Complete Image Processing on a Single-slot VME Board

High performance imaging has become a reliable, cost-effective, and increasingly widespread technology with a growing number of applications in manufacturing, medicine, R&D/Defense, and other areas. Manipulating images at frame rates, however, can be challenging. Handling a huge volume of pixels and a continuous series of frames requires significant computational horsepower.

Datacube meets this challenge with the MaxVideo 250, a single-slot VME card that can acquire, process, store, and display image data at frame rates. It derives its power from pipeline processing — a method of specialized parallel processing uniquely suited to the demands of image manipulation. Fast VMEbus transfer is available for applications where access to image data by the host CPU is useful.

Each MaxVideo 250 can be equipped with a module to acquire analog or digital images. It interfaces with a wide variety of sensors including line-scan, TDI, multi-tap, or multi-spectral cameras, at a variety of speeds and resolutions.

The MaxVideo 250 uses a collection of specialized computational elements connected sequentially. As pixels pass through the pipeline, operations are performed upon them. Multiple parallel pipelines work synchronously to provide tremendous throughput.

A non-blocking crosspoint switch with 640 MB/sec. of internal bandwidth allows the computational elements to be re-configured between frames. Linear, non-linear, convolution, histogram, and statistical processing operations can be performed in parallel by connecting the processing elements under control of Datacube's ImageFlow software.

The MaxVideo 250 has six VSIMs (Virtual Surface Image Memories) that provide a total of 28 MB of memory. In addition to being surface stores, VSIMs have a crosspoint switch, statistical processor, LUT, and ALU, allowing them to perform specific processing functions at 40 MHz.
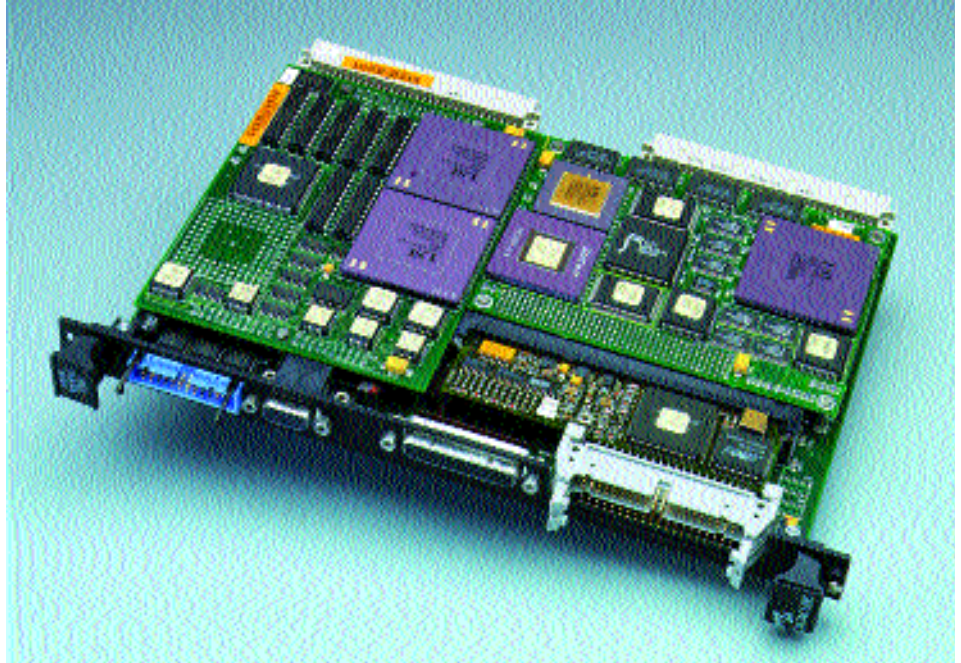
The MaxVideo 250's built-in Analog Gener-ator provides a programmable display and graphics overlay for a variety of resolutions and outputs including gray-scale, pseudocolor, and true color.

The optional Advanced Processor daughtercard enhances the convolution, statistical analysis, LUT processing, and binary morphology capabilities of the MaxVideo 250.

Each MaxVideo 250 can be fitted with an optional MaxModule to enhance the performance of a specific image processing function (e.g., image warping). Even when fully loaded with an acquisition device, Advanced Processor, and a MaxModule, the MaxVideo 250 requires only one VMEbus slot.

The MAXbus ports allow image data interchange with no performance penalty be-tween the MaxVideo 250 and other boards such as Datacube's XI Display Controller and MD1 Digital Image Recorder. It also allows cas-cading of multiple MaxVideo 250s for enhanced processing horsepower.

High Speed Image Access (HSIA) enhances the transfer of frame-rate image data over the VMEbus. In some applications, HSIA allows utilization of the host CPU to augment image processing functionality.

Applications development on the MaxVideo 250 is significantly simplified by Datacube's ImageFlow software. This library of C-callable functions synchronizes multiple data transfers at frame-rates, hiding the complexities of the hardware from the programmer. It is also flexible, with the ability to work with a variety of CPUs and operating systems.

The MaxVideo 250 provides a comprehensive image processing solution — a phenomenal 7 BOPS of processing power, excellent flexibility and versatility — overall price/performance without equal.

