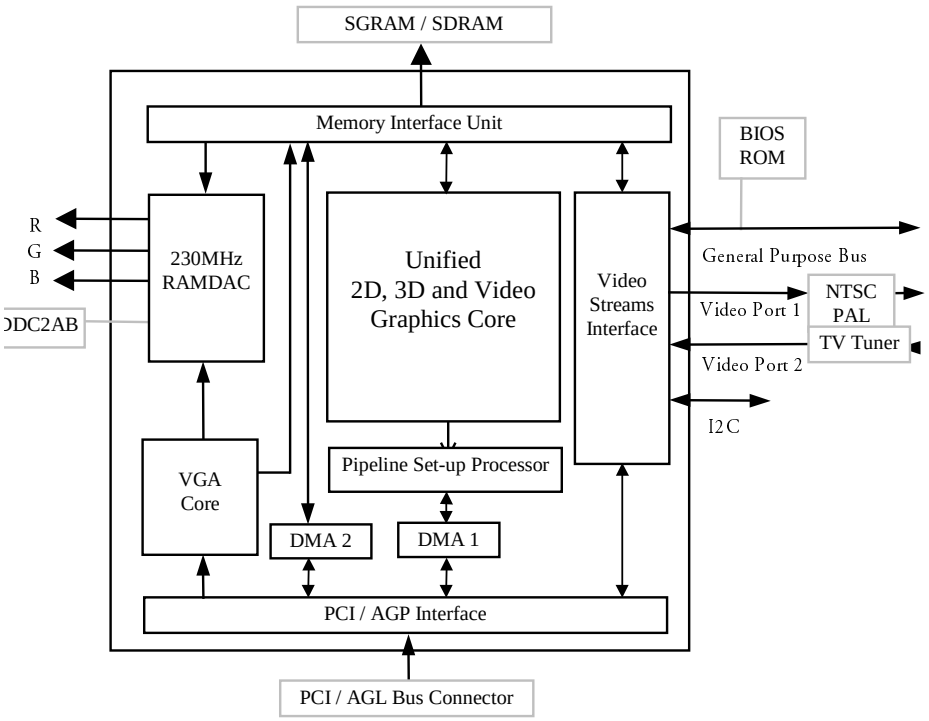
- Flexible multi-function SDRAM or SGRAM memory (2, 4, 6 or 8 Mbytes)
- Microsoft PC97 and Intel GPC97 compliance
- Comprehensive suite of optimized software drivers
- Reference board designs and manufacturing kits

1.2 PERMEDIA 2 - A Pervasive Architecture

PERMEDIA 2 sets a new standard for 3D graphics and represents the ideal fully-integrated solution to meet the increasingly pervasive requirement for low-cost 3D, 2D and multimedia acceleration. Based on a proven low-cost and scalable architecture, PERMEDIA 2 accelerates a broad range of applications, including; games, multimedia, animations, presentations, authoring, 3D internet browsers, personal CAD and visualization.

1.3 Chip Level Block Diagram

PERMEDIA 2 has been designed as a single low-cost package that combines maximum levels of integration with the demands for flexible multimedia I/O requirements.



2. PERMEDIA 2 Features

PERMEDIA 2 incorporates the following key functions in hardware to provide superior 3D, 2D and video benefits.

2.1 3D Graphics

Full primitive support	*Points, lines, triangles, rectangles*
Efficient processing of small primitives	*Integrated set-up calculation, low latency*
High fill rate	*Wide data paths, high performance memory*
Fast buffer clears	*SGRAM block fill for any buffer type*
Efficient texture storage	*Fully flexible formats, internal 256 entry LUT*
High quality rendering	*Sub-pixel and sub-texel accurate*
High quality textures	*Accurate perspective correction and bilinear filtering*
High quality lighting	*Interpolated diffuse and specular components*
Extremely realistic special effects	*Interpolated fog and depth-cueing*
Translucent objects and sprites	*Blending/transparency on any primitive*
High quality texture cut-outs	*Color key with bilinear filter does not leave edge effects*
Anti-aliased sprites	*Edge anti-aliasing for zoomed sprites*
Fast hidden surface elimination	*Depth (Z) buffering*
Fast shadow and transparency effects	*Area stippling with no performance cost*
Arbitrary cut-out and multi-pass rendering	*Stencil buffer*
High quality output at any color depth	*Dithering with no performance cost*
Fast sprite handing	*Color key, scale, stretch, rotate, mirror*
Seamless integration of video and 3D	*Color key with depth test and perspective correction*
Minimize update area, target selection	*Hardware extent checking and picking*
Improved image quality at lower resolutions	*Full screen anti-aliasing*
Use of rendered images as textures	*Multi-function memory*
Full range of double buffer techniques	*Full screen flip, per window buffer selection, fast BLT*
Overlays	*Per-pixel main image/overlay selection*
Texture cache support	*Page tables for map indirection, AGP, DMA*

