ATMEL SPACEWIRE PRODUCTS FAMILY

Session: Components

Short Paper

Nicolas RENAUD, Yohann BRICARD

ATMEL Nantes – La Chantrerie – 44306 NANTES Cedex 3

E-mail: nicolas.renaud@atmel.com, yohann.bricard@atmel.com

ABSTRACT

This paper presents the status of the SpaceWire products available at ATMEL for space applications. This includes the SpaceWire SMCS communication controller ASICs (three SpaceWire links or one SpaceWire link version), the SpaceWire Router ASIC and the SpaceWire Remote Terminal Controller (RTC). It gives a high-level overview of the product features, their main characteristics (packaging, operating ranges...) and availability dates for engineering and flight models. A focus is done on the technologies on which these products rely, as well as on the expected radiation capabilities (total dose and single event effects). The paper also describes the way to interface these SpaceWire chips with other ATMEL rad-hard devices, such as the AT697 Sparc V8 processor or the ATF280 SRAM based FPGA. The building of a complete SpaceWire network based on ATMEL rad-hard products is underlined.

1 ATMEL SPACEWIRE PRODUCTS FAMILY OVERVIEW

The ATMEL portfolio of SpaceWire devices includes :

- the AT7910E, or SpaceWire Router
- the AT7911E, or SMCS332SpW
- the AT7912E, or SMCS116SpW
- the AT7913E, or SpaceWire RTC (Remote Terminal Controller).

An overview of the functionalities and the main characteristics of these chips are provided in the rest of this first section.

1.1 STANDARD ASICS

ATMEL is regularly working with most of its key space customers to make their ASIC designs available as standard ASICs when they correspond to commonly used functions on the market. The four SpaceWire chips described in this paper meet this requirement. The SMCS-SpW devices have been designed by EADS Astrium in Germany. The SpaceWire router is designed by Austrian Aerospace in Austria and the University of Dundee in Scotland. The SpaceWire RTC is designed by Saab Space in Sweden. All these designs are made under ESA contracts.

1.2 SMCS-SPACEWIRE CHIPS

The **AT7911E**, or **SMCS332SpW** for "Scalable Multi-channel Communication Subsystem for SpaceWire", provides an interface between three SpaceWire links compliant with the SpaceWire standard ECSS-E-50-12A specification and a data processing node consisting of a Control Processing Unit and a communication data memory. The AT7911E can connect modules with different processors (e.g. TSC695F or AT697E) and modules without any communication features such as special image compression chips or mass memory. The AT7911E may also be used in systems containing "non-intelligent" modules such as A/D-converter or sensor interfaces. More details on the AT7911E features can be found in EADS Astrium 'SMCS332SpW User Manual' [1], available on the ATMEL web site together with the AT7911E datasheet [2]. The AT7911E is packaged in a MQFPL 196 pins and can operate in both 5V or 3.3V voltage ranges. The engineering samples are available and flight models can be ordered.

The **AT7912E**, or **SMCS116SpW**, provides an interface between a SpaceWire link compliant with the SpaceWire Standard ECSS-E-50-12A specification and several different interfaces such as ADC/DAC, RAM, FIFO, GPIOs and UARTs. It supports both the standard SpaceWire link protocol (transparent mode) and the STUP (Serial Transfer Universal Protocol) for efficient packet oriented data transfer. More details on the AT7912E features can be found in EADS Astrium 'SMCS116SpW User Manual' [3], available on the ATMEL web site together with the ATMEL AT7912E datasheet [4]. The AT7912E is packaged in a MQFPF 100 pins and can operate in both 5V or 3.3V voltage ranges. The engineering samples are available and flight models can be ordered.

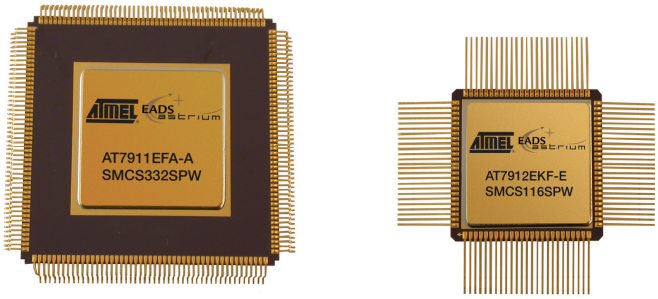

Figure 1 – SMCS-SpW chips

1.3 SPACEWIRE ROUTER

The **AT7910E SpaceWire Router** provides eight SpaceWire ports, two external parallel ports and an internal configuration port. It can be used as a standalone router or as a node interface using the external parallel ports. For more details on the AT7910E functionalities, it should be referred to the University of Dundee 'SpaceWire Router datasheet' [5]. The AT7910E is packaged in a MQFPF 196 pins and operates in 3.3V voltage range. The ATMEL AT7910E datasheet will be available in Q4 2007 on the ATMEL web site. The engineering samples will be available in Q1 2008. The order entry for flight models will open in Q1 2008.

