PolarFire® FPGAs

Architecture, Applications, Security Features, Design Environment, Design Hardware

MICROCHIP

microchip.com

PolarFire® FPGAs

PolarFire Cost-Optimized FPGAs Deliver the Lowest Power at Mid-Range Densities

Microchip extends its low-power FPGA leadership with the PolarFire family of cost-optimized FPGAs. PolarFire FPGAs deliver up to 50% lower power than equivalent SRAM FPGAs. The devices are ideal for a wide range of applications within wireline access networks and cellular infrastructure, defense and commercial aviation markets, as well as industrial automation and IoT markets.

As a true broad-range FPGA supplier, we offer FPGA product families spanning 1K to 500K Logic Elements (LEs).

The devices offer unprecedented capabilities with the smallest form factors in their class, while maintaining all the advantages traditionally associated with non-volatile FPGAs such as the lowest static power, security and Single Event Upset (SEU) immunity.

Cost-Optimized Architecture

- Transceiver performance optimized for 12.7 Gbps, which yields smaller size
- Architecture and process optimizations for specific band-widths (10 Gbps–40 Gbps) at specific densities
- 1.6 Gbps I/Os—best-in-class hardened I/O gearing logic with CDR (supports SGMII/GbE links on these GPIOs)
- High-performance, best-in-class hardened security IP in mid-range devices

Power Optimization

- The lowest static power—28 nm non-volatile process yields very low static power
- Optimized for 12.7 Gbps, which yields the lowest power
- Integrated hard IP—DDR PHY, PCIe® endpoint/root port, crypto processor
- Total power (static and dynamic)—up to 50% lower power

Solving Key Market Issues

Communications

- Significantly improved network capacity and coverage with limited spectrum and CAPEX
- Delivers 4K video
- Lower OPEX
- IoT growth with minimal energy consumption
- Lower physical and carbon footprint

Defense

- Anti-tamper for Foreign Military Sales (FMS)
- Increasing automation in vehicles and weaponry
- Enhancing operator situational awareness
- Battlefield portability and increased mission life
- Increased cybersecurity
- Supply chain security

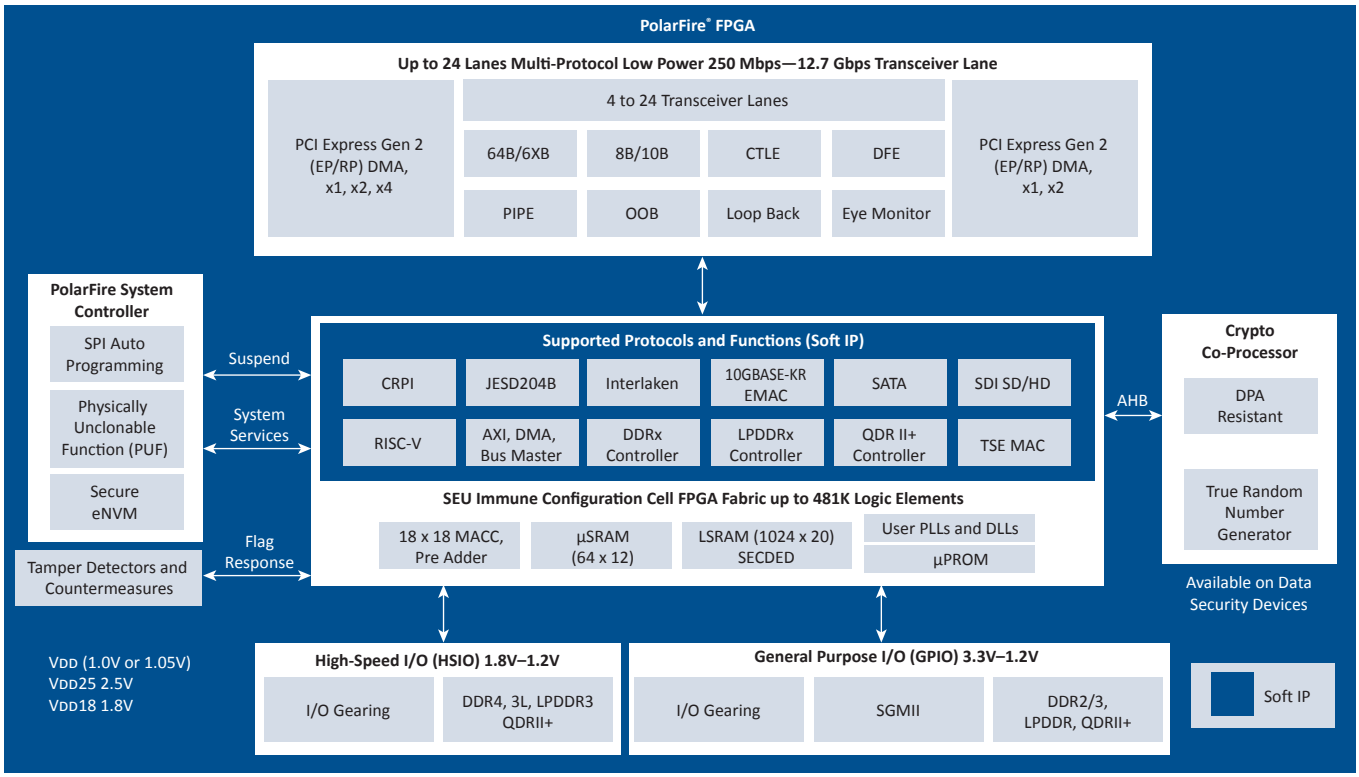
Industrial

- Increased networking of factory automation
- M2M—growth of additional sensors and nodes
- Rise of cloud services requiring decentralized, secure computing
- Portability becoming more prevalent
- Cybersecurity threats
- Functional safety

PolarFire Architecture

PolarFire FPGAs Deliver Up to 500K LEs, 12.7G Transceivers and 50% Lower Power

- High-speed serial connectivity with built-in multi-gigabit/multi-protocol transceivers from 250 Mbps to 12.7 Gbps
- Up to 481K logic elements consisting of a 4-input look-up table (LUT) with a fractureable D-type flip-flop
- Up to 33 Mbits of RAM
- Up to 1480 18x18 multiply accumulate blocks with hardened pre-adders
- Integrated dual PCIe for up to x4 Gen 2 endpoint (EP) and root port (RP) designs
- High-speed I/O (HSIO) supporting up to 1600 Mbps DDR4, 1333 Mbps DDR3L, and 1333 Mbps LPDDR3/DDR3 memories with integrated I/O gearing
- General purpose I/O (GPIO) supporting 3.3 V built-in CDR to support SGMII for serial gigabit Ethernet, 1067 Mbps DDR3, and 1600 Mbps LVDS I/O speed with integrated I/O gearing logic



