LEON3FT Processor with PCI, Ethernet and Reed-Solomon SDRAM protection

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LEON3 SPARC V8 PROCESSOR

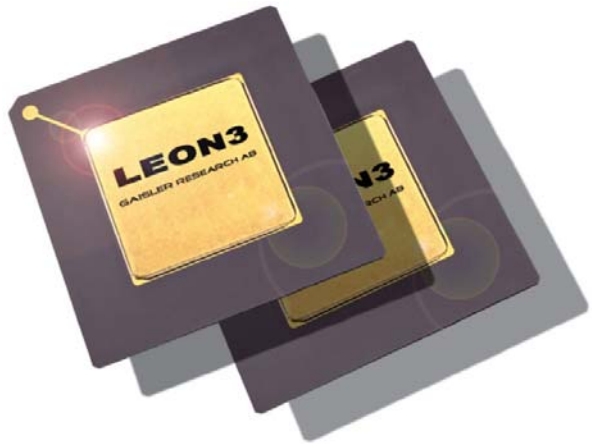
- 7-stage pipeline, multi-processor support
- Separate multi-set caches with LRU/LRR/RND
- On-chip debug support unit with trace buffer
- 400 MHz on ASIC (130 nm, 400 MIPS, 400 MFLOPS, 25 kgates
- 125 MHz on Virtex5 FPGA, 3500 LUT
- 20-30 MHz on Actel RTAX-2000S
- Highly configurable:
  - Cache size 1-256 kbyte, sets 1-4, LRU/LRR Random
  - Hardware Mul/Div options, FPU, MMU
  - Pipeline optimisation for specific target technologies

GRLIB IP-LIBRARY

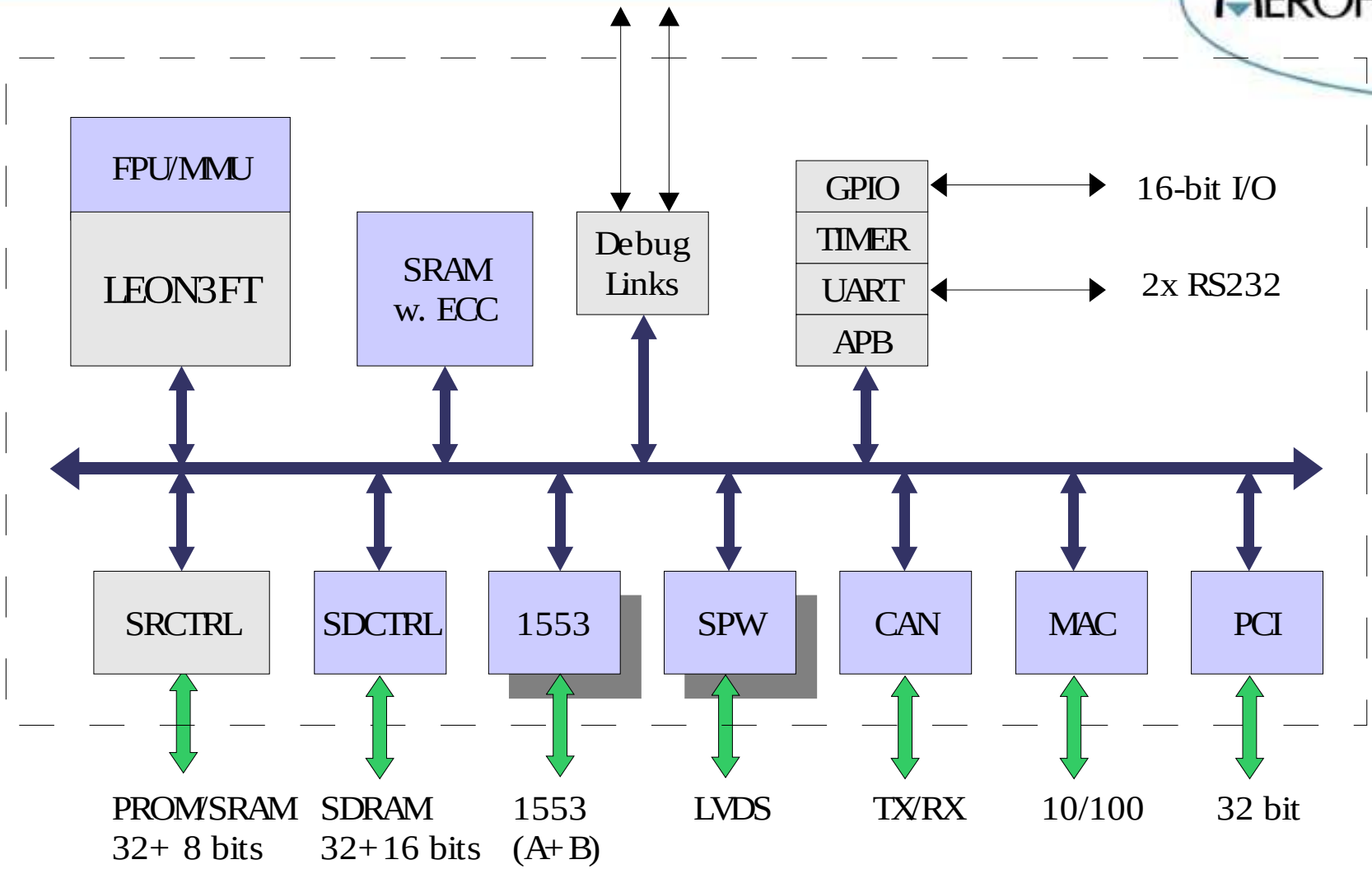
- GRLIB is a complete design environment:
  - LEON3
  - True SMP multi-processing, up to 16 processor cores on the same chip
  - Floating Point Unit, Mul/Div
  - Timers, Interrupt Controller
  - Memory controllers (SRAM, SDRAM (Reed-Solomon), DDR1/2)
  - Memory management unit (MMU)
  - CAN, Ethernet, PCI, USB 2.0, PS2, UART, VGA, SPI, I2C
  - SpaceWire
  - CCSDS: Telemetry, Telecommand
  - AMBA on-chip bus with Plug & Play support
- Fault tolerant and standard version
- Support for many tools and prototyping boards
- Support for portability between technologies

