PolarFire SoC
Different and Unique SoC Solution
CERN – 3rd SoC Workshop

A Leading Provider of Smart, Connected and Secure Embedded Control Solutions

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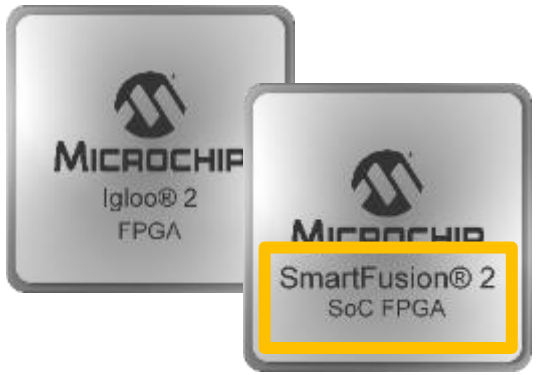
October, 2023

Broad Range FPGA Supplier

Smallest Packages
CPLD Replacements



More Resources
Low Density FPGAs

Cost Optimized
Mid-Range Density FPGAs

Quad Core RISC V
Real Time / Linux

Up to 50% Lower Power

Proven Security

SEU Immune FPGA Configuration

Instant-on and Non-volatile

Actel → Microsemi → MICROCHIP

Embedded Processors on MICROCHIP FPGA's

- PolarFire® is our 1st Mid-Range FPGA family
- PolarFire® SoC offers the 1st RISC-V core complex in the programmable market

Features	SmartFusion ProASIC3, IGLOO	SmartFusion2 IGLOO2	PolarFire	PolarFire SoC
Logic Elements	100 - 30K	5K - 150K	100K - 480K	25K - 450K
Transceiver Rate	--	1-5 Gbps	250 Mbps-12.7 Gbps	250 Mbps-12.7 Gbps
I/O Speeds	400 Mbps LVDS	667 Mbps DDR3 750 Mbps LVDS	1600 Mbps DDR4 1.6 Gbps LVDS	1600 Mbps DDR4 1.6 Gbps LVDS
DSP (18x18 Multipliers)	--	240	1480	1420
Max RAM	144 Kb	5 Mb	33 Mb	32 Mb
Processor Option	100 MHz ARM Cortex-M3	**Soft RISC-V** Secure MCU 166 MHz ARM Cortex-M3	**Soft RISC-V** Hard Crypto Co-Processor	**Soft RISC-V** **5x Hard RISC-V (1xE51 + 4xU54)** **Multicore System (625MHz)** Hard Crypto Co-Processor
On-board Flash	Up to 512 KB code store	Up To 512 KB code store	56 KB secure NVM	56 KB secure NVM 128KB BootFlash
Family Type	CPLD Replacements Smallest Packages	Low Density FPGAs with more resources & lowest power	Mid-Range Density FPGAs Lowest Power, Cost Optimized	Open, Lowest Power, Cost Optimized, Programmable SoC
	3rd Generation 130nm	*4th Generation 65nm*	←	*5th Generation 28nm* →

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PolarFire SoC: Main Differentiators

Industry's 1st RISC V based SoC FPGA

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Why RISC-V? What is it?

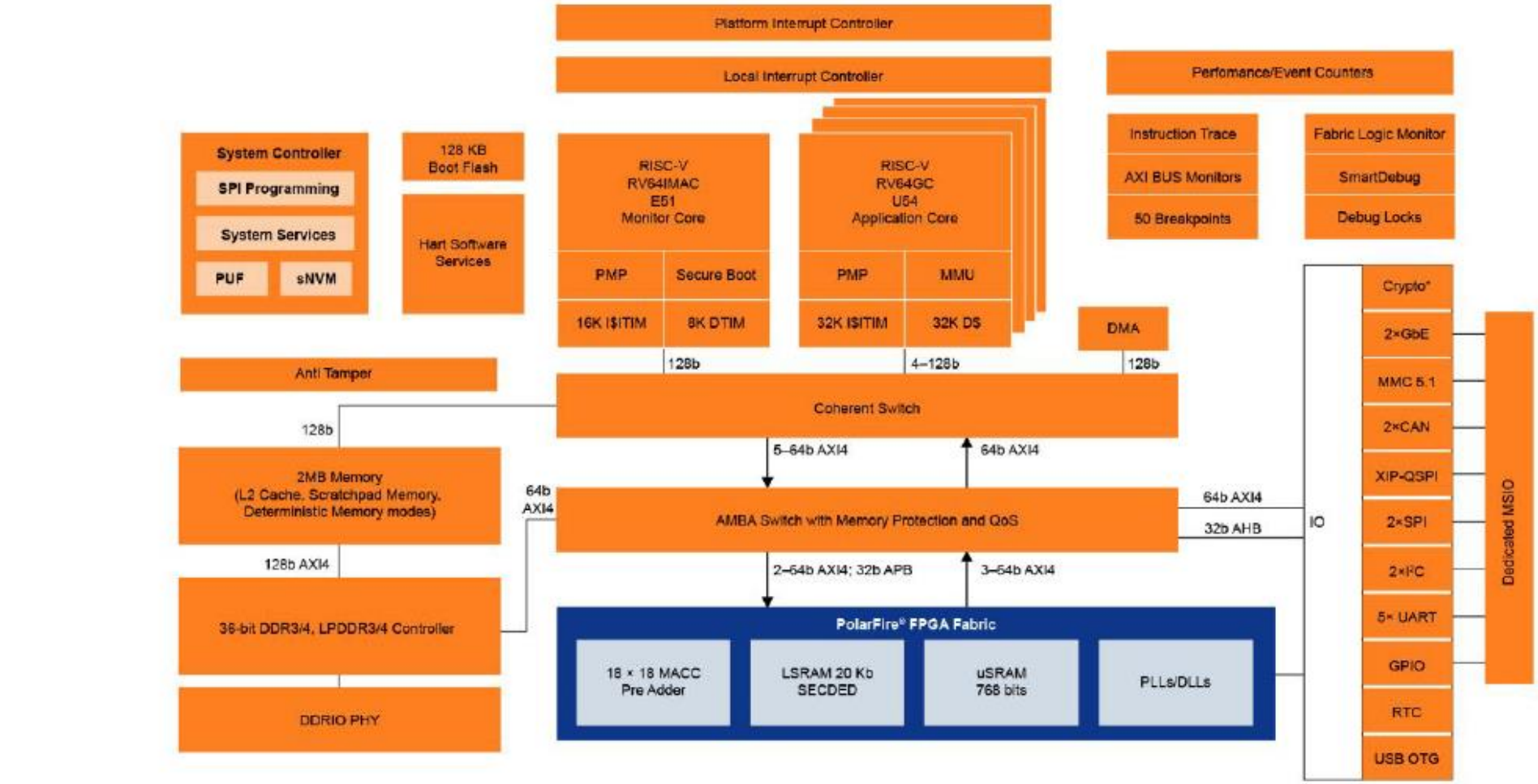
- **Initiative of UC Berkeley in 2010 to look at what ISAs to use for their next set of projects**
  - Avoid x86 and ARM solutions: both too complex, IP issues
  - Non-profit RISC-V Foundation created in 2015 to govern the ISA

- **ISA designed for**
  - **Simplicity** - < 50 instructions required to run Linux. Far smaller than other commercial ISAs
  - **Longevity** - Fixed ISA for long term code portability and easy migration to an ASIC (when using Soft RISC-V = Mi-V) without negotiating a license from ARM

- **Open Source ISA**
  - Allows for RTL inspection – Trust and Certifications
  - Strong industry support - > 60 Sponsor companies.

