Matrox Vio

Installation and Hardware Reference

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Contents

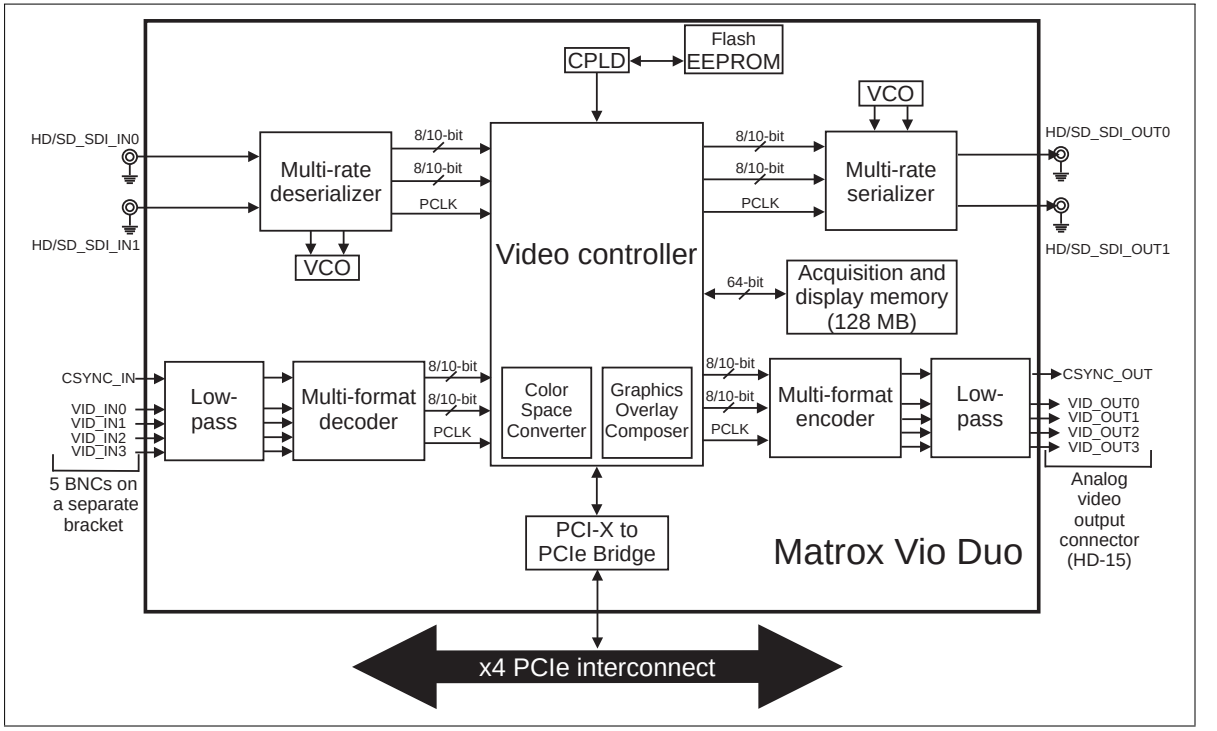
Chapter 1

Introduction

This chapter briefly describes the key features of the Matrox Vio frame grabber, as well as the software that can be used with the board.

Matrox Vio

The Matrox Vio family consists of two x4 PCIe members: Matrox Vio Duo and Matrox Vio Analog. Matrox Vio Duo is a frame grabber capable of acquiring and displaying standard definition (SD) or high definition (HD) analog or digital video. Matrox Vio Analog is a frame grabber capable of acquiring and displaying only SD or HD analog video.



This manual will explain how to install the Matrox Vio Duo, as well as the features and the necessary technical information about Matrox Vio Duo. Everything that applies to Matrox Vio Duo also applies to Matrox Vio Analog, with the exception of the digital acquisition and display information.

Acquisition features

Matrox Vio Duo can acquire video data from an SD or HD analog or digital video source; the analog path utilizes a multi-format decoder for capturing video data, whereas the digital path uses a multi-rate deserializer. The table below summarizes the supported acquisition video formats:

Acquisition video formats		
Transmission standard	**Digital video**	**Analog video**
1080i at 30 frames/sec	HD-SDI	YPbPr, RGB
720p at 60 frames/sec	HD-SDI	YPbPr, RGB
480i at 30 frames/sec	HD-SDI	YPbPr, RGB
576i at 25 frames/sec (PAL)	SD-SDI	CVBS, RGB[1], Y/C, YPbPr (non-square pixels)
480i at 30 frames/sec (NTSC)	SD-SDI	CVBS, RGB[1], Y/C, YPbPr (non-square pixels)
576i at 25 frames/sec (CCIR)	-	CVBS, RGB, Y/C, YPbPr (square pixels)
480i at 30 frames/sec (RS-170)	-	CVBS, RGB, Y/C, YPbPr (square pixels)

1. Although the multi-format decoder can capture RGB analog video, it digitizes the data to 20-bit YCbCr.

Video data is converted by the decoder or the deserializer into either YUV or 20-bit YCbCr. Grabbed images can then be transferred to the Host in BGR24 packed, BGR32 packed, RGB24 planar, YUV, or monochrome pixel formats. Images can be transferred to an auxiliary display, but the resolution of the output has to be identical to the resolution of the image acquired.

Matrox Vio Duo can acquire data from only one video source at a time; however you can attach several video sources and switch between them. You can connect up to two analog (one CVBS and one RGB/YPbPr/YC) and two digital video sources.

Display features

Matrox Vio Duo can output video to an auxiliary analog display device, an auxiliary digital display device[1], or to both simultaneously. Although the board allows for simultaneous analog and digital display, the same information is sent to both outputs.

1. Except when outputting video captured with square pixel digitization.

Matrox Vio Duo uses a multi-format encoder to output in analog mode and a multi-rate serializer to output in digital mode. In either mode, video is output to the display at the original acquisition resolution; the format can change as long as the resolution is the same.

Besides outputting acquired video, Matrox Vio Duo can also output static images from on-board memory.

In addition, Matrox Vio Duo is capable of dynamically overlaying an image over images that are being displayed. The overlay image can be static or dynamic (different for every frame of the underlay image).

❖ Note, the display section of Matrox Vio Duo can only output to non-windowed auxiliary displays.

Memory

As a standard feature, Matrox Vio Duo has 128 Mbytes of linearly addressable DDR SDRAM, used as acquisition and display memory, with a bandwidth of up to 100 MHz (1.6 Gbytes/sec), and a 64-bit data bus. The memory interfaces to the video controller and is used for the storage of acquisition video data, overlay images, and static images transferred from the Host.

Data transfer

Matrox Vio Duo can exchange data with the Host at a peak transfer rate of up to 800 Mbytes/sec when used in a four lane PCIe slot. Internal data paths allow for transfer of live video to on-board memory, Host memory, or auxiliary display.

Software

To operate the Matrox Vio Duo, you can purchase one or more Matrox Imaging software products that support the board. These are the Matrox Imaging Library (MIL) and its derivatives (MIL-Lite, ActiveMIL, ActiveMIL-Lite, and Matrox Inspector). All Matrox software is supported under Windows; consult your software manual for supported Windows environments.

❖ Note, the discussion throughout this manual is based in terms of Matrox Imaging software products.

MIL

MIL is a high-level programming library with an extensive set of optimized functions for image capture, processing, analysis, transfer, compression, display, and archiving. Image processing operations include point-to-point, statistical, spatial filtering, morphological, geometric transformation, and FFT operations. Analysis operations support calibration, are performed with sub-pixel accuracy, and include pattern recognition (normalized grayscale correlation and Geometric Model Finder), blob analysis, edge extraction and analysis, measurement, metrology, character recognition (template-based and feature-based), code recognition and verification (1D, 2D and composite code types), 3D reconstruction, and color analysis.

MIL applications are easily ported to new Matrox hardware platforms and can be designed to take advantage of multi-processing and multi-threading environments.

MIL-Lite

MIL-Lite is a subset of MIL. It includes all the MIL functions for image acquisition, transfer, display control, and archiving. It also allows you to perform processing operations that are typically useful to pre-process grabbed images.

ActiveMIL

ActiveMIL is a set of ActiveX controls that are based on MIL. ActiveMIL was designed for rapid application development (RAD) tools, such as Microsoft's Visual Basic. ActiveMIL is included with MIL (ActiveMIL-Lite is included with MIL-Lite).

Matrox Inspector

Matrox Inspector is an interactive Windows application for image capture, processing, analysis, and archiving. MIL application developers can use Matrox Inspector as a prototyping tool to quickly build proof-of-concept demonstrations. End users can use Matrox Inspector to perform and automate image enhancement and measurement tasks.

