A Leading Provider of Microcontroller, Mixed-Signal, Analog & Flash-IP Solutions

Aerospace & Defense
ESCCON 2019
COTS to Rad Tolerant and Rad Hard solutions
• A&D BU in Europe

• Scalable ARM SoC

• Products Portfolio (A&D BU)
• A&D BU in Europe

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## Combined Portfolio Aerospace & Defense

### COMBINED CAPABILITIES

<table>
<thead>
<tr>
<th>MCUs</th>
<th>Analog</th>
<th>Mixed signal</th>
<th>Interface</th>
<th>Memory</th>
<th>Power mgmt.</th>
<th>Switches &amp; controllers</th>
<th>High-Rel Discrete</th>
<th>Enterprise storage</th>
<th>FPGA</th>
</tr>
</thead>
</table>

**Industry Breakdown:**
- Industrial: 27%
- Automotive: 17%
- Consumer: 16%
- Communication: 13%
- Computing: 12%
- A&D: 11%
- Enterprise storage: 8%
- FPGA: 6%

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Image credits:
- Industrial: Microchip Technology, Inc.
- Automotive: Microchip Technology, Inc.
- Consumer: Microchip Technology, Inc.
- Communication: Microchip Technology, Inc.
- Computing: Microchip Technology, Inc.
- A&D: Microchip Technology, Inc.
- Enterprise storage: Microchip Technology, Inc.
- FPGA: Microchip Technology, Inc.
**Combined Portfolio Aerospace & Defense**

**Combined Products Portfolio for Aerospace & Defense**
Total System Solution (TSS)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Industrial</td>
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*Combined Portfolio: Industrial 27%, Automotive 17%, Consumer 16%, Communication 13%, Computing 12%, A&D 11%*

**COMBINED CAPABILITIES**

*Aerospace & Defense Group*
Aerospace & Defense Product line (Microchip)

- Committed to High Reliability and Long Term Supply
  - Delivering Aerospace ICs for more than 30 years
  - Strong Flight Heritage in Space & Avionics applications
  - Leverage from Automotive solutions for “New Space” challenges: Volumes, Costs and Time To Market

- Major Products Focus
  - ASICs
  - Processors & Microcontrollers
  - Communication Interfaces and Memories

- Internal Qualified Supply Chain
  - DLA / ESCC : Wafer lot to Qualified parts (France)
  - DLA : Assembly line (Thailand)

- Long term cooperation with European agencies:
  - ESA, CNES, DGA, DLR....
A&D Product Line
>80 people to support
New Product Development

A&D BU in Europe

A&D Product Line
HC = 47
Product Engineering
Supply Chain
Tests

HC = 31
Technology Hardening
Radiations Testing
Hirel Design

Product, Test Engr
Operations

Quality

HC = 3

Product Marketing

Application Lab

Aerospace & Defense Group

Product Development

HC = 47

HC = 31

Nantes
Rousset
Supporting Total System Solutions

Microcontrollers, Microprocessors & ASICs / FPGAs

- Power
- Encryption & Security
- DC-DC Converters
- Supervisors
- LDOs
- PoE

- Motor Drivers
- Power Drivers
- D/A
- LED Drivers
- Smoke Detector
- & Piezoelectric
- Horn Drivers

- Sensors
- Amplifiers
- Filters
- A/D

- Digital Potentiometer
- Precision Voltage Reference
- Timing
- • Clocks
- • Timers
- • RTCC
- Memory
- • EEPROM
- • Serial Flash
- • Serial SRAM

- Sensing
- • Proximity/3D
- • Buttons/Slider
- • Touch Screen
- USB
- • Smart Hubs
- • Switches
- • Transceivers
- • Bridges
- Auto/Industrial Communication
- • MOST
- • RS232/485
- • CAN/LIN

- Wireless
- • Wi-Fi®
- • Bluetooth®
- • LoRa®
- • ZigBee®/MiWi™

- Ethernet
- • Switches
- • Controllers
- • EtherCAT
- • PHYs

Long product life times – customer driven obsolescence
• A&D BU in Europe

• Scalable ARM SoC

• Products Portfolio (A&D BU)
## Use of COTS in Space

### Advantages
- Easy access and costs effective (volume)
- AECQ100 Automotive qualified parts
- Reliability linked to high volumes & high nb of users
- Wide access to State of art technologies & architectures
- Access to free ecosystem and benefit from community

### Drawbacks
- No traceability, No SLDC, High silicon lots discrepancy
- Limited access to qualification & supply chain datas
  => PPAP only for “specific” auto customers / volumes
- Products turnover, versioning & obsolescence (EOL)
- Weak or Unknown radiations performances. Not always lucky.
- Product knowledge & costs for radiations testing/screening
- No FM support from silicon provider, no guarantee & RMA
Scalable Solutions for Aerospace