- **A modular ISA**
  - Small standard base ISA
  - Multiple standard extensions

PolarFire® SoC - RISC-V Innovation Platform



*DPA-Safe Crypto co-processor supported in S devices
**SECDED supported on all MSS memories

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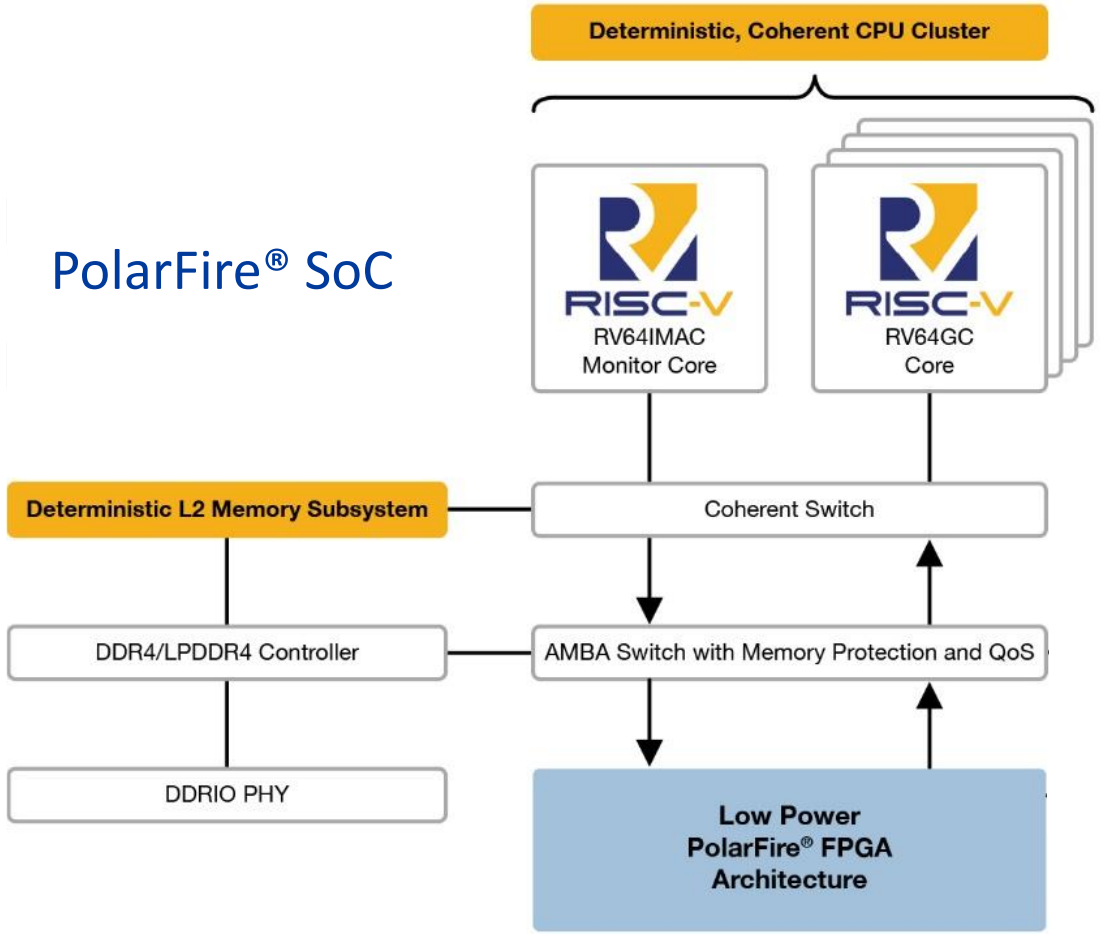
Enjoy Absolute Freedom to Innovate…

PolarFire® SoC



Asymmetric MultiProcessing (AMP) with 2X power efficiency

- Quad-core 64-bit RISC-V processors
- Linux® and real-time operating systems

Highly flexible 2MB L2 cache

With the most comprehensive RISC-V development ecosystem

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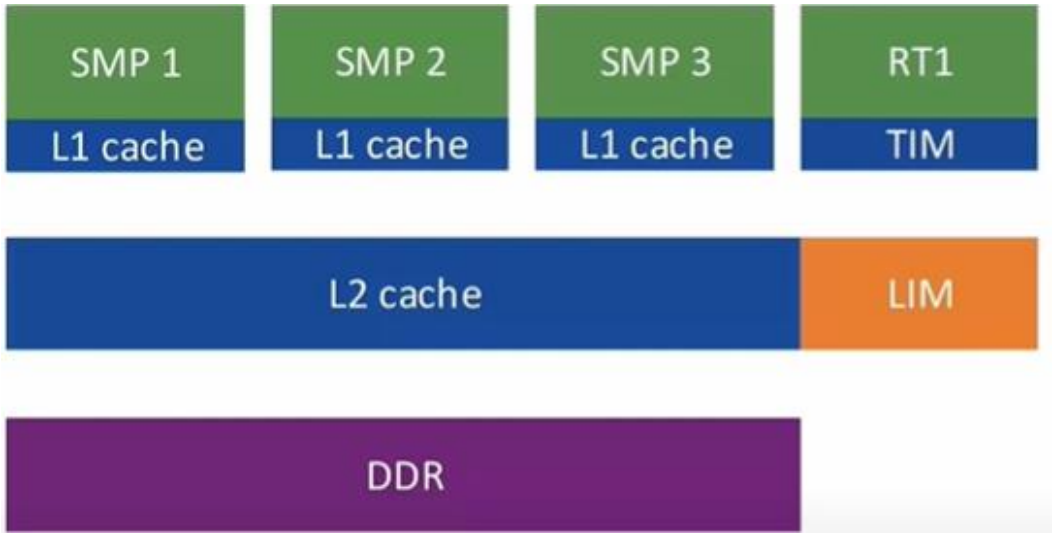
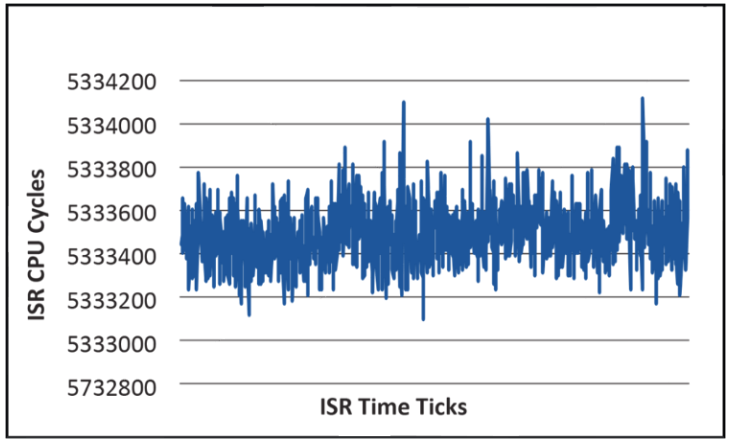
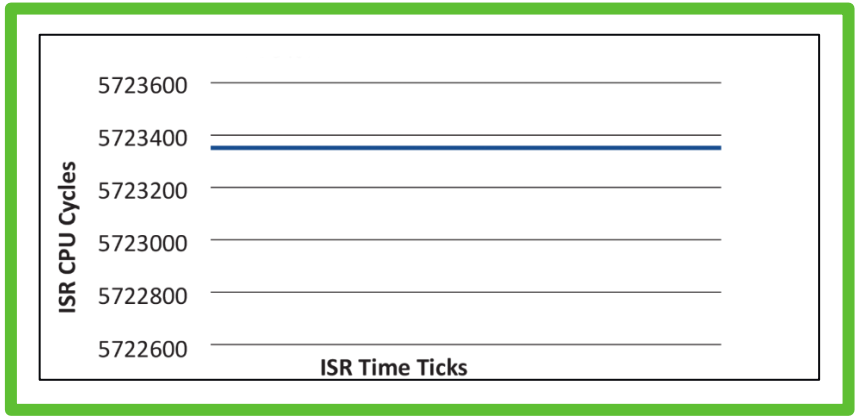
AMP is a Key Differentiator

Develop Deterministic Hard, Real-Time Systems

- **Deterministic real-time systems**
- **L2-Loosely Integrated Memory (LIM) with branch prediction turned off**
- **Unique to PolarFire® SoC**
  - Not offered by competition