1.4 SPACEWIRE REMOTE TERMINAL CONTROLLER

The **AT7913E SpaceWire Remote Terminal Controller** provides a bridge between a SpaceWire network and a CAN bus, and includes a LEON2-FT processor with additional interfaces to ADC/DAC, RAM, FIFO, GPIOs and UARTs. This chip allows the

interfacing of high speed serial SpaceWire network and low-speed spacecraft control bus based on CAN. The possible use of the embedded LEON2-FT processor also allows the SpaceWire RTC to contribute to instrument controller processing tasks. For more details on the AT7913E functionalities, it should be referred to the Saab Space 'SpaceWire RTC datasheet' [6] that will be publicly available in Q4 2007. The AT7913E is packaged in a MCGA 349 pins and operates in 3.3V voltage range for the I/Os, and 1.8V voltage range for the core. The ATMEL AT7913E datasheet will be available in Q4 2007 on the ATMEL web site. The engineering samples will be available in Q1 2008. The order entry for flight models will open in Q2 2008.

2 GENERAL INFORMATION ON TECHNOLOGY, QUALITY, RADIATION AND TOOLS

2.1 TECHNOLOGIES AND ASSOCIATED QUALITY ASPECTS

The above mentioned four SpaceWire chips rely on well proven ATMEL ASIC families for space :

- the AT7911E and AT7912E (SMCS-SpW) are based on the MG2RT radiation tolerant 0.5 µm CMOS sea of gates ASIC family,
- the AT7910E (SpaceWire Router) is based on the MH1RT rad-hard 0.35 µm CMOS sea of gates ASIC family
- the AT7913E (SpaceWire RTC) is based on the ATC18RHA rad-hard 0.18 µm CMOS cell-based ASIC family.

Space production screenings and qualification are compliant either with ESCC 9000 or MIL-PRF-38535. Atmel is fully DSCC QML qualified for level Q (military) and V (space). Qualification is granted for all the above mentioned technologies. Atmel is ESCC qualified for MH1RT ASIC family according to ESCC 2549000 (ESCC QML) and plan to get by the end of 2007 the ESCC certification and qualification process for the ATC18RHA ASIC family. Detailed space quality flows can be found in [7]. The four SpaceWire chips are or will be available in QML-Q and QML-V quality flows with SMD.

2.2 RADIATION

The radiation test results obtained on the MG2RT, MH1RT and ATC18RHA ASIC families are applicable to the SpaceWire chips. As a consequence :

- the AT7911E and AT7912E can be tested successfully up to a total dose of 50 Krad(Si), according to MIL STD 1019 method,
- the AT7910E and AT7913E can be tested successfully up to a total dose of 300 Krad(Si), according to MIL STD 1019 method.
- there is no Single Event Latchup at a LET of 70 MeV/mg/cm^2.
- the four chips use the SEU hardened flip-flops of the associated library for all critical bits, thus the SEU error rate in space is very low.

Radiation test reports for the associated technologies and/or for the above SpaceWire chips are available and can be obtained from ATMEL on demand.

2.3 TECHNICAL SUPPORT AND TOOLS

Technical support can be obtained by contacting the following ATMEL hotline :
assp-applab.hotline@nto.atmel.com

A number of development boards, software tools and test equipments to facilitate the design using one of the above mentioned SpaceWire chips are available, for example at Star-Dundee, 4Links, Aurelia Microelectronica or Gaisler Research.

3 BUILDING A SPACEWIRE NETWORK BASED ON ATMEL RAD-HARD PRODUCTS

3.1 OVERVIEW OF A COMPLETE SPACEWIRE NETWORK BASED ON ATMEL PRODUCTS

The four above mentioned chips, associated together and complemented by other ATMEL rad-hard products such as processors, memories, ASICs or FPGAs, allow the building of a complete and cost-effective system using a SpaceWire network based on rad-hard products.