Qualification level:
- QMLV/ESCC
- QMLY/ESCC
- QMLQ
- QMLN
- AQEC
- AECQ100

Other Aerospace applications

Temperature performances:
- -55 to 125°C

Radiations performances:
- TID >100 Krad

Latch Up Immune

Rad Tolerant

Rad Hard by Design

Space applications

Extended Temp

Auto COTS

ET

RT
COTS to Rad Tolerant devices

- **Start from Industrial/Automotive products**
  - Same mask set
  - Same functionality
  - Same development tools
  - Easy access via commercial eval kit
  - Free tool chain & libraries
  - Same pin out as commercial device

- **Hardening of critical parameters**
  - Technology process change / tuning
    - Target no **single event latch-up up to 62 MeV/mg/cm² @ 125°C**
  - Embedded Flash & SRAM robustness, **SEFI LET > 30Mev**
  - SEU Full characterization, blocks by blocks
  - TiD between **20 to 50KRad** (Space)

- **Scalable solution, 2 proposed Quality Flows**
  - **Space Grade Ceramic**: SV / MQ qualification & screening, QML equivalent
  - **Hirel Plastic**: Temp screening, Auto / AQEC like qualification, Full lot traceability
RHBD and RT devices – quality levels

(*) compliance = Qualification testing, screening testing, and TCI/QCI inspections meet MIL-PRF 38535 or ESCC9000 requirements
ARM Cortex-M7 Architecture

Designed for Safety and Powerful real time applications

Embedded in **SAMV71** High End Automotive SoC
SAMV71 Scalable Unique Solution

Qualification level

QMLV/ESCC
QMLY/ESCC
QMLQ
QMLN
AQEC
AECQ100

Other Aerospace applications

Auto COTS

ARM Cortex M7 SoC

Hirel & RT

SAMV71Q21RT
600DMIPS
Rad Tolerant
Latch Up Immune

SAMRH71
>200DMIPS
Rad Hard
TID >100Krad

Space applications

Radiations performances

1553 SpaceWire

Microchip

Microchip Technology Inc.

Microchip Technology

Microchip Technology

Microchip Technology

Microchip Technology

Microchip Technology
**Targeted application:** Geostationary orbit application

**Customer Algorithms used:**
- Algo 1: Basic correlation algorithm on a small pixel matrix 21x21
- Algo 2: Advanced correlation algorithm on a large pixel matrix 512x128

<table>
<thead>
<tr>
<th>Execution time of customer algorithms running @ 48 MHz</th>
<th>Algo 1</th>
<th>Algo 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEON3-FT (UT699)</td>
<td>4,3 ms</td>
<td>2600 ms</td>
</tr>
<tr>
<td>Cortex-M7 (SAMRH71)</td>
<td>1,4 ms</td>
<td>548 ms</td>
</tr>
</tbody>
</table>

**SAMRH71 is 3 to 5 time more performant**
ARM Cortex M7 SoC
Benefits from same HW/SW ecosystem

Xplained board
Ordering Code: ATSAMV71-XULT

Ready to SW use example projects
- demo with detailed documentation
- samv71_softpack_1.5_for_astudio
- exist for other software environment (IAR, EWARM, KEIL, XULT GNU)

Atmel SAM-ICE Emulator
Ordering Code: AT91SAM-ICE

Already ported OS for M7 SoC (V71)

Atmel ICE programmer and debugger
Ordering code P/N: ATATMEL-ICE

On going BSP projects: RTEMS, Xstratum
● A&D BU in Europe

● Scalable ARM SoC

● Products Portfolio (A&D BU)
## COTS Rad Tolerant MCU/MPUs

### Radiation Tolerant & Extended Temperature

<table>
<thead>
<tr>
<th>Products</th>
<th>Type</th>
<th>ET/RT</th>
<th>Summary / Highlights</th>
<th>Flight Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATmega128</td>
<td>AVR8</td>
<td>ET/RT</td>
<td>&lt;20DMIPS, SPI, TWI, UART, ADC</td>
<td>Available</td>
</tr>
<tr>
<td>ATmega64M1</td>
<td>AVR8</td>
<td>ET/RT</td>
<td>&lt;20DMIPS, CAN, DAC &amp; Motor Control</td>
<td>Available</td>
</tr>
<tr>
<td>SAMV71Q21</td>
<td>ARM32 M7</td>
<td>ET/RT</td>
<td>600DMIPS, CAN FD, Ethernet TSN, DSP</td>
<td>Available</td>
</tr>
<tr>
<td>SAM3X8E</td>
<td>ARM32 M3</td>
<td>RT</td>
<td>100DMIPS, CAN, Ethernet, Dual Ban</td>
<td>Q2 2019 (Apr19)</td>
</tr>
<tr>
<td>dsPIC33CH128MP</td>
<td>MCU16</td>
<td>ET/RT</td>
<td>16Bit DSC w High-Resolution PWM &amp; CAN FD</td>
<td>H2 2019</td>
</tr>
<tr>
<td>SAMA5D2</td>
<td>ARM32 A5</td>
<td>ET/RT</td>
<td>850DMIPS, Gbit Ethernet TSN, DDR3, MMU</td>
<td>H1 2020</td>
</tr>
<tr>
<td>SAMCA2</td>
<td>ARM32 M0+</td>
<td>ET/RT</td>
<td>45DMIPS, ECC Flash &amp; SRAM, 150°C</td>
<td>H2 2020</td>
</tr>
</tbody>
</table>