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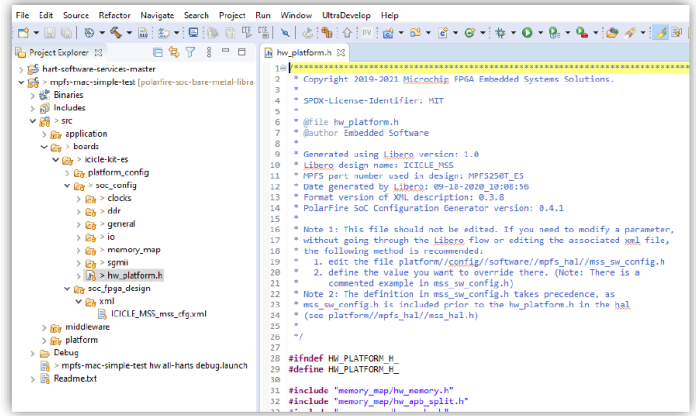
Development Flow and Tools



3rd Party IDEs

MSS "C" Configuration Data

SoftConsole

Memory Clients

sNVM, eNVM

Application Image (Linux, other)

MSS Configurator

Software IDE

Libero IDE

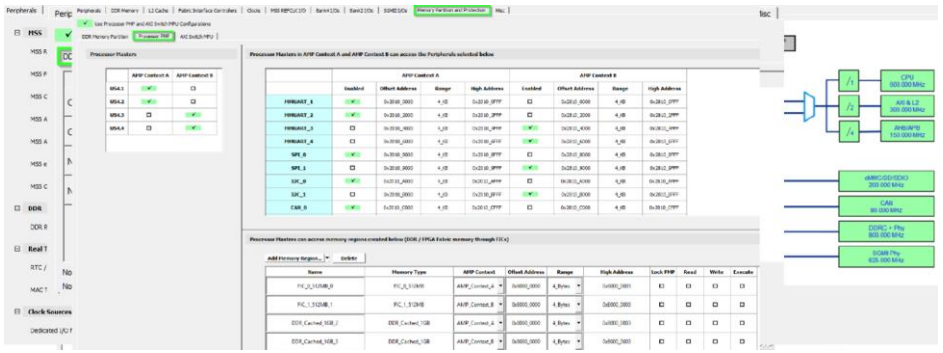
Libero® MSS Component

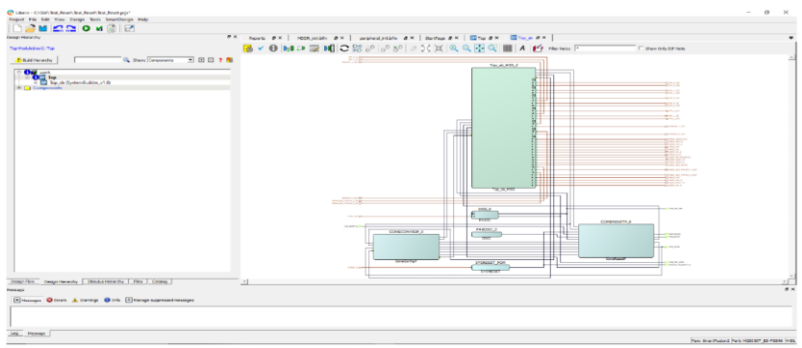
Compile

Bitstream Generation

SPI Flash Manager

SPI Flash Image





Separate flows for the embedded developer and the FPGA designer

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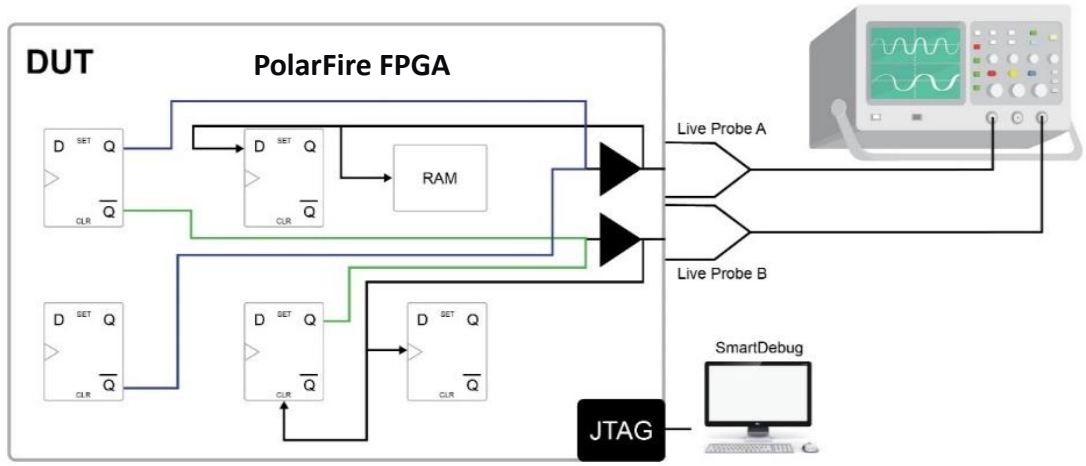
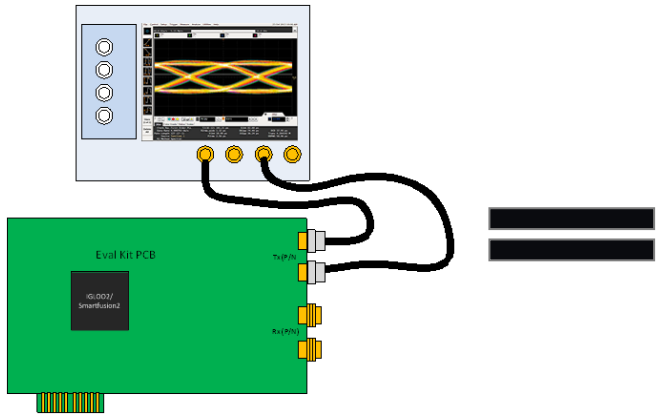
SmartDebug – Live Probes

Oscilloscope Inside Your FPGA

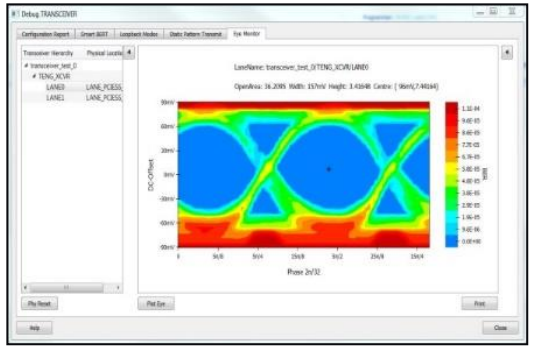
- Pick any 2 points inside the device and you can view them on an oscilloscope
- No recompiling required
- Slashes Debug Time