Matrox Intellicam

Matrox Intellicam is an interactive Windows program that allows for fast video source interfacing and provides interactive access to all the acquisition features of your Matrox board. Matrox Intellicam also has the ability to create custom digitizer configuration format (DCF) files, which MIL and its derivatives use to interface to specific non-standard video sources. Matrox Intellicam is included with all Matrox Imaging software products.

Essentials for getting started

To begin using Matrox Vio Duo, you need the following:

- An available PCIe slot with four or more lanes. In addition, if installing the expanded video input adapter board, an available slot to fasten it onto the chassis.
- Microsoft Windows operating system (consult the software package for supported environments and computer memory/storage requirements).
- Processor with an Intel 32-bit architecture (IA32) or equivalent. Please refer to the Matrox Imaging website for information on compatible chipsets.
- A CD drive, and a hard disk or network drive on which to install the Matrox Vio Duo software.
- A proper power supply. Refer to the *Electrical specifications* section of *Appendix B: Technical information*.

Inspecting the Matrox Vio Duo package

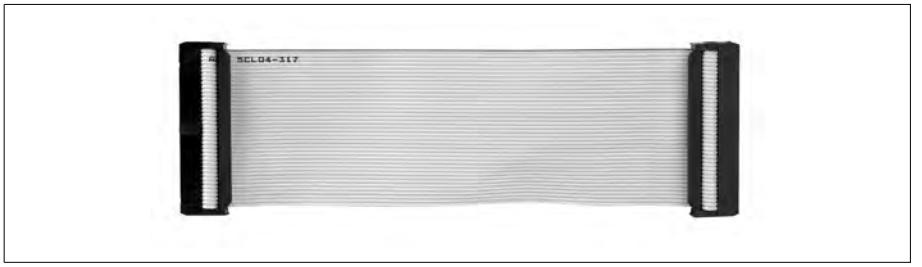
You should check the contents of your Matrox Vio Duo package when you first open it. If something is missing or damaged, contact your Matrox representative.

Standard items

You should receive the following items:

- The Matrox Vio Duo board.
- An expanded video input adapter board.

- A flat ribbon cable to interface the frame grabber with the input adapter board.



- A CD with the Matrox Vio Duo Installation and Hardware Reference manual (this document).

Available separately

You might have also ordered one of the following:

- MIL, which includes ActiveMIL; MIL-Lite, which includes ActiveMIL-Lite; or Matrox Inspector. Matrox Intellicam is included with each of the aforementioned software packages.

Handling components

The electronic circuits in your computer and the circuits on Matrox Vio are sensitive to static electricity and surges. Improper handling can seriously damage the circuits. Be sure to drain static electricity from your body by touching a metal fixture (or ground) before you touch any electronic component. In addition, do not let your clothing come in contact with the circuit boards or components.

Warning

Before you add or remove devices from your computer, always **turn off** the power to your computer and all peripherals.

Installation

The installation procedure consists of the following steps:

1. Complete the hardware installation as described in *Chapter 2: Hardware Installation*.

2. Complete the software installation procedure as described in the documentation accompanying your software package.

For in-depth hardware information, refer to *Chapter 3: Matrox Vio Duo Hardware Reference*; whereas for a summary of this information, as well as environmental and electrical specifications, and connector pinout descriptions, see *Appendix B: Technical information*.

This manual occasionally makes reference to MIL-Lite functions. However, anything that can be accomplished with MIL-Lite can also be accomplished with MIL, ActiveMIL, ActiveMIL-Lite, or Matrox Inspector.[1]

❖ Note that, although other software products might be available to operate Matrox Vio Duo, the discussion throughout this manual is based in terms of Matrox Imaging software products.

Conventions

When the term Host is used in this manual, it refers to the host computer.

Need help?

If you experience problems during installation or while using this product, refer to the support page on the Matrox Imaging web site: www.matrox.com/imaging/support. This page provides answers to frequently asked questions, and also offers registered customers additional ways of obtaining support.

If your question is not addressed and you are registered, you can contact technical support. To do so, you should first complete and submit the online Technical Support Request Form, accessible from the above-mentioned page. Once the information is submitted, a Matrox support agent will contact you shortly thereafter by email or phone, depending on the problem.

1. Most operations can be accomplished with Matrox Inspector.

Chapter

2

Hardware Installation

This chapter explains how to install the Matrox Vio Duo board in your computer.

Installing the Matrox Vio Duo board

Before installing your Matrox Vio Duo board, some precautionary measures must be taken. Turn off the power to your computer and all its peripherals, and drain static electricity from your body (by touching a metal part of the computer chassis).

Proceed with the following steps to install your board. Note that your board should be installed before you install your software.

1. Remove the cover from your computer; refer to your computer's documentation for instructions.

2. Ensure that you have an empty PCIe slot with a minimum of four lanes in which to install your Matrox Vio Duo board.

If you intend to connect multiple video devices, or a device that requires additional synchronization and control signals, you will need to install the expanded video input adapter board. This will require an additional empty slot. This slot can be any type of PCI slot and need not be adjacent to the Matrox Vio Duo board. Note that the expanded video input adapter board does not plug into a slot's PCI/PCI-X/PCIe connector; it attaches only to the back of the computer's chassis.

3. Remove the metal plate(s) at the back of the selected slot(s), if present. If the metal plate is held in place using a screw, keep the removed screw(s). You will need the screw to anchor the board onto the chassis or to secure the expanded video input adapter board, if installed.

4. Position your Matrox Vio Duo board over the selected slot. Once aligned perfectly, press the board firmly but carefully into the connector of the slot.

5. Anchor the board to the chassis. Replace the screw(s) removed in step 3, if any.

6. If required, install the expanded video input adapter board of the Matrox Vio Duo board as described in the *Installing the expanded video input adapter board* section later in this chapter.

7. Replace the cover of your computer. Attach the video output display(s) and input video sources.

8. Turn on your computer.

❖ Upon booting your computer, Windows' Plug-and-Play system will detect a new Multimedia Video Device and you will be asked to assign it a driver. At this point, you should click on **Cancel** because the driver will be installed during the installation of Matrox Vio Duo software.

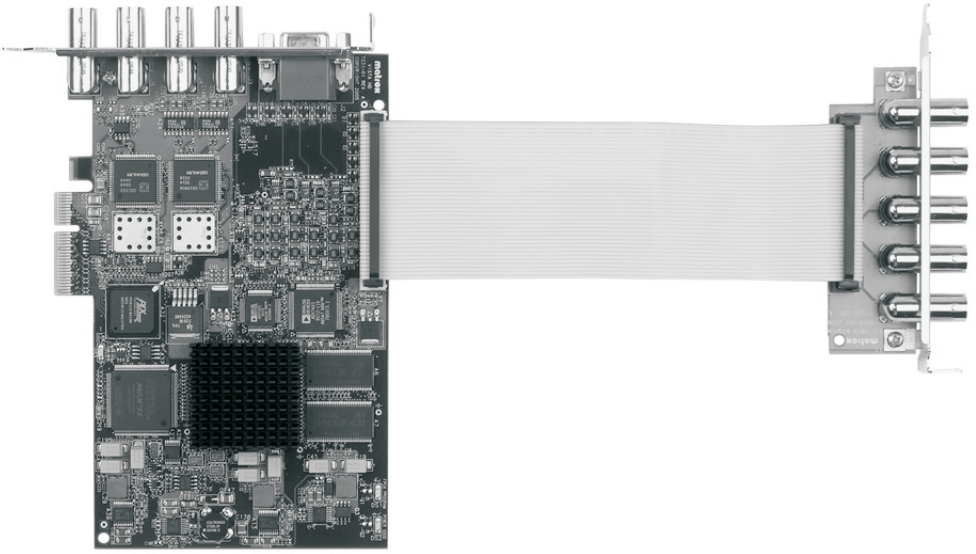
Installing the expanded video input adapter board

Proceed with the following steps to install the expanded video input adapter board:

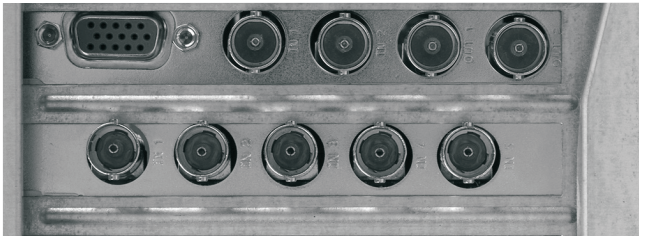
1. Ensure that your Matrox Vio Duo board is securely fastened to the computer chassis.