Reliability Features

- SEU immune FPGA configuration cells
- Built-in SECDED and memory interleaving on LSRAMs
- System controller suspend mode for safety-critical designs

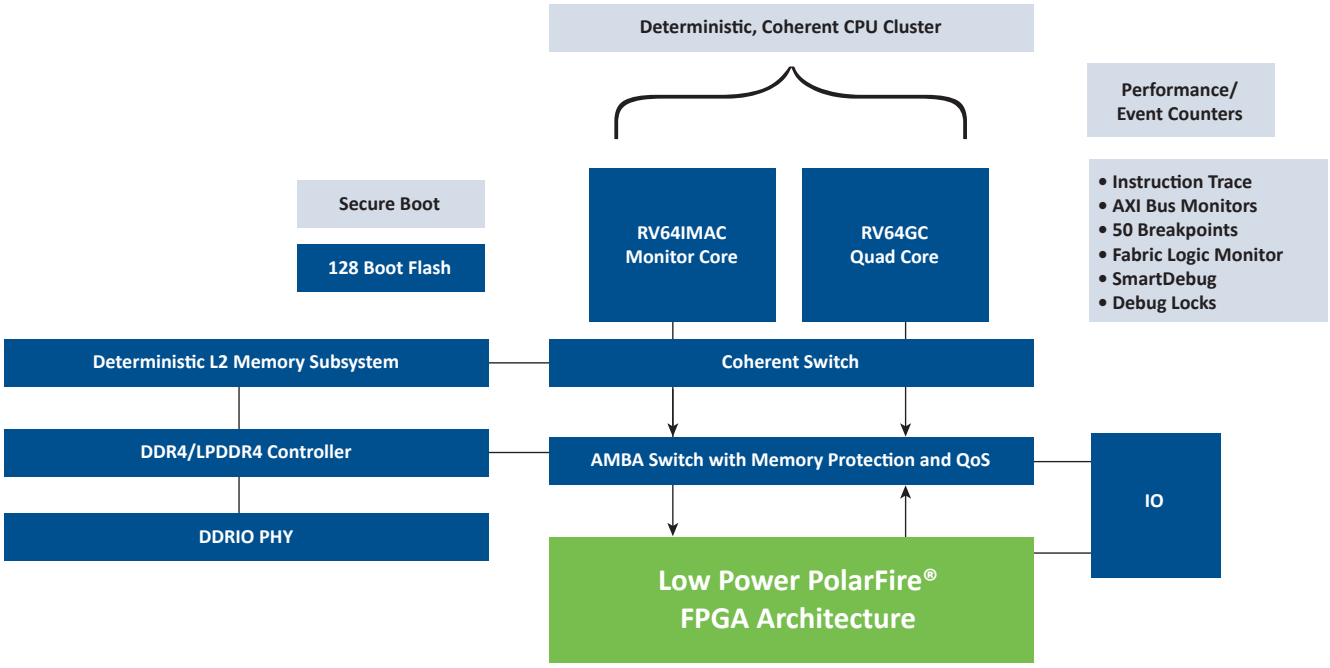
Security Features

- Cryptography Research Incorporated (CRI)-patented differential power analysis (DPA) bitstream protection
- Integrated physically unclonable function (PUF)
- 56 Kbytes of secure eNVM (sNVM)
- Built-in tamper detectors and countermeasures
- Integrated Athena TeraFire EXP5200B Crypto Co-processor, Suite B-capable
- Digest integrity check for FPGA, µPROM, and sNVM
- True random number generator
- CRI DPA countermeasure pass through license

PolarFire SoC Architecture

PolarFire SoC Integrates a Versatile, Low-Power Multi-Core RISC-V CPU Sub-System

- Linux® capable 64-bit multi-core CPU cluster
- Deterministic operation
- Defense grade secure boot
- 50 breakpoints or watch points
- Instruction trace
- Runtime configurable AXI bus monitors
- Instant on
- Low power
- Rich I/O



Development Platforms

- Libero® Design Suite for FPGA design
- SoftConsole IDE for C and C++ development
- PolarFire SoC Development Kit
- Antmicro Renode PolarFire SoC modeling platform

MSS Configurator

- Push button processor subsystem configuration
- Presets for
  - Quad core SMP Linux
  - Bare Metal
  - Linux + Real Time

Built in Reliability and Security

- SECDED on all memories
- Physical Memory Protection
- DPA safe Crypto Coprocessor
- Inspectable RTL for Trust and Certifications

Industry's Best FPGA Security

Cyber Security is the #1 Concern for Connected Devices on the Network Edge

It is not enough for today's demanding applications to meet the functional requirements of their design—they must do so in a secured way. Security starts during silicon manufacturing and continues through system deployment and operations. Microchip's PolarFire FPGAs represent the industry's most advanced and secure programmable FPGAs.

Security Leadership

Security Advantage	Low Density		Mid-Range	
	Microchip	Competition	Microchip	Competition
Prevent overbuilding and cloning	Best Low-density Security	N/A	Best Security in the Industry	N/A
Full design IP protection		N/A		Weak
Root of trust		N/A		N/A
Secure data communications		N/A		Weak
Anti-tamper		N/A		N/A

"The number of IoT sensors is expected to approach 30 billion in 5 years – and each unit is a potential entry point for cyber-criminals"

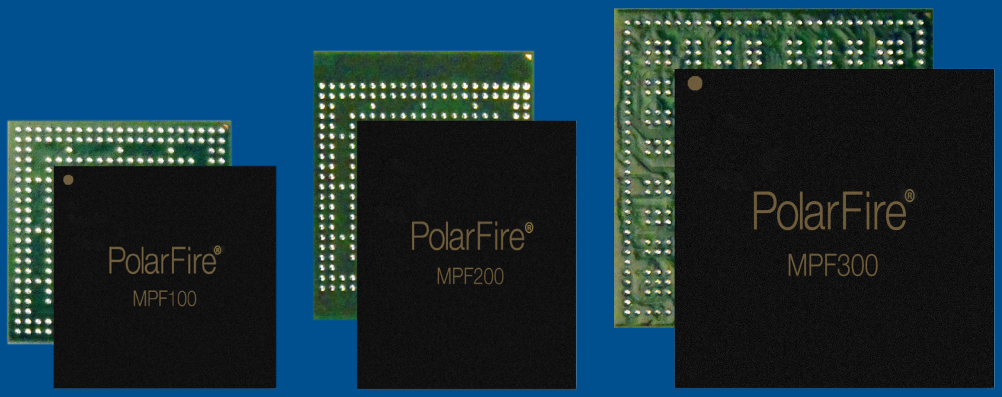
The Economist Intelligence Unit, April, 2016