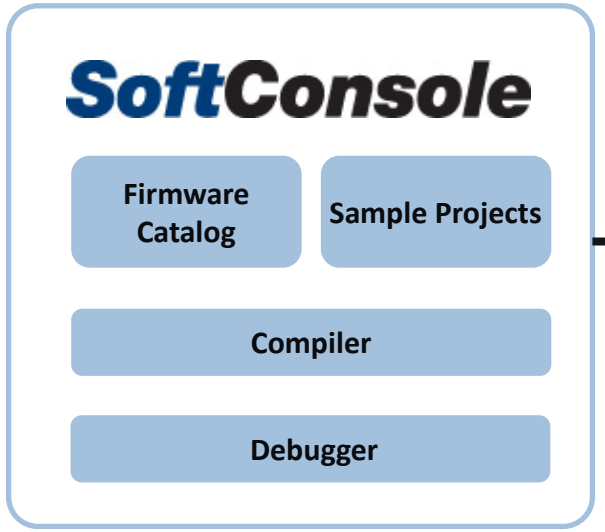
- Even SERDES Debug Available



SmartDebug Screen Shot



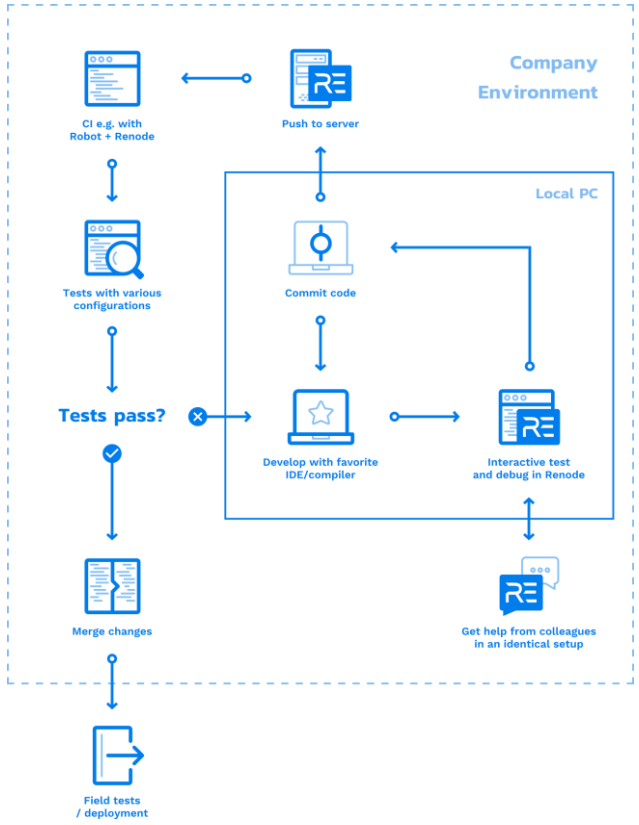
Renode Virtual development platform



GDB

RENODE™

Eclipse IDE Design Flow



- **Free Rapid Software Development and Debug Capabilities Without Hardware**
- **17 video tutorials on the web**
  - renode webinar series

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Mi-V Ecosystem Solutions

Mi-V
MICROCHIP
DESIGN PARTNER

IP / SoftCPU

Technolution
PQSecure
PQSHIELD
sandlogic
PRAESUM COMMUNICATIONS
logictronix
SiFive
ultraSoC
Microsemi
DirectCore

Development Tools

Libero System-on-Chip
SoftConsole
IAR SYSTEMS
Green Hills SOFTWARE
SIEMENS
SEGGER
LAUTERBACH DEVELOPMENT TOOLS
AdaCore Build software that matters.
ASHLING
MathWorks
MPSI

OS / RTOS

NuttX RTO
ubuntu
Embedded With RTEMS
RIOT
seL4 Security. Performance. Proof.
NUCLEUS
GNOME
amazon FreeRTOS
ROS
µ-velOSity
Microsoft Azure
FreeBSD
INTEGRITY
Zephyr

Mi-V

Hardware

aries embedded Intelligence for Industry
DIGITAL CORE TECHNOLOGIES QUALITY BY DESIGN
ALDEC THE DESIGN VERIFICATION COMPANY
ENCLUSTRA FPGA SOLUTIONS
CONCLUSIVE ENGINEERING
EmCraft systems
trenz electronic
SUNDANCE DSP INC
Linera
NUMATO LAB

Design Services

aries embedded Intelligence for Industry
antmicro
CONCLUSIVE ENGINEERING
DornerWorks
DIGITAL CORE TECHNOLOGIES QUALITY BY DESIGN
ENCLUSTRA FPGA SOLUTIONS
CodeChink
EMDALO TECHNOLOGIES Embedded Intelligent Systems
PRAESUM COMMUNICATIONS
trenz electronic
SUNDANCE DSP INC
OFFCODE
Linera
Dornerwerk
YOUR EMBEDDED DESIGN SERVICES PARTNER
NUMATO LAB

Middleware

antmicro
aicas
wolfSSL
Golioth
imperas
0x5 HEX-Five
DornerWorks
Veridify Security

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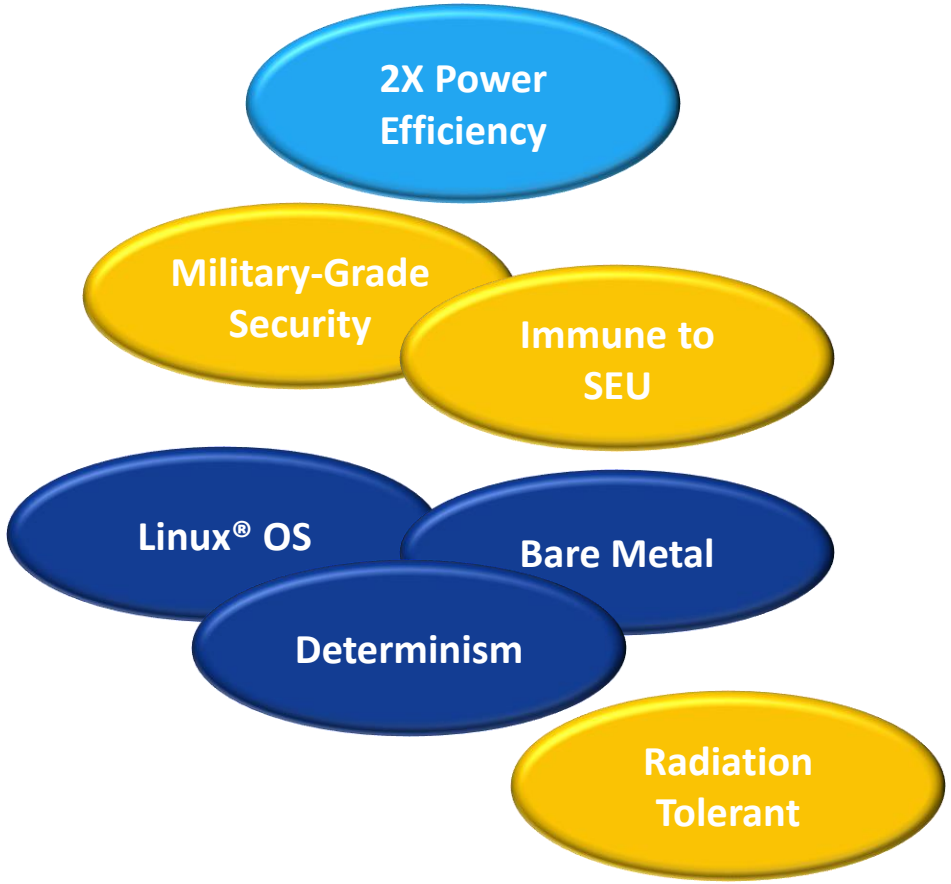
New Challenges at the 'Edge'

Top Five Demands of
The Intelligent Edge

- Thermal Constraints
- Minimal Power Budgets
- Safety and Security
- Zero Configuration Failures
- Real-Time & Flexible Response



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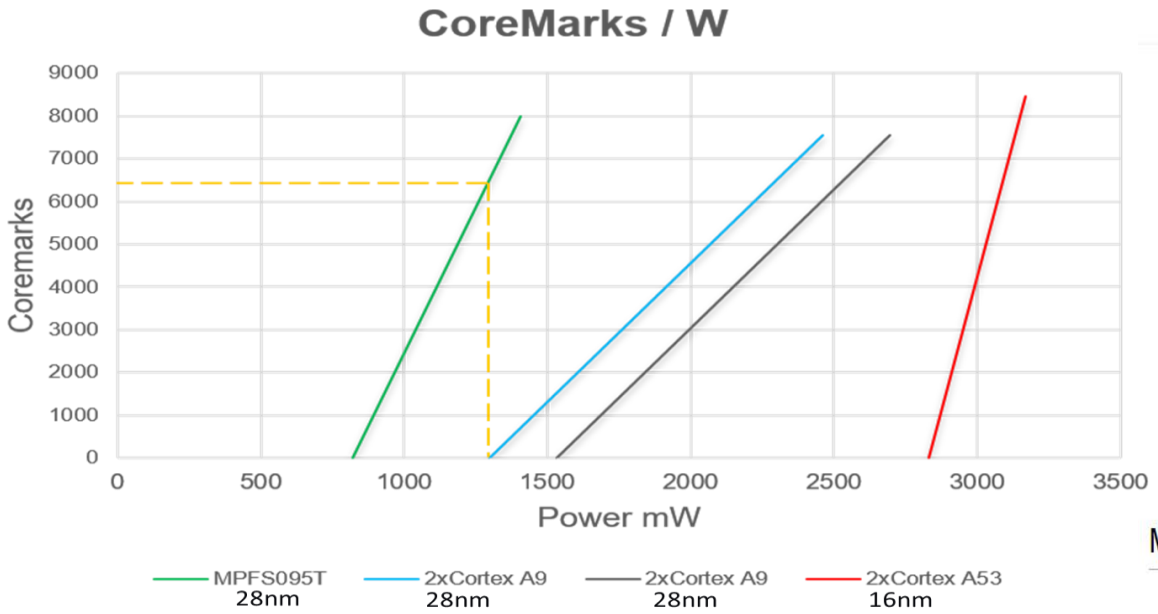
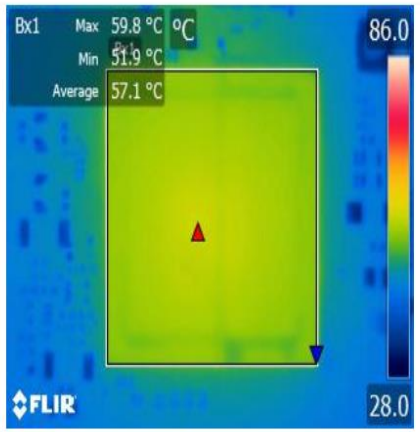
Power is Money: FPGAs With Exceptional Compute and Thermal Efficiency