   Connect one end of the flat ribbon cable to the 40-pin internal connector of the Matrox Vio Duo board. To do so, position the ribbon cable so that the red colored stripe is on the same side as the bracket of the board. In this position, the connector on only one end of the cable will latch properly. In addition, you should hear a snap when the hooks of the cable's connector latch onto the 40-pin internal connector on the board.

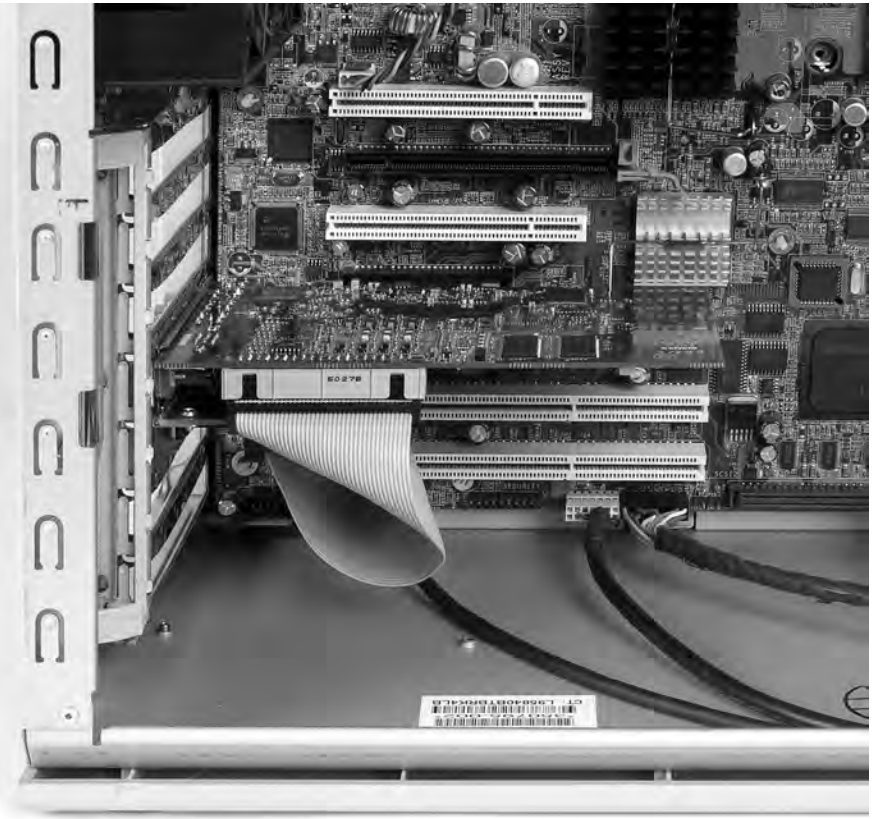
2. Connect the other end of the flat ribbon cable to the 40-pin internal connector on the expanded video input adapter board. Position the connectors so that their triangular etchings face each other. The etchings indicate the location of pin 1.



3. Slide the bracket into the opening at the back of the selected slot. The expanded video input connector should now be accessible from outside of the chassis.



4. Secure the adapter board's bracket to the chassis. Replace the screw(s) removed in the previous section, if any.



Connecting external devices

The Matrox Vio Duo board has five external interface connectors on its main bracket and one internal connector. The expanded video input adapter board has five external interface connectors and one internal connector.

Matrox Vio Duo main bracket: connectors

- **Two external digital video input connectors.** Two high-quality BNC connectors used to receive digital video in HD/SD-SDI format.

- **Two external digital video output connectors.** Two high-quality BNC connectors used to output digital video in HD/SD-SDI format. Both connectors output the same video stream. The output is compatible with monitors using an HD/SD-SDI input.

- **One external analog video output connector.** A high-quality 15-pin, D-type (HD-15) connector, used to output analog video and digital synchronization signals to an auxiliary display. The output is compatible with high-resolution TV monitors.

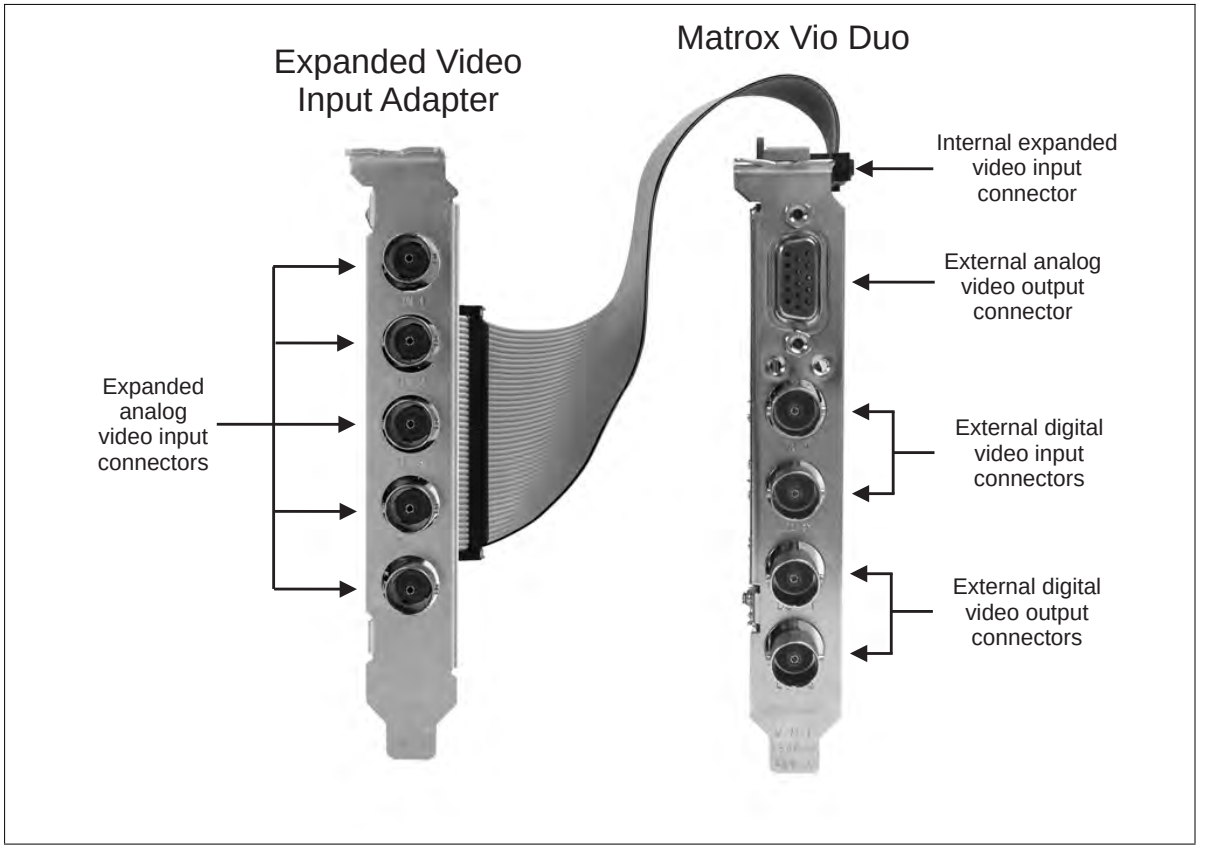
- **One internal expanded video input connector.** A 40-pin male connector used to transmit analog video and synchronization signals between the Matrox Vio Duo board and the expanded video input adapter board. The connector is located on the edge of the board, making the signals accessible from inside of the computer enclosure.

Expanded video input adapter board: connectors

To access the signals of the internal expanded video input connector from outside of the computer enclosure, you might have installed the corresponding adapter board. The adapter board has five external BNC connectors and one internal 40-pin connector.

- **Five expanded analog video input connectors.** Five standard, low profile, 75 Ohm impedance BNC connectors, used to input video signals.

- **One internal connector.** One 40-pin connector to connect to the internal expanded video input connector on the Matrox Vio Duo board.



You can use a standard video cable to connect an external digital video input connector to a digital video source. Note that this cable is not available from Matrox.

You can use a standard BNC coaxial cable to connect to an expanded analog video input connector. Note that this cable is not available from Matrox.

You can use a VGA-compatible cable to connect the external analog video output connector to a high-resolution TV monitor. Note that this cable is not available from Matrox.

You can use a standard video cable to connect an external digital video output connector to a monitor compatible with the HD/SD-SDI format. Recall that both connectors output the same video stream. For a clear signal, you should use a shorter cable as the data rate increases. Note that this cable is not available from Matrox.

