Each MaxVideo 250 and MaxVideo 200 board-level image processor can be customized with one of three MaxModules to enhance a specific image processing function. All of these daughterboards are fully supported by Datacube's ImageFlow software.

MiniWarper

A high-speed image warping module, the MiniWarper performs 1st- and 2nd-order polynomial spatial rendering at 20 MHz. A single MiniWarper is capable of pipelined warping at 10 MPels/sec. Greater throughput can be achieved with multiple MiniWarpers (e.g., two for 20 MPel/sec., four for 40 MPel/sec.).
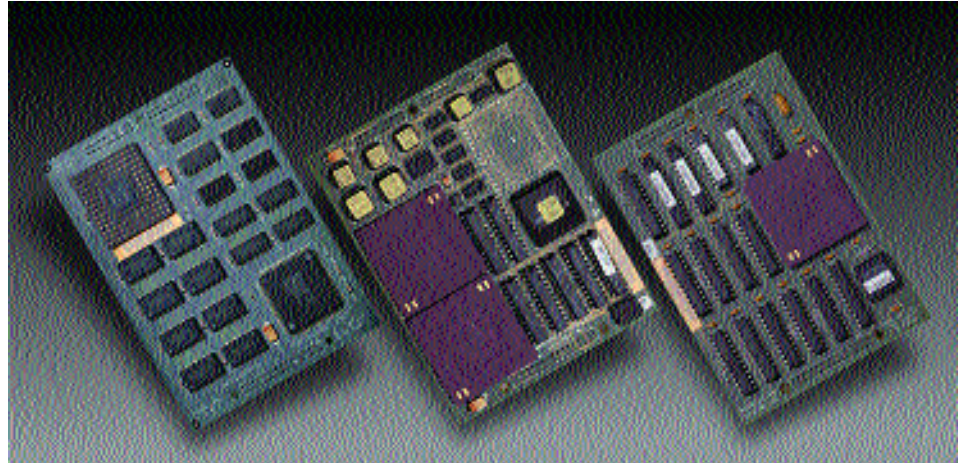
The MiniWarper provides resampling and sub-pixel interpolation operations for distortion or sensor correction, scan conversion, image translation, rotation, aspect ratio transformation, and zoom. ImageFlow includes software objects to make efficient use of the MiniWarper's capabilities.

Performance of the MiniWarper can be up to 1,000 times greater than software solutions on CPU platforms. It is also flexible, with variable settings for data precision, interpolation, filter aperture, and coefficient precision. 8-bit data is warped in one pass, while multiple pass techniques are employed to warp 12-bit data. A high render rate makes multiple pass techniques on the MiniWarper a practical alternative to costly hardware solutions.

Its 1st-order image translation, rotation, and scale capabilities significantly improve the performance of applications such as imaging workstation window manipulation. 2nd-order warping applications including sensor non-linearity correction, aspect angle distortion adjustment, and earth curvature compensation are also greatly accelerated.

The MiniWarper creates a warped (target) image that faithfully represents the transformed source image, eliminating distortion and unwanted artifacts with sophisticated interpolation techniques. Target pixels are created by interpolating between several pixels near the source. The interpolation algorithms are performed with sub-pixel precision.

For machine vision applications, MiniWarper provides low-cost solutions for problems such as template matching on randomly positioned parts by warping the image to correct for differences in perspective or rotation.

NMAC

The NMAC (Neighborhood Multiply and Accumulate) MaxModule is a high-performance, cost-effective add-on convolution and neighborhood processor that enhances the MaxVideo 250 and 200's convolution capabilities. It is available in three configurations:

NMAC1: A base-model 8-bit convolver with a single FIR chip used for 8-bit, 8x8 convolutions.

NMAC2: This dual 8-bit convolver with two FIR chips can perform one or two independent 8x8 convolutions on the same input data. When used with an external 8x8 convolver such as the MaxVideo 250 or 200's AP device, it can perform 12-bit convolutions.

NMAC3: The most powerful NMAC configuration, this dual 8-bit convolver has two FIR chips and one Pythagorean coordinate transform IC. It performs one or two independent 8x8 convolutions on the same input data, and complex rectangular-to-polar data conversion on video output data. It can also perform 12-bit convolutions when used with the MaxVideo 250 or 200's AP device.

RVF

The RVF (Rank Value Filter) MaxModule is a programmable 64-tap filter that provides enhanced rank value, median, maximum, and minimum filtering on 8- or 12-bit data at 20 MHz. It handles images with an infinite vertical dimension and line lengths to 5048.

It is most commonly used for median filtering, an effective technique for removing spike or impulse-like noise while preserving monotonic changes in the input data. Maximum and minimum filtering are used to suppress noise in a non-linear manner.

The RVF computes a given rank of the input values in a moving window and outputs the rank value. Values can be masked from the computation, allowing control over the window of the filter so that the size and shape of the window can be varied by application.