2.2 2D Graphics

Full primitive support	*Points, lines, spans, rectangles, polygons*
Efficient processing of small primitives	*Integrated set-up calculation, low latency*
Window clip	*Hardware rectangle clipping*
Ultra-fast solid fill	*SGRAM block fills*
Ultra-fast monochrome expansion	*SGRAM block fills with pixel mask*
High speed color brushes	*Internal pattern RAM*
High speed monochrome brushes	*Internal stipple table*
Raster operations	*Logic op unit*
Fast BLTS	*Wide data path*
Fast upload and download	*Packed into 32 bit words*
High speed monochrome download	*Bitmask test with SGRAM block fills*
Flexible font caching support	*Byte aligned monochrome bitmaps in local memory*
Color translation	*Through internal LUT*
High speed stretch BLT	*Using texture operations*

2.3 MPEG2 and Video

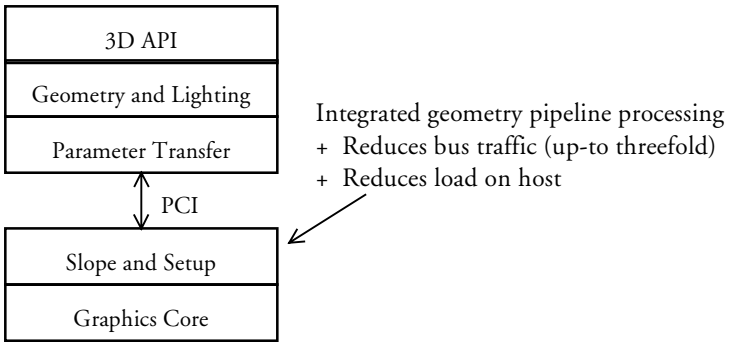
Support for software decoders	*DMA from system or write directly to local memory*
Support for hardware decoders	*Input data through video port*
High speed color space conversion	*YUV to RGB with no performance cost*
Flexible YUV data formats	*4:4:4, 4:2:2, 4:2:0*
Fast arbitrary stretch with filter	*Bilinear filter*
Full featured video effects	*Scale, stretch, rotate, mirror*

3. PERMEDIA 2 Architecture

The PERMEDIA 2 architecture consists of the set-up processor and the main graphics processor augmented by external interfaces, which are described in detail below.

3.1 Geometry Set-up Processing

The on-chip geometry set-up unit is a 100 MFLOPS OpenGL and Direct3D compliant set-up processor, designed to break the 3D bottleneck on PCs that are unable to saturate PERMEDIA 2's rendering capabilities. The unit calculates the slope and sup information, and performs high precision floating-to-fixed point conversion. The unit significantly reduces the load on the CPU and the PCI Bus and is general purpose in design to support any 3D API.



The geometry set-up unit accepts the coordinates of vertices plus color, depth, fog and texture parameters. It accepts the input parameters in either fixed point format or IEEE single precision floating point format; internal calculations are performed in floating point format. Vertex sharing for meshes, fans and polylines is supported with the shared vertices being loaded only once.

3.2 Graphics Processor

The graphics processor unifies 3D, 2D, and video operations into the same processing pipeline. This gives unbeatable flexibility in the way that data may be handled, while ensuring there is no duplication of functions.

The graphics processor rasterizes each primitive to determine the pixels that it covers on the screen. It then processes each pixel through the following sequence of operations:

- Clip to window
- Apply stipple pattern
- Perform depth and stencil test
- Calculate texture address, fetch and format texture data
- Color key test
- Update depth and stencil buffer
- Color interpolation
- Texture application
- Fog application
- Transparency application
- Dither to final color format
- Apply logic op
- Update framebuffer
- Update extent and picking statistics

Each stage is optional and may be omitted. If a pixel fails any of the tests it does not take part in any further processing. For example, if a pixel fails the depth test it will not have a texture address calculated for it, nor will it have texture data read from memory and applied. This ensures that time is not wasted processing pixels that will not be written to memory.

The graphics processor supports a high degree of parallelism which allows several pixels to be processed at the same time. The design ensures a very high throughput while maintaining a low latency between primitives. It is not necessary for one primitive to have been completed before the next one is started.

3.3 Host Interfaces

3.3.1 AGP Interface

AGP is Intel's high performance, component level interconnect targeted at 3D display applications which uses a 66MHz PCI specification as a baseline.

The specification for PERMEDIA 2's AGP implementation is:

- 66 MHz operation
- DMA and Execute mode support
- Sideband addressing

Implementing these features enables PERMEDIA 2 to achieve over 250Mbytes per second bandwidth from the host for instructions, textures and video data (limited by the host system throughput).