Chapter

3

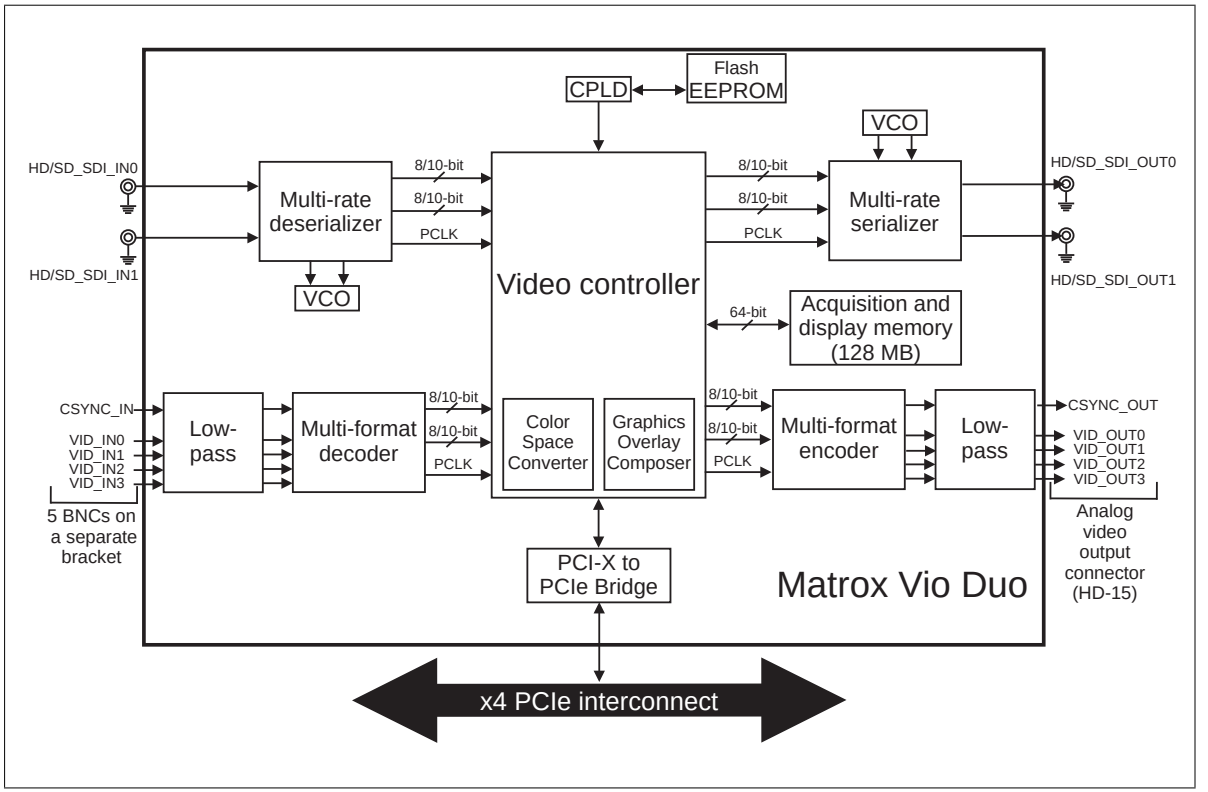
Matrox Vio Duo Hardware Reference

This chapter explains the architecture of the Matrox Vio Duo hardware, as well as the features and modes of operation.

Matrox Vio Duo hardware reference

This chapter provides information on the hardware architecture of Matrox Vio Duo, as well as the available features and operating modes supported by the board.

The chapter is divided into three sections. The first section describes the Matrox Vio Duo hardware associated with the acquisition of images, while the second section discusses the video controller. The third section describes the hardware related to the transfer of images to an auxiliary display.



A summary of the information in this chapter, as well as pin assignments for the various connectors, can be found in *Appendix B: Technical information*.

Matrox Vio Duo acquisition section

Matrox Vio Duo supports acquisition of both analog and digital video. Although you can acquire data from only one video source at a time, you can attach several video sources and switch between them. The board features six software-selectable input channels: four for analog video and two for digital video.

For analog video acquisition, you can attach either:

- One CVBS video source.
- One Y/C video source (and if required one CVBS video source).
- One RGB video source (and if required one CVBS video source).
- One YPbPr video source (and if required one CVBS video source).

For digital video acquisition, you can attach up to two independent HD/SD-SDI video sources.

To switch between video sources of the same type, allocate a single digitizer (using the MIL-Lite function **MdigAlloc**()) and switch between the input channels (using the MIL-Lite function **MdigChannel**()). To grab and switch between different types of video sources, allocate a digitizer for each type of video source.

Digital acquisition

The digital acquisition path captures SD or HD digital video in SDI format and converts it to 20-bit YCbCr data.

Cable equalizer

The digital video signal acquired by the input BNC passes through a multi-rate cable equalizer. This is a high speed bipolar integrated circuit that equalizes and restores signals received over the 75 Ohm co-axial cable.

Multi-rate deserializer

A multi-rate deserializer is used to recreate data that is transmitted over a serial digital input stream. The deserializer can accept SD-SDI video (480i) at 270 Mbytes/sec (SMPTE 259M-C) or HD-SDI video (720p, 1080i) at 1.485 Gbytes/sec (SMPTE 292M). It uses the reference clock signal from a voltage controlled oscillator (VCO) to reclock the input stream and then convert the data to YCbCr 20-bit pixel format.

Analog acquisition

The analog acquisition path captures SD (CVBS, RGB, Y/C, or YPbPr) or HD (RGB or YPbPr) analog video and converts it to 20-bit YCbCr data.

Low-pass filter

Analog video signals acquired by the expanded video input adapter board pass through a 4th order Butterworth filter in a low-pass filtering stage. This effectively restricts the frequency bandwidth and limits high frequency noise and aliasing effects at the input of the A/D converters in the decoder. Enable the low-pass filter using the MIL-Lite function **MdigControl**() with **M_INPUT_FILTER**.

Multi-format video decoder

A multi-format video decoder is implemented for analog video acquisition and subsequent conversion to digitized video with square pixel or ITU-R BT.601 digitization. The decoder can capture standard definition (NTSC, PAL) video in CVBS, RGB, Y/C, or YPbPr video formats, with either ITU-601or square pixel digitization, or high definition (720p, 1080i) video in RGB or YPbPr video format. In addition, it can capture RS-170/CCIR analog monochrome video in CVBS video format. Component video signals (RGB/YPbPr) can have either embedded synchronization or external synchronization.

Note that if the decoder is capturing video with square pixel digitization, the encoder must also operate with the same digitization standard.

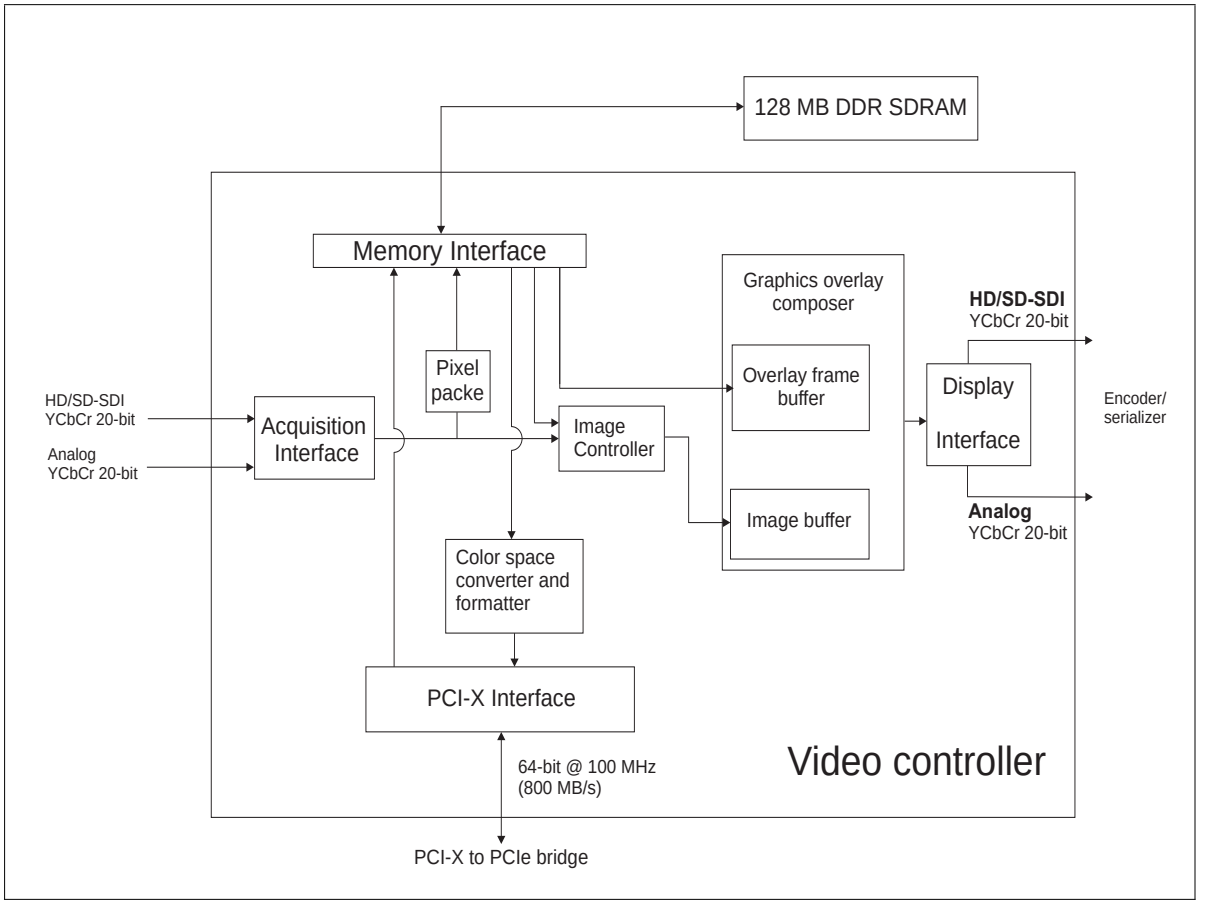
A built-in multiplexer allows for connectivity to multiple video sources and internal current and voltage clamps ensure the removal of DC offsets from the input video signal. Three 12-bit A/D converters then digitize the analog video signal into a 20-bit YCbCr pixel stream. The video decoder has an adaptive multi-line comb filter for enhanced chrominance and luminance separation of composite video signals.

