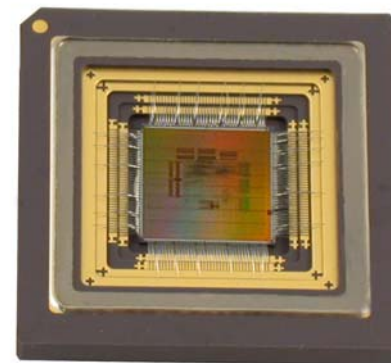
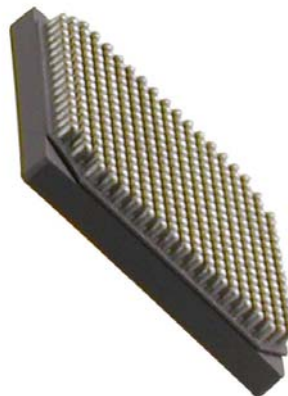
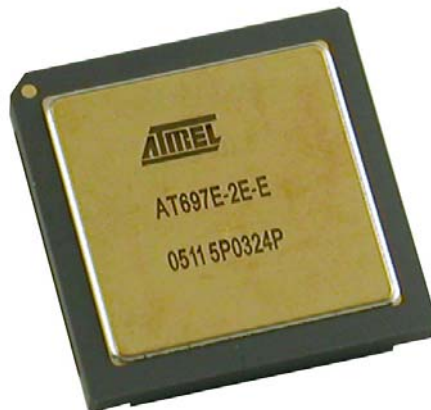




# AT697 LEON2-FT FLIGHT MODELS

March 7, 2007

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**Atmel ASIC Business Unit**





## CONTRACTS

- **For LEON2 FT prototypes:**
  - **ESA contract n° 15036/01/NL/FM**
  
- **For LEONT2 FT FM development and Atmel qualification:**
  - **ESA contract 19083/05/NL/FM-COO2**



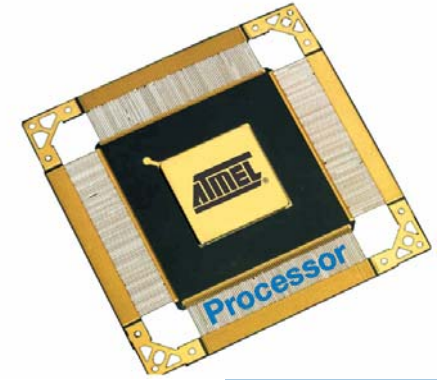
## Overview

- **Status on AT697E**
- **AT697F presentation**
- **AT697F development plan and current status**



## ATMEL Sparc microprocessor family

- **ATMEL works on Sparc processors for space for almost 15 years**
  
- **Sparc V7 : TSC695F processor**
  - **Radiation hardened**
  - **20 Mips / 5 MFlops at 25 MHz ; 230 mA ; 5V  $\pm$  0.5V**
  - **DSCC qualified (SMD 5962-00540)**
  - **High Flight heritage**
    - **Launchers – telecomm & scientific satellites**
    - **Europe : SMART-1 lunar mission, Alcatel Spacebus satellite platforms, Galileo...**
    - **USA : Deep Impact, Mars Reconnaissance Orbiter...**
  - **A 3.3V version available : the TSC695FL**
    - **12 Mips ; 100 mA**





## New Sparc V8 AT697E

- Sparc V8 LEON2-FT Integer and Floating Point Unit
- Embedded Instruction and Data caches
  - Icache : 32Kbytes; dcache : 16 Kbytes
- EDAC protection for external memories (PROM / SRAM)
- SDRAM memory controller
- PCI 2.2 interface (33 MHz)
- User friendly Debug Support Unit