The add-in slot defined for AGP uses a new connector body which is not compatible with the PCI connector, therefore boards designed for use in an AGP slot are not mechanically interchangeable with PCI boards.

DMA Mode Texturing

To achieve optimal performance PERMEDIA 2 treats the local synchronous memory as the working texture store, and uses the performance of AGP to utilize system memory as a high speed virtual texture store for textures that are not currently held in memory. This demand loaded texture mechanism is optimized via the use of a DMA controller to transfer data directly into local memory.

Execute Mode Texturing

To achieve optimal performance in low-cost systems PERMEDIA 2 implements the AGP 'execute' model and can directly access textures stored in system memory, without needing to load them into local memory.

3.3.2 PCI Interface

The host interface on PERMEDIA 2 is PCI and is fully v2.1 compliant and contains a FIFO and DMA controllers. Control registers for the host interface are memory mapped onto the PCI Bus. The host can read back control and state information from the programmable registers.

Two methods of communication are available between the host and PERMEDIA 2. Direct to the FIFO, where PERMEDIA 2 acts as a PCI slave, or alternatively PERMEDIA 2 can be programmed to be a PCI master and use the internal DMA controller to fetch commands into the FIFO.

PCI Characteristics

- Glueless interface - simple and low-cost design-in
- 32-bit Master/Slave - maximum speed
- Bi-endian - avoids byte swapping on PowerMacs
- Plug and Play - Revision 2.1 compliant

DMA1 Controller - Graphics Core

- Autonomous- set-up/fetch parallelism
- No wait state - maximum transfer rate
- Programmable block size - large DMA buffers

DMA2 Controller - Direct to Memory

- Fast texture/image uploads and download
- Fast software MPEG2 download

Input FIFO

- 256 entries - fetch/draw parallelism
- Burst mode - bursts for programmed IO
- PCI Disconnect on full - avoids polling FIFO

Interrupt Controller

- End-of-DMA - allows DMA chaining
- VSYNC - efficient double buffering
- Scanline - special effects
- Video streams - separate input and output frame interrupts
- I2C start condition - alert host to start of I2C transfer
- Sync - indicates graphics core is idle
- Error - e.g. writing to a full FIFO

Core Bypass to Memory

- Fast access to memory - for software rendering

3.4 Memory Interface

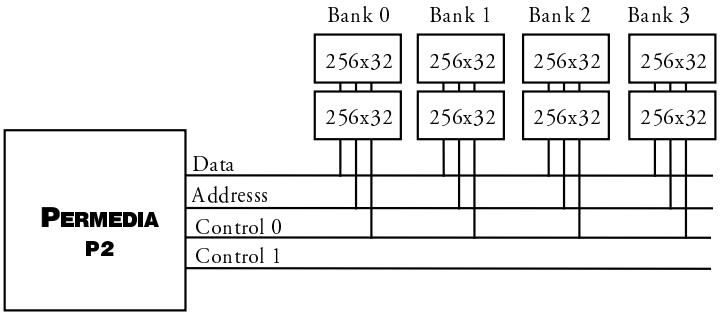
The PERMEDIA 2 memory subsystem uses Synchronous Graphics RAM (SGRAM) or compatible Synchronous DRAM to supply the memory bandwidth needed for 3D operations and display update.

3.4.1 SDRAM/SGRAM Overview

- 64-bit Synchronous Memory Interface
    - SGRAM for best performance (block fills and write masks)
    - SDRAM for reduced cost
- Two 256K x 32 parts for every bank of memory (i.e. 2 Mbytes)
- Four banks of memory maximum (i.e. 2, 4, 6 or 8 Mbytes of total memory)
- 83 MHz operation and above
- High speed block fill and masked writes
- Single cycle burst reads

3.4.2 Memory Organization

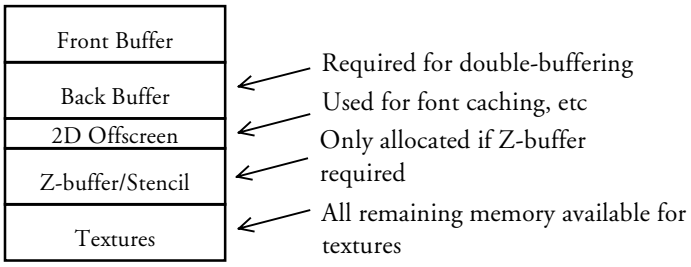
Each bank is made up of two 32 bit wide devices. The data and address lines are common to all the memory devices. There are two sets of control lines which are provided to reduce loading: they are driven identically. The example above shows one set of control lines driving bank 0 and bank 1, with the second set driving bank 2 and bank 3. Alternatively the control lines can be split along the upper and lower devices in each bank.



