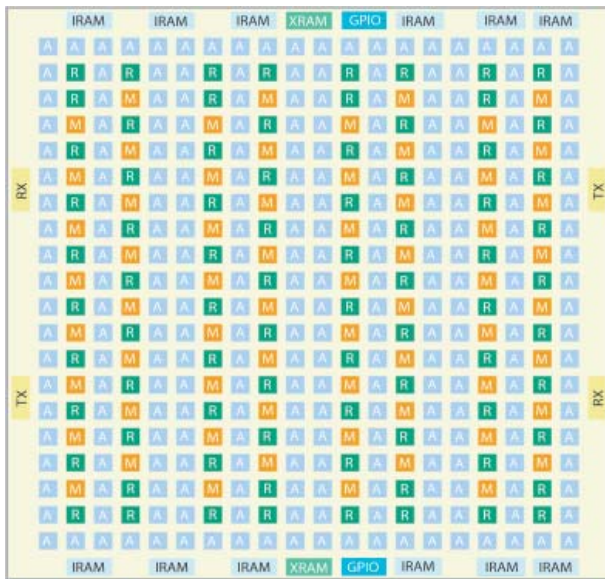




FPOA Overview

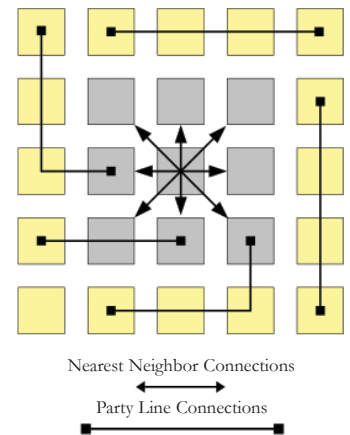
The Arrix® Family of Field Programmable Objects Arrays is the second generation of FPOA products from MathStar. A 1 GHz FPOA delivers up to four times the performance of today's top FPGAs and combines high performance and re-programmability to meet a wide variety of application needs. FPOAs are comprised of hundreds of objects that pass data and signals to each other through a patented 1 GHz interconnect fabric. The Arrix Family of FPOAs support 256 Arithmetic Logic Unit (ALU), 80 Register File, and 64 MAC (multiply accumulator) objects. The objects and the interconnect fabric run on a common clock and operate deterministically at frequencies up to 1 GHz. This deterministic performance eliminates the tedious timing closure steps associated with FPGAs, reducing design iterations and development time.



- A Arithmetic Logic Units
- R Register Files
- M Multiply/Accumulators
- IRAM Internal SRAM Banks
- XRAM External Memory Interfaces
- GPIO General Purpose I/O Banks
- TX High Speed Transmit Ports
- RX High Speed Receive Ports

1 GHz FPOA Architecture

The FPOA architecture provides a massively parallel, high-performance computation fabric consisting of hundreds of 16 bit processing elements called Silicon Objects. Each Silicon Object is programmed individually and acts autonomously. Each ALU Silicon Object can be programmed from a choice of 32 instructions. Each MAC performs multiplication and accumulation of two 16 bit words of data with a 40 bit result. Each RF of 64 words can operate as a dualport RAM or FIFO. These objects are surrounded by additional Internal RAM (IRAM) blocks, memory controllers and a rich mix of high-performance I/O. Communication between adjacent Silicon Objects is accomplished via the *Nearest Neighbor* interconnects. Communication across multiple objects is via patented *Party Line* technology. All communication planes operate at 1 GHz, are independently configurable and provide deterministic timing.



Features and Benefits

| Features | Description and Benefits |
|----------------------------|--|
| High Performance | 1 GHz operation / 1 GHz data movement |
| Deterministic, cycle-based | Objects and interconnect fabric run deterministically |
| Re-programmability | Re-programmable in as little as 10 milliseconds - delivers on the fly flexibility in the field. |
| Simplified Design Flow | Deterministic, cycle based timing closure, graphical design environment, and rapid floorplanning and placement speed time to market. |

Silicon Object and I/O Characteristics

| Resource | Architecture | Operating Speed |
|-------------------------|---|-------------------|
| ALU | 16 bit data, 5 bits control, 32 operations, control logic | Up to 1 GHz |
| RF | 128 Byte, dualport RAM or FIFO | Up to 1 GHz |
| MAC | 16x16 bit multiply, 40 bit accumulate | Up to 1 GHz |
| Internal RAM | 2K x 76 bits each | Up to 500 MHz |
| External RAM | 36 bit RLDRAM II | Up to 300 MHz DDR |
| General Purpose I/O | 48 pins per bank, programmable clocking | Up to 100 MHz |
| High Speed I/O Transmit | 16 + 1 bit LVDS | Up to 500 MHz DDR |
| High Speed I/O Receive | 16 + 1 bit LVDS | Up to 500 MHz DDR |