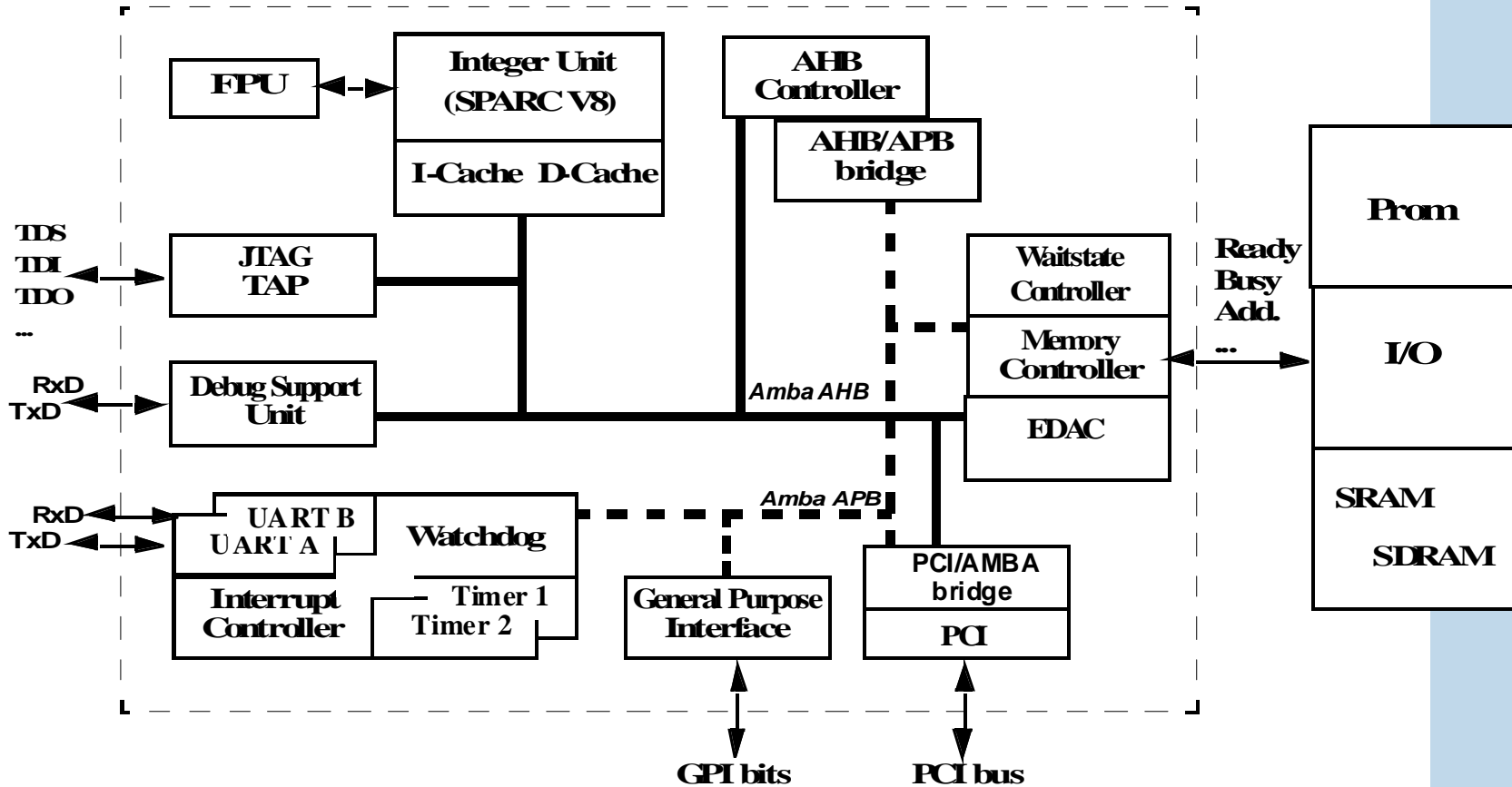


## AT697E basics

- **CMOS 0.18 micron; 1.8 V core; 3.3V I/Os**
- **Fault tolerance by design**
  - **Triple Modular Redundancy with skew**
    - SEU and SET protection
  - **EDAC on register files and external memories**
  - **Parity on the caches**
- **Multi Column Grid Array MCGA 349 package**
  - **Advantage in term of weight, size, thermal resistance**
  - **Space qualified**
- **Available as a standalone part**



# AT697E block diagram





## AT697E performance

### ■ Performance at 100MHz

- 86 MIPS (Dhrystone 2.1)
- 23 MFLOPs (Whetstone)

### ■ Power consumption

- 7 mW / MHz
  - At 100 MHz and for high activity : core at 0.5 W, I/O at 0.2 W





## AT697E radiation performance

### ■ Total Ionizing Dose

- Parts fully functional at 200 krad (Si)
- 3.3V I/O standby current increases after 100 krad (Si), and recovers after high temperature annealing