"Some call cybercrime the greatest transfer of wealth in human history"

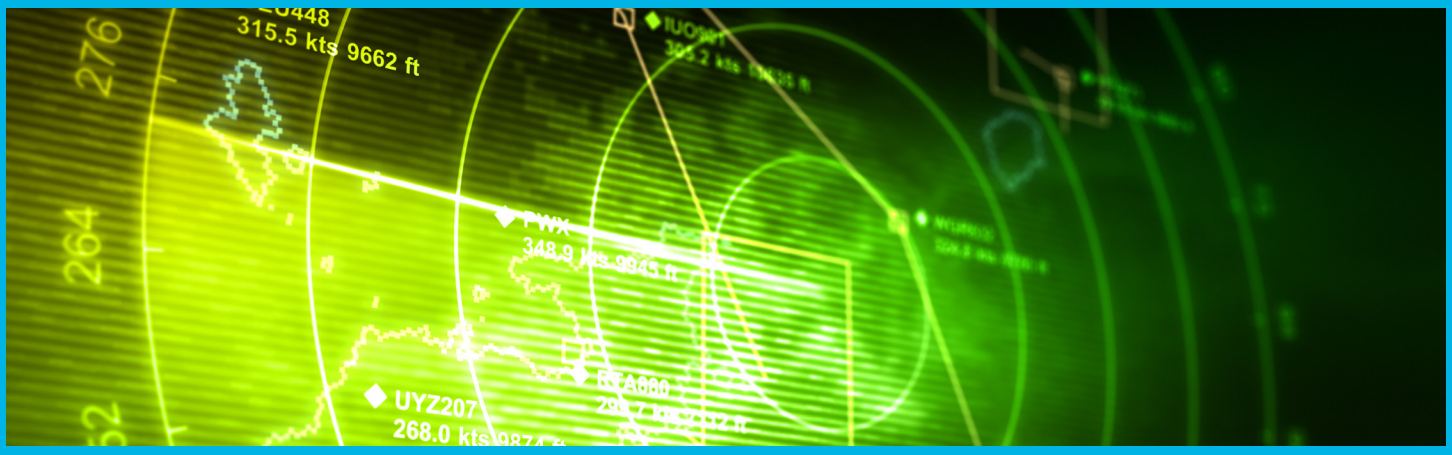
The Center of Strategic and International Studies, The Economic Impact of Cybercrime, July 2013

PolarFire Smallest Form Factors

PolarFire FPGAs offer best-in-class form factors at 100K, 200K, and 300K LEs.



MPF100	MPF200	MPF300
11 x 11 mm	11 x 14 mm	16 x 16 mm



Communications—Wireline Access and Cellular Infrastructure

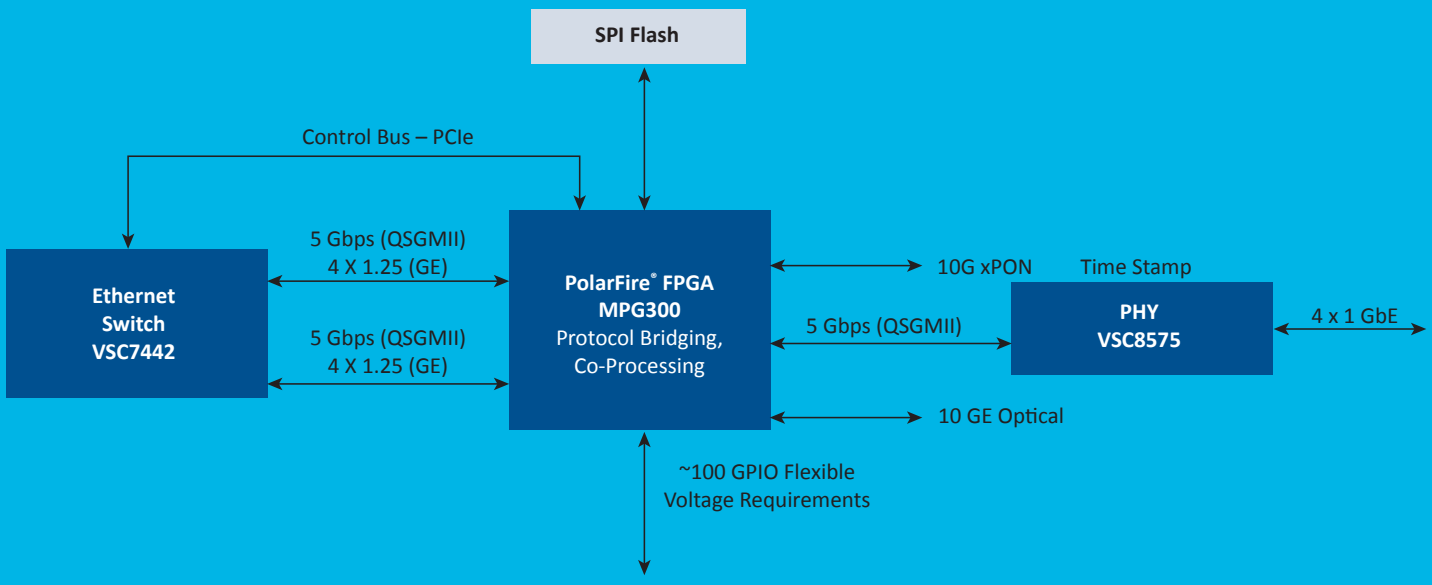
Delivering Additional Bandwidth at Lower Cost

Today's cellular infrastructure and wireline access networks are facing a rapid transformation, having to deliver terabytes of high value content to consumers while reducing operational and capital expenditure spend, as well as reducing their thermal and carbon footprint. PolarFire FPGAs provide cost-effective bandwidth processing capabilities for the increasing number of converged 10 Gbps ports with the lowest power footprint. The FPGAs also address the market's growing concerns over cybersecurity threats as well as the reliability concerns that face deep submicron SRAM-based FPGAs as they relate to SEUs in their configuration memory.