6500 CoreMark score of processing *before competitor gets started*

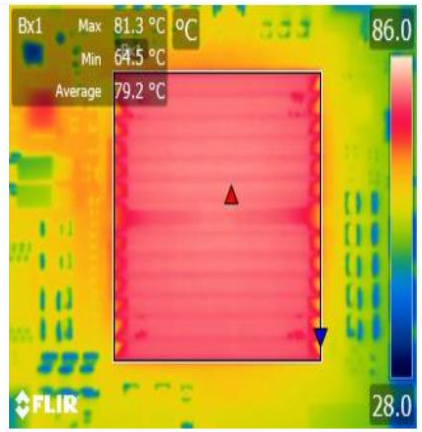


$1.5 / W to Remove Heat

Throw out heat sinks, fans, complex chassis



Microchip Polarfire FPGA 3.5W, 59.8°C, 24.2 FIT, 28nm



Competitor X FPGA 6.0W, 81.3°C, 96.3 FIT, 16nm

10°C rise in temp doubles the FIT

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Defense Grade Security, Ready for IoT

- **PolarFire SoC inherits best in class PolarFire FPGA Security**
  - DPA resistant bitstream programming
  - Anti-tamper
  - Cryptographical bound supply chain assurance
  - Physically Unclonable function
  - True random number generator
  - Side channel resistant crypto coprocessor

- **PolarFire SoC adds:**
  - + Standard secure boot and user defined Secure Boot
  - + Spectre and Meltdown immunity
  - + Physical Memory Protection
  - + SECDED on all memories MSS memories

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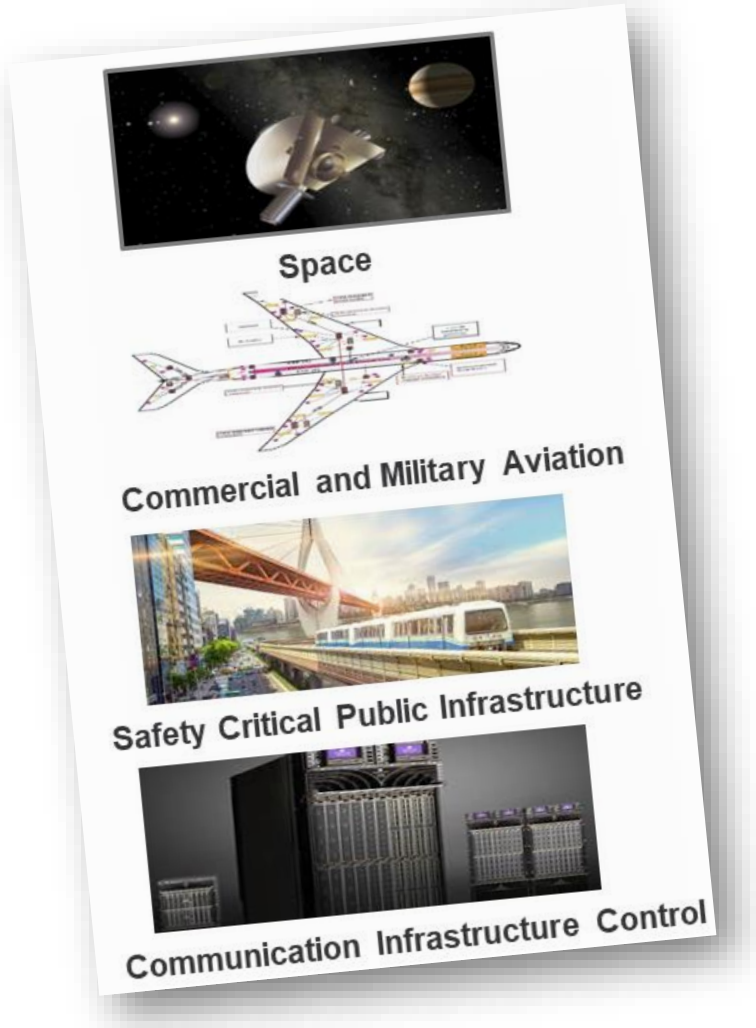
Endurance for Any Design

Microchip FPGAs have exceptional reliability



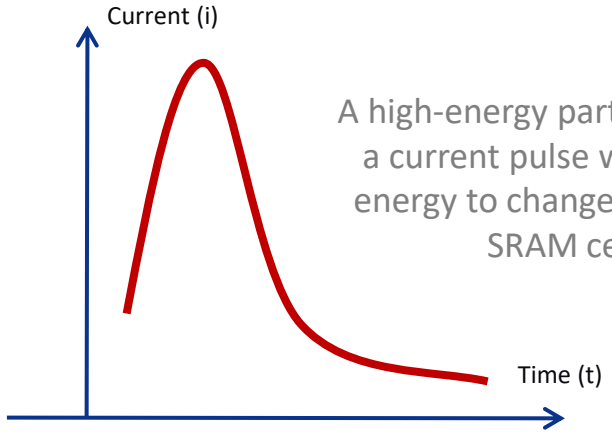
An FPGA fabric that's immune to SEU

- No scrubbing required/lowers design cost

MSS memories protected via built-in SECDED

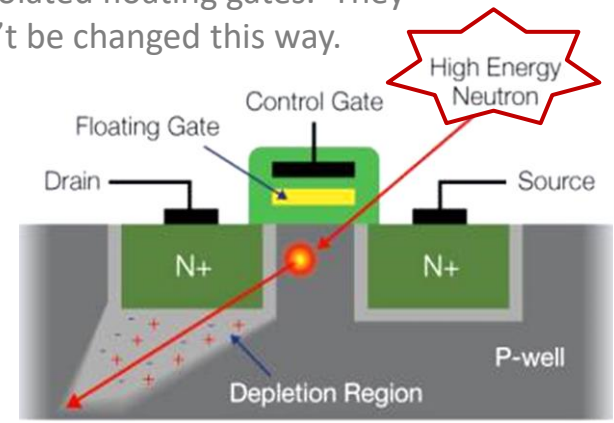
System Controller Suspend Mode

- For any safety-critical application



A high-energy particle can have a current pulse with enough energy to change the state of SRAM cells!

But Microchip FPGAs store charges in oxide-isolated floating gates. They can't be changed this way.