Video Timing Parameters				
	ITU-R BT.601 Digitization		**Square Pixel Digitization**	
	NTSC/RS-170	**PAL/CCIR**	**NTSC/RS-170**	**PAL/CCIR**
Sampling rate (MHz)	13.5	13.5	12.27	14.75
Field Rate (Hz)	60	50	60	50
Pixels/line (Pixels)	858	864	780	944
Active pixels/line (Pixels)	720	720	640	768
Active lines/frame (Lines)	480	576	480	576
Clock Frequency (MHz)	27.0	27.0	24.54	29.5

The video decoder also features automatic gain control (AGC). This allows the video signal processing range to be optimized before being digitized. You can, however, disable the AGC and set the gain manually, using the MIL-Lite function **MdigControl**() function with **M_GRAB_AUTOMATIC_INPUT_GAIN** set to **M_DISABLE** and **M_GRAB_INPUT_GAIN** set to any integer value between 0 to 255.

Video controller

The video controller processes and formats digitized video received from the decoder or the deserializer, before transferring the video data to an auxiliary display or to the Host. Video data can be output to an auxiliary display in the same format that it was acquired, or it can be transferred to the Host in either monochrome, BGR24 packed, BGR32 packed, or YUV pixel formats. The video controller also allows for dynamic allocation of overlay images on image data.



Acquisition interface

The acquisition interface receives the grabbed images from the decoder and the deserializer as a stream of digital pixels in 20-bit YCbCr pixel format. The video controller can route grabbed images directly to the display (bypass/ low-latency mode), store them in on-board memory, or perform both operations simultaneously. The internal data paths preserve the full pixel resolution.

Display interface

The video controller feeds the encoder and/or serializer with a stream of digital pixels in 20-bit YCbCr pixel format. The encoder and/or serializer reconvert the digitized video and transfer the video signal to an auxiliary display. Digital acquisition images can be sent to either the digital display interface or to the analog display interface. Although analog acquisition images captured using ITU-601 digitization can be sent to either the analog display interface and/or the digital display interface, images captured using square pixel digitization can only be sent to the analog display interface. You can have simultaneous analog and digital display, however both outputs will display the same video signal.

Note that the video controller does not implement resolution conversion and will display images at the same frame rate as they were acquired. It also does not support display of progressive images if the acquisition was interlaced nor does it support the display of interlaced images if the acquisition was progressive.

Memory interface

The video controller is interfaced to 128 Mbytes of linearly addressable DDR SDRAM, having a bandwidth of up to 100 MHz (1.6 Gbytes/sec) and a 64-bit data bus. The on-board memory is responsible for the storage of acquisition video data, overlay images, and static images transferred from the Host.

Using the PCI-X interface, Matrox Vio Duo can access Host DMA memory (physically contiguous, non-paged memory). An advantage of DMA memory is that a bus mastering device (such as Matrox Vio Duo) can access this memory without Host intervention.

Overlay composer

The overlay composer overlays image(s) onto image data. Overlay images are stored in local memory in a 32-bit color format (BGR32 packed), however the overlay composer converts each overlay pixel to YCbCr 30-bit pixel format before combining it with the underlay image. The overlay image pixels replace the original pixels in the image based on a specific keying color. Pixels of the overlay

image are displayed unless they are equal to the keying color, in which case the corresponding pixels of the underlay image are displayed instead. The overlay image size should equal the size of the underlay image to avoid corrupting the image.

Color space converter and formatter

The color space converter and formatter can crop captured images, downscale them (subsample), and convert their color format. Images can be flipped vertically as well.

The color space converter and formatter can crop captured images (ROI capture) or arbitrarily downscale them to 1/16th of a field or frame. Downscaling is implemented using a configurable pixel subsampling engine, which allows for integer subsampling values between 0 (no subsampling) and 16 (1 pixel out of 16). This can be useful to implement custom software-based motion detection because at a reduced scale, comparison is faster.

The color space converter and formatter can convert YCbCr 20-bit images to BGR packed 24-bit, 32-bit, or 48-bit images, or to YUV 16-bit images. The color space converter and formatter can extract the Y component from a YUV stream; it can also extract R, G, or B from the result of the conversion. The color space converter and formatter can also perform *color kill,* which first converts data to grayscale and then converts it to its appropriate destination format. Each color component is transferred to the destination in packed mode; however, planar transfer mode is available for all output color formats in SD. Planar transfer mode is not sustainable for real-time transfers in HD.

The equations for the conversion from YCbCr to RGB are described in the following table:

Color space conversion	Equations
YCbCr-to-RGB (SD)	• R = 1.164Y + 1.596Cr - 222.912 • G = 1.164Y - 0.813Cr - 0.391Cb +135.488 • B = 1.164Y + 2.018Cb - 276.928
YCbCr-to-RGB (HD)	• R = 1.164Y + 1.793Cr - 248.128 • G = 1.164Y - 0.534Cr - 0.213Cb + 76.992 • B = 1.164Y + 2.115Cb - 289.344

PCI-X interface

PCI-X bus technology is implemented for interfacing the video controller to the Host. PCI-X is an enhanced PCI bus standard that doubles the speed and the data exchanged between the system bus and the peripherals. The PCI-X bus is 64-bits wide and runs at a bus speed of 100 MHz, providing a throughput of up to 800 Mbytes/sec. The PCI-X interface integrates a DMA write engine for direct data transfer from local memory to Host memory. However, it does not support master read transaction. Therefore, the Host must write data to the on-board memory itself.

PCI-X to PCIe bridge

Matrox Vio Duo is a PCIe board. It connects to the 4x PCIe connector of a 4-lane PCIe slot on the motherboard. PCIe is a high-speed serial transmission protocol based upon the PCI bus standard. However, since Matrox Vio Duo implements PCI-X bus technology to interface with on-board components, a PCI-X to PCIe bridge is installed on the board to translate between the two protocols.

Flash EEPROM and CPLD

The video controller interfaces to a CPLD, which in turn interfaces to a 1 Mbyte flash EEPROM.

The flash EEPROM stores:

- Board initialization parameters and board data.
- Configuration data for the acquisition section.

The CPLD generates a serial bitstream from data stored in the EEPROM, which programs the video controller upon power-up.

Matrox Vio Duo display section

Matrox Vio Duo can output video to an auxiliary display in either analog mode, digital mode[1], or both simultaneously. In either mode, video is output to the display at the original acquisition resolution. In addition, if the acquisition mode and the display mode are the same, video is output in its original acquisition resolution; the format can change as long as the resolution is the same.

Digital display

The digital display path converts the digitized video output by the video controller to its appropriate digital video format.