Applications

- Wireline access, edge, metro (1G–40G)
- Wireless heterogeneous networks
- Wireless backhaul
- Smart optical modules
- Video broadcasting

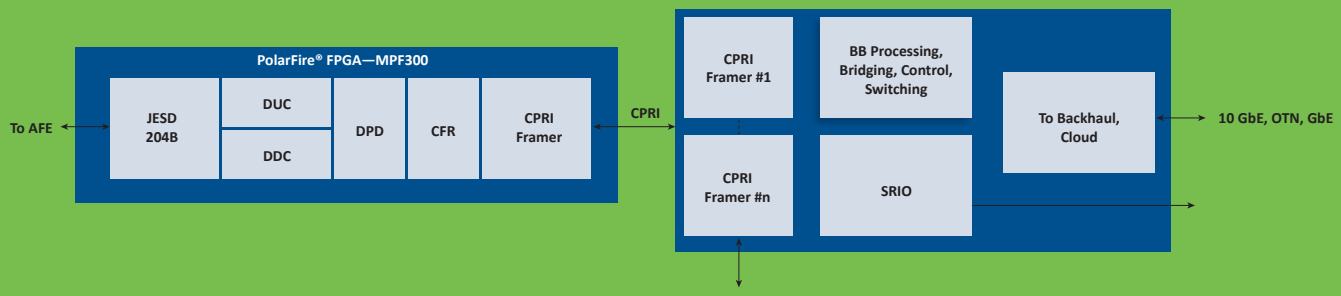
Wireline Access



PolarFire Solution

- Low-cost 10G SERDES with built-in burst mode receiver for PON applications
- Built-in CDR on GPIO enables use of smaller devices when using GbE
- Up to 50% lower total power
- Non-volatile, instant-on
- Best-in-class security and immune to configuration SEU

HetNet—Remote Radio Head Digital Front End and BBU



PolarFire Solution

- Lowers power up to 50% for power-constrained wireless products
- Especially important for power-constrained small cells and thermally-constrained outdoor units
- Signal processing capabilities with hardened pre-adders ideal for low/mid-bandwidth DFE 4 x 4 x 60 MHz and baseband processing
- Includes ultra-low power transceiver for 10G CPRI, bridging, and fronthaul/backhaul transport
- Provides best-in-class security against tampering and hacking

Defense and Aviation

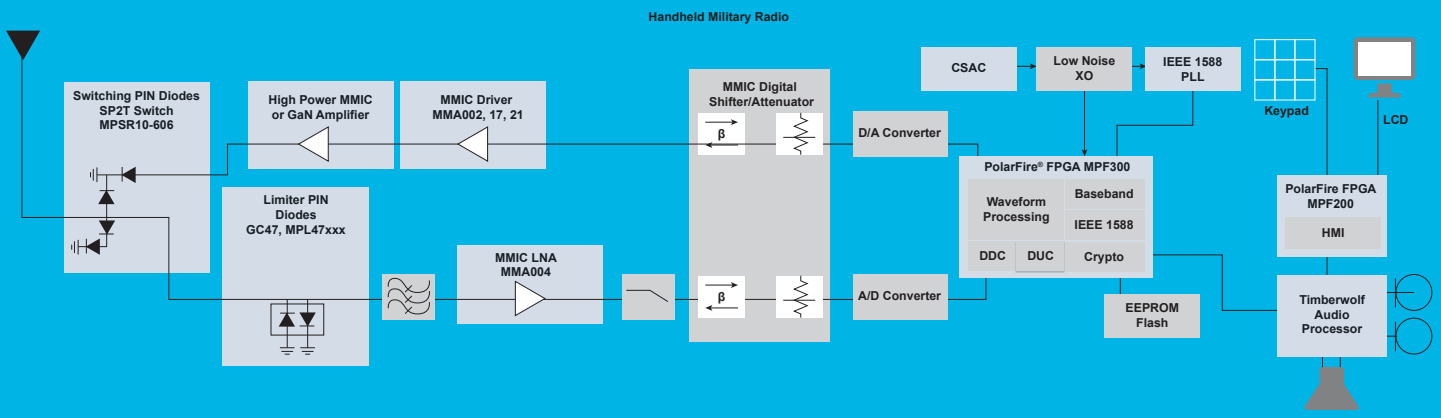
Enabling Security While Lowering Size, Weight and Power

For the modern solider to be successful in the battlefield, it is imperative that they be equipped with gear that delivers high-tech capabilities at the lowest size and weight possible. Mission life is as key as portability, and power consumption is a decisive factor. PolarFire FPGAs provide high bandwidth radio and image signal processing capabilities at a fraction of the power of competing FPGAs. Microchip also delivers best-in-class anti-tamper and data security capabilities in cost-efficient FPGAs for FMS, smart munitions, radar and secure radios.

Defense and Aviation Applications

- Encryption and root of trust
- Secure wireless communications
- Smart munitions
- Radar and electronic warfare
- Aircraft networking
- Actuation and control