To minimize page breaks, PERMEDIA 2 can store and access data in memory as 2D patches. This is particularly useful for texture maps, where texture accesses can go in any direction through memory. By storing the data in a 2D format, the chances of a page break are reduced. 3Dlabs drivers allow configurable texture compression on download, saving memory and increasing performance.

3.4.3 Flexible Multi-function Memory Layout

PERMEDIA 2 stores a variety of data and color formats in memory at the same time. The organization of data in memory is unconstrained, and allows mixing of buffers of any data type. The color data (ready for display) is referred to as the framebuffer, which in double-buffering applications such as games and animations is made up of a front-buffer and a back-buffer (one being drawn to, the other being displayed). After these buffers are allocated, the Z-buffer (depth), stencil-buffer and texture-buffer are stored in the remaining memory.



The multi-function nature of the memory organization allows PERMEDIA 2 to store the different buffers anywhere in the same physical memory, minimizing memory wastage and offering a simplified programming model. It is not necessary to store all data of a particular type together, so a texture map may be followed by a depth buffer or a framebuffer or another texture map.

The VGA is an independent unit that shares the memory controller to access the framebuffer when active.

3.4.4 Supported Memory Data Formats

A variety of data formats are supported by PERMEDIA 2 for storing and retrieving information to be held in the various memory buffers.

Framebuffer Color Formats

The PERMEDIA 2 supports a number of color formats for the framestore (frontbuffer and backbuffer). Both RGBA and BGRA ordering of pixels is supported.

- 8-bit RGBA 2:3:2:1 or 3:3:2:-
- 16-bit RGBA 5:5:5:1 or 5:6:5:- or 4:4:4:-
- 24-bit RGB 8:8:8
- 32-bit RGBA 8:8:8:8
- Color Index (CI) 8:-:-:-

Texture Formats

Textures can be stored in memory in the formats described below. These formats are a superset of the framebuffer formats due to the support for 4- and 8-bit palletized textures and the YUV formats. The use of palletized textures significantly reduces the texture memory requirements, and enhances performance.

If the texture format is different to the framebuffer format then the graphics core performs the conversion between color formats. If the texture map is 4- or 8-bits palletized, then the user defined on-chip lookup table is used to convert the data into full RGBA.

Supported Texture Formats:

- 4-bit palletized
- 8-bit palletized
- 8-bit RGBA 2:3:2:1 or 3:3:2:-
- 16-bit RGBA 5:5:5:1 or 5:6:5:- or 4:4:4:-
- 24-bit RGB 8:8:8
- 32-bit RGBA 8:8:8:8
- YUV: 4:4:4 or 4:2:2 or 4:2:0

Depth and Stencil Formats

The use of depth and stencil buffers is optional. Not using depth or stencil buffers increases the memory available to support higher display resolutions and more local texture storage.

- Depth: 0, 15 or 16-bits
- Stencil: 0 or 1 *(if 1 then the depth must be set to 0 or 15)*

3.5 Video Streams Interface

PERMEDIA 2 supports independent input and output of digital video. The input stream complies to the VESA VMI specification. Input data may be scaled and filtered before being written to local memory. The output stream is based on the VMI specification and is designed to work with common PAL/NTSC encoders. Both streams are independent of the video output to the monitor.

The interface may be configured to meet different needs. The table shows the modes supported:

Input width	Output width	Notes
8	8	Simultaneous input and output
16	0	Input only Zoom Video port
0	16	Output only Zoom Video port

Input data may be scaled and filtered to reduce memory requirements. The output stream may be gamma corrected and converted from RGB to YUV. The output video is a slave and supplies data on demand from the external encoder chip. Both streams support automatic hardware triple buffering.

Separate control is provided for Vertical Blank Interval (VBI) data such as closed caption, Teletext, or Intercast. VBI data may be inserted into the output stream or extracted from the input stream as required.

3.5.1 Control Buses

The interface supports two separate buses for programming devices connected to the video streams. The I2C bus is a two wire serial bus that is commonly used to control chips supplying or receiving data on the video ports. The general purpose bus is a parallel bus that supports a higher bandwidth and uses an eight bit data path with a four bit address. If the parallel bus is used only input video is available.

3.5.2 External ROM

In PERMEDIA 2 the external ROM is used to store the Video BIOS and is also used to store the power up configuration information (reducing the need for configuration resistors in board designs). Access to the ROM is by the general purpose bus during which both video streams are disabled.

If the ROM fitted is FLASH programmable, the contents may be modified under software control.

3.6 RAMDAC

PERMEDIA 2 incorporates a high performance 230MHz RAMDAC.

