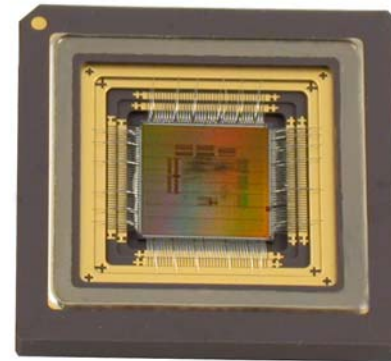
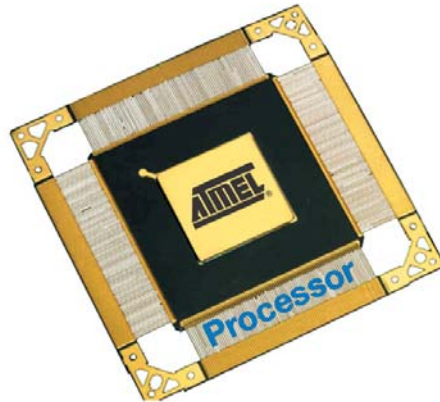




ATMEL

Available Microprocessors and On going Projects



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ATMEL microprocessor family

- **ATMEL works on processors for space for more than 15 years**
- **Existing processors for space**
 - **80C32E**
 - **TSC21020 DSP**
 - **TSC695F and TSC695FL Sparc V7**
 - **AT7913E LEON2-FT Sparc V8**
 - **AT697E LEON2-FT Sparc V8**
 - **AT697F LEON2-FT Sparc V8**



NEW



80C32E 8-Bit Architecture

- **80C32: 8-bit ROMless microcontroller rad.tolerant**
 - Side Brazed 40-pin, MQFPJ 44-pin
 - Total Ionizing dose : 30 krads (Si) according to MIL STD 883
 - No Single Event Latch up below 80 MeV/mg/cm²
 - QML Q and V with SMD 5962-00518
- **0.8μm RT CMOS technology**
- **End of life announcement 2010/11**
- **No new design based on this product**



TSC21020F

- **Standard 32/40-bit Floating Point from Analog Devices**
 - Radiation tolerant version of ADSP-21020
 - Superscalar IEEE Floating Point Processor
 - 20 MHz max; $5V \pm 0.5V$
 - 40 MFlops sustained performance, 60 MFlops peak
 - Space qualified MQFPF-256 for flight models
 - Total Ionizing dose : 100 Krad
 - No Single Event Latch up below 80 MeV/mg/cm²
- **0.6 μ m RTP CMOS technology**
- **End of life announcement 2011/12**
- **No new design based on this product**
- **Next generation of DSP not yet defined**



ATMEL SPARC microprocessor family



TSC695F: SPARC 32bit Space Processor

- MQFPF256, 25 MHz, 20Mips, 5Mflops @ 5V+/-0.5V
- SEU Rate Better than $1.6E-8E/d/d$ on GEO
- SEU Rate Better than $8E-10E/d/d$ on LEO
- Latch up immune, 300Krads (RHA=R)
- Fully static design
- 41 mA power down current @ 25 MHz
- 230 mA operating current @ 25 MHz
- ESCC & QML V (5962-005401)



TSC695FL: Low Power SPARC 32bit Space Processor

- MQFPF256, 15 MHz, 12Mips, 3Mflops @ 3.3V+/-0.15V
- SEU Rate Better than $1.2E-7E/d/d$ on GEO
- SEU Rate Better than $4E-5E/d/d$ on LEO
- Latch up immune, 300Krads (RHA=R)
- Fully static design
- 10 mA power down current @ 15 MHz
- 100 mA operating current @ 15 MHz
- 70% power saving at only 40% MIPs cost
- ESCC & QML V (5962-03246)



TSC695F/FL

- Flight heritage more than 1600 flight model
- 0.5 μ m RTP CMOS Technology
- End of life announcement 2013/14
- Die banking on qualified lot



