Space Rad-Hard Integrated Circuits
Customized and Standard Products
For over 20 years, Atmel® has been a leading supplier providing highly integrated solutions to the Aerospace Industry. Thanks to its dual-use strategy, Atmel gives customers access to the latest commercial technology innovations by adapting them to rad-hard application requirements. Atmel’s offering is one of the most attractive and competitive on the market. It includes:

- From 0.18µm to 90 nm CMOS processes
- 100 MIPS RISC rad-hard microprocessors
- 4-Mbit SRAM and EEPROM
- Memory modules
- SEU hardened re-programmable FPGA

Atmel is paving the way to full-system integration and System On Chip, thanks to advanced products and dedicated packaging supporting stacked dies or module techniques with QML certified lines and world-class quality level. The complexity of future systems solutions requires partnership with key market contributors: government agencies and aerospace equipment manufacturers. This allows Atmel to validate products/services in actual system environments. Atmel is committed for the long term to support the aerospace industry.

Company Experience
Long Term Commitment to the Aerospace

Quality Management

Atmel’s ultimate goal is to reach full customer satisfaction through a continuous improvement of its products and services. To achieve this objective, Atmel has developed a Corporate Quality Management System including:

- A worldwide Quality Organization, with dedicated resources for Space offering.
- A robust Corporate Quality System that, beyond the traditional ISO9001-V2000 registrations, complies either with MIL-PRF-38535 or ESCC-QML. Atmel facilities are fully QML qualified by the U.S. DSCC (Defense Supply Center Colombus) and the European Space Agency (ESA), covering a wide range of technologies including most advanced silicon and high pin-count assembly techniques. This system is periodically ranked by the most demanding Aerospace customers, as well as prestigious national and international space agencies, such as ESA, CNES (Centre National d’Etudes Spatiales) and NASA (National Aeronautics and Space Administration).
  - Our 0.35µm ASIC is the first ever ESCC-QML qualified process for space.
  - A policy of systematic Continuous Improvement, supported by state-of-the-art approaches, techniques and methodologies (self-assessment against Business Excellence models, “Six Sigma”, Hoshin, etc.)
  - Periodic reporting and review of actual performance by the top management.
  - The customer satisfaction is regularly measured thanks to periodic business reviews, score cards and customer surveys.
Over the last 15 years, Atmel has been steadily building a consistent space microprocessor strategy based on the SPARC® architecture. The single-chip Sparc V8 processor—the AT697—is the latest release developed with ESA support to serve the increasing demand for on-board processing.

The AT697E processor implements the LEON2 FT (Fault Tolerant) VHDL model owned by ESA. It includes a SPARC V8 Integer Unit, a Floating Point Unit, separate instruction and data caches, a PCI interface and a flexible memory controller that can interface with SRAM, PROM and SDRAM. It delivers 86 MIPs and 23 MFlops at 100 MHz. The ratio between performance and power consumption reaches a value as high as 150 MIPs/W.

The design and the implementation of a new version of the AT697, the AT697F, is on-going. This new version will correct some AT697E limitations and will have a few extended functionalities.

Based on the SPARC V7 architecture, the well proven TSC695F microprocessor is used in flight on most European missions, including scientific and telecommunication satellites, as well as moon or deep space probes.

<table>
<thead>
<tr>
<th>Description</th>
<th>TSC695F</th>
<th>TSC695FL</th>
<th>AT697E</th>
<th>AT697F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
<td>20 MIPs/5 MFlops (double precision) @ SYSCLK = 25 MHz</td>
<td>12 MIPs/5 MFlops (double precision) @ SYSCLK = 15 MHz</td>
<td>&gt; 85 MIPs @ SYSCLK = 100 MHz</td>
<td>&gt; 85 MIPs @ SYSCLK = 100 MHz</td>
</tr>
<tr>
<td><strong>Consumption</strong></td>
<td>1.5W typ.@20 MPs 0.7W typ.@8 MP s</td>
<td>0.3W typ.@12 MP s</td>
<td>0.7W typ.@85 MP s</td>
<td>0.7W typ.@85 MP s</td>
</tr>
<tr>
<td><strong>Operation Voltage</strong></td>
<td>4.5V to 5.5V</td>
<td>3.15V to 3.4V</td>
<td>1.65V to 1.95V (Logic) 3V to 3.6V (Buffers)</td>
<td>1.65V to 1.95V (Logic) 3V to 3.6V (Buffers)</td>
</tr>
<tr>
<td><strong>TID; Latch up</strong></td>
<td>&gt;300 Krad; 70 MeV/mg/cm²</td>
<td>&gt;300 Krad; 70 MeV/mg/cm²</td>
<td>&gt;200 Krad; 90 MeV/mg/cm²</td>
<td>&gt;300 Krad; 90 MeV/mg/cm²</td>
</tr>
<tr>
<td><strong>Availability</strong></td>
<td>Now; ESCC &amp; QMLV</td>
<td>Now; ESCC &amp; QMLV</td>
<td>Now; QMLQ</td>
<td>Now; ESCC &amp; QMLV</td>
</tr>
</tbody>
</table>

