



Vision processors

# Matrox Odyssey eA/XA >>>

Leading-edge vision processor board.



## Key features

- > x4 PCIe™ (eA) or PCI-X® (XA) long card
- > G4 PowerPC™ and proprietary ASIC combine for over 130 BOPS<sup>1</sup>
- > over 5 GB per second of memory bandwidth
- > 512 MB of DDR SDRAM memory
- > integrated quad-input analog frame grabber acquires up to 640 MB per second
- > up to 1 GB per second of I/O bandwidth to host PC
- > available software is sold separately and includes Matrox Imaging Library (MIL)<sup>2</sup> and Matrox Odyssey Developer's Toolkit
- > host OS support for 32/64-bit Microsoft® Windows® XP/Vista® and 32-bit Linux®
- > royalty-free redistribution of MIL and ONL run-time environments<sup>2</sup>

## Evolutionary architecture with leading-edge performance

Matrox Odyssey eA/XA is a fourth generation vision processor board that optimally combines the latest off-the-shelf and custom technologies within an established architecture to deliver leading-edge performance and value. Designed with demanding semiconductor inspection, medical imaging, print inspection, surface inspection and signal processing applications in mind, the Matrox Odyssey XA is the ideal choice for applications with data acquisition and processing rates in the order of hundreds of MBytes per second and/or where the PC is heavily loaded with other system activities.

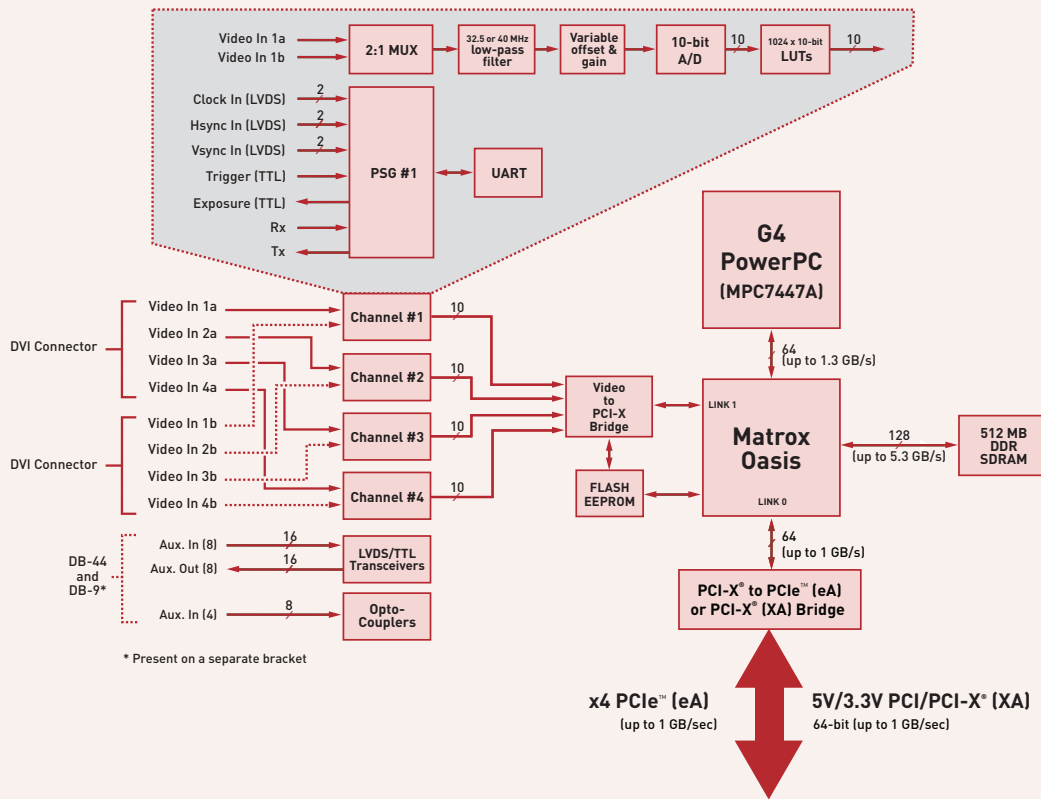
The premier embedded microprocessor, state-of-the-art proprietary processor and router ASIC, DDR memory, and PCIe™/PCI-X® connectivity come together on the Matrox Odyssey eA/XA to provide unrivaled power for a single vision processor board. All this power and flexibility is accessed through an easy-to-learn programming environment compatible with Matrox Imaging's previous generation vision processor and incorporating elaborate image processing and analysis algorithms.