AT7913E Sparc V8

- Sparc V8 Leon2 FT with Floating Point Unit
- AT7913E RTC (Remote Terminal Controller)
 - Two CAN interface
 - FIFO interface (parity check)
 - ADC/DAC interface
 - 2 UART interfaces
 - 2 bidirectional SPW link 200Mbit/s on chip LVDS
 - 64kB x 32 on chip memory with EDAC
 - ...
- CMOS Technology: ATC18RHA (0,18 μm)
- LGA 349
- MQFPF 352 to be introduce ? Depending on customers need
- Power consumption: ~0.7W@50MHz
- 1.8V core, 3.3V I/O
- More detail in the next presentation



AT697 Sparc V8 32-bit Architecture

- **SPARC V8 LEON2-FT with Integer and Floating Point Unit**
- **On chip Amba Bus**
- **Embedded Instruction and Data caches**
 - **16Kbytes multi-sets Data cache**
 - **32Kbytes multi-sets Instruction Cache**
- **Memories Interface for PROM, SRAM and SDRAM**
- **PCI 2.2 interface (33 MHz)**
- **Two Timers, two 8-bit Uarts and interrupt Controller**
- **User friendly Debug Support Unit**
 - **Trace buffer 512 lines of 16 bytes**

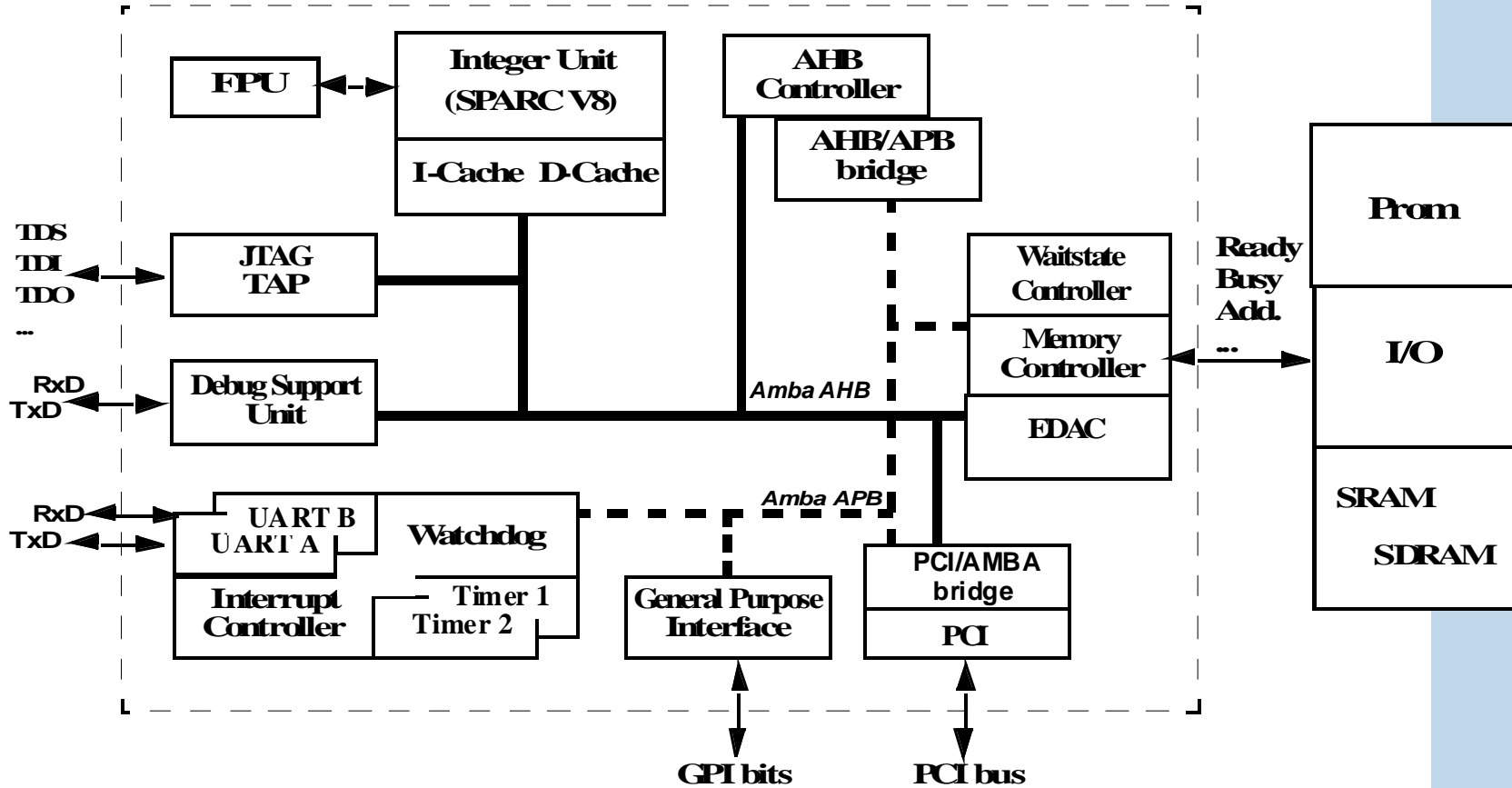


AT697 basics

- **ATC18RHA 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 file and external memories**
 - **Parity on the caches**
- **Available package**
 - **MCGA 349 last delivery Q2_2011**
 - **LGA 349**
 - **MQFPF 256**