3.6.1 RAMDAC Characteristics

- 230 MHz, 64-bit RAMDAC
- Supporting screen resolutions up to 1600x1280 @ 85Hz refresh rate
- Supports packed pixel formats
- Supports per-window double-buffering
- Color depths of 8, 16, 24 and 32 bits/pixel
- Dot clock and memory clock phase-locked loops (PLLs)
- Triple 8-bit D/A converters
- 64x64x2 hardware cursor

3.6.2 Display Resolutions

PERMEDIA 2 supports all the standard screen resolutions at ergonomic refresh rates.

For each resolution and color depth in the table below, the number represents the refresh rate supported using the VESA generalized Timing formula and having 50% of the memory bandwidth used for screen refresh and 50% for drawing, and assuming a memory clock of 80MHz.

Resolution	8 bpp	16 bpp	24 bpp	32 bpp
320x200	220 Hz	220 Hz	220 Hz	220 Hz
640x480	220 Hz	220 Hz	220 Hz	220 Hz
800x600	220 Hz	220 Hz	204 Hz	153 Hz
1024x768	220 Hz	186 Hz	124 Hz	93 Hz
1152x860	153 Hz	153 Hz	107 Hz	85 Hz
1280x1024	118 Hz	118 Hz	85 Hz	60 Hz
1600x1200	85 Hz	85 Hz	-	-

3.6.3 Display Data Channels (DDC)

Two control lines are dedicated on PERMEDIA 2 to support DDC1 and DDC2AB+ monitor configuration utilities. The DDC2 serial bus is independent of the serial bus in the VMI interface.

3.7 SVGA

The on-chip SVGA unit is register level compatible with standard VGA devices and requires no software emulation. It supports all standard VGA modes and modes h100 and h101 SVGA modes. Using UniVBE drivers the resolution may be increased to 1600x1200.

The SVGA unit is a high performance 32-bit implementation.

Mode (hex)	Alpha Format	Char Size	Colors	Max Page	Type Format	Resolution
00 0	40 by 25	8 by 8	16/256K bw	8	Alpha	320 x 200
0*	40 by 25	8 by 14	16/256K bw	8	Alpha	320 x 350
0+	40 by 25	9 by 16	16/256K bw	8	Alpha	360 x 400
01 1	40 by 25	8 by 8	16/256K	8	Alpha	320 x 200
1*	40 by 25	8 by 14	16/256K	8	Alpha	320 x 350
1+	40 by 25	9 by 16	16/256K	8	Alpha	360 x 400
02 2	80 by 25	8 by 8	16/256K bw	8	Alpha	640 x 200
2*	80 by 25	8 by 14	16/256K bw	8	Alpha	640 x 350
2+	80 by 25	9 by 16	16/256K bw	8	Alpha	720 x 400
03 3	80 by 25	8 by 8	16/256K	8	Alpha	720 x 200
3*	80 by 25	8 by 14	16/256K	8	Alpha	640 x 350
3+	80 by 25	9 by 16	16/256K	8	Alpha	720 x 400
04 4	40 by 25	8 by 8	4/256K	1	Graph	320 x 200
05 5	40 by 25	8 by 8	4/256K bw	1	Graph	320 x 200
06 6	80 by 25	8 by 8	2/256K bw	1	Graph	640 x 200
07 7	80 by 25	9 by 14	bw	8	Alpha	720 x 350
7+	80 by 25	9 by 16	bw	8	Alpha	720 x 400
0D D	40 by 25	8 by 8	16/256K	8	Graph	320 x 200
0E E	80 by 25	8 by 8	16/256K	4	Graph	640 x 200
0F F	80 by 25	8 by 14	bw	2	Graph	640 x 350
10 10	80 by 25	8 by 14	16/256K	2	Graph	640 x 350
11 11	80 by 30	8 by 16	2/256K	1	Graph	640 x 480
12 12	80 by 30	8 by 16	16/256K	1	Graph	640 x 480
13 13	40 by 25	8 by 8	256/256K	1	Graph	320 x 200

The following VESA SVGA modes are supported:

Mode (hex)	Pixels	Colors
100	640 by 400	256
101	640 by 480	256

ModeX is also supported.

4. Software Drivers

3Dlabs have extensive experience and a proven track record in delivering high performance, high quality, ready-to-ship software drivers that extract the maximum performance from both the PERMEDIA 2 processor and the entire system.

4.1 2D Drivers

PERMEDIA 2 is a high performance 2D and Video engine supplied with optimized drivers for:

- Windows 95 with DirectX and DirectDraw
- Windows NT with DirectX and DirectDraw
- QuickDraw

Other drivers are available on request.