LEON3-FT-RTAX OVERVIEW

- 32-bit embedded processor implemented on RTAX-2000S
- Based on LEON3FT and GRLIB IP Library
- LEON3FT core with separate I/D cache
- IEEE-754 FPU
- SPARC Reference Memory Management Unit
- Multiple 100 Mbit/s SpaceWire links
- Dual MIL-STD-1553 BRM (based on Actel IP core)
- Multiple Ethernet MAC
- PCI Initiator / Target / Arbiter (based on Actel PCIF IP core)
- CAN-2.0 interface
- 8/32-bit memory controller with ECC (BCH and Reed-Solomon)
- 25 MHz, 500 mW
- Delivered as pre-programmed OTS component or custom configuration



LEON3FT-RTAX ARCHITECTURE



SDRAM CONTROLLER WITH REED-SOLOMON

- The SDRAM memory controller has been extended to implement Reed-Solomon codes to protect the external SDRAM memory
- The Reed-Solomon code can detect and correct two 4-bit nibbles in data (32-bit) and check bits (16-bit)
- This detection and correction capability supports the usage of 4- and 8-bit wide SDRAM memory devices, providing protection against device wide Single Event Functional Interrupt (SEFI) which is common for SDRAM devices
- The implementation is highly-pipelined not to reduce the maximum operating frequency (25 MHz for an RTAX2000S)
- The latency is the same as for BCH codes when no errors are present, there is a latency penalty for the first error that needs correction but not for any subsequent errors in a burst
- The Reed-Solomon code is an option to the BCH code

PCI INTERFACE

- The PCI interfaces is based on the PCIF IP core from Actel
- It implements both Initiator and Target capability
- Memory accesses can be made through hardware DMA, not requiring any CPU intervention
- The PCIF IP core has been adapted and wrapped up to fit into the GRLIB IP core library, adding AMBA interfaces and Plug&Play support
- The back-end implements FIFOs for maximum throughput
- The PCI core operates at 33 MHz, with 32-bit data/address
- The PCI interface allows the extension of the LEON3FT processor by accessing external devices implementing additional interfaces or protocols that would not fit in a single RTAX2000S device
- This allows for more complex spacecraft subsystems to be supported by LEON3FT implemented in an RTAX2000S device