Algorithm Support

FPOA devices have the performance to support large, computationally-intensive applications. The programmability and 1 GHz clock of the FPOA make these devices ideally suited for the following algorithms:

- JPEG 2000 Encoder/Decoder
 - MPEG-4/H.264 Encoder/Decoder
 - MPEG-2 Encoder/Decoder
 - Flat Field Error Correction
 - Scalable Ultrasound Beamforming
 - Sobel Edge Detector
 - Multi-point FFT implementation
 - Scalable 2D Convolution Filter
 - Multi-tap FIR filter
- See www.mathstar.com for a complete list

FFT Performance

| Points | Sample Frequency | Throughput |
|--------|------------------|------------------|
| 1K | 2 GHz | 2 samples/cycle |
| 4K | 1 GHz | 1 sample/cycle |
| 16K | 500 MHz | 0.5 sample/cycle |

FIR Performance

| Tap | Sample Frequency | Throughput |
|-----|------------------|--------------------|
| 128 | 500 MHz | 0.5 sample/cycle |
| 256 | 250 MHz | 0.25 sample/cycle |
| 512 | 125 MHz | 0.125 sample/cycle |

Video Codec Performance

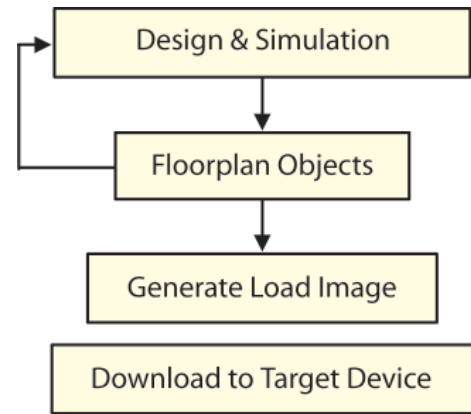
| Codec | Color Space / Depth | HD Resolution | Throughput | Core Clock |
|-------------------|-------------------------------------|---------------------------------|---|--------------------|
| MPEG-2 Decoder | 4:2:2 / 8 bits per color component | 1080i (30 fps) 720p (60 fps) | Up to 200 Mbps | 600-800 MHz |
| MPEG-2 Encoder | 4:2:2 / 8 bits per color component | 1080i (30 fps) 720p (60 fps) | Up to 100 Mbps | 600-800 MHz |
| JPEG 2000 Encoder | 4:4:4 / 12 bits per color component | Up to 2048 x 2048 | Up to 200 MSPS (mono) or 66 MSPS (color) | 700 MHz - 1 GHz |

Development System

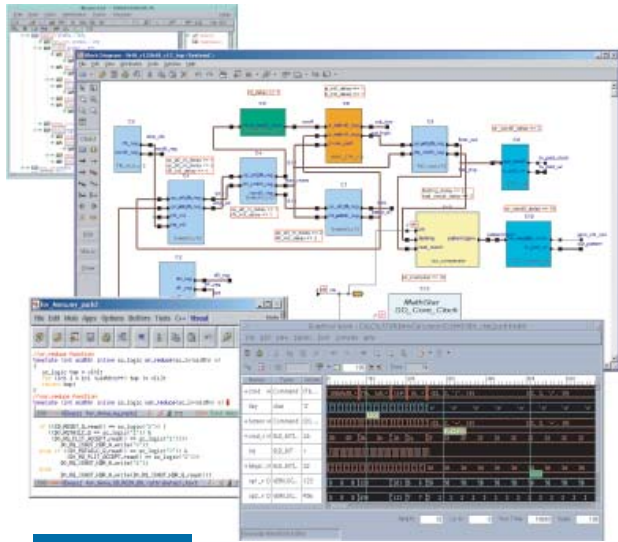
MathStar offers the high-performance Arrix FPOA product as part of a development system that is designed to speed algorithm and system development. Applications or algorithms can be designed in the FPOA tool suite well in advance of designing specific hardware platforms. This speeds time-to-market and decreases risk.

Design Flow

MathStar's Field Programmable Object Array design software enables designers to create, verify, program and debug their algorithms on FPOA devices at a higher level of abstraction than used in FPGAs. Designs are entered and simulated behaviorally using Visual Elite™ from Mentor Graphics. Then they are compiled and mapped into the hardware resources of the FPOA device using MathStar COAST design software. A bistream is generated and is loaded onto the array via a PROM or through a JTAG interface. FPOA designs have a deterministic timing structure. As such, they are timed only on cycle boundaries of the internal clock with no need for gate-level timing closure. This greatly simplifies the design process, improving productivity and development predictability. MathStar also provides a debug tool to enable designers to analyze their designs once they have been loaded on the FPOA.