High Reliability Screening and Qualification

- **Supported qualification standards**
  - JEDEC
  - JEDEC+
    - ELFR 48hr Burn-In
      - V_{DD}+20% & Tj (140C) vs Datasheet specs
  - AECQ-100
  - Mil Std 883 Class B
  - PEMs qual on request
- **Gold bond wire options**

Commercial	Industrial	Automotive T2/T1	Mil Temp	Mil-Std 883 class B
Wafer Sort	Wafer Sort	Wafer Sort	Wafer Sort	Wafer Sort
Package Assembly	Package Assembly	Package Assembly	Package Assembly	Package Assembly
Final Test +25°C	Final Test +25°C	Burn-in (Dyn, Opt.)	Final Test +25°C	Internal Visual
	Sample Test +100°C	Final Test +25°C	Final Test -55°C	Temp. Cycling
		Final Test +125/135°C	Final Test +125°C	Const. Acceleration
				PIND
				Visual
				Electrical Test
				Dynamic Burn-in
				Final Test +25°C
				Final Test -55°C
				Final Test +125°C
				Seal
				Group A Lot Sample
				Group B Lot Sample
QC Mon. Sample	QC Mon. Sample	QC Mon. Sample	QC Mon. Sample	QC Mon. Sample

Microchip FPGAs Immunity to Config Failures

		Equivalent Functional Failure Rate - FIT Rates Per Device			
		Ground Level Applications		Aviation (Typical)	Aviation (Worst Case)
FPGA	**Technology**	**Sea level -NYC**	**5,000' - NYC**	**40,000' - NYC**	**50,000' - 80°N**
Microchip PolarFire® FPGA	**28 nm SONOS**	**No Failures Detected**			
Microchip SmartFusion® 2 FPGA M2S050	**65 nm Flash**	**No Failures Detected**			
Microchip Fusion® FPGA AFS1500	**130 nm Flash**	**No Failures Detected**			
Microchip ProASIC® 4 FPGA A3PE600	**130 nm Flash**	**No Failures Detected**			
Microchip ProASIC® Plus FPGA APA1000	**220 nm Flash**	**No Failures Detected**			
Microchip Accelerator® FPGA AX1000	**150 nm Antifuse**	**No Failures Detected**			
Competitor X 3M Gate FPGA	150 nm SRAM	**1,150**	**4,200**	**592k**	**1.1M**
Competitor X 1M Gate FPGA	90 nm SRAM	**320**	**1,200**	**165k**	**319k**
Competitor X 24k Logic Cell FPGA	45 nm SRAM	**1,180**	**4,300**	**608k**	**1.1M**
Competitor X 44k Logic Cell FPGA	45 nm SRAM	**2,170**	**7,900**	**1.1M**	**2.2M**
Competitor X 75k Logic Cell FPGA	40 nm SRAM	**2,527**	**9,200**	**1.3M**	**2.5M**
Competitor X 75k Logic Cell FPGA	28 nm SRAM	**2,481**	**9,100**	**1.3M**	**2.4M**
Competitor I 1M Gate FPGA	130 nm SRAM	**460**	**1,700**	**237k**	**458k**
Competitor I1M Gate FPGA	90 nm SRAM	**730**	**2,700**	**376k**	**727k**
Competitor I 2M Gate FPGA	65 nm SRAM	**1,600**	**5,800**	**824k**	**1.6M**
Competitor I 25k Logic Cell FPGA	65 nm SRAM	**580**	**2,100**	**299k**	**578k**
Competitor I 55k Logic Cell FPGA	65 nm SRAM	**1,500**	**5,500**	**773k**	**1.5M**
Competitor I 120k Logic Cell FPGA	65 nm SRAM	**2,900**	**10,600**	**1.5M**	**2.9M**
Competitor I 50k Logic Cell FPGA	60 nm SRAM	**2,200**	**8,000**	**1.1M**	**2.2M**

- *FIT = number of errors in 10^9 hours – Acceptable FIT rates for high-reliability applications are < 20*
- *Testing of Microchip FPGAs and competition at 90nm, 130nm, and 150nm performed by IROC Technologies*
- *Competitor X 45nm, 40nm, and 28nm based on reliability data, Competitor I 65nm and 60nm estimated at 100 Fit / Mbit*

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Dependable Longevity of Supply

January 26, 2022

Dear Valued Customer,

Thank you for your continued interest in Microchip/Microsemi FPGA products. The purpose of this letter is to address Microchip/Microsemi's FPGA product longevity. Below you will find a matrix of device families with data on when parts first shipped and an approximate timeframe that we expect to have wafer availability; please note that this is not a guarantee of availability.

Device Family Name	Microsemi Part Number Starts With…	Year First Shipped	Expected Availability from 2021
MX	A40MX, A42MX	1997	10 years
SX	A54SX	1999	5 years
SXA	A54SX_A	1999	10 years
AX	AX	2001	10 years
eX	eX	2001	10 years
ProAsic Plus	APA	2001	10 years
ProAsic 3	A3P, A3PN, A3PL	2005	10 years
Igloo	AGL, AGLN	2005	10 years
Igloo Plus	AGLP	2005	10 years
Fusion	AFS	2006	10 years
SmartFusion	A2F	2010	10 years
SmartFusion 2	M2S	2013	15 years
Igloo 2	M2GL	2013	15 years
PolarFire	MPF	2017	20 years
PolarFire Soc	MPFS	2021	20 years

Note: The expected supply continuity does not apply to EOL'ed products.

March 13, 2023

Dear Valued Customer,

Thank you for your continued interest in Microchip products. The purpose of this letter is to address Microchip FPGA product longevity. Below you will find a matrix of device families with data on when parts first shipped and an approximate timeframe that we expect to have wafer availability; please note that this is not a guarantee of availability.

Device Family Name	Microchip Part Number Starts With…	Year First Shipped	Expected Availability from 2023
MX	A40MX, A42MX	1997	10 years
SX	A54SX	1999	5 years
SXA	A54SX_A	1999	10 years
AX	AX	2001	10 years
eX	eX	2001	10 years
ProAsic Plus	APA	2001	10 years
ProAsic 3	A3P, A3PN, A3PL	2005	10 years
Igloo	AGL, AGLN	2005	10 years
Igloo Plus	AGLP	2005	10 years
Fusion	AFS	2006	10 years
SmartFusion	A2F	2010	10 years
SmartFusion 2	M2S	2013	15 years
Igloo 2	M2GL	2013	15 years
PolarFire	MPF	2017	20 years
PolarFire Soc	MPFS	2021	20 years
RTSX-SU	RTSXxxSU	2004	10 years
RTAX-S/SL	RTAXxxxS, RTAXxxxSL	2004	15 years
RTAX-DSP	RTAXxxxD, RTAXxxxDL	2011	15 years
RT ProASIC3	RT3P	2010	15years
RTG4	RT4G150	2015	15 years
RT PolarFire	RTPF	2022	20 years

Note: The expected supply continuity does not apply to EOL'ed products.

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PolarFire SoC Family

	Features	MPFS025T	MPFS095T	MPFS160T	MPFS250T	MPFS460T
FPGA Fabric	K Logic Elements (4LUT + DFF)	23	93	161	254	461
	Math Blocks (18x18 MACC)	68	292	498	784	1420
	LSRAM Blocks (20k bit)	84	308	520	812	1460
	uSRAM Blocks (64x12)	204	876	1494	2352	4260
	Total RAM Mbits	1.8	6.7	11.3	17.6	31.6
	uPROM Kbits	194	387	415	470	553
	User DLL's/PLL's	8 each	8 each	8 each	8 each	8 each
High Speed IO	250 Mbps to 12.5 Gbps SERDES Lanes	4	4	8	16	20
	PCIe Gen2 End Points/Root Ports	2	2	2	2	2
Total FPGA IO	HSIO+GPIO	108	276	312	372	468
Total MSS IO	MSS IO	136	136	136	136	136
MSS DDR DB	MSS DDR Data Bus	16 / 32	16 / 32	32	32	32
Packaging Commerical & Industrial RoHS	**Type/Size/Pitch**	**MSS IO / HSIO / GPIO / XCVRs**				
	FCSG325 (11x11, 11x14.5[+], 0.5 mm)	102 / 32 / 48 / 2	102 / 32 / 48 / 2			
	FCSG536 (16x16, 0.5 mm)		136 / 60 / 108 / 4	136 / 60 / 108 / 4	136 / 60 / 108 / 4	
	FCVG484 (19x19, 0.8 mm)	136 / 60 / 48 / 4	136 / 60 / 84 / 4	136 / 60 / 84 / 4	136 / 60 / 84 / 4	
	FCVG784 (23x23, 0.8 mm)		136 / 144 / 132 / 4	136 / 144 / 168 / 8	136 / 144 / 180 / 8	
	FCG1152 (35x35, 1.0 mm)				136 / 144 / 228 / 16	136 / 180 / 288 / 20