4.2 3D Drivers

PERMEDIA 2 has been designed to accelerate the key consumer focused 3D APIs and drivers. 3Dlabs' processors have become the reference port for many 3D drivers, including Microsoft's Direct3D.

- Direct3D
- OpenGL
- Creative Labs' CGL
- QuickDraw3D and RAVE
- Autodesk's Heidi for 3D Studio MAX Support

4.3 Other

- SVGA BIOS

5. OEM Focused Solutions

A range of PERMEDIA 2 based add-in boards and motherboards can be designed to meet the requirements of particular markets and their price/performance criteria. 3Dlabs produce reference designs for many of the more common configurations, all of which can support our full suite of software drivers, including Windows 95, Windows NT, QuickDraw, OpenGL and Direct3D.

5.1 PERMEDIA 2 for Windows 95 and Windows NT

For users seeking a pervasive 3D accelerator for Windows 95 and Windows NT applications based on Direct3D, OpenGL or 3D Studio MAX there can be no better solution than a 2-8 MByte graphics board based on the PERMEDIA 2 processor.

This solution delivers unrivalled 3D and multimedia acceleration for both business and consumer 3D applications such as Web browsers, authoring tools, games and personal design packages.

5.2 PERMEDIA 2 for QuickDraw3D and QuickDraw RAVE

For users seeking the ultimate 3D solution for PCI based Macintosh systems, a PERMEDIA 2 board offers the best price/performance features for both the business and consumer user. With built in QuickDraw3D specific features, bi-endian support and high quality driver optimisations, PERMEDIA 2 is the ideal Power Mac 3D and multimedia accelerator.

5.3 PERMEDIA 2 and GLINT

Users looking for the ultimate in high-end, workstation class performance and functionality for accelerating professional OpenGL applications should choose GLINT based solutions. The GLINT 500TX offers VRAM based solutions supporting higher true color screen resolutions, 24-bit Z-buffer, 8-bit stencil buffer, up to 32Mbyte framebuffer and 48Mbytes Z and texture memory, plus advanced OpenGL features including 8-bit overlays and advanced anti-aliasing.

5.4 Early Access Program

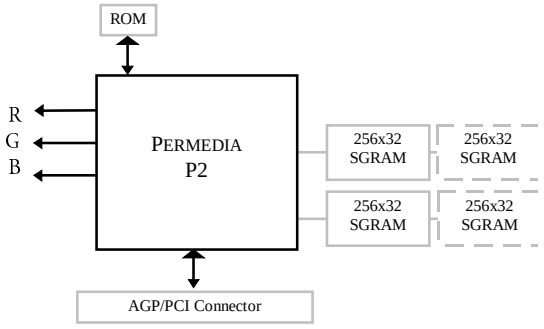
The PERMEDIA 2 Early Access Program (EAP) is for Independent Hardware Vendors (IHVs) and OEMs who wish to work closely with 3Dlabs in bringing PERMEDIA 2 based designs to market quickly and efficiently. Supporting a close technical and marketing collaboration, the program is open to IHVs committed to developing PERMEDIA 2 based solutions. It offers:

- Close technical support and joint marketing and press programs
- Early access to design engineers, design guides and application notes
- Priority supply of sample parts and access to reference board schematics
- Participation in driver Beta programs

To minimize development times 3Dlabs provides PERMEDIA 2 EAPs with access to extensive design documentation for the 3Dlabs reference boards including board schematics, ORCAD and Gerber files, design guides, application notes and access to a full suite of 3D and 2D device drivers.