Multi-rate serializer

A multi-rate serializer converts the YCbCr 20-bit digitized video received from the video controller into a serial digital bitstream and performs appropriate encoding and scrambling. It does so in conjunction with the reference clock signal from a Voltage Controlled Oscillator (VCO). When displaying acquired data, the reference clock signal that is produced is the same as the reference clock signal used during acquisition.

Cable driver

The digital video signal output by the serializer goes through a multi-rate cable driver. This is a high-speed bipolar integrated circuit designed to drive signals sent over one or two 75 Ohm co-axial cables.

Analog display

The analog display path converts the digitized video, output by the video controller, to its appropriate analog video format.

Multi-format video encoder

A multi-format video encoder converts the 20-bit YCbCr digitized video stream output by the video controller into an analog video signal. The encoder contains six 12-bit D/A converters which perform high-speed digital-to-analog conversion.

Low-pass filters

Analog video signals, sent to the analog video output connector, pass through 4th order Butterworth filters in a low-pass filtering stage. This limits high frequency noise and smooths the reconstructed signal by removing unwanted higher frequency components.

1. Except when outputting video captured with square pixel digitization.

Appendix A: Glossary

This appendix defines some of the specialized terms used in the Matrox Vio SDI documentation.

Glossary

- **Band**

  One of the surfaces of a buffer. A grayscale image requires just one band. A color image requires three bands, one for each color component.

- **Bandwidth**

  A term describing the capacity to transfer data. Greater bandwidth is needed to sustain a higher transfer rate. Greater bandwidth can be achieved, for example, by using a wider bus.

- **Blanking period**

  The portion of a video signal after the end of a line or frame, and before the beginning of a new line or frame. During this period, the video signal is "blank" so that a scan line can be brought back to the beginning of the new line or frame.

- **Bus**

  A pathway along which signals are sent, generally in two directions, for communication of data.

- **Color component**

  One of the components that make up a color space. Typically, each component of a color image is stored in a separate band of a multi-band buffer.

- **Color space**

  A color space is a way of representing and describing the complete range of perceived colors. A number of color spaces have been developed. Common color spaces are RGB and HSL. Both describe the same range of perceivable colors.

- **Composite synchronization**

  A synchronization signal made up of two components: one horizontal and one vertical.

- **DCF**

  Digitizer Configuration Format. A file format that defines the input data format and, for example, how to accept or generate video timing signals, such as horizontal sync, vertical sync, and pixel clock. Such files have a *.dcf* extension.

- **DDR SDRAM**

  Double Data Rate Synchronous Dynamic Random Access Memory. A type of memory used for image capture and processing. SDRAM allows the Matrox Solios FPGA to access data at very high speed, which is important for I/O-bound functions.

- **Decoder**

  A device which separates the various components of a composite video signal and converts the information into digital format.

- **Double buffering**

  Alternating the destination of an operation between two buffers. Double buffering allows you to, for example, process one buffer while grabbing into the other buffer.

- **Dynamic range**

  The range of values present in a buffer. An unsigned 8-bit buffer, for example, has an allowable range of 0 to 255; its dynamic range can be any range within these values.

- **Encoder**

  A device that combines the individual component signals into a composite signal and converts the information into analog format.

- **Exposure signal**

  The signal generated by one of the programmable timers of the frame grabber module. The exposure signal can be used to control external hardware. For example, it can be fed to the video source to control its exposure time or used to fire a strobe light.

- **Exposure time**

  Refers to the period during which the image sensor of a video source is exposed to light. As the length of this period increases, so does the image brightness.

- **Field**

  One of the two halves that together make up the image grabbed from an interlaced video source. One half consists of the image's odd lines (known as the *odd field*); the other half consists of the image's even lines (known as the *even field*).

- **FPGA**

  Field-programmable gate array. An array of digital electronic components that can be programmed to perform a specific function. An FPGA can contain logic gates, lookup tables, flip-flops, and programmable interconnect wiring. This combination of customizability and functionality allows for the same FPGA design to be used in a variety of projects.

- **Frame**

  A single image grabbed from a video source.

- **Grab**

  To acquire an image from a video source.

- **Horizontal blanking period**

  The portion of a video signal after the end of a line and before the beginning of a new line. During this period, the video signal is "blank".

  See also *vertical blanking period*.

- **Horizontal synchronization signal**

  The part of a video signal that indicates the end of a line and the start of a new one.

  See also *vertical synchronization signal*.

- **Interlaced scanning**

  Describes a transfer of data in which the odd-numbered lines of the source are written to the destination buffer first, and then the even-numbered lines (or vice-versa).

  See also *progressive scanning*.

- **Latency**

  The time from when an operation is started to when the final result is produced.

- **PCI**

  Peripheral Component Interconnect. Present day standard expansion bus.

- **PCI-X**

  Peripheral Component Interconnect Extended. An enhanced PCI bus standard that doubles the speed and the data exchanged between the system bus and the peripherals.

- **PCIe**

  Peripheral Component Interconnect Express. A high speed serial transmission protocol based upon the PCI bus standard.

- **Progressive scanning**

  Describes a transfer of data in which the lines of the source are written sequentially into the destination buffer.

  Also known as *non-interlaced.* See also *interlaced scanning*.

- **Reference levels**

  The zero and full-scale levels of an analog-to-digital converter. Voltages below a *black reference level* are converted to a zero pixel value; voltages above a *white reference level* are converted to the maximum pixel value. Together with the analog gain factor, the reference levels affect the brightness and contrast of the resulting image.

- **RGB**

  A color space that represents color using the primary colors (red, green and blue) as components.

- **Saturate**

  To replace overflows (or underflows) in an operation with the highest (or lowest) possible value that can be held in the destination buffer of the operation.

- **Vertical blanking period**

  The portion of a video signal after the end of a frame and before the beginning of a new frame. During this period, the video signal is "blank".

  See also *horizontal blanking period*.

- **Vertical synchronization signal**

  The part of a video signal that indicates the end of a frame and the start of a new one.

  See also *horizontal synchronization signal*.

Appendix B: Technical information

This appendix contains information that might be useful when installing your Matrox Vio Duo board.

Board summary

This appendix contains information that might be useful during installation.

Global information

- Operating system: See software manual for supported versions of Microsoft Windows.
- System requirements:
  - An available conventional PCIe slot with four or more lanes.
  - Processor with an Intel 32-bit architecture (IA32) or equivalent.

Important

  - A proper power supply. Refer to the *Electrical specifications* section (next page).

To learn more about appropriate chipsets, refer to the Matrox Imaging website.

Technical features of Matrox Vio Duo

- Can acquire data from one video source at a time.
- The analog acquisition path supports capture of standard definition (NTSC/PAL) video in RGB, CVBS, Y/C, and YPbPr video formats and high definition video (1080i, 720p) in RGB and YPbPr video format. It also supports capture of analog monochrome video in RS-170/CCIR video format.
- The digital acquisition path can acquire standard definition (480i) and high definition (1080i, 720p) video in SDI format.
- Allows you to connect up to two analog (one CVBS and one RGB/YPbPr/YC) and two digital video sources, and switch between them.
- All video data is converted by the decoder or the deserializer into either YUV or 20-bit YCbCr. However, data can be transferred to the Host in BGR24 packed, BGR32 packed, RGB24 planar, YUV16, or monochrome pixel formats. The data can also be cropped (ROI capture), arbitrarily downscaled to 1/16th of a field or frame, and vertically flipped.
- Can display to an auxiliary analog display device, an auxiliary digital display device[1], or both simultaneously. If displaying to both analog and digital display

1. Except when outputting video captured with square pixel digitization.

devices, the same information will be sent to both. In either mode, video can only be output to the display device at the original acquisition resolution. Performs static or dynamic overlaying of an image onto an underlay image.

- 128 Mbytes of 100 MHz DDR SDRAM used as acquisition and display memory. 1.6 Gbytes/sec of memory bandwidth and 64-bit wide data bus.

- 1 Mbyte flash EEPROM for storage of board data.

Electrical specifications

Matrox Vio Duo (applies to PCB# Y7231-01)	
Operating voltage and current	Typical: 3.3 V, 2.48 A = 8.18 W Typical 12.0 V, 0.73 A = 8.76 W Total (typical) = 16.94 W

Dimensions and environmental specifications

- Dimensions:

Board	**Dimensions**
Matrox Vio Duo	16.3 L x 11.1 H 0.158 W cm (6.4" x 4.4" 0.062") from bottom edge of goldfinger to top edge of board.

- Ventilation:

Board	**Ventilation**
Matrox Vio Duo	~100 LFM between boards.