**AT697E Evaluation Board & Development Kit**

To help designers developing their application, Atmel offers an evaluation board including:

- Demo-board with a AT697F engineering sample
- On-board Atmel rad-hard 4-Mbit SRAM (40 Mbits)

When delivered with the GRMON debug monitor, the evaluation board can be used as a development kit.
**Rad-Hard DSP for Space**

For years, Atmel has been the only company to offer a DSP for space applications. Atmel’s 32-bit floating point DSP TSC21020F is pin and code compatible with the ADI Product ADSP-21020, allowing for cost effective and straightforward system development by using existing development tools and application algorithm. It features 32-bit single-precision and 40-bit extended precision IEEE® floating-point data formats, and 32-bit fixed-point formats, integer and fractional, with 80-bit accumulators. Not for new designs.

**Hotline** 21020-applab.hotline@nto.atmel.com

**8032E Microcontrollers**

Atmel works with some of its key customers to make their ASIC designs available as standard ASICs when they correspond to commonly used functions on the market.

With this approach, Atmel offers space customers a set of SpaceWire dedicated products allowing to build a complete SpaceWire network-based on rad-hard devices. These products include SpaceWire links High Speed Controllers (SMCS), a SpaceWire Router and a SpaceWire Remote Terminal Controller.

**Communication ICs**

Atmel also offers a CAN controller and the SCTMTC chip which provides on board telemetry and telecommand services via standardized interfaces.

![SMCS332SpW device](SMCS332SpWdevice.png)

![SMCS116SpW device](SMCS116SpWdevice.png)

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>29C516E</td>
<td>16-bit Flow through EDAC Error Detection And Correction unit</td>
<td>Now</td>
</tr>
<tr>
<td>TSS901E</td>
<td>Triple Point-to-Point IEEE 1355 High Speed Controller (SMCS332)</td>
<td>Now</td>
</tr>
<tr>
<td>AT7906E</td>
<td>Single point-to-Point IEEE 1355 High Speed Controller (SMCS116)</td>
<td>Now</td>
</tr>
<tr>
<td>AT7908E</td>
<td>CAN Controller</td>
<td>Now</td>
</tr>
<tr>
<td>AT7909E</td>
<td>Single Chip TeleMetry and TeleCommand (SCTMTC)</td>
<td>Now</td>
</tr>
<tr>
<td>AT7910E</td>
<td>SpaceWire Router</td>
<td>2H 2009</td>
</tr>
<tr>
<td>AT7911E</td>
<td>Triple SpaceWire links High Speed Controller (SMCS332SpW)</td>
<td>Now</td>
</tr>
<tr>
<td>AT7912F</td>
<td>Single SpaceWire links High Speed Controller (SMCS116SpW)</td>
<td>2H 2009</td>
</tr>
<tr>
<td>AT7913E</td>
<td>SpaceWire Remote Terminal Controller</td>
<td>2H 2009</td>
</tr>
</tbody>
</table>
Memories for Space

Atmel has a long track record with memories (SRAM, DPRAM, FIFO and EEPROM) and its current offering supports the space industry efforts for the rationalization of part variations with respect to:

- Size and format
- Package
- Power consumption and speed

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Type</th>
<th>Process Feature Size (µm)</th>
<th>Format</th>
<th>Operating Voltage (V)</th>
<th>Prime Speed Spec (ns/mA)</th>
<th>TID (Krad)</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>M65608E</td>
<td>SRAM</td>
<td>0.6</td>
<td>128K x 8</td>
<td>4.5 – 5.5</td>
<td>30/130</td>
<td>30</td>
<td>FP32.4</td>
</tr>
<tr>
<td>M65609E</td>
<td>SRAM</td>
<td>0.35</td>
<td>128K x 8</td>
<td>3.0 – 3.6</td>
<td>40/50</td>
<td>300</td>
<td>FP32.4</td>
</tr>
<tr>
<td>AT60142FT*</td>
<td>SRAM</td>
<td>0.25</td>
<td>512K x 8</td>
<td>3.0 – 3.6*</td>
<td>17/100</td>
<td>300</td>
<td>FP36.5</td>
</tr>
<tr>
<td>AT60142F</td>
<td>SRAM</td>
<td>0.25</td>
<td>512K x 8</td>
<td>3.0 – 3.6</td>
<td>15/180</td>
<td>300</td>
<td>FP36.5</td>
</tr>
<tr>
<td>AT68166FT*</td>
<td>MCM SRAM</td>
<td>0.25</td>
<td>512K x 32</td>
<td>3.0 – 3.6*</td>
<td>20/170</td>
<td>300</td>
<td>MQFP68</td>
</tr>
<tr>
<td>AT68166F</td>
<td>MCM SRAM</td>
<td>0.25</td>
<td>512K x 32</td>
<td>3.0 – 3.6</td>
<td>18/180</td>
<td>300</td>
<td>MQFP68</td>
</tr>
<tr>
<td>M67025E**</td>
<td>DPRAM</td>
<td>0.6</td>
<td>8K x 16</td>
<td>4.5 – 5.5</td>
<td>30/200</td>
<td>30</td>
<td>MQFP84</td>
</tr>
<tr>
<td>M67204H**</td>
<td>FIFO</td>
<td>0.6</td>
<td>4K x 9</td>
<td>4.5 – 5.5</td>
<td>15/120</td>
<td>30</td>
<td>FP28.4</td>
</tr>
<tr>
<td>M67206H**</td>
<td>FIFO</td>
<td>0.6</td>
<td>8K x 9</td>
<td>4.5 – 5.5</td>
<td>15/120</td>
<td>30</td>
<td>FP28.4</td>
</tr>
<tr>
<td>M672051H**</td>
<td>FIFO</td>
<td>0.6</td>
<td>8K x 9</td>
<td>4.5 – 5.5</td>
<td>15/120</td>
<td>30</td>
<td>FP28.4</td>
</tr>
<tr>
<td>AT28C010-12DK</td>
<td>EEPROM</td>
<td>0.6</td>
<td>128K x 8</td>
<td>4.5 – 5.5</td>
<td>120/80</td>
<td>30</td>
<td>FP32.4</td>
</tr>
<tr>
<td>AT17LV010-10DP</td>
<td>EEPROM</td>
<td>0.35</td>
<td>1M x 1</td>
<td>3.0 – 3.6</td>
<td>100/10</td>
<td>60</td>
<td>FP18.3</td>
</tr>
<tr>
<td>AT69170E</td>
<td>EEPROM</td>
<td>0.18</td>
<td>4M x 1</td>
<td>3.0 – 3.6</td>
<td>70/10</td>
<td>60</td>
<td>FP18.3</td>
</tr>
</tbody>
</table>

* 5V tolerant
** Not for new designs
The Atmel Aerospace ASIC offering is enriched with new libraries each time the latest generation technology is introduced. As an example, the ninth generation of Aerospace ASIC technologies, the ATC18RHA series is a standard cells library characterized on the Atmel CMOS 0.18µm technology.

Combined with those libraries are multiple options for embedding dedicated blocks, and a large choice of complex hermetic packages. A MPW (Multi Project Wafer) service allows the users to lower the NRE.

### ASICs for Space

The development of the tenth generation of space ASIC libraries is already on its way and will allow tackling the 20 Mgaits barrier, with more embedded features which will include, among others, very high speed serial links. Higher pin count packages will also be made available.