### State-of-the-art Matrox Oasis ASIC

The Matrox Imaging designed Oasis ASIC is the pivotal component of the Matrox Odyssey eA/XA. A high-density chip, the Matrox Oasis integrates a CPU bridge, Links Controller, main memory controller and Pixel Accelerator.



## Matrox Odyssey eA/XA



### Pixel Accelerator

The Pixel Accelerator (PA) is a parallel processor core, which considerably accelerates neighborhood, point-to-point and LUT mapping operations. It consists of an array of 64 processing elements all working in parallel. Each processing element has a multiply-accumulate (MAC) unit and an arithmetic-logic unit (ALU).

The MAC unit is capable of performing a single 16-bit by 16-bit, two 8-bit by 16-bit or four 8-bit by 8-bit multiplies with 40-bit accumulation per cycle for convolution operations. The 40-bit accumulator guarantees no overflow situation for a 16 by 16 kernel with 16-bit coefficients and data. In addition, the PA architecture allows symmetrical kernels to be processed four times faster. The MAC unit is also able to perform up to four minimum or maximum operations per cycle for grayscale morphology operations.

The ALU can execute a wide variety of arithmetic and logical operations. It can be programmed to execute a sequence of 256 instructions per pixel at one instruction per cycle reducing the amount of memory accesses and further accelerating memory I/O-bound sequences. The PA can accept up to four source buffers<sup>3</sup> and output to four destination buffers allowing several operations to be performed at once or in a single pass (i.e., four images can be averaged in one pass). Operating at a core frequency of 167 MHz enables the PA to carry out up to 100 BOPS<sup>1</sup> (i.e., process over two billion pixels per second).

### Memory controller

The Matrox Oasis includes a very efficient main memory controller for managing the 128-bit wide interface to DDR SDRAM memory. Operating at 167 MHz, the DDR SDRAM memory and controller combine to deliver a memory bandwidth in excess of 5 GB per second. Such ample memory bandwidth allows the Odyssey eA/XA to comfortably handle demanding video I/O while maintaining PA performance even for memory I/O-bound operations.

### Links Controller

The Links Controller (LINX) is the router that manages all data movement inside and outside the processing node, which consists of the PA, CPU and main memory. It can handle several concurrent video and message streams.

Video streams are used to transfer image data from the integrated frame grabber to the processing node and the processing node to the host PC including display. The video streams have adjustable priority levels, either above or below message streams. Video streams can be subject to various formatting operations including plane separation on input and merging on output, input cropping, input and output sub-sampling (1 to 16), and independent control of horizontal and vertical scanning direction. The latter is particularly useful for reconstructing a proper image from a camera whose readout requires multiple taps, each with different scanning directions.

### Links Controller (cont.)

Message streams are for all types of inter-processor communications. The LINX handles message streams between the processing node and the host PC independently of video streams. Message passing relies on hardware-assisted mechanisms for low overheads and real-time operation. Together, the above capabilities off-load the CPU and PA from data management tasks so they can focus on image processing tasks.

### Best-of-breed *freescale™ G4 PowerPC™* microprocessor

The CPU that controls activities on the Matrox Odyssey eA/XA and performs operations not accelerated by the PA is the *freescale™ G4 PowerPC™* microprocessor. The G4 combines the best features of a general purpose CPU and a DSP, and provides top performance at a given clock rate. The G4 is also backed by *freescale™*'s solid migration path for increased performance, all the while maintaining code compatibility.

The G4 incorporates a powerful 32-bit superscalar RISC and AltiVec™ technology's 128-bit vector execution unit. 512 KB of internal L2 cache helps sustain maximum processor performance. A 64-bit MPX bus offers efficient access to main memory and provides a sustained bandwidth close to its theoretical maximum of 1.3 GB per second.



AltiVec™ technology is specifically designed to meet the heavy computational requirements of applications such as video and image processing. This technology consists of a high-performance parallel processing engine for vector data. It uses the SIMD (single instruction, multiple data) model to process, in parallel, up to 16 pixels per cycle. It delivers a peak processing power of 16 billion 8-bit MACs per second or 8 billion 32-bit floating point operations per second when running at 1 GHz. Additionally, AltiVec™ technology operates concurrently with other execution units within the G4.



### Choice of high-performance host bus interfaces

Four lane (x4) PCIe™ and PCI-X® are the interfaces used to connect to the host PC on the Matrox Odyssey eA and Matrox Odyssey XA boards respectively. PCIe™ is the follow-on to conventional PCI and PCI-X®. Version 1.x of PCIe™ operates at 2.5 GHz to deliver a peak bandwidth of 1GB/sec over a x4 implementation. PCI-X® is a high-performance backwards-compatible enhancement to conventional PCI. Version 1.0a of PCI-X® specifies a 64-bit physical connection running at speeds of up to 133 MHz resulting in a peak bandwidth of up to 1 GB per second.