- Minimum/maximum ambient operating temperature: 0°C to 55°C (32°F to 131°F).

- Minimum/maximum storage temperature: -40°C to 75°C.

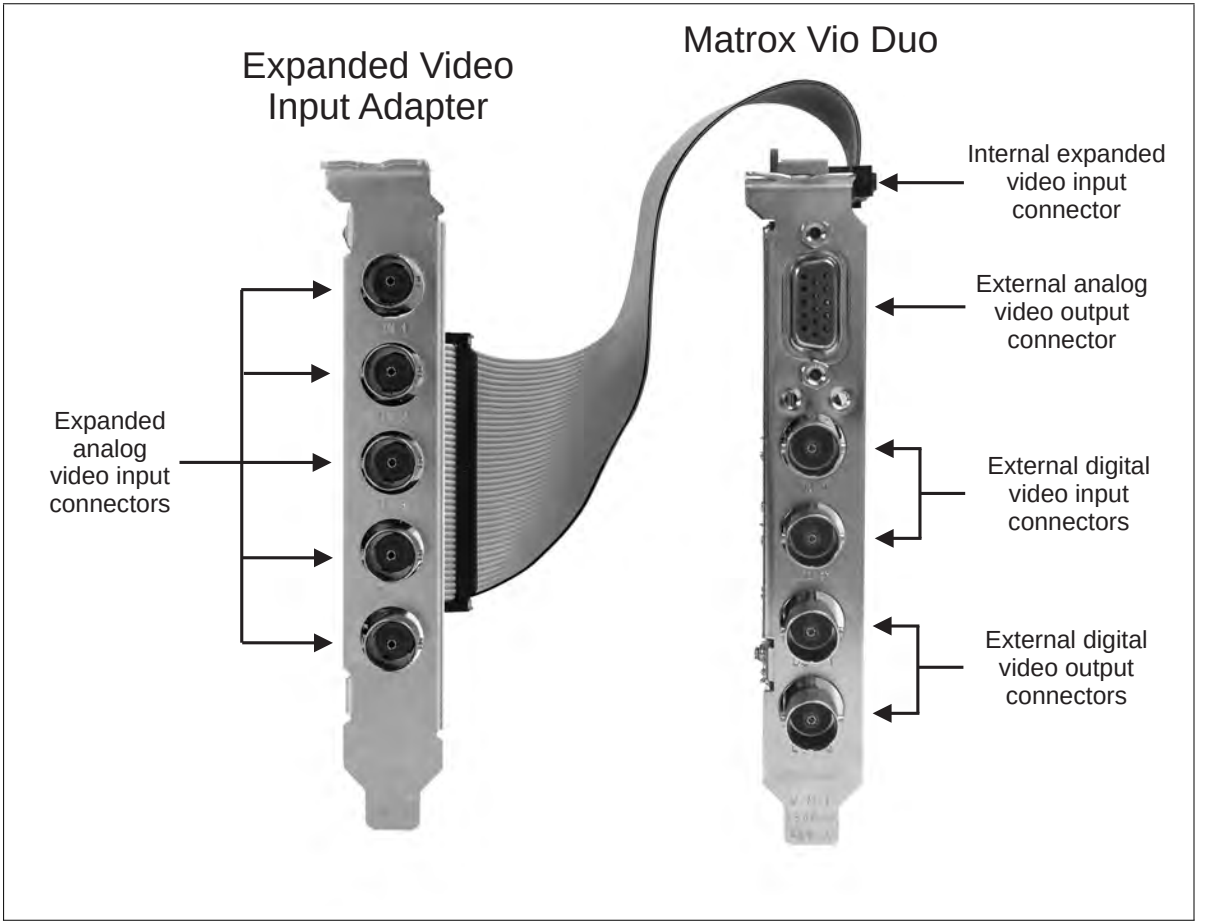
- Operating humidity: 0 to 95% relative humidity (non-condensing).

- Storage humidity: 0 to 95% relative humidity (non-condensing).

Connectors on Matrox Vio Duo

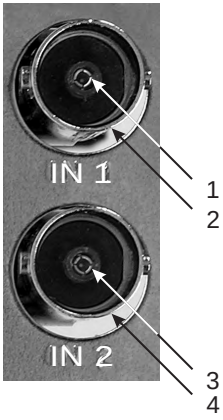
The Matrox Vio Duo board has several interface connectors. The board has two BNC connectors for digital video input, two BNC connectors for digital video output, and a high density 15-pin (HD-15) connector for analog video output on its main bracket. On the top edge of the board, there is an internal 40-pin connector that connects to the expanded video input adapter board via a flat ribbon cable. The adapter board has five BNC connectors for analog video input.

The following image illustrates the connectors on Matrox Vio Duo:



External digital video input connectors

The external digital video input connectors are standard, low profile, 75 Ohm impedance BNC connectors, used to receive HD/SD-SDI video signals. The connectors are shown in the following image.



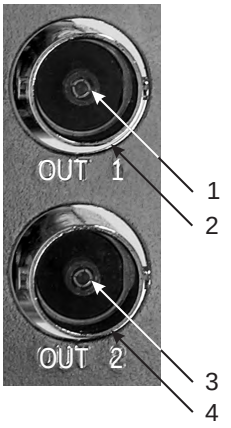
Their pin assignment is as follows:

Pin	Signal	Description
1	HD/SD_SDI_IN0	High definition or standard definition serial digital video input 0.
2 (SHELL)	GND	Ground.
3	HD/SD_SDI_IN1	High definition or standard definition serial digital video input 1.
4 (SHELL)	GND	Ground.

You can use a standard video cable (available from your local electronics store) to interface with these connectors. If the cable has to be longer than normal, you will need a very good cable, or very good components, in order to prevent loss.

External digital video output connectors

The digital video output connectors are standard, low profile, 75 Ohm impedance BNC connectors, used to send HD/SD-SDI video signals. The connectors are shown in the following image.



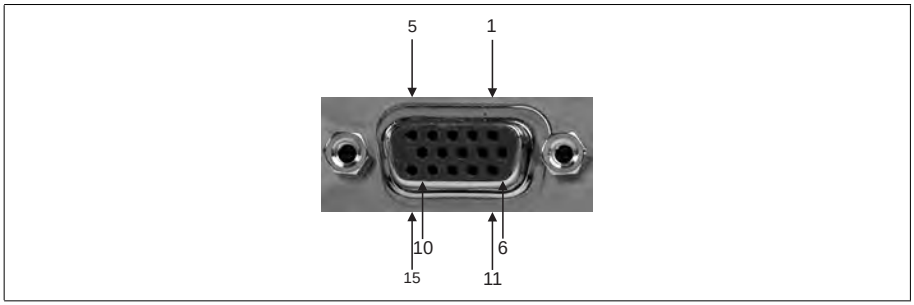
Their pin assignment is as follows:

Pin	Signal	Description
1	HD/SD_SDI_OUT0	High definition or standard definition serial digital video output 0.
2 (SHELL)	GND	Ground.
3	HD/SD_SDI_OUT1	High definition or standard definition serial digital video output 1.
4 (SHELL)	GND	Ground.

For a clear signal, you should use a shorter cable as the data rate increases. To prevent data loss, especially with higher definition signals, you will need high quality components and a high-quality cable to compensate. You can use a standard video cable to interface with these connectors.

External analog video output connector

The external analog video output connector is a high density 15-pin (HD-15) female connector used to output video signals to an auxiliary display. The connector is shown in the following image.



Its pin assignment is as follows:

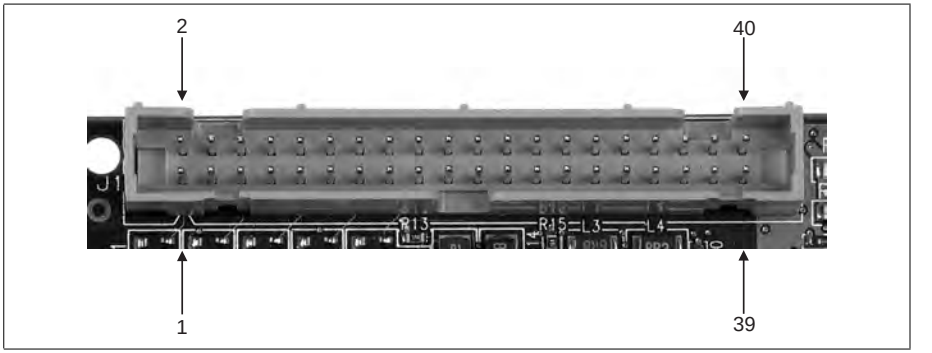
Pin	Signal	Description
1	VID_OUT2	Pr component of YPbPr output, or R component of RGB output.
2	VID_OUT0	Y component of YPbPr output, G component of RGB output, or Y component of Y/C output.
3	VID_OUT1	Pb component of YPbPr output, B component of RGB output, or C component of Y/C output.
4	N/C	No connection.
5	GND	Ground.
6	GND	Ground.
7	GND	Ground.
8	GND	Ground.
9	N/C	No connection.
10	GND	Ground.
11	N/C	No connection.
12	N/C	No connection.
13	CSYNC_OUT	Analog composite sync output.
14	VID_OUT3	CVBS video output[1].
15	N/C	No connection.