Extended Commercial (0ºC-100ºC) and Industrial (-40ºC-100ºC) Temperature Support for all Die Package Combinations - RoHS only

Additional Temp Grade: Military (-55ºC-125ºC) - Leaded packages only

[+] FCSG325 package dimension for MPFS095T: 11x14.5, 0.5mm)

MICROCHIP

PolarFire SoC

Full temperature range offering

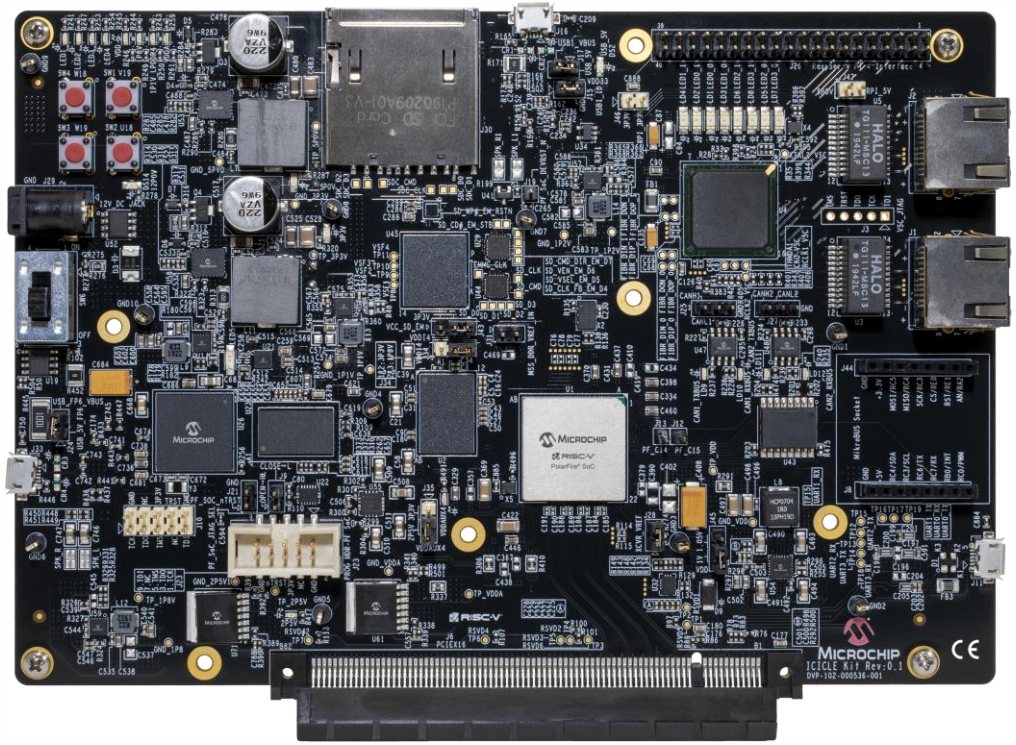
Features	MPFS025T	MPFS095T	MPFS160T	MPFS250T	MPFS460T
Extended Commercial / Industrial	MSS IO / HSIO / GPIO / XCVRs				
FCSG325[+] (11x11, 0.5 mm)	102 / 32 / 48 / 2	102 / 32 / 48 / 2			
FCSG536 (16x16, 0.5 mm)		136 / 60 / 84 / 4	136 / 60 / 108 / 4	136 / 60 / 108 / 4	
FCVG484 (19x19, 0.8 mm)	136 / 60 / 48 / 4	136 / 60 / 84 / 4	136 / 60 / 84 / 4	136 / 60 / 84 / 4	
FCVG784 (23x23, 0.8 mm)		136 / 144 / 132 / 4	136 / 144 / 168 / 8	136 / 144 / 180 / 8	
FCG1152 (35x35, 1.0 mm)				136 / 144 / 228 / 16	136 / 180 / 288 / 20
Military “S” devices only	MSS IO / HSIO / GPIO / XCVRs				
FCS25 (11x14.5, 0.5 mm)		102 / 32 / 48 / 2			
FCS36 (16x16, 0.5 mm)				136 / 60 / 108 / 4	
FCV484 (19x19, 0.8 mm)				136 / 60 / 84 / 4	
FCV784 (23x23, 0.8 mm)				136 / 144 / 180 / 8	
FC152 (35x35, 1.0 mm)				136 / 144 / 228 / 16	136 / 180 / 288 / 20
Automotive T2	MSS IO / HSIO / GPIO / XCVRs				
FCSG325[+] (11x11, 0.5 mm)	102 / 32 / 48 / 2	102 / 32 / 48 / 2			
FCSG536 (16x16, 0.5 mm)		136 / 60 / 84 / 4	136 / 60 / 108 / 4	136 / 60 / 108 / 4	
FCVG484 (19x19, 0.8 mm)	136 / 60 / 48 / 4	136 / 60 / 84 / 4	136 / 60 / 84 / 4	136 / 60 / 84 / 4	
FCVG784 (23x23, 0.8 mm)		136 / 144 / 132 / 4	136 / 144 / 168 / 8	136 / 144 / 180 / 8	
FCG1152 (35x35, 1.0 mm)					136 / 180 / 288 / 20

[+] FCSG325 package dimension for MPFS095T: 11x14.5, 0.5mm)

PolarFire SoC Resources

PolarFire SoC Icicle kit

Features and Collaterals



- **PolarFire SoC (MPFS250T-FCVG484EES)** with 1× RV64IMAC core and 4× RV64GC cores by SiFive, 4× 12.7 Gbps SERDES ad Secure boot
- **Memory and Storage**
  - 2 GB LPDDR4 × 32
  - 1 Gb SPI Flash
  - 8 GB eMMC Flash or SD card slot (multiplexed)
- **Interfaces**
  - 2× Gigabit Ethernet
  - Raspberry Pi-compatible 40-pin header
  - mikroBUS socket
  - PCIe® Gen 2, Micro USB 2.0 Hi-Speed OTG, 4× UART (via single micro USB), 2× CAN, SPI,I²C
- **Programming and Debugging**
  - UART via micro-USB
  - Onboard JTAG connector or embedded FlashPro6 (multiplexed)
  - 52× test points