### Flash EEPROM for full autonomy

Matrox Odyssey eA/XA has a flash EEPROM that stores the G4 PowerPC™ boot sequence, system initialization parameters and a debugging utility. It can also be used to store the operating system and application program in order to implement a truly autonomous system from power-up.

### Integrated analog frame grabber

The integrated analog frame grabber has four completely independent inputs, each capable of high frequency and high fidelity video capture. In addition to being able to simultaneously acquire from up to four single-tap video sources, the inputs can be combined to simultaneously acquire from two dual-tap video sources or one RGB video source. The inputs can also be combined to simultaneously acquire from two video sources at double the nominal acquisition rate. The analog frame grabber also includes an internal video generator for troubleshooting installation and operation.

### All-encompassing programming environment

The Matrox Odyssey eA/XA offers the developer a choice of application programming interfaces (APIs) and programming models. Application developers can program the board using the Matrox Imaging Library or Matrox Odyssey Native Library, each with royalty-free run-time environments<sup>2</sup>. The application program can run on the host PC to remotely control the Matrox Odyssey eA/XA (i.e., options A and B) or it can be made to run entirely on the Matrox Odyssey eA/XA (i.e., options C and D).

### Matrox Imaging Library (MIL)

MIL is a complete and easy-to-use programming library for image capture, processing, analysis, display and archiving that supports the complete line of existing and future Matrox Imaging hardware. MIL's field-proven processing and analysis functions include point-to-point, statistics, filtering, morphology, geometric transformations, FFT, segmentation, pattern recognition, blob analysis, edge extraction and analysis, measurement, character recognition, 1D and 2D code reading, calibration, and JPEG/JPEG2000 image compression. These functions run on the Matrox Odyssey eA/XA and are fully optimized for the G4 PowerPC™ and PA.

MIL for the Matrox Odyssey eA/XA is carefully tuned to exhibit low function call overheads, maximizing application efficiency and performance. MIL provides transparent image display management with automatic tracking and updating of image display windows at live video rates. MIL also allows for image display in a user-specified window. In addition, MIL supports live display of multiple video streams using multiple independent windows or a single mosaic window. Moreover, MIL provides non-destructive graphics overlay, suppression of tearing artifacts and filling the display area at live video rates. All of these features are performed with little or no host CPU intervention when using the appropriate graphics hardware. Refer to the MIL datasheet for more information.

### Odyssey Native Library (ONL)

ONL is an easy-to-use programming library specific to the Matrox Odyssey family of vision processor boards. The programming interface is compatible with the Matrox Genesis family of vision processor boards. Aside from video capture and system control, ONL includes functions for image processing, normalized grayscale correlation-based pattern recognition, blob analysis and JPEG compression. These functions are fully optimized to exploit the power of the G4 PowerPC™ and PA. ONL functions exhibit the lowest call overheads.

### Programming models

Application programs for the Matrox Odyssey eA/XA can run in a host-driven or fully embedded mode. In the host-driven mode, the application program runs on the CPU of the host PC and remotely sends commands to the Matrox Odyssey eA/XA for execution. The host-driven mode is the easiest to implement but it may be subject to the lack of determinism of the host PC platform. In the fully embedded mode, the application program runs directly on the G4 PowerPC™. The application program has little or no interaction with the host PC platform, ensuring deterministic behavior. Using the fully embedded mode requires the Matrox Odyssey Developer's Toolkit.

### Matrox Odyssey Developer's Toolkit

The Matrox Odyssey Developer's Toolkit (DTK) allows a developer to extract the full power of the Matrox Odyssey eA/XA. In addition to giving the means to run a MIL and/or ONL-based application program directly on the G4 PowerPC™, the Matrox Odyssey DTK lets a developer further optimize an algorithm by merging ONL functions to reduce main memory I/O bottlenecks.