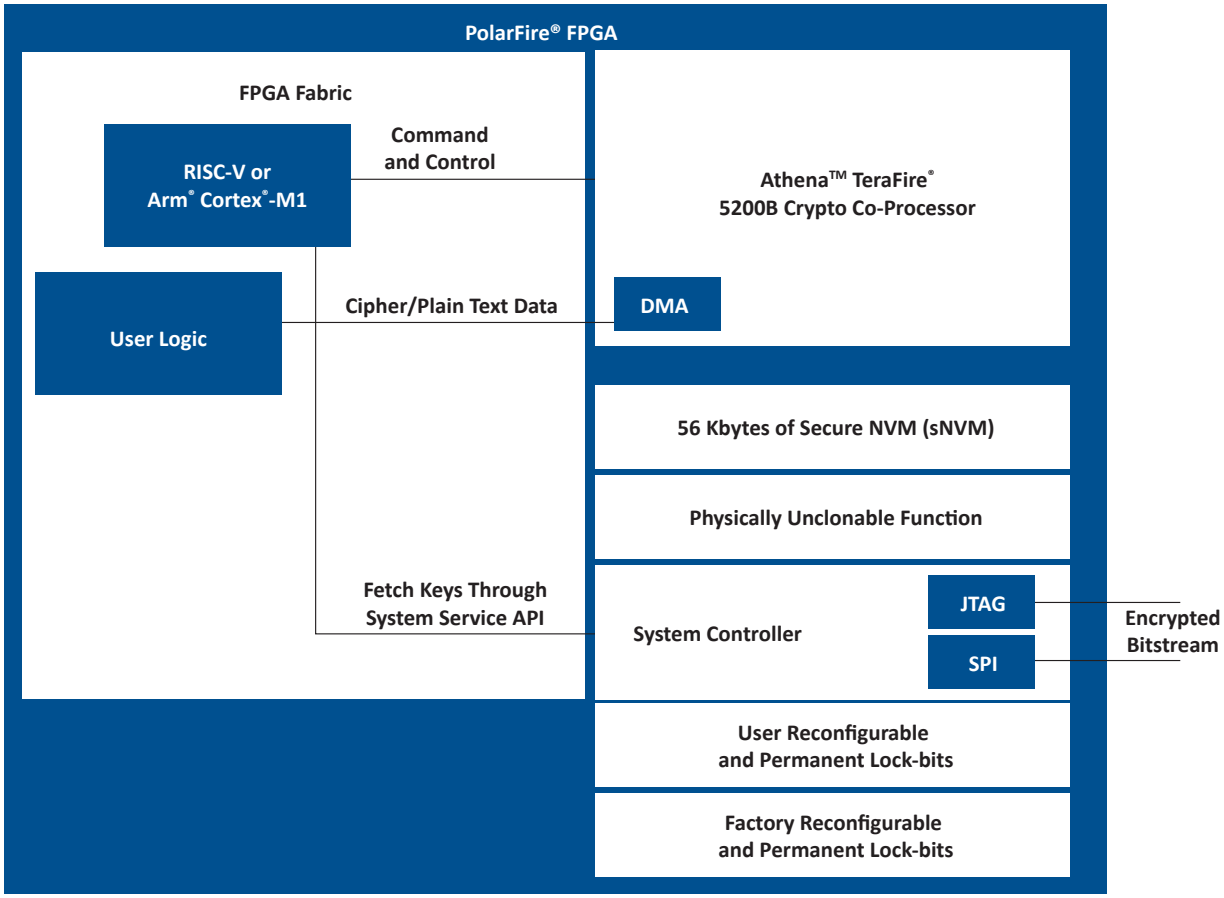
Handheld Military Radio



PolarFire Solution

- DSP blocks with hardened pre-address running at 450 MHz for high speed radio and image signal processing
- GPIOs supporting ADC/DACs at up to 1.6 Gbps
- Up to 50% lower total power
- Non-volatile, instant-on
- Best-in-class security and secure manufacturing
- Exceptional reliability—immune to configuration SEU

Secure Cryptographic Communications



Industrial

Enhance Tomorrow's Industrial Solutions

Today, Microchip FPGAs and technology solutions are deployed at the highest safety levels within industrial markets around the world. Our heritage in safety-critical industrial applications range from hazardous area laser curtain sensors, liquid flow meters, nuclear power plant control, navigation systems, and secure communications.

Industry 4.0 combines the smart factory with connectivity using the Internet of Things (IoT). This will require the intelligence to move to the edge of the industrial network, and will require FPGAs with high bandwidth and processing capabilities using packet-based interfaces. Machine vision, robotics, thermal imaging, and other technologies will require increased image processing capabilities throughout the network in the most power-efficient manner.

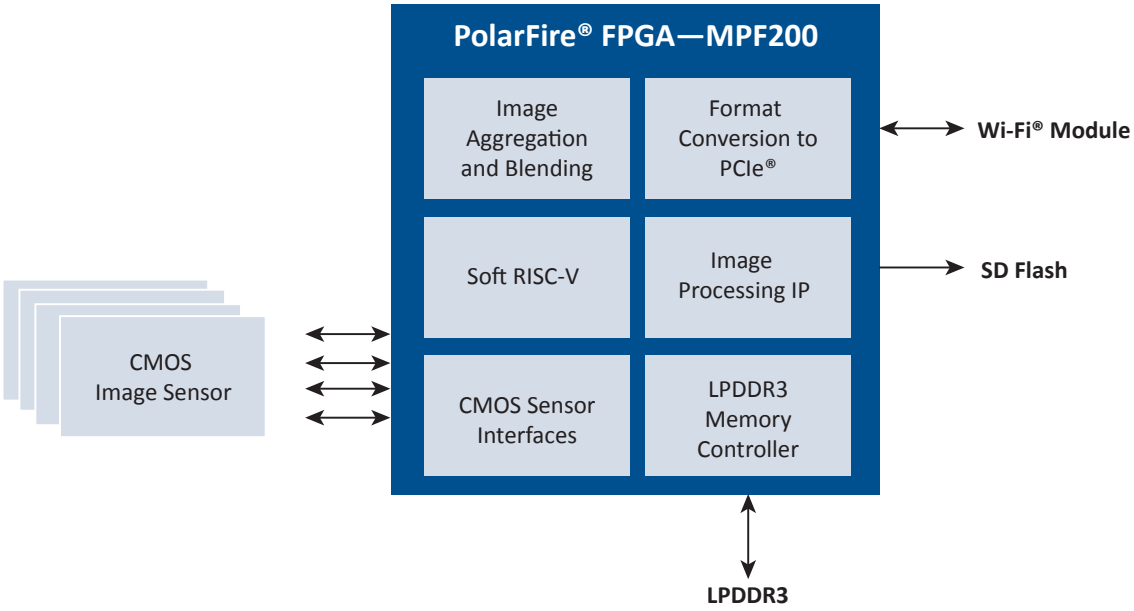
Industrial Applications

- Process control and factory automation
- Machine vision, processing and analytics
- Thermal and image processing
- Robotics and motion control
- Industrial IoT
- Programmable logic controllers
- Industrial networking