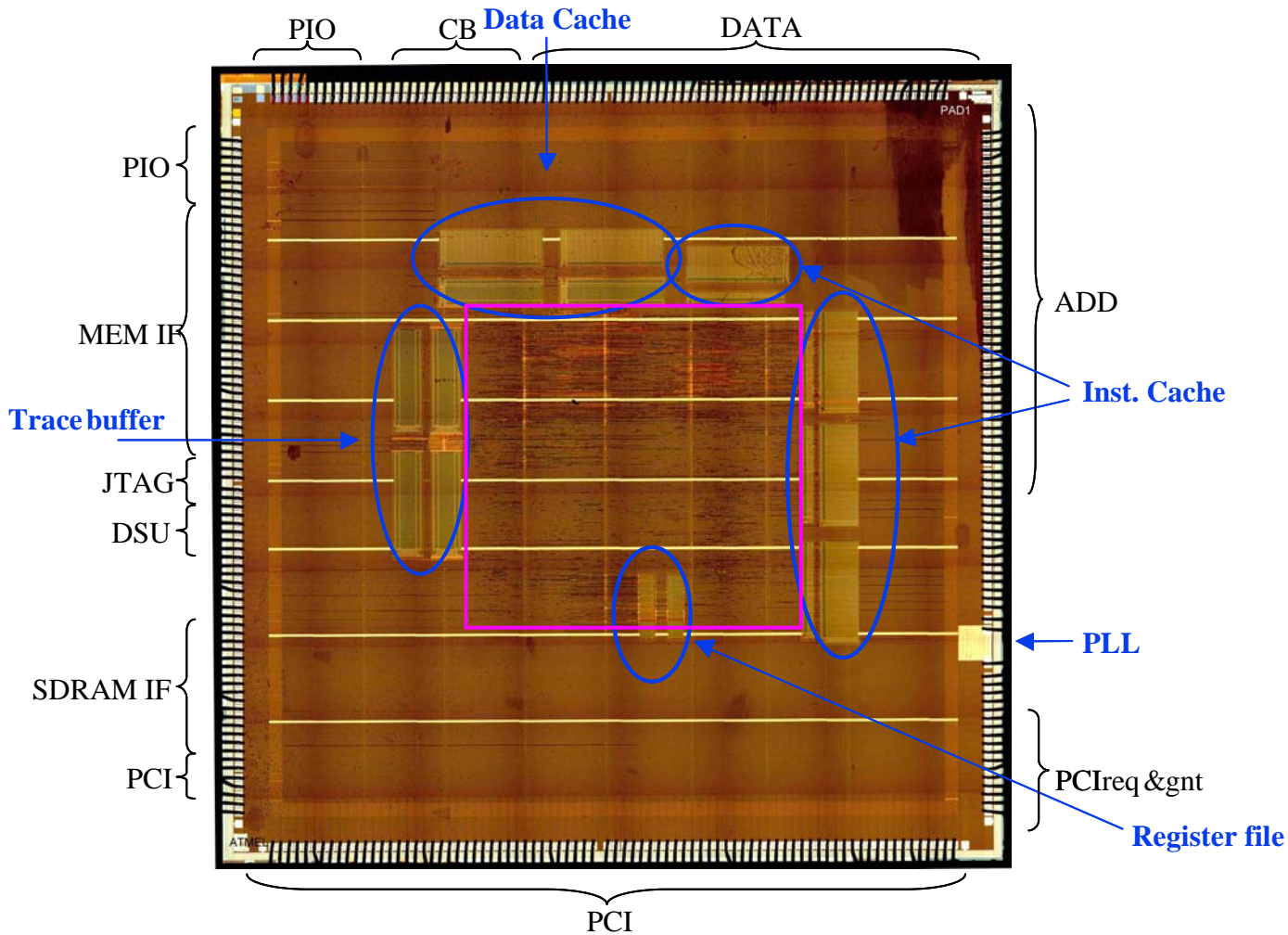


AT697 block diagram





AT697 Die View





AT697E performance

■ Performance at 100MHz

- 86 MIPS (Dhrystone 2.1)
- 23 MFLOPs (Whetstone)
- SDRAM interface speed impacted by the bus load
 - On AT697-EVAB (2 SRAM and 1 SDRAM banks) : 65 MHz maximum

■ Power consumption

- 7 mW / MHz

150 MIPS/W

- 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
- These results allow to use these AT697E parts for space mission requiring a maximum of 60 krad (Si)

■ Single Event Effects

- No Single Event Latchup (SEL) at 95 MeV/mg/cm² – max voltage – 125°C for a fluence of 1 E7 particles/cm²
- Very good Single Event Upset/Transient (SEU/SET) protection



AT697F rationales

- **Prototype devices: AT697E and Flight devices: AT697F**
- **ATC18RHA library**
 - To allow successful total dose test up to 300 krad (Si)
 - To ensure appropriate process reliability monitoring (through SEC test vehicle)
- **Bug removal**
 - All known bugs has been corrected (see AT697E errata sheet)
- **Removal of existing functions**
 - 16-bit mode PROM/RAM interface (no EDAC support)
 - PCI single transaction mode
- **Addition of new functions**
 - Addition of Two Memory Block Protection Units (TSC695F compatible)
- **Pin out compatible with AT697E**



AT697F improvements of existing functions

- **Many feedbacks from customers during AT697E validation phase and first designs**
- **Improvements**
 - **Asynchronous assertion of BRDYN**
 - **Use of the BRDYN for PROM area**
 - **Extending the timers to 32-bits**
 - **Addition of four external interrupts**
 - **AHB trace buffer halt**
 - **New 8-bit memory EDAC scheme**
 - **Write to 8-bit PROM with EDAC enabled**
 - **PCI device configuration boot pin made readable**
 - **PCI configuration registers made AHB readable in satellite mode**
 - **Higher capacitive load capability.**
 - **Higher ESD protection 2000V (250V for AT697E)**
- **SDRAM interface speed**