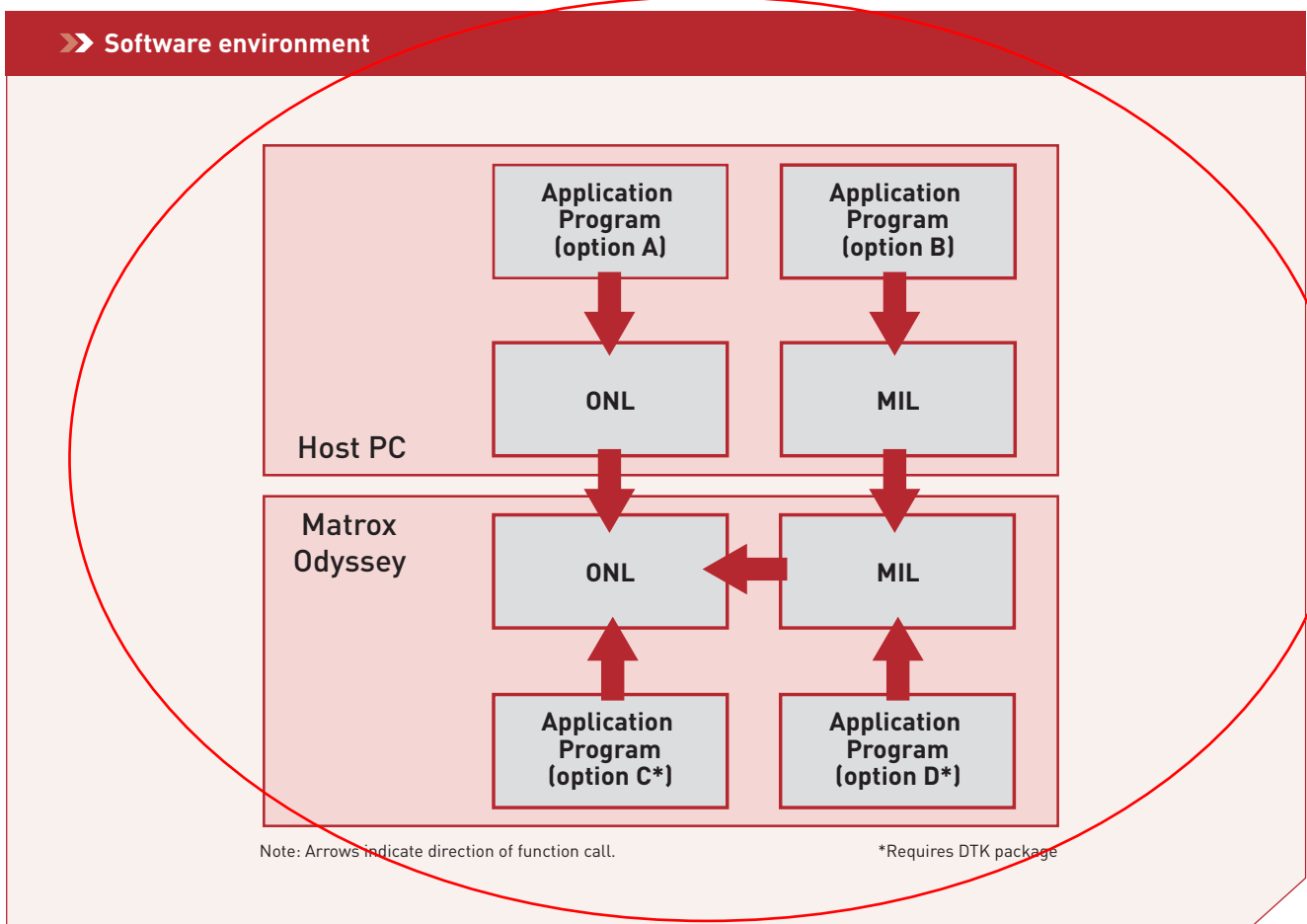
The Matrox Odyssey DTK also allows developers to write custom G4 PowerPC™ and PA functions. Custom G4 PowerPC™ code is written entirely in C/C++ including optimizations for AltiVec™ technology. AltiVec™ technology is programmed through C language extensions and intrinsic functions. No exotic assembly code is required. Custom PA code is done through a low-level API and pseudo-assembly language. Refer to the Matrox Odyssey Developer's Toolkit datasheet for more information.

### Utilities

Bundled with the MIL and ONL software development kit is the Matrox Intellicam camera configuration utility. Matrox Intellicam is a Windows®-based program that lets users interactively configure the frame grabber modules to capture from a variety of video sources. Also included is an interactive system configuration and debugging utility that incorporates a memory and command viewer, performance monitor and system diagnostic tool.

### Operating system support

Supported host environments for the Matrox Odyssey eA/XA are 32/64-bit Microsoft® Windows® XP/Vista® and 32-bit Linux. The G4 PowerPC runs an off-the-shelf RTOS with a very small footprint and fast response to task switches and interrupts.