#### Technology

- **Feature Size (µm)**
  - MH1RT: 0.35
  - ATC18RHA: 0.18
- **Metal Layers**
  - MH1RT: 4
  - ATC18RHA: 6
- **SoG/Std Cell**
  - MH1RT: SoG
  - ATC18RHA: Std Cell
- **Design Gates Complexity**
  - MH1RT: 1600 Kgaits
  - ATC18RHA: >5000 Kgaits
- **Used Gates/mm²**
  - MH1RT: 8000
  - ATC18RHA: 50000
- **Pad Count**
  - MH1RT: 506
  - ATC18RHA: >900
- **Cell Libraries Supply**
  - MH1RT: 5.3V
  - ATC18RHA: 3.3/2.5V
- **Cell Libraries Supply**
  - MH1RT: 3.3V ± 0.3% 2.5V ± 0.2%
  - ATC18RHA: 1.8V ± 0.15%
- **Cold Sparing**
  - MH1RT: Yes
  - ATC18RHA: Yes
- **Power Consumption (µW/gate/MHz)**
  - MH1RT: 0.08 @ 3V
  - ATC18RHA: 0.001 @ 1.8V
- **NAND2 typ. prop. delay (ps)**
  - MH1RT: 180 @ 3V
  - ATC18RHA: 100 @ 1.6V

#### Availability

- **Functional TID (Krads)**
  - MH1RT: 300 @ 3.6V
  - ATC18RHA: 300 @ 3.3V
- **Latch up (MeV/mg/cm²)**
  - MH1RT: >70
  - ATC18RHA: >95 @ 125°C
- **Rad Hardness**
  - MH1RT: Yes
  - ATC18RHA: Yes
- **Power Consumption (µW/gate/MHz)**
  - MH1RT: 0.08 @ 3V
  - ATC18RHA: 0.001 @ 1.8V
- **NAND2 typ. prop. delay (ps)**
  - MH1RT: 180 @ 3V
  - ATC18RHA: 100 @ 1.6V

The development of the tenth generation of space ASIC libraries is already on its way and will allow tackling the 20 Mgaits barrier, with more embedded features which will include, among others, very high speed serial links. Higher pin count packages will also be made available.
FPGA Conversion

Converting to ASIC means benefiting from the ASIC technical advantages such as having a faster and smaller chip and lower power consumption while maintaining the original functionality. In the aerospace domain, it also means better reliability and radiation performances. Atmel has built a low cost rad-hard FPGA conversion offer allowing an economical and reliable solution for the replacement of the Actel® RH1020/1280 and RT54SX32S/RT54SX72S families. A new replacement offer will be available soon for Actel RTAX family.

Hotline aerospace@nto.atmel.com

SEU Hardened re-programmable FPGAs

For low gate count ASIC, the aerospace market trends toward FPGA. Capitalizing on its expertise in advanced architectures, Atmel offers new alternatives to the aerospace market with the re-programmable FPGA series. They support an innovative built-in SEU protection, which allows the user to design his application without using mitigation techniques that can triple FPGA design gate count, thus saving expensive development resources and FPGA cost.

The Atmel FPGAs series are specifically designed for compute-intensive DSP functions such as efficient and ultra-fast array multipliers. Being reprogrammable, multiple design iterations can be implemented at no additional cost; post programming burn-in is not necessary, while spare and attrition parts can be used for new projects, thus saving huge costs. Atmel is achieving the architecture migration of the AT40KEL040 series on the 0.18 µm rad-hard technology. This will allow the increase of the complexity from 46K equivalent ASIC gates to 288K and the embedded memory from 18 Kbit to 115 Kbit. In addition, Atmel has added a new protection: a check of the FPGA configuration during its operation (Self check in below figure). The ATF280 FPGA series availability is set for 2009. An SOI version, SEU/SET free, hosting 450k ASIC gates, will be available end 2010.
Reprogrammable FPGAs for Space Applications

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT40KEL040 design kit (MQFP160 based)</td>
<td>AT40KEL-DK</td>
</tr>
<tr>
<td>MQFP256 adaptation kit for AT40KEL040 design kit</td>
<td>ATDH40D256M</td>
</tr>
<tr>
<td>ATF280 design kit</td>
<td>ATFS450E-DK</td>
</tr>
</tbody>
</table>

Serial EEPROM for FPGA Configuration

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT40KEL040 Design Kit</td>
<td>ATF280E-DK</td>
</tr>
</tbody>
</table>

Hotline: rachard-fpga@nto.atmel.com

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