360 Surround Camera—Aggregates Image Sensors and Performs Image Processing

PolarFire Solution

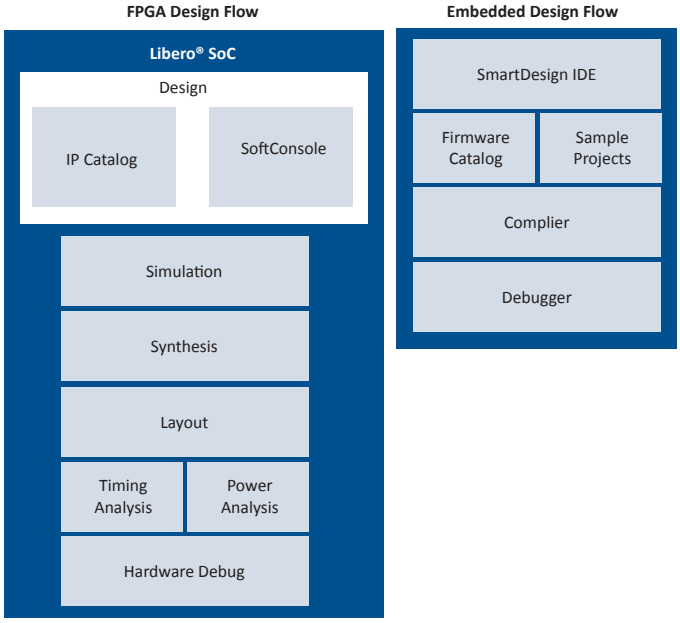
- GPIOs supporting sensor interfaces at up to 1.2 Gbps
- Industry-leading 1588 algorithms for TSN
- Support for low-power multi rate SDI support
- DSP blocks with hardened preadders running at 450 MHz for 4K2K image signal processing
- Up to 50% lower total power
- Non-volatile, instant-on
- Best-in-class security
- Soft RISC-V processor for protocol stacks
- SEU immunity for functional safety requirements



PolarFire Design Environment

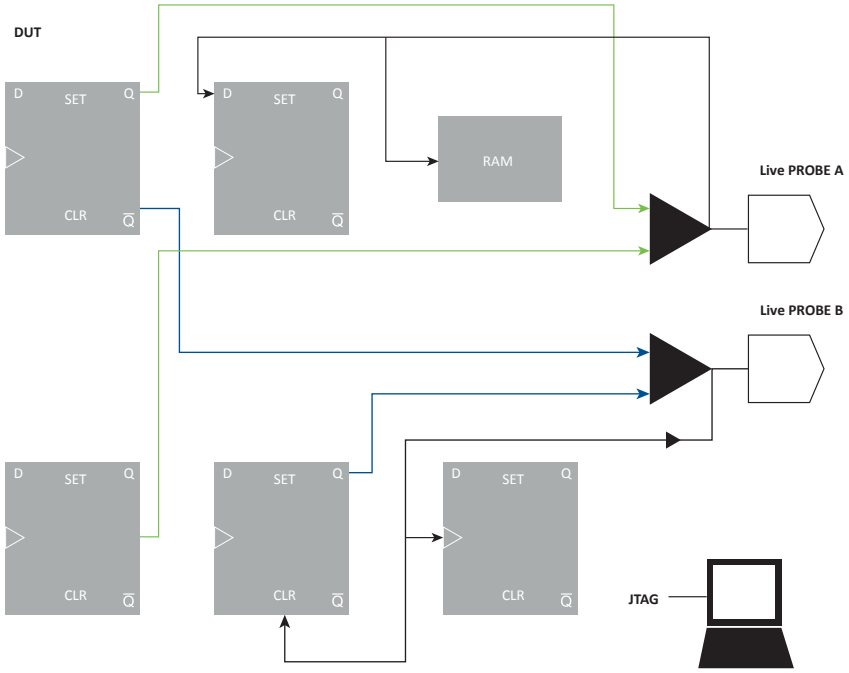
Libero SoC PolarFire Design Suite

Microchip enhances your design productivity by providing an extensive suite of proven and optimized IP cores for use with Microchip FPGAs. Our extensive suite of IP cores covers all key markets and applications. Our cores are organized as either Microchip-developed DirectCores or third-party-developed CompanionCores. Most DirectCores are available for free within our Libero tool suite and include common communications interfaces, peripherals, and processing elements.



SmartDebug

SmartDebug offers the equivalent of an oscilloscope inside Microchip FPGAs. SmartDebug features a tool called LiveProbes that enables an engineer to see any two nodes inside the FPGA on external pins, without requiring recompilation of a design. Nodes can be quickly selected and modified and the real-time signals can be seen externally immediately. This SmartDebug capability can cut engineers' debug time by weeks, if not months. In addition, the SmartBERT module allows customers to configure and monitor the built-in PMA tester in PolarFire devices.



PolarFire Design Hardware

Microchip and their distribution partners have created boards to allow customers to evaluate PolarFire FPGAs and the fully develop their applications.

PolarFire Evaluation Kit

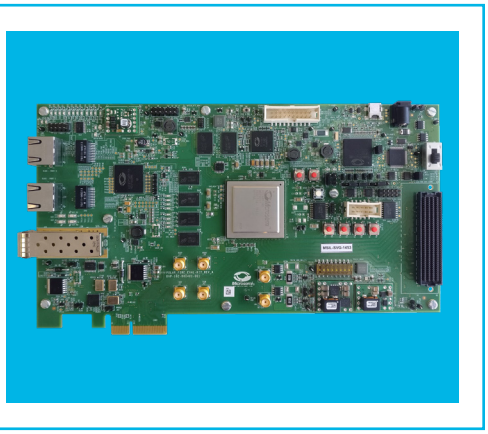
Device: MPF300TS-1FCG1152EES

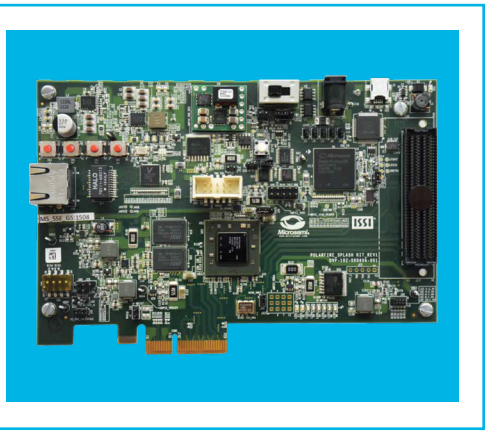
- 4 GB 32-bit DDR4, 2GB 16-bit DDR3, and 1Gb SPI Flash Memory
- 2x RJ45 ports with PHY for Ethernet 1588 applications
- Support for SFP+ interface and IOG loopback
- High-speed SerDes interface
- 4x FMC connector (HPC)
- In-silicon temperature monitoring
- On-board 50 MHz system clock