## Specifications

### Hardware

- x4 PCIe™ long card or PCI/PCI-X® long card with universal 64-bit card edge connector (64-bit 33/66 MHz 5/3.3V PCI and 64-bit 66/100/133 MHz PCI-X)
- 1 GHz MPC7447A (167 MHz MPX bus)
- 512 MB of 167 MHz DDR SDRAM main memory
- 16 MB flash EEPROM
- four independent analog video inputs with
  - 2:1 mux
  - AC or DC coupling
  - selectable low pass filter: 7.5 MHz or 40 MHz
  - variable gain amplifier and adjustable references
  - 10-bit A/D with sampling rate up to 80 MHz
  - SNR of 51.7 dB<sup>4</sup>
  - pixel jitter of  $\pm 2.3$  ns<sup>5</sup>
  - adjustable clock phase (256 steps with 0.5 ns resolution)
  - four 1K x 10-bit LUTs
  - LVDS/TTL pixel clock, hsync/csync, and vsync inputs or outputs
  - TTL trigger input and exposure output
  - RS-232 serial port
- inputs can be combined to acquire from
  - component RGB video source
  - two dual-tap monochrome video sources
  - two monochrome video sources at up to 160 MHz
- supports frame and line-scan video sources
- eight TTL/LVDS configurable auxiliary inputs
- eight TTL/LVDS configurable auxiliary outputs
- four opto-isolated auxiliary inputs
- PROM for storing calibration parameters
- internal video generator for diagnostics

### Dimensions and environmental information

- 31.2 L x 10.7 H x 1.73 W cm (12.3" x 4.2" x 0.68") from bottom edge of goldfinger to top edge of board and without bracket and retainer
- power consumption (typical): 4.27A @ 3.3V or 14.1W, 5.56A @ 5V or 27.8W, 0.38A @ 12V or 4.6W, or 46.5W total
- operating temperature: 0°C to 55° C (32° F to 131° F)
- ventilation requirements: 100 LFM (linear feet per minute) over board(s)
- relative humidity: up to 95% (non-condensing)
- FCC class A
- CE class A
- RoHS-compliant

### Software drivers

- host drivers for 32/64-bit Microsoft® Windows® XP/Vista® and 32-bit Linux®

## Ordering Information

### Board

Part number	Description
O 10G 5M QHAL*	PCI-X® vision processor board with 1 GHz MPC7447A, 512MB DDR SDRAM, integrated analog frame grabber with four independent inputs and cable adapter board (LVDS aux. I/O).
O 10G 5M QHAL E*	x4 PCIe™ vision processor board with 1 GHz MPC7447A, 512MB DDR SDRAM, integrated analog frame grabber with four independent inputs and cable adapter board (LVDS aux. I/O).

### Software

Part number	Description
MIL 9 WIN32 ODY	MIL 9 development toolkit for Matrox Odyssey running under 32-bit Windows® XP/Vista. Includes DVDs with MIL, ONL, ActiveMIL, Intellicam, Inspector, Matrox display drivers and online documentation.
MIL 9 WIN64	MIL 9 development toolkit for 64-bit Windows® XP/Vista. Includes DVD with MIL, ONL, Intellicam, Matrox display drivers and online documentation. Also requires MIL9WIN32ODY
MIL 9 LNX32 EA	MIL 9 development toolkit for 32-bit Linux. Includes DVD with MIL, ONL and online documentation. Also requires MIL9WIN32ODY.
MIL 9 DTK WIN32	Add-on to MIL 9 development toolkit for 32-bit Windows® XP / Vista®. Required for writing code for Matrox Odyssey's Pixel Accelerator (PA) and PowerPC™. Also requires Code Warrior™ for Power PC™ Embedded Systems.
MIL 9 DTK WIN64	Add-on to MIL 9 development toolkit for 64-bit Windows® XP / Vista®. Required for writing code for Matrox Odyssey's Pixel Accelerator (PA) and PowerPC™. Also requires Code Warrior™ for Power PC™ Embedded Systems.

### Software Maintenance Program

Included in the original purchase price of the Matrox Odyssey SDK and DTK, it entitles registered users to one year of technical support and free updates.

Part number	Description
MIL MAINTENANCE	One year program extension per developer.

### Cables

Part number	Description
DVI-T0-8BNC/O	8' or 2.4 m cable, DVI to 8 BNCs and open end (requires customization).

#### Notes:

1. Billion operations per second.
2. MIL for Matrox Odyssey includes MIL for IA32 (host PC), which requires an additional development or run-time license.
3. Only one source buffer for MAC unit.
4. Measured with 40MHz low pass filter.
5. Measured with a horizontal reference signal at 15.7KHz (RS-170).

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