### ■ Single Event Effects

- No Single Event Latchup (SEL) at 95 MeV/mg/cm<sup>2</sup> – max voltage – 125°C for a fluence of 1 E7 particles/cm<sup>2</sup>
- Very good Single Event Upset/Transient (SEU/SET) protection



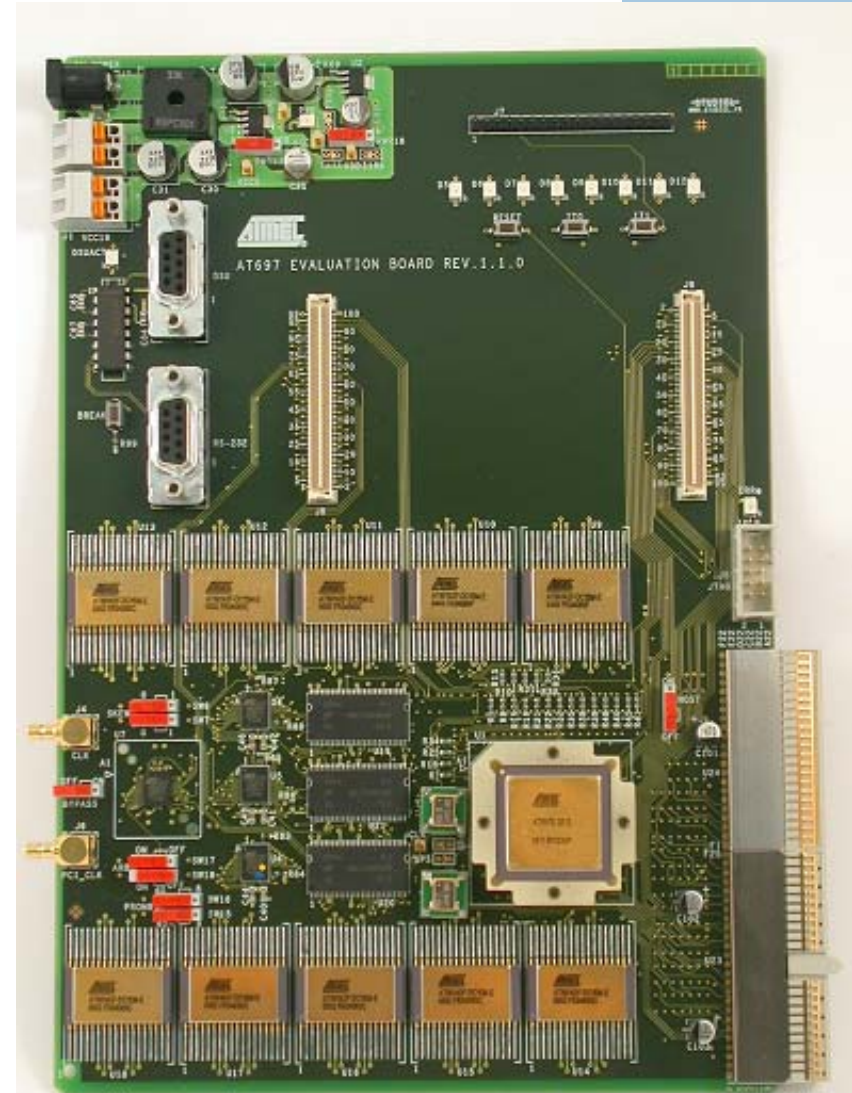
## AT697E product status

- **Fully validated and characterized over military temp range**
  - **ATMEL internal validation**
  - **Validation done as well by a number of alpha customers**
  
- **AT697E-2E-E samples commercially available off-the-shelf since beginning 2006**



# ATMEL AT697 Compact PCI Evaluation board

- Compact PCI plug-in format
  - 6U format, 32 bit, 33MHz interface
  - Configurable for System and Peripheral slot operation
- Processor
  - Atmel AT697E, Rad-Hard 32 bit Sparc V8 Embedded Processor
- On-board memory
  - SRAM - 4Mbyte
    - 2 AT60142 SRAM banks
  - FLASH - 2Mbyte
  - SDRAM - 64Mbyte
- Interfaces
  - Memory/Peripheral expansion connectors
  - Debug Support Unit interface
  - PIO expansion
  - On-board power regulation allows operation from PCI slot, or stand-alone with +5V supply.