PolarFire Splash Kit

Device: MPF300TS-1FCG484EES

- x32 bit DDR4 and 1 Gb SPI Flash Memory
- RJ45 port with PHY for SGMII applications
- FMC connector (LPC)
- Prototype breadboard area
- PCI express (x4) edge connector
- On-board 50 MHz system clock

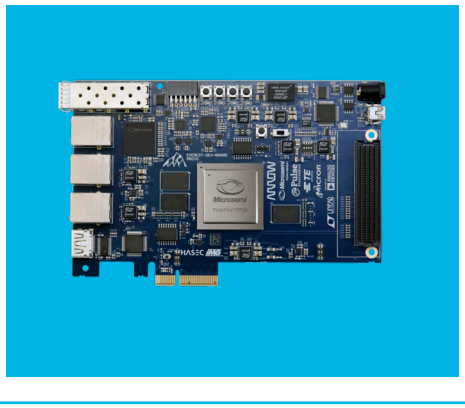




Arrow Everest Kit

Device: MPF300TS-1FCG1152EES

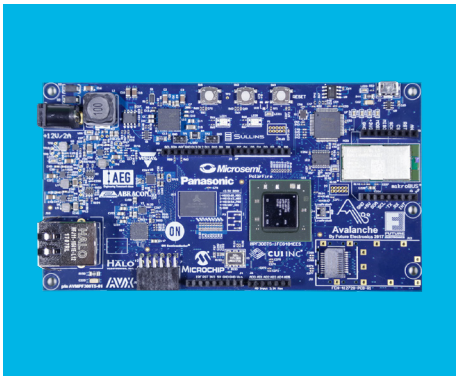
- Triple 1GbE interface
- 1 × 10GbE SFP+ cage
- PCI express (x4) Gen2
- Dual DDR3L (x32 and x16)
- High-speed FMC (HPC) expansion
- HDMI output
- Expansion connectors: PMOD
- Other low-speed interfaces: UART, SPI and I^2C



Future Avalanche Board

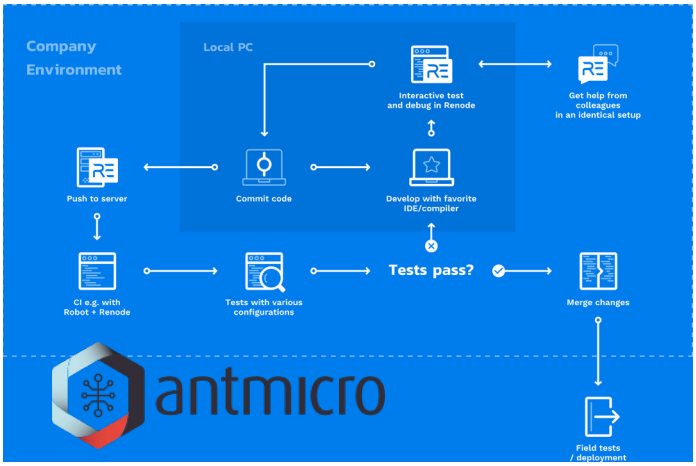
Device: MPF300TS-FCG484EES

- 1 GbE interface with PHY (VSC8531)
- Wi-Fi® module
- Expansion connectors: Arduino Shield, MikroBus, PMOD
- DDR3 SDRAM (256Mx16)
- SFP cage
- 64 Mbit SPI Flash
- Other low-speed interfaces: UART and JTAG



PolarFire SoC Development

Virtual Platforms



Antmicro Renode PolarFire SoC Emulation Platform

Antmicro's Renode platform offers multiple connected virtual devices (multi-node) setups within the same simulated environment, bypassing the limitations associated with single device solutions.

Using C#, a high productivity programming platform, and advanced abstraction layers, the solution boasts ease-of-development for customers without the hassle of C programming.

In addition, it offers full visibility of simulated platform enabling better insight and increased security, and open source to allow for unlimited integrations, modifications and additions, as well as easy bundling and distribution to customers—particularly those leveraging Microchip's SoftConsole IDE.

imperas

Imperas supports Microchip's RISC-V based SoC FPGAs with the Mi-V FreeRTOS Extendable Platform Kit (EPK), tools to help in development, porting, debug and test.

Mi-V RISC-V Ecosystem

Microchip's Mi-V RISC-V Ecosystem of FPGA and embedded systems solutions advances the adoption of the RISC-V ISA by giving developers the resources they need to implement their designs in silicon.

Operating Systems

RISC-V soft CPUs are supported with the most popular commercial and open-source real-time operating systems.

Commercial Operating Systems for RISC-V

µC/OS™ RTOS and Stacks

THREADX

Open-Source Operating Systems for RISC-V

APACHE mynewt

freeRTOS

HUAWEI

Zephyr™ Project

PolarFire SoC will include support for Buildroot Linux for the RTOSs above.

Buildroot Making Embedded Linux Easy

Mi-V Embedded Experts Network

The Mi-V Embedded Experts is a network of qualified third-party design houses available to help customers with their PolarFire SoC designs through the lifecycle of their project.

aries embedded

DIGITAL CORE TECHNOLOGIES

0x5 HEX-Five™

antmicro

EMDALO TECHNOLOGIES Embedded Intelligent Systems

Micriμm® Embedded Software

PHYTEC

expresslogic

ultraSOC

SiFive

EmCraft systems

Solutions

Microchip posts various designs, solutions, demos and example projects for RISC-V on the GitHub site to provide easy access for designers as well as regular updates of solutions.