MathStar FPOA Design Flow



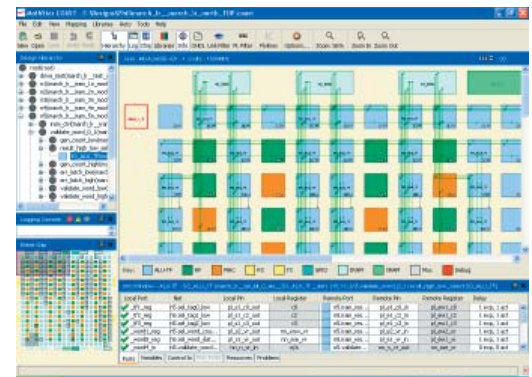
Create designs for FPOA using Visual Elite™ by Mentor Graphics™

Design Flow Features

- Graphical design using Visual Elite™ from Mentor Graphics
- No RTL synthesis or gate-level timing closure is required
- Cycle-accurate models support fast and accurate hardware simulation
- Includes tools for floorplanning, compilation, and debugging tools

COAST

A design is floorplanned and optimized using MathStar's COAST (COntection and ASSignment Tool) software. COAST is a graphical floorplanning editor that allows the designer to assign functional modules to the physical resources of the FPOA. In addition to floorplanning, COAST includes powerful analysis and guidance logic to assist the user. COAST presents the user with graphical representations of the design hierarchy and the array resources. COAST enables designers to alter, upgrade, or optimize existing designs as requirements change during the design process. A variety of predefined library elements are also available to assist the designer.



Place FPOA objects using MathStar's Connection and Assignment Tool (COAST)

Target Applications

Professional Video



The broadcast and professional video market is experiencing a period of rapid growth in both size and innovation. HD video is driving processing and bandwidth requirements across the video equipment value chain. MathStar's Arrix FPOA is ideally suited for video processing applications such as MPEG-2 422P profile encoding and decoding, and high sample rate JPEG 2000. The FPOA can be programmed in real time for 1080i / 720p High Definition or multi-stream Standard Definition applications.

Medical Imaging



Medical Imaging modalities such as ultrasound and computed tomography are experiencing a period of rapid innovation and use across an expanding breadth of clinical applications, driven by the emergence of 3D / 4D imaging. MathStar FPOAs are ideally suited to address many of these applications, offering up to four times the performance of today's high end FPGAs for processing the filters, transforms, and search routines that comprise the underlying algorithms.

Machine Vision



A broad range of inspection and test applications—including electronic board assembly inspection, pharmaceutical inspection, and semiconductor test—demand fast, flexible machine vision systems, capable of processing up to 4K x 4K pixel images. Operating deterministically at speeds of 1 GHz, MathStar FPOAs are ideally suited for many DSP-intensive tasks image processing tasks, including color space conversion, bayer demosaicing, object recognition, pattern matching and edge detection.

Test & Measurement



The general purpose Test and Measurement market is experiencing a rapid period of innovation. Product segments such as spectrum analyzers, oscilloscopes, network analyzers and wireless test equipment are being driven by the relentless demand for better and better performance. The FPOA architecture is capable of processing very high sample rates and can be completely reconfigured hundreds of times per second. This makes FPOAs a great fit for multi-channel data processing, signal processing, programmable triggering, and real time displays.

Military/Aerospace



Military and Aerospace applications continue to drive advanced requirements in reconfigurable digital signal processing, including radar and sonar processors, uplink / downlink systems, and cryptographic systems. For example, UAV high resolution radar and video systems are driving the need for more sophisticated on-board image processing and image compression. Offering up to four times the performance of today's most advanced FPGAs, MathStar FPOAs are ideally suited for processing the building block filters and transforms found in these applications, as well as solution-level tasks such as JPEG 2000 encoding.

Arrix Product Family Ordering

| Product | Product Code | Package |
|-------------------------------|-----------------|------------|
| Arrix FPOA Component | MOA2400D-10R* | HFCBGA-896 |
| Arrix FPOA Component | MOA2400D-09R* | HFCBGA-896 |
| Arrix FPOA Component | MOA2400D-08R* | HFCBGA-896 |
| Arrix FPOA Component | MOA2400D-06R* | HFCBGA-896 |
| Arrix FPOA Development System | MS2400D-10 | N/A |
| Arrix FPOA Design Software | MDS-VCD02-T12FW | N/A |

* Available in RoHS and Eutectic packages.

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