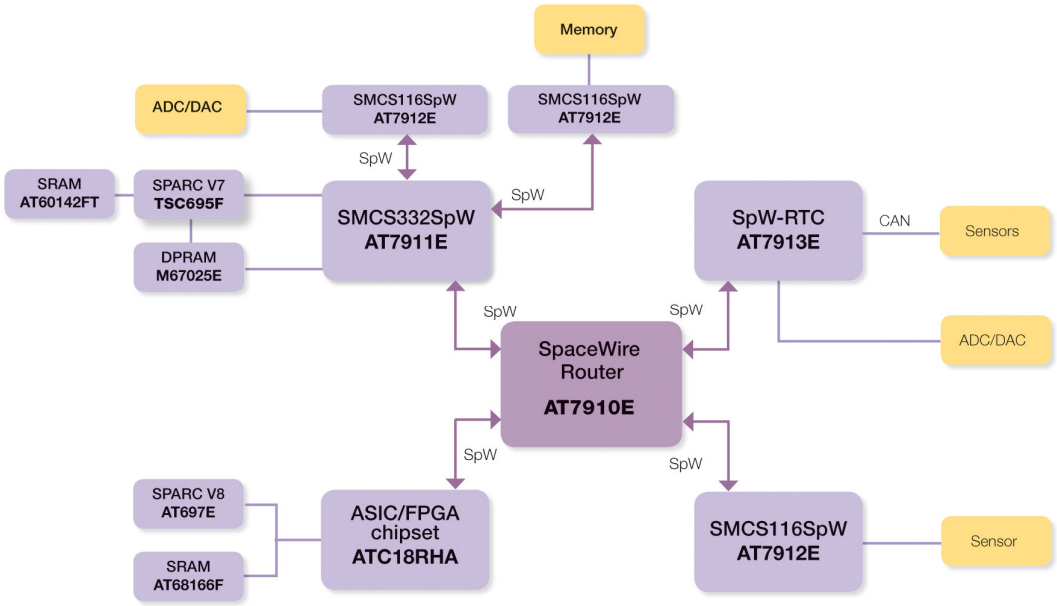

Figure 2 – Complete SpaceWire network based on ATMEL rad-hard products

3.2 INTERFACING ATMEL SPARC RAD-HARD PROCESSORS IN A SPACEWIRE NETWORK

The TSC695 Sparc V7 processor and the AT697 Sparc V8 processor families do not embed the SpaceWire interface capability.

Processor architectures requiring a single link to SpaceWire network can integrate the AT7912E single SpaceWire link high speed controller together with its communication DPRAM in order to provide a direct access from the processor to the SpaceWire network. Direct connections of the processor to both the control interface and the communication interface of the SpaceWire controller are sufficient to provide a SpaceWire communication front-end to the processor, as shown in the figure 3.

For processor architecture requiring more than a single SpaceWire link to communicate on the SpaceWire network, up to 3 SpaceWire links can be integrated in the architecture using the AT7911E triple Spacewire links high speed controller. External LVDS drivers should be used as the AT7911E and the AT7912E do not implement them.

Interfacing between the Sparc processor and the SpaceWire network can also be done by the use of a dedicated ASIC or FPGA chipset.

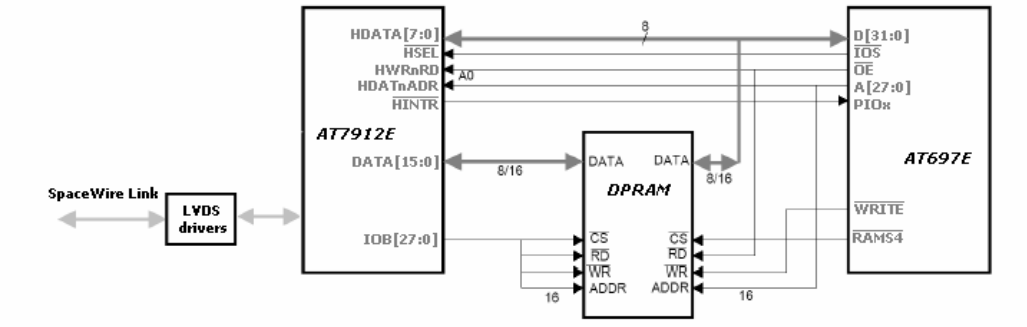

Figure 3 : SpaceWire Front End addition to AT697E processor principle

3.3 INTERFACING ATMEL RAD-HARD FPGAS WITH A SPACEWIRE NETWORK

The ATF280E FPGA integrates 280K equivalent ASIC gates that make it possible to build a SpaceWire communication interface. Integration of a SpaceWire IP on the FPGA provides a direct access to the SpaceWire network without any need for external LVDS drivers as the FPGA implements them on-chip. The same applies to MH1RT or ATC18RHA based ASIC designs when they embed the ESA SpaceWire IP.

4 CONCLUSION

The SpaceWire standard was developed by a european space industry working group sponsored by ESA and is now recognized by NASA. It ensures reliable and fast serial links for data handling between equipments and subsystems, allowing their standardization and re-use for several kinds of missions. ATMEL supports and promotes the SpaceWire standard through cooperations with ESA and space users. The availability of four new rad-hard SpaceWire devices, the AT7910E, AT7911E, AT7912E and AT7913E, designed by EADS Astrium, Austrian Aerospace and Saab Space will allow the space users to build complete and cost-effective systems using SpaceWire networks based on rad-hard devices.

5 REFERENCES

[1] EADS Astrium SMCS332SpW User Manual – SMCS_ASTD_UM_100 Issue 1.5 – 10/07/07

[2] ATMEL AT7911E datasheet – 7737A-AERO-07/07

[3] EADS Astrium SMCS116SpW User Manual – SMCS_ASTD_UM_116 Issue 1.0 – 10/07/07

[4] ATMEL AT7912E datasheet – 7743A-AERO-07/07

[5] University of Dundee SpaceWire Router datasheet – UOD_SPW_10X_Datasheet – Issue 2.0 – 18/08/2006

[6] Saab Space SpaceWire RTC datasheet – P-ASIC-NOT-00256-SE – Issue 6 – 29/05/2007 – Preliminary version

[7] ATMEL Aerospace products quality flows – 4288C – AERO- 11/05

[8] ATMEL web site – aerospace products : http://www.atmel.com/products/radhard/

[9] ESA SpaceWire web site : http://spacewire.esa.int