ETHERNET MAC

- The Ethernet MAC IP core supports 10/100 Mbit/s communication in half and full duplex
- Data is transferred to memory by hardware DMA, without CPU intervention
- The external PHY is attached using a standardized MII interface
- Ethernet is now being baselined for several space missions
- Ethernet has the advantage of being a widely used protocol in ground applications with a vast amount of legacy software and test hardware

SPACECRAFT CONTROLLER

A new Spacecraft controller has been developed based on:

- LEON3FT processor with Memory Management Unit
- 33 MHz, 32-bit PCI initiator/target interface
- 8-slot PCI arbiter
- 10/100 Mbit/s Ethernet MAC
- 32+16 bit SDRAM controller with Reed-Solomon protection

The spacecraft controller fits in a single RTAX2000S devices and operates at 25 MHz system frequency.

The spacecraft controller can be used as a PCI system slot controller.

LEON3FT-RTAX OTS CONFIGURATIONS

Configuration name	Instrument Controller-1	Instrument Controller-2	Spacecraft Controller-1	Spacecraft Controller-2
Floating Point Unit	Yes	Yes	Yes	
Memory Management Unit				
Debug Support Unit	Yes	Yes	Yes	Yes
On-Chip Memory	4 kbytes		2 kbytes	
1553 RT	1			
1553 BC/RT/MT			2	
SpaceWire		2		3
CAN 2.0	1			
Memory Controller	Yes	Yes	Yes	Yes
SDRAM Support				Yes**
Standard peripherals	Yes	Yes	Yes	Yes
Package	CQFP352	CQFP352	CQFP352	CCGA624

** With Reed-Solomon option

LEON3FT-RTAX OTS CONFIGURATIONS (cont.)

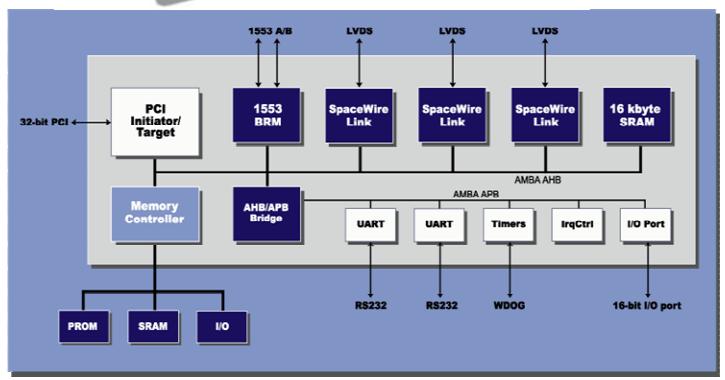
Configuration name	Spacecraft Controller-3	Spacecraft Controller-4	Payload Controller-1	Payload Controller-2
Floating Point Unit			Yes	Yes
Memory Management Unit	Yes	Yes		
Debug Support Unit	Yes	Yes	Yes	Yes
1553 RT				
1553 BC/RT/MT				
SpaceWire	2		2	
CAN 2.0	1			
PCI		1		
Ethernet		1		2
Memory Controller	Yes	Yes	Yes	Yes
SDRAM Support	Yes**	Yes**	Yes**	Yes**
Standard peripherals	Yes	Yes	Yes	Yes
Package	CCGA624	CCGA624	CQFP352	CCGA624