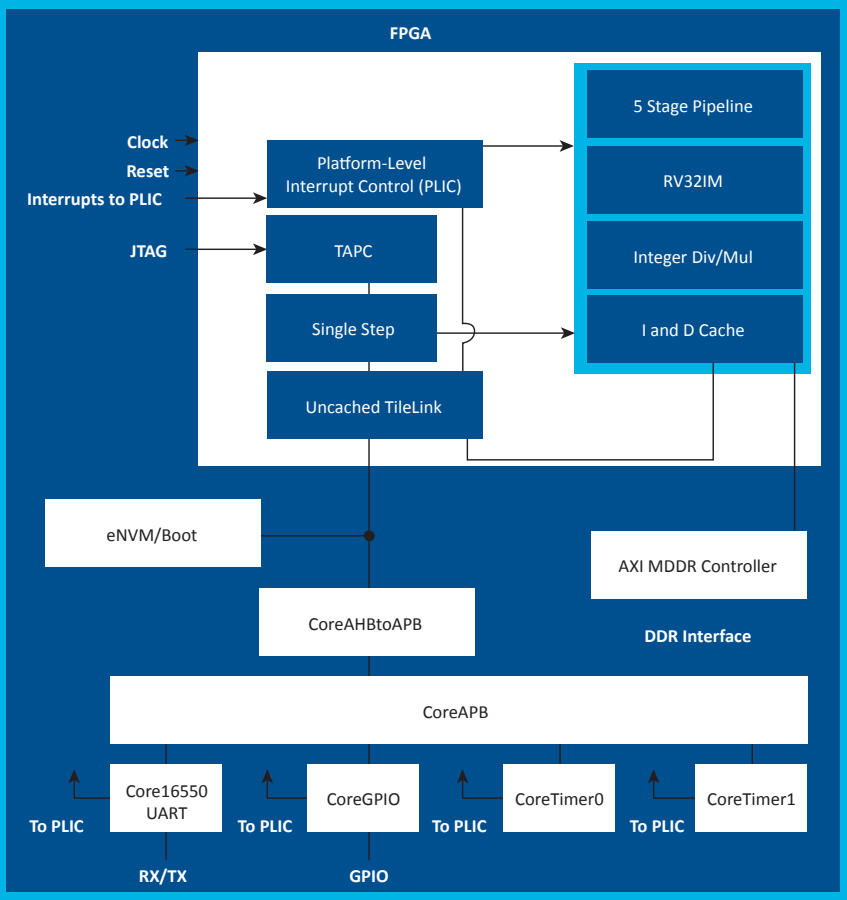
github.com/RISCV-on-Microsemi-FPGA

Solutions provided on GitHub include:

- Buildroot Linux SDK
- Libero projects
- Example schematics and layouts
- FreeRTOS demo and source files
- RISC-V bare metal bootloader
- RISC-V hardware abstraction layer

RISC-V Soft CPUs

Mircochip's 32-bit RISC-V Soft CPUs are readily available for RTG4, IGLOO®2 and PolarFire FPGAs.



RISC-V Soft CPUs	Logic Elements	Cache	Bus	Floating Point
CORE_RISCV_AXI4	10K	8K I and D	AXI	N/A
Mi_V_RV32IMA_L1_AHB	10K	8K I and D	AHB	N/A
Mi_V_RV32IMA_L1_AXI	10K	8K I and D	AXI	N/A
Mi_V_RV32IMAF_L1_AHB	26K	8K I and D	AHB	Single Precision

PolarFire IP and Demo Designs

Microchip enhances your design productivity by providing an extensive suite of proven and optimized IP cores for use with Microchip FPGAs. Our extensive suite of IP cores covers all key markets and applications. Our cores are organized as either Microchip-developed DirectCores or third-party-developed CompanionCores. Most DirectCores are available for free within our Libero tool suite and include common communications interfaces, peripherals, and processing elements.

PolarFire IP

- AXI4Interconnect
- Core3DES
- CoreABC
- CoreAHBLite
- CoreAHBL2AHBL Bridge
- CoreAHBLTOAXI
- CoreAHBLSRAM
- CoreAHBtoAPB3
- CoreAPB3
- CoreAXI4DMA Controller
- CoreAXI4SRAM
- CoreAXItoAHBL
- CoreCORDIC
- CoreDDRMemCtrlr
- CoreDDS (NCO)
- CoreDES
- CoreFFT
- CoreFIFO
- CoreFIR
- CoreGPIO
- CoreI2C
- CoreJESD204BRX
- CoreJESD204BTX
- CoreMDIO_APB
- CorePCS
- CorePWM
- CoreRSDEC
- CoreRSENC
- CoreRISCV
- CoreRMII
- CoreSPI
- CoreSysServices_PF
- CoreUART
- CoreUART_APB
- CoreLSM
- CPRI (PHY only)
- CRYPTO
- DDR3
- DPSRAM
- DRI
- PCIe End Point
- TAMPER
- TPSRAM
- UPROM
- URAM
- 1GbE IO-CDR
- Core10GMAC 10GBASE-R
- Core429
- CoreSGMII
- CoreTSE, CoreTSE_AHB
- DDR4
- CoreRGMII

PolarFire Imaging and Video IP

- Support for 4K resolution
- Alpha Blending
- Bayer Conversion
- Color Space (YCbCr)
- Color Space (RGB)
- Crest Factor Reduction
- DeepLearning
- Digital Pre-distortion
- Display Controller
- Display Enhancement (Brightness/ Contrast/Hue)
- Display Port 1.4a
- HDMI Rx, Tx 2.0
- HDCP 2.2
- Image Edge Detection
- Image Sharpening Filter
- MIPI CSI-2 Receiver Decoder
- Support for RAW8
- MIPI CSI-2 Tx
- Support for RAW8
- LVDS 7:1 Display
- TX and Rx
- Pattern Generator
- SATA 2.0
- Video DMA
- Video Scalar

PolarFire IP Roadmap

- 10GBaseR PHY
- 10G NGPON
- 12G SDI
- Core1553BRM
- Core1553BRT
- Core1553BRT_APB
- CoreDivision
- CoreFPU
- CoreLNSQRT
- CoreQDR
- CoreQSPI
- CoreSDITX/ CoreSDIRX (HD/3G)
- CoreSDITX/ CoreSDIRX (SD/HD/3G)
- CoreUSXGMII
- Convolutional Encoder
- Crest Factor Reduction
- CSI-2 Tx
- CSI-2 Rx
- Image De-noising Filter
- DSI-Tx
- H.264
- H.265
- HD-SDI Tx/HD-SDI Rx (3G)
- HSR PRP
- Image Signal Processor
- MIPI CSI-2 Receiver Decoder
- MIPI CSI-2 Tx
- PCIe Root Port
- QSGMII
- Quad Rate Ethernet MAC
- SATA 3.0
- SRIO
- SLVS-EC Rx up to 8 lanes
- TSN
- Turbo Encoder/Decoder
- USB 3.1 gen2 + UVC Support
- VbyOne
- Viterbi Decoder

Microchip Technology Inc. | 2355 W. Chandler Blvd. | Chandler AZ, 85224-6199 | microchip.com

DS00002874D

MICROCHIP