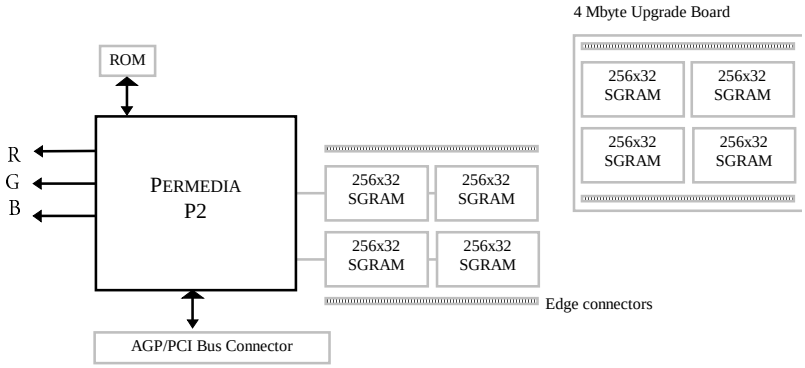
5.5 OEM Solution Designs

5.5.1 Pervasive 3D Solution



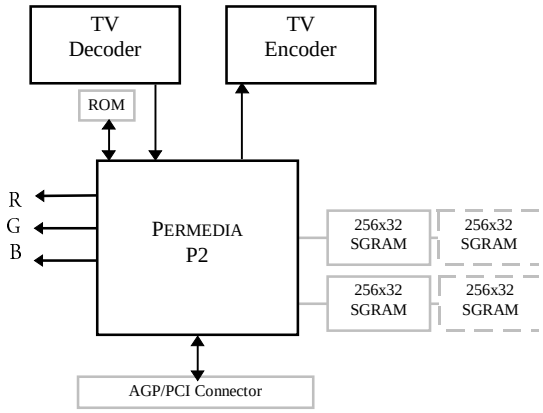
This board sets the standard for low-cost, high volume 3D, 2D and video acceleration. It is based on a PERMEDIA 2 with 2 Mbytes of memory and the option for an additional 2 Mbytes. It may be built as either a standard PCI board or as an AGP card. If an AGP card, it uses the AGP execute model to avoid storing textures locally; this frees memory for higher resolution screens.

5.5.2 Business 3D Solution



Designed for the business user or home enthusiast, this reference board adds extra memory for higher screen resolutions and extended local texture storage. This may be either a standard PCI board or an AGP card. As an AGP card, it would uses the DMA model to transfer textures into local memory where it caches them for higher performance.

5.5.3 Home PC Solution



This reference board based on the Pervasive 3D solution, adds the necessary hardware to enable TV input and output.

5.5.4 Other Solutions

Other PERMEDIA 2 possibilities include:

- Hardware MPEG2 solution

  Add hardware decompression to the video streams port.
- Video Conferencing Solution

  Add hardware video conferencing support to video streams port.

5.6 Typical Memory Configurations and Resolutions

The following table shows the color and display resolutions and texture storage supported for some typical memory configurations. All 3D content is assumed to be double buffered.

5.6.1 3D Memory Configurations

The texture column indicates the amount of texture memory available after the framebuffer (including backbuffer) and depth buffer have been allocated.

Width	Height	Color	Z	Texture Space		
				2Mb	4Mb	8Mb
512	384	8-bit	0-bit	1.6 Mb	3.6 Mb	7.6 Mb
512	384	8-bit	16-bit	1.2 Mb	3.2 Mb	7.2 Mb
512	384	16-bit	0-bit	1.2 Mb	3.2 Mb	7.2 Mb
512	384	16-bit	16-bit	0.8 Mb	2.8 Mb	6.8 Mb
512	384	24-bit	0-bit	0.9 Mb	2.9 Mb	6.9 Mb
512	384	24-bit	16-bit	0.5 Mb	2.5 Mb	6.5 Mb
512	384	32-bit	0-bit	0.5 Mb	2.5 Mb	6.5 Mb
512	384	32-bit	16-bit	0.1 Mb	2.1 Mb	6.1 Mb
640	400	8-bit	0-bit	1.5 Mb	3.5 Mb	6.48 Mb
640	400	8-bit	16-bit	1 Mb	3 Mb	7 Mb
640	400	16-bit	0-bit	1 Mb	3 Mb	7 Mb
640	400	16-bit	16-bit	0.5 Mb	2.5 Mb	6.5 Mb
640	400	24-bit	0-bit	0.5 Mb	2.5 Mb	6.5 Mb
640	400	24-bit	16-bit	0.05 Mb	2 Mb	6 Mb
640	400	32-bit	0-bit	0.05 Mb	2 Mb	6 Mb
640	400	32-bit	16-bit	-	1.6 Mb	5.6 Mb
640	480	8-bit	0-bit	1.5 Mb	3.5 Mb	6.5 Mb
640	480	8-bit	16-bit	0.8 Mb	2.8 Mb	6.8 Mb
640	480	16-bit	0-bit	0.8 Mb	2.8 Mb	6.8 Mb
640	480	16-bit	16-bit	0.25 Mb	2.25 Mb	6.25 Mb
640	480	24-bit	0-bit	0.25 Mb	2.25 Mb	6.25 Mb
640	480	24-bit	16-bit	-	1.7 Mb	5.7 Mb
640	480	32-bit	0-bit	-	1.7 Mb	5.7 Mb
640	480	32-bit	16-bit	-	1.1 Mb	5.1 Mb
800	600	8-bit	0-bit	1 Mb	3 Mb	7 Mb
800	600	8-bit	16-bit	-	2.1 Mb	6.1 Mb
800	600	16-bit	0-bit	-	2.1 Mb	6.1 Mb
800	600	16-bit	16-bit	-	1.3 Mb	5.3 Mb
800	600	24-bit	0-bit	-	1.3 Mb	5.3 Mb
800	600	24-bit	16-bit	-	0.35 Mb	4.35 Mb
800	600	32-bit	0-bit	-	0.35 Mb	4.35 Mb
800	600	32-bit	16-bit	-	-	3.6 Mb
1024	768	8-bit	0-bit	0.5 Mb	2.5 Mb	6.5 Mb
1024	768	8-bit	16-bit	-	1 Mb	5 Mb
1024	768	16-bit	0-bit	-	1 Mb	5 Mb
1024	768	16-bit	16-bit	-	-	3.6 Mb
1024	768	24-bit	0-bit	-	-	3.6 Mb
1024	768	24-bit	16-bit	-	-	2 Mb
1024	768	32-bit	0-bit	-	-	2 Mb
1024	768	32-bit	16-bit	-	-	0.5 Mb
1280	1024	8-bit	0-bit	-	1.5 Mb	5.5 Mb
1280	1024	8-bit	16-bit	-	-	3.1 Mb
1280	1024	16-bit	0-bit	-	-	3.1 Mb
1280	1024	16-bit	16-bit	-	-	0.5 Mb
1280	1024	24-bit	0-bit	-	-	0.5 Mb
1280	1024	24-bit	16-bit	-	-	-
1280	1024	32-bit	0-bit	-	-	-
1280	1024	32-bit	16-bit	-	-	-