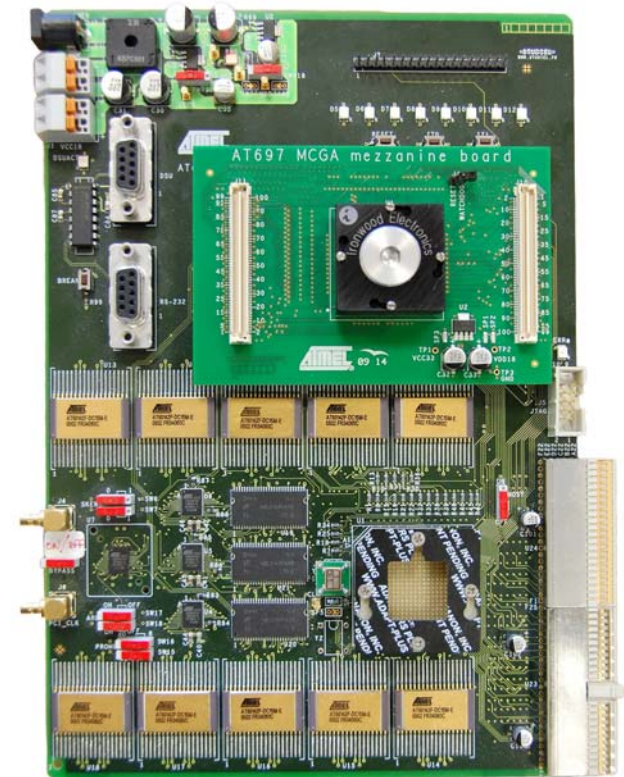
AT697F development tasks

- **Electrical characterisation and validation**
 - Full bias voltages and military temperature ranges
- **Application Tests**
 - Update of the evaluation board
- **ESCC evaluation On going**
- **Space Qualification**
 - QML Q, QML V, ESCC screening on going
- **Radiation characterisation**
 - Total dose : tested up to 300Krad(si) successfully
 - Single Event Effects (heavy ions and protons) TBD



ATMEL AT697 Compact PCI Evaluation board

- Compact PCI plug-in format
 - **6U format, 32 bit, 33MHz interface**
 - **Configurable for System and Peripheral slot operation**
 - **Two mezzanine board MCGA & MQFPF**
- Processor
 - **Atmel AT697E/F , 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)



Reconfigurable Processor

■ Processor

- AT697F SPARC V8 LEON2-FT

■ Reconfigurable unit

- ATF280F SRAM based FPGA

■ Total dose up to 300Krad(si)

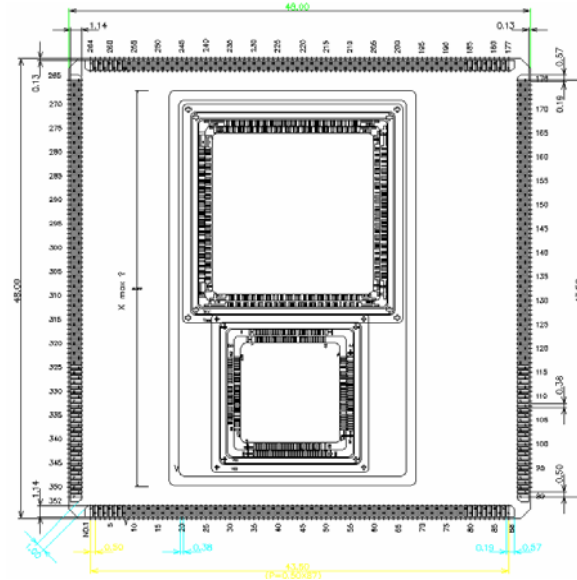
■ Available package

- MQPFP 352

■ First application based on CNES space application

- FPGA predominance, AT697F in limited speed performance
- 2 LVDS transceivers (out of 8)
- All Global Clocks and Fast Clocks available
- 250 FPGA I/Os available

■ Possible derivative implementation





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

- **Radiation report available upon request**



Thank You