- MaxModules enhance specific image processing functions of the MaxVideo 250 and 200

- MiniWarper provides economical 1st- and 2nd-order image warping including image translation, rotation, scale capabilities, non-linear correction, aspect angle distortion adjustment, and curvature compensation

- NMAC (Neighborhood Multiply & Accumulate) MaxModule significantly enhances the convolution capabilities of the MaxVideo 250 and 200

- RVF (Rank Value Filter) MaxModule provides enhanced rank value, median, maximum, and minimum filtering on 8- or 12-bit data at 20 MHz

MiniWarper

Features

- 20 MB/40 MB input data rate
- Warps 8-bit data in one pass using 8-bit coefficients
- Data and coefficient precision expandable to 12-bits (multiple passes)
- 20 MPel/sec. (millions of pixels per sec.), 2x2 (bi-linear) interpolation render rate
- 6 Watts maximum power consumption
- I/O mapped to CPU
- Fast CPU access (approx. 10 MPel/sec.) to image memory surface store
- 256 KB (8-bit) coefficient store, I/O mapped to CPU
- Filter aperture expandable to non-separated 8x8 kernel (multiple passes)

Address Generation

- 1st- and 2nd-order bi-quadratic, 20 MHz address generator for polynomial warps
- X and Y sub-pixel addressing to 1/16th pixel
- Smooth continuous adjustment due to 32-bit precision address generation coefficients
- External memory auxiliary addressing information supports arbitrary warp transforms

Specifications

- **Internal Addressing:** Cascaded forward difference method with 32-bit and 40-bit integer accumulators. Evaluates two 2nd-order quadratic polynomials at a 20 MHz rate
- **External Addressing:** Two 14-bit linear interpolators convert two 10 MHz external addressing streams to two 20 MHz streams. External address is translated to sub-pixel resolution
- **Performance:** Target pixels rendered at 20 MHz for 1st- and 2nd-order linear warps using address generation capabilities, or for nth-order and non-linear warps, using auxiliary addressing feature. Example render times:

128x128:	1 mSec
512x512:	14 mSec
1024x1024:	53 mSec

- **Render Rate:** 20 million bytes/sec.
- **Input Bandwidths:**
  20 MB/sec. (Non-interleaved)
  40 MB/sec. (Interleaved 2:1 vert.)
- **Filter Processing Rate:** 80 million multiply-accumulates/sec.
- **Filter Aperture:** 2x2, expandable to 8x8 in multiple passes
- **Numeric Precision:** 8-bits data and coefficient, expandable to 12-bits in multiple passes

- **Result Precision:** 15 bits (2's complement)
- **Data Memory Size:** 1 MB or 4 MB, 8-bit; I/O mapped to CPU
- **Coefficient Memory Size:** 256 KB, 8-bit; I/O mapped to CPU
- **Host Bus Specifications:** MiniWarper is accessed via the VME interface of its MaxVideo 250 or 200 host. It is controlled via a 16-bit bus in accordance with Datacube's MaxModule interface specification

Electrical

- +5 Volts (±5%) 1.2 Amps (Max)

NMAC

Features

- Single 8x8 convolutions on same input data
- Two independent 8x8 convolutions (NMAC2 & NMAC3 devices only)
- 12-bit convolutions when used with an external 8x8 convolver such as MaxVideo 250 or 200's AP device (NMAC2 & NMAC3 only)
- Complex rectangular-to-polar data conversion on video output data (NMAC3 only)
- Very accurate directional gradient (Sobel)
- Adaptive filtering

Specifications

- **Data Transfer Rate:** 20 MB/sec. for each port
- **Module Ports:**

Port	Name	Config.	Bits
Receive	DQ_M0	Input	8
Transceiver	DQ_M1	Output	8
Transceiver	DQ_M2	Output	8
Transceiver	DQ_M3	Output	8

- **Command and Control Bus:** 8-bit bus (MaxModule specification) control via carrier device's control space
- **Bus Transaction Rate:** 150 ns/word cycle (synchronous or asynchronous) plus carrier access time

Electrical

- +5 Volts (±5%) 2.4 Amps (NMAC1)
  2.9 Amps (NMAC2)
  3.0 Amps (NMAC3)

RVF

Features

- Reconfigurable 64-tap Rank-Value Filter processor for operation as a 1-D or 2-D filter on 8- or 12-bit unsigned or signed data
- Configurable window size and shape: 8x8, 4x16, or 2x32 2-D or 1x64 1-D window
- Sorts and selects output data value based on input rank (0000000=min, 1111111=max)
- Performs 8x8 median filtering of images to remove impulse-like noise

- Performs maximum and minimum filtering to suppress noise in a non-linear manner
- Window shape programmable via a 64-bit mask. Only the unmasked data values are sent to the rank selector

Specifications

- Performance 20 MHz processing rate
- Data Transfer Rate: 20 MB/sec. for each port
- Module Ports:

Port	Name	Config.	Bits
Receive	DQ_M0	Input	4/8
Transceiver	DQ_M1	Input	4/8
Transceiver	DQ_M2	Output	8
Transceiver	DQ_M3	Output	8

Command and Control Bus:

- 16-bit bus (MaxModule specification) control via carrier device's control space

Bus Transaction Rate:

- 150 ns/word cycle (synchronous or asynchronous) plus carrier access time

Electrical

- +5 Volts (±5%) 0.6 Amps (typical)
  1.2 Amps (max)

MaxModules (all)

Environmental

- All MaxModules perform within the following environmental limits:
  Operating Temperature: 0° to 55° C
  Storage Temperature: -40° to 100° C
  Relative Humidity: 10-90% (non-condensing)

Physical

- MaxModules share a common form factor:

Height:	5.2"	(132 mm)
Length:	4.0"	(102 mm)
Width:	0.62"	(15.7 mm)

- **MaxVideo 250:** Each main board has a single MaxModule port and accommodates one MaxModule
- **MaxVideo 200:** One MaxModule can be plugged into the MaxModule port of the AP device. The AP device must be present on MaxVideo 200 to accommodate MaxModules.

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
MaxVideo 250 Data Sheet

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