5.6.2 2D Memory Configurations

The following table shows the 2D screen resolutions supported by different amounts of memory.

Width	Height	Color	Card size		
			2Mb	4Mb	8Mb
512	384	8-bit	✓	✓	✓
512	384	16-bit	✓	✓	✓
512	384	24-bit	✓	✓	✓
512	384	32-bit	✓	✓	✓
640	400	8-bit	✓	✓	✓
640	400	16-bit	✓	✓	✓
640	400	24-bit	✓	✓	✓
640	400	32-bit	✓	✓	✓
640	480	8-bit	✓	✓	✓
640	480	16-bit	✓	✓	✓
640	480	24-bit	✓	✓	✓
640	480	32-bit	✓	✓	✓
800	600	8-bit	✓	✓	✓
800	600	16-bit	✓	✓	✓
800	600	24-bit	✓	✓	✓
800	600	32-bit	✓	✓	✓
1024	768	8-bit	✓	✓	✓
1024	768	16-bit	✓	✓	✓
1024	768	24-bit	-	✓	✓
1024	768	32-bit	-	✓	✓
1280	1024	8-bit	✓	✓	✓
1280	1024	16-bit	-	✓	✓
1280	1024	24-bit	-	✓	✓
1280	1024	32-bit	-	-	✓
1600	1200	8-bit	✓	✓	✓
1600	1200	16-bit	-	✓	✓
1600	1200	24-bit	-	-	✓
1600	1200	32-bit	-	-	✓

5.7 Datasheet

Texture Mapping

- True perspective correction
- Bilinear filtering
- Palletized and RGB textures
- Transparency maps
- Local texture buffer
- Specular highlights
- Fast texture loading
- Color keying

3D Rendering

- Points, lines, triangles & bitmaps
- Gouraud and flat shading
- 8-, 16-, 24-, or 32-bit RGBA
- Depth (z) buffering
- Fogging & depth-cueing
- Alpha blending
- Full screen anti-aliasing
- Dithering
- Area stippling
- Stencil test and stencil buffer
- Scissor test and logic operations

Display Features

- 8-, 16-, 24-, or 32-bit RGB
- 8-bit color index
- Double and triple-buffering
- Hardware dithering
- Hardware pan
- Per window double buffering
- Overlays

Programming

- Direct3D and OpenGL
- Windows 95 and Windows NT
- Creative Labs' CGL
- QuickDraw 3D and RAVE
- Heidi for 3D Studio MAX

Fast Video Playback

- MPEG2 playback acceleration
- YUV color space conversion
- Scaling (bilinear filtered)
- Dithering
- Color keying (blue-screen)

GUI Acceleration

- BitBlt with ROPs
- Points, lines, polygons
- Fills, and text primitives
- Fast linear framebuffer
- On chip SVGA
- Windows and QuickDraw

PCI/AGP Interface

- 32-bit glueless PCI V2.1
- 33MHz PCI / 66MHz AGP
- Target and master support
- DMA mastering
- 256 entry command FIFO
- Bi-endian apertures on bus
- Interrupts

Memory Architecture

- 64-bit SGRAM/SDRAM interface
- Single multi-function memory
- Optimal memory usage
- 2-8 Mbytes

Display Resolutions

- 320x200 to 1600x1200
- Ergonomic refresh rates

Video Output

- 230 MHz RAMDAC interface

TV In, TV Out

- Simultaneous digital video input and output

Green PC and Plug & Play

- VESA DPMS
- VESA DDC support

Industry Standard Package BGA

- 256-pin BGA)
- 3.3 V (5V Tolerant I/O)