* With Reed-Solomon option

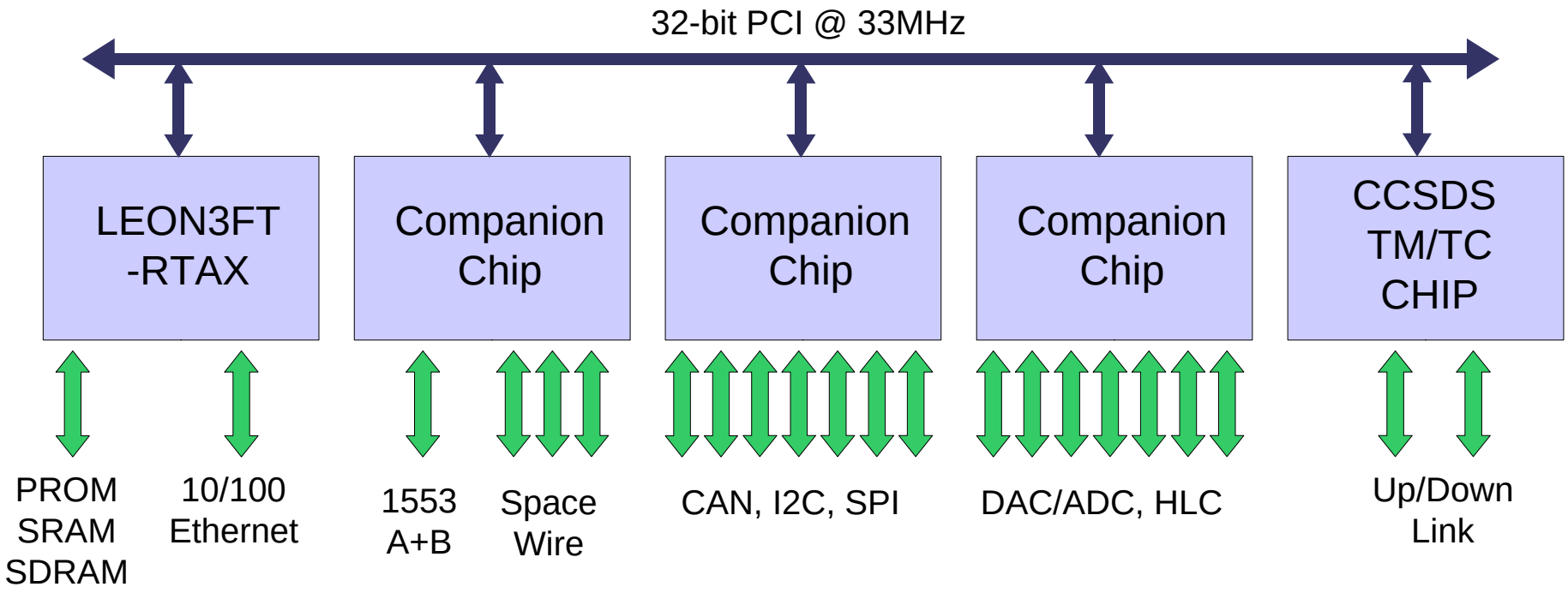
PCI to SPACEWIRE AND 1553 BRIDGE

FEATURES:

- Companion chip for space processors and systems with PCI interface implemented on RTAX2000S
- PCI bus Initiator and Target, 32-bit, 33 MHz
- 3 SpaceWire links with RMAP, 80 MBit/s
- Redundant MIL-STD-1553 BRM
- 2 UART/RS232 interfaces
- 16-bit I/O port
- 16 kbyte EDAC protected on-chip SRAM
- 8-bit EDAC protected bus to external memory
- Timers and watch dog
- CQ352B package
- Power consumption < 500 mW @ 33 MHz



OBDH SYSTEM USING GRLIB BLOCKS AND RTAX FPGAs



LEON3FT-RTAX SUPPORTED DEVICES

- LEON3FT-RTAX can be delivered in all Actel quality levels
- Hi-rel parts available in CQFP352 and CCGA624 packages
- Delivered as pre-programmed *off-the-shelf* component
- Low-cost prototypes in AX2000/FG896 also available

LEON3 OPERATING SYSTEMS

- LEON3 is supported by several open-source kernels:
  - eCos, RTEMS, Pthreads, uCLinux, Linux 2.6
  - GNU GCC-3.4.4 compiler and associated tools
  - Debugging based on GDB/DDD
  - Eclipse IDE available for RTEMS and Pthreads
- LEON Port and BSP available for VxWorks 5.4 and 6.X
- LEON Port and BSP available for ThreadX-5.0
- LEON Port and BSP available for Nucleus
- LEON Port and BSP for LynxOS will be released Q4 2008
- SW drivers available for SpW, 1553, CAN, Ethernet, PCI
- Windows and LINUX hosts