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**ATmegaS128**

Flight early 2018
ESA GOMX-4B
Hirel companions
Candidates for ET/RT

- Digital Pot.
- Precision Voltage Reference
- Amplifiers
- ADC
- Wireless
- High-Voltage I/Os
- Touch Controllers
- Sensors
- Temperature
- Current
- Precision
- General Purpose
- Low Power
- Instrumentation
- Pipelined Delta-Sigma SAR
- Wi-Fi
- Bluetooth
- LoRa
- MIWiFi Protocol
- ZigBee
- Microprocessors (MPU)*
- Power Management
- DC/DC Converters
- AC/DC Converters
- Battery Management
- CAN FD/Ethernet AVB
- FPGA
- ASIC
- Microprocessors (MPU)*
- Microcontrollers (MCU), Digital Signal Controllers (DSC)*
- (Microchip products outside the MCU can also be easily paired with an ASIC or FPGA)
- LDO 3Amp Digital Power
- serial & //
- 16 to 64Mbit Serial & //
- Serial EEPROM
- Serial SRAM
- Serial NVRAM
- PHYs
- CAN
- USB
- Ethernet
- Transceivers
- RS232/485
- CAN/LIN
- USB
- Ethernet
- Timing
- Clocks
- Crystals (MEMS & Quartz)
- Encryption
- (KeaLoc* Speech
- Co-Processing
- Smoke Detector
- ICs
- Plezoelectric Horn Drivers
- MOSFET Drivers
- MOSFETs
- DAC
- LCD Drivers
- LED Drivers

*In addition to its broad portfolio of specialized discrete ICs, Microchip offers microcontroller and digital signal controller devices with a wide array of integrated peripheral options.
ASIC System Solution
With Mixed Signal Capabilities

- MCHP proprietary 0,15 µm SOI technology initially developed for Automotive circuit design purpose

- Enhancement to achieve Space requirements (ATMX150RHA)
  
  **Radiation hardened standard cell libraries for Space**

  **Proven Technology**
  
  Radiation Hardened SEL immune, TID>100 Krad (Si tested)
  Extended temperature range -55°C to +125°C
  Reliability Life Time 20 years

- **Digital, Analog and Mixed** signal circuit development
  - Digital up to 22 usable Mgates equivalent NAND2
  - 5V compatibility
  - A set of qualified Analog IP: PLL, Voltage regulator, Voltage reference, Clock synthesizer, Signal conditioning

- Dedicated local design and development team (Assy, PE/TE)

- Fast and low cost prototyping with quarterly MPW
Sub-QML: Bridging the Gap Between QML and COTS

Sub-QML: Bridging the Gap Between QML and COTS

Sub-QML Hermetic Pkg
Radiation Hardened
By Design

Sub-QML Plastic Pkg
Radiation Hardened
By Design

QML Class Q
Radiation Hardened
By Design

QML Class V
Radiation Hardened
By Design

Commercial Off The Shelf

Component Cost

- Flight Heritage / Baselined
- Radiation Support
- Traceability and Homogeneity
- Lower Cost than QML Components

Qualification
Rad Characterization
Traceability
Lot Homogeneity

Component Cost
## Microchip Quality levels – All Possible

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Microsemi MCHP</th>
<th>Package</th>
<th>Temperature range</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSS, NASA Class1</td>
<td>QML-V / EV QMLV/SV ESCC QML</td>
<td>Hermetic Ceramic</td>
<td>-55°C – 125°C</td>
<td>MIL-PRF-38535</td>
</tr>
<tr>
<td>Entry Level Trad. Space</td>
<td>QML-Q / EQ QMLQ/MQ</td>
<td>Hermetic Ceramic</td>
<td>-55°C – 125°C</td>
<td>MIL-PRF-38535</td>
</tr>
<tr>
<td>Engineering samples</td>
<td>ES -E</td>
<td>Ceramic (Hermeticity not Guaranteed)</td>
<td>-55°C – 125°C (majority)</td>
<td>Internal spec</td>
</tr>
<tr>
<td>Hermetic devices for New Space</td>
<td>R or M -HC</td>
<td>Hermetic Ceramic</td>
<td>-55°C – 125°C</td>
<td>MIL-STD-883 Class B</td>
</tr>
<tr>
<td>Plastic devices for new space</td>
<td>-SN</td>
<td>Plastic</td>
<td>-55°C – 125°C (majority)</td>
<td>MIL-STD-883 class N</td>
</tr>
<tr>
<td>Plastic devices for new space</td>
<td>M or I HP</td>
<td>Plastic</td>
<td>-55°C – 125°C (majority)</td>
<td>JEDEC’s AEC-Q’s</td>
</tr>
</tbody>
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