- High Speed Image Access provides fast transfer of image data over the VMEbus

- 7 BOPS of processing power

- Cascadable multiple boards for increased processing bandwidth

- Image acquisition, storage, processing, and display in a single VME slot

- 28 MB of VSIM memory

- Massive, wide-bandwidth, non-blocking crosspoint switch

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Specifications

Features and Benefits

- Performs convolutions, statistical analysis, LUT processing, binary morphology, and many other types of operations
- 7 BOPS processing power
- 20/40 MHz pipeline processing
- Single-slot VME form factor, even when fully loaded with Advanced Processor, acquisition module, and MaxModule
- 28 MB memory
- High Speed Image Access optimizes VMEbus transfer rate
- Cascadable multiple boards for increased processing bandwidth
- Crosspoint switch provides processor reconfiguration at 640 MB/sec.
- MAXbus expansion ports to interface to other MaxVideo devices
- With fewer components and all parts soldered or fastened, the MaxVideo 250 is more rugged than the previous model, with an enhanced MTBF

System Components

Motherboard

- **Architectural Adapter (AB)**
  - VMEbus host interface (HSIA P1 & P2 connectors)
  - MAXbus ports (P3/P4 and P5-P10 front connectors, all 20 MHz)
  - Port for optional AS, AD, or AC image acquisition module
  - Port for an Advanced Processor (AP) daughtercard
  - Port for one MaxModule daughtercard
  - Configured with 28 MB VSIM memory
- **Crosspoint Switch**
  - Wide bandwidth (32x32x8), non-blocking
  - High speed (640 MB/sec.)
  - Reconfigurable by software at frame-rates
- **Analog Generator (AG)** provides graphics and overlay capabilities
  - Pseudocolor, true color, gray-scale
  - With or without 4-bit graphics overlay at 10 MHz, 20 MHz, 40 MHz
  - Output formats include RS-170/CCIR, square pixel, 512x512, 1Kx1K, and 120 Hz stereo
- **Arithmetic Unit (AU)** linear, non-linear, and statistical processing
  - Four 11-bit multipliers
  - Seven 10-bit ALUs
  - Two run-length encoders
  - Two statistics processors
  - Two row and column address generators
  - Ten 8-bit data paths @ 20 MHz
- **Virtual Surface Image Memory (VSIM)** advanced architecture provides virtual memory storage and 40 MHz processing (6 per board)
  - 40 MHz memory/processor on each module
  - Custom ASIC (225k gate)
  - Crosspoint switch, statistical processor, LUT, ALU
  - 28 MB

Image Acquisition Modules

- Modules have fully programmable timing: master or slave, horizontal, vertical, composite, or pixel clock
- **Analog Scanner (AS)**
  - Conditions and digitizes analog input signals
  - Digitalization rates at 8-bits from DC to 26 MHz
  - Interfaces to most analog 1D or 2D cameras and sensors
  - Programmable gain, offset, filter selection, and synchronization
- **Acquire Digital (AD)**
  - Accepts 24-bit input signals
  - Digital input: 24-bit single-ended, 12-bit differential
  - Interfaces to most 1D or 2D cameras and sensors
  - Data rates from DC to 20 MHz
- **Acquire Color (AC)**
  - Supports standard analog color input formats including composite (PAL or NTSC), gray-scale (CCIR or RS-170), and YC (S-Video)
  - Also works well with low quality or irregular signals such as those produced by VCRs
  - Outputs either 24-bit RGB data or 16-bit YU/YV interleaved data

Advanced Processor (AP) enhanced processing resources

- Convolution:
  - 64-point, 8-bit FIR filter
  - 2D modes: 8x8 kernel, two 8x4 kernels, 3x3 Sobel edge extraction
  - 1D 64x1 filter operation
  - Convolutions yield 24-bit normalized result
- Statistical Analysis:
  - Histogramming on 8-bit data into 256 (24-bit bins)
  - Feature listing: 512 bins
  - Hough transformations: modified, using a single angle per pass
- LUT processing: 16x16
- Binary Morphology: 3x3 operations when used with the LUT

MaxModules one per board (with or without AP device)

- **MiniWarper** provides *n*th order warping
- **mmNMAC** enhances convolution and neighborhood processing
- **mmRVF** enhances rank value, median, max/min filtering

High Speed Image Access

- Provides sustained VMEbus access of up to 10 MB/sec. random or sequential 32-bit LWORD reads or writes
- Five VSIMs are of a standard configuration, while the 6th VSIM is an enhanced High Speed Image Access (HSIA) configuration
- HSIA advanced VSIM has two memory banks — one bank can be used for video pipeline transfers, with the other available for high speed image access to the VMEbus
- The banks can be swapped at any time under software control

Environmental

- Operating temperature: 0° to 55° C (32° to 131° F)
- Storage temperature: -40° to 100° C (-40° to 212° F)
- Relative humidity: 10% to 90% (non-condensing)
- Air flow requirement: 50 LFPM (minimum)

Physical

- Height: 6.3" (160 mm)
- Length: 9.19" (233.5 mm)
- Depth: 0.8" (20.3 mm)
- Weight: 24 oz. (680 grams)

Additional Information

For more information about the products mentioned in this document, please refer to the following Datacube literature:

ImageFlow Data Sheet
ImageFlow Technical Description
MaxModules Data Sheet
MD1 Family of Digital Image Recorders
XI Display Controller Data Sheet

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