1. Only available in standard definition mode

You can use a standard HD D-Sub 15-pin VGA to 5x BNC monitor cable to interface with this connector.

Internal expanded video input connector

The internal expanded video input connector is a standard, 0.1" spacing, 40-pin male connector, used to receive video input signals. It connects to a similar connector on the expanded video input adapter board via a 40-pin flat ribbon cable. The connector is shown in the following image.



Its pin assignment is as follows:

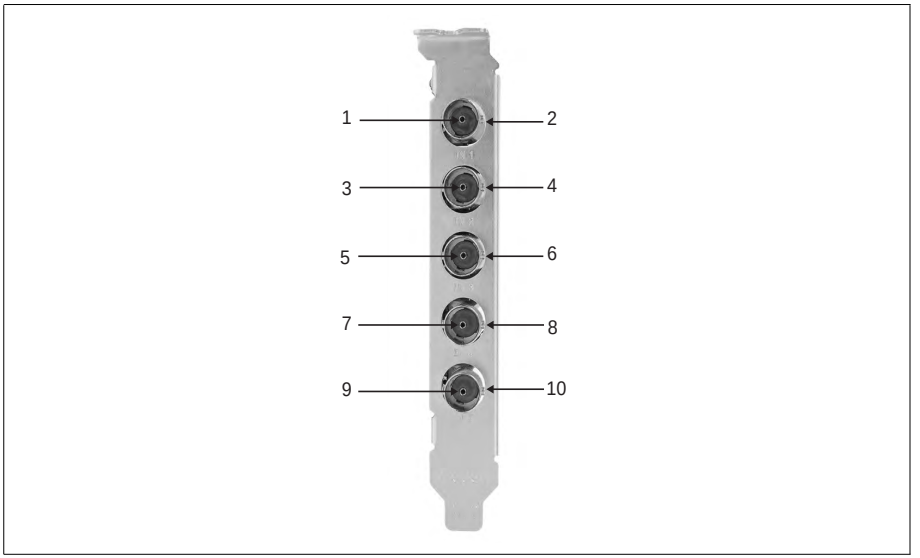
Pin	Signal	Description
1	Reserved	Reserved.
2	GND	Ground.
3	GND	Ground.
4	GND	Ground.
5	Reserved	Reserved.
6	GND	Ground.
7	GND	Ground.
8	GND	Ground.
9	Reserved	Reserved.
10	GND	Ground.
11	GND	Ground.
12	GND	Ground.
13	Reserved	Reserved.
14	GND	Ground.
15	GND	Ground.
16	GND	Ground.
17	Reserved	Reserved.

Pin	Signal	Description
18	GND	Ground.
19	N/C	No connection.
20	GND	Ground.
21	N/C	No connection.
22	GND	Ground.
23	CSYNC_IN	Analog component sync input.
24	GND	Ground.
25	GND	Ground.
26	GND	Ground.
27	VID_IN0	Y component of YPbPr input, G component of RGB input, or Y component of Y/C input.
28	GND	Ground.
29	GND	Ground.
30	GND	Ground.
31	VID_IN1	Pb component of YPbPr input, B component of RGB input, or C component of Y/C input.
32	GND	Ground.
33	GND	Ground.
34	GND	Ground.
35	VID_IN2	Pr component of YPbPr input, or R component of RGB input.
36	GND	Ground.
37	GND	Ground.
38	GND	Ground.
39	VID_IN3	CVBS video input.[1]
40	GND	Ground.

1. Only available in standard definition mode.

Expanded analog video input connectors

The expanded analog video input connectors are five standard, low profile, 75 Ohm impedence BNC connectors, used to receive video input signals. The connectors are shown in the following image:



The pin assignment for the connectors are as follows:

Pin	Signal	Description
1	VID_IN2	Pr component of YPbPr input, or R component of RGB input.
2 (SHELL)	GND	Ground.
3	VID_IN0	Y component of YPbPr input, G component of RGB input, or Y component of Y/C input.
4 (SHELL)	GND	Ground.
5	VID_IN1	Pb component of YPbPr input, B component RGB input, or C component of Y/C input.
6 (SHELL)	GND	Ground.
7	CSYNC_IN	Analog component sync input.
8 (SHELL)	GND	Ground.
9	VID_IN3	CVBS video connection (SD mode only).
10 (SHELL)	GND	Ground.

You can use a standard BNC coaxial cable to interface with one of the connectors.

Appendix C: Listing of Matrox Vio boards

Major revisions of Matrox Vio

Board	Part#	Version#	Description
Matrox Vio Analog	VIO7IAOA*	101	• Initial product version. ROHS compliant. • Upgrade analog video decoder version.
Matrox Vio Duo	VIO7ISAOSA*	101	• Initial product version. ROHS compliant. • Upgrade analog video decoder version.
	VIO7ISAOSA	101	• Initial product version.
		103	• Upgrade analog video decoder version. • Upgrade PCIe™ bridge version.
		105	• Update onboard FPGA firmware. • Add C-SYNC hardware support for capture.

Index

M

N

O

P

R

S

T

V

Y

Regulatory Compliance

FCC Compliance Statement

Warning

Changes or modifications to these units not expressly approved by the party responsible for the compliance could void the user's authority to operate this equipment.

The use of shielded cables for connections of these devices to other peripherals is required to meet the regulatory requirements.

Note

These devices comply with Part 15 of FCC Rules. Operation is subject to the following two conditions:

1. These devices may not cause harmful interference, and
2. These devices must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for Class A digital devices, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of these devices in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his/her own expense.

Industry Canada Compliance Statement

These digital apparatuses do not exceed the Class A limits for radio noise emission from digital apparatuses set out in the Radio Interference Regulations of Industry Canada.

Ces appareils numériques n'émettent pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de Classe A prescrites dans le Règlement sur le brouillage radioélectrique édicté par Industrie Canada.

EU Notice (European Union)

WARNING: These are class A products. In a domestic environment these products may cause radio interference in which case the user may be required to take adequate measures.

AVERTISSEMENT: Ces appareils sont des produits informatiques de Classe A. Lorsque ces appareils sont utilisent dans un environnement résidentiel, ces produits peuvent entraîner des interférences radioélectriques. Dans ce cas, l'usager peut être prié de prendre des mesures correctives appropriées.

This device complies with EC Directive 89/336/EEC for Class A digital devices. They have been tested and found to comply with EN55022/CISPR22 and EN55024/CISPR24 when installed in a typical class A compliant host system. It is assumed that these devices will also achieve compliance in any Class A compliant system.

Ces unités sont conformes à la Directive communautaire 89/336/EEC pour les unités numériques de Classe A. Les tests effectués one prouvé qu'elles sont conformes aux normes EN55022/CISPR22 et EN55024/CISPR24 lorsqu'elles sont installées dans un système hôte typique de la Classe A. On suppose qu'ils présenteront la même compatibilité dans tout système compatible de la Classe A.

Directive on Waste Electrical and Electronic Equipment (WEEE)

Europe

(English) European user's information – Directive on Waste Electrical and Electronic Equipment (WEEE)

Please refer to the Matrox Web site (**www.matrox.com/environment/weee**) for recycling information.

(Français) Informations aux utilisateurs Européens – Règlementation des déchets d'équipements électriques et électroniques (DEEE)

Se référer au site Web de Matrox (**www.matrox.com/environment/weee**) pour l'information concernant le recyclage.

(Deutsch) Information für europäische Anwender – Europäische Regelungen zu Elektro- und Elektronikaltgeräten (WEEE)

Bitte wenden Sie sich an dem Matrox-Website (**www.matrox.com/environment/weee**) für Recycling Informationen.

(Italiano) Informazioni per gli utenti europei – Direttiva sui rifiuti di apparecchiature elettriche ed elettroniche (RAEE)

Si prega di riferirsi al sito Web Matrox (**www.matrox.com/environment/weee**) per le informazioni di riciclaggio.

Limited Warranty

Refer to the warranty statement that came with your product.