## AT697 Software Development Tools

### ■ Compiler

- Bare-C Cross-compiler
- RTEMS Cross-compiler

### ■ Debugger

- GRMON debug monitor  
target debug through serial DSU or PCI interface

### ■ Simulator

- TSIM simulator

### ■ Real Time Operating Systems

- RTEMS
- VxWorks
- eCOS
- Snapgear Embedded Linux (uClinux)



## AT697 Links / Documentation

- **Documentation regularly updated on ATMEL web site**
  - <http://www.atmel.com/products/radhard/>
  - Datasheet, errata sheet, evaluation board user manual
  
- **One dedicated Sparc Hotline**
  - [sparc-applab.hotline@nto.atmel.com](mailto:sparc-applab.hotline@nto.atmel.com)
  
- **Radiation report available upon request**



## AT697E Summary results

- **AT697E prototypes available since April 2005**
- **Validation, characterisation, radiation test results available since end 2005, and very positive :**
  - **AT697E is fully functional**
    - **over the whole bias voltages and mil temp ranges**
  - **86 MIPs / 23 MFLOPs at 100 MHz**
  - **7 mW / MHz**
  - **Successfully tested up to 200 Krad (Si)**
  - **SEU/SET hardened processor**
  - **No SEL at room temperature for a LET of 70 MeV/mg/cm<sup>2</sup>**

**150 MIPs/W**



## AT697E production

- **Samples and production parts available off the shelves**
  - AT697E-2E-MQ (QML-Q like)
  - SMD ongoing for QML-Q / QML-V availability in Q2 2007
  
- **Will fly in 2007 on some projects**
  - e.g. PROBA2



## AT697E interest

- **A number of early AT697E design starters**
  - In Europe (~ 10)
  - In North America (~ 5)
  
- **More than half of the technical questions received on the ATMEL Sparc hotline are AT697 related**





## Overview

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## AT697F rationales

### ■ Bug corrections

- All the model bugs described in the AT697E errata sheet will be corrected

### ■ ATC18RHA library

- To allow successful total dose test up to 300 krad (Si)
- To ensure appropriate process reliability monitoring (through SEC & test vehicle)

### ■ A few improvements

- Functional : refer to following slides
- SDRAM interface speed

### ■ Pin out compatible with AT697E

- Start the design with AT697E and switch to AT697F Flight models is OK

### ■ Packaging

- A MQFP-F 256 pins package will be introduced in addition to MCGA349



## AT697F functional improvements

- **Many feedbacks from customers during AT697E validation phase and first designs**
- **ESA / ATMEL / Gaisler Research exchanges**
- **Main modifications (summary)**
  - **New write memory block protection, easier to use**
  - **Simplified 8-bit memory EDAC scheme (boot)**
  - **Counters extended to 32 bits**
  - **Four additional interrupts**
  - **Asynchronous sampling of BRDYN signal + extension to PROM, to ease the interfacing with external devices**
- **All these modifications will be presented in detail in the AT697F preliminary datasheet (Q2 2007)**



## AT697F development main tasks (1)

- **Specification and development plan**
- **Design Phase**
  - **Synthesis / simulations**
  - **Layout phase**
- **Manufacturing and assembly of engineering devices**
  - **Mask generation**
  - **Manufacturing of an engineering lot**
  - **Assembly of samples**
- **Electrical characterisation and validation**
  - **Full bias voltages and military temperature ranges**
  - **Application tests**
    - **Update of the evaluation board**
    - **Improvement of the tools offering**



## AT697F development main tasks (2)

- **ESCC evaluation**
  
- **Space Qualification**
  - QML Q, QML V, ESCC screening
  - Product variability with process variation
  - Analysis of rejects / read&record
  
- **Radiation characterisation**
  - Total dose
  - Single Event Effects (heavy ions and protons)



## Key dates

- **December 06 : New LEON2-FT model delivered by ESA**
- **Q4 2007 : AT697F Samples**
- **Q2 2008 : AT697F FM (order entry)**



## CONCLUSION

- LEON2 FT prototypes right the first time
- LEON2 FT prototype QM will fly on PROBA2
- LEON2 FM will benefit of the prototype version
- All LEON2 FT prototype sockets will be able to receive the FM version
- It will become the best processor for the Mips / W