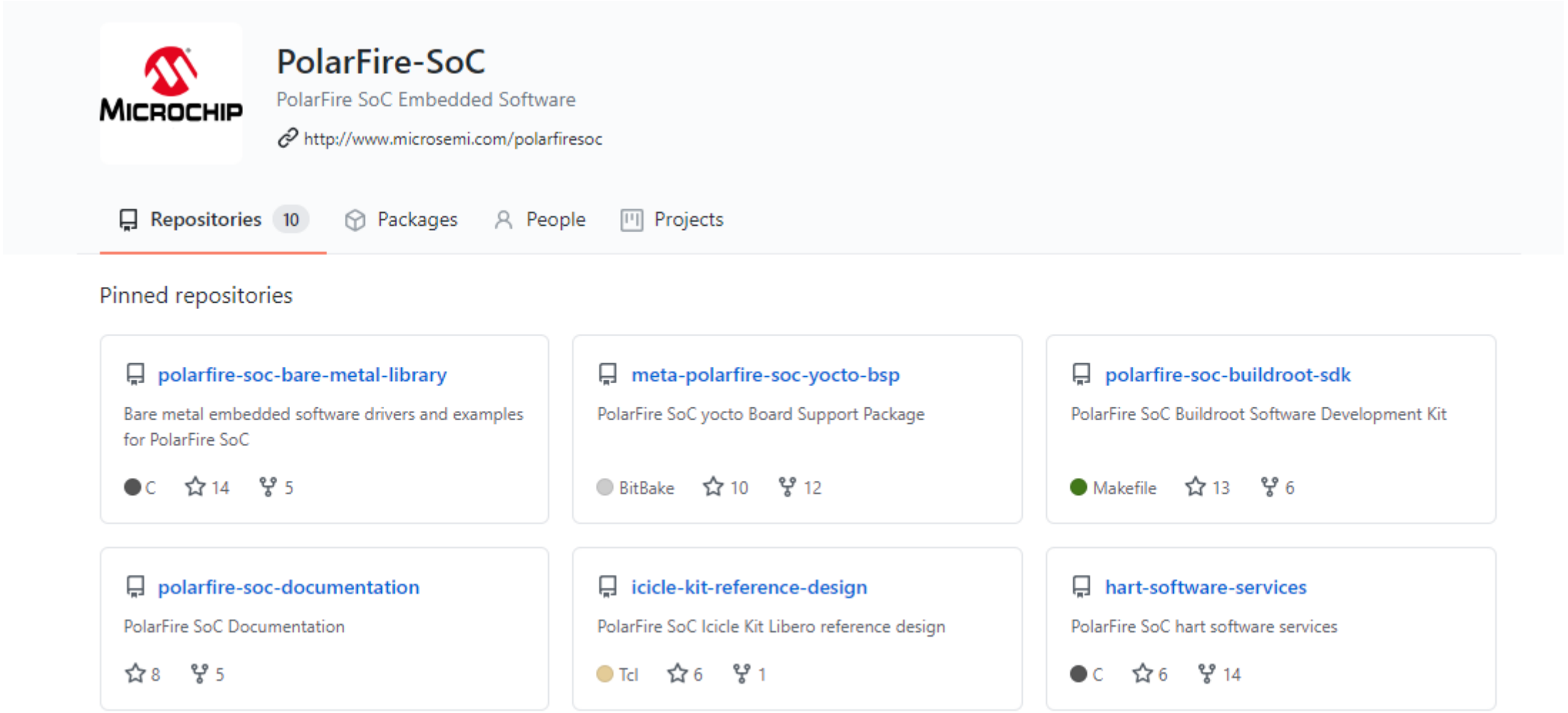
Reference designs and other collateral available here

Orderable Part Number	MPFS-ICICLE-KIT-ES
List Price	~590$

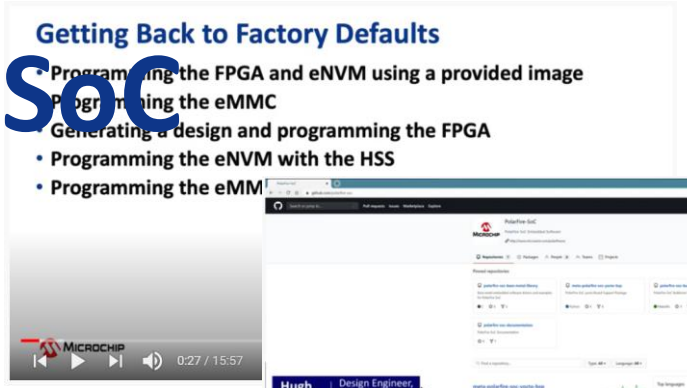
MICROCHIP

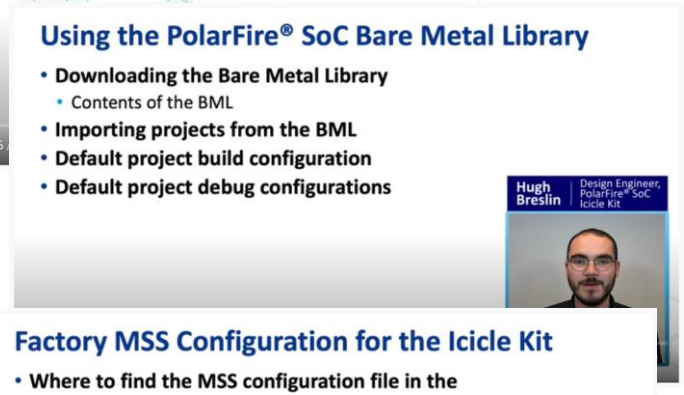
On Github

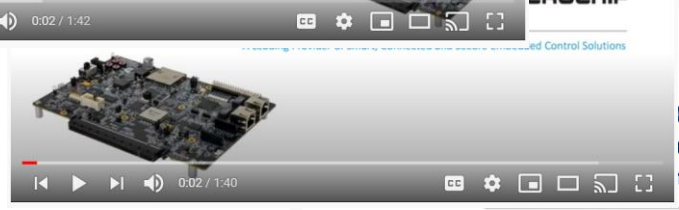
Search for PolarFire SoC Github

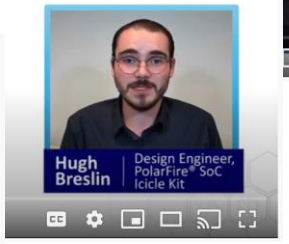


Get Started with PolarFire SoC









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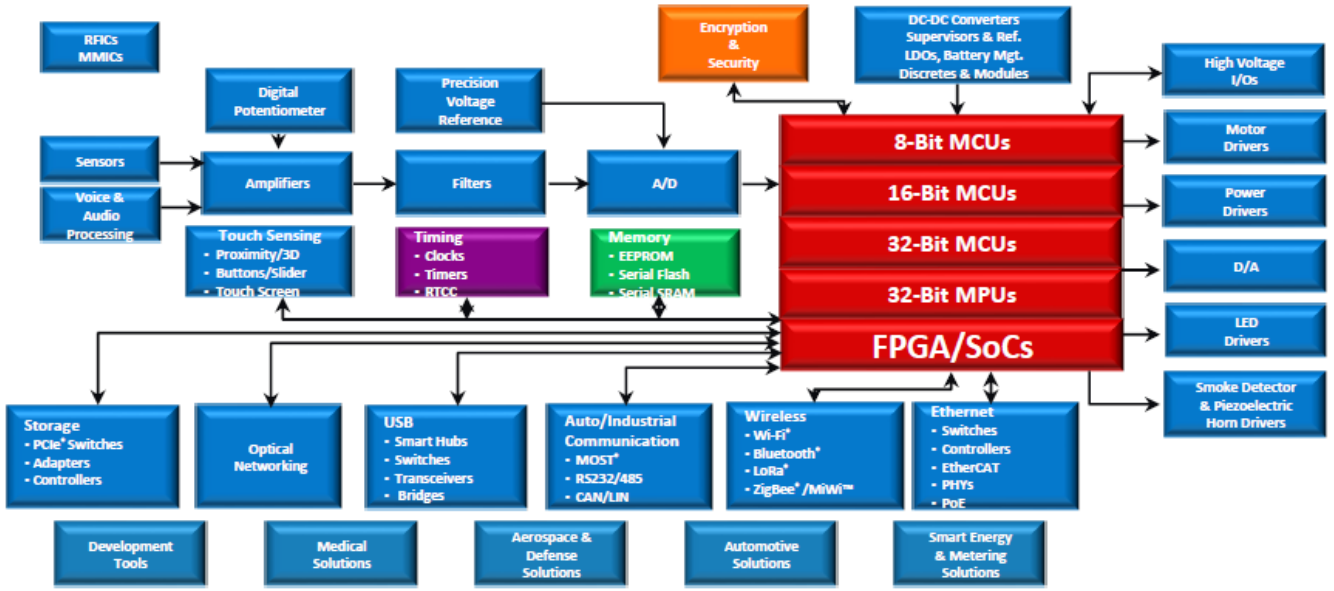
PolarFire® SoC Summary

- **Polarfire®SoC-Multiprocessing**
  - Linux and Real Time in a deterministic, coherent CPU cluster
  - AMBA extensions into FPGA fabric for seamless communication
  - Low Power
  - Defense grade security/secure boot
  - Exceptional reliability
  - Smallest form factors – 11x11
  - Getting Started
- **Longevity**
- **Microchip Total System Solutions**
- **Microchip University Virtual Classes:** www.microchip.com/mu



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Thank you