Product Brief

RC64 Many-Core DSP
64-Core High Performance Rad-Hard Single Chip Parallel DSP

General
RC64 is a many-core digital signal processor (DSP) enabling high performance computing in space. RC64 enables fine-grain parallelism, delivering linear scalability and near-linear speedup. RC64 integrates sixty-four 8/16/32-bit integer/floating-point DSP cores, each with 8-issue VLIW and up to 16-way SIMD operation and twenty operations per cycle.

RC64 includes an on-chip 4MB 256-port shared memory. Each core has direct access to shared memory, and can randomly and directly access it on every clock cycle. In addition, the processors contain a small private memory and write-through private instruction and data caches, eliminating coherency problems.

The 64 cores are managed at runtime by a hardware Synchronizer / Scheduler that automatically manages parallel tasks. It removes task management overhead from the cores and software, allocates tasks to the cores, enables nearly-perfect dynamic load balancing among the cores and facilitates task switching at a very high rate and very low latency. Allocated tasks are executed to completion before cores become available for new task allocation. Code and commands are downloaded into RC64 via two SpaceWire links or loaded from PROM.

A task-oriented programming model simplifies the conversion of serial code into parallel programs for RC64 and enables intuitive parallel programming of new applications by using standard C/C++ code and a task-mapping methodology to identify and map dependencies among tasks. A software development system for either Linux or Windows facilitates easy development, profiling and optimization of the code.

Preliminary Specifications
- Manufactured on 65nm CMOS
- Rad-hard RadSafe™ Ramon Chips technology
- Sixty-four 8/16/32-bit CEVA X1643 DSP cores
- Instruction cache, data cache and private memory per each core
- 300MHz clock frequency
- Each DSP core contains four flexible MACs, each processing one 32-bit or four 8/16-bit multiply-accumulate operations per cycle, facilitating total 76.8 (16-bit) GMAC/s
- VLIW cores enabling two load/store operations, two address modification operations, and up to 16 MAC operations, totaling 384 GOPS
- Sixty-four single-precision Floating Point Units
- Peak floating point performance 38.4 GFLOPS
- Modem and encryption accelerators
- Hardware synchronizer/scheduler
- 4MB shared data memory
- DDR3 memory controller with 32-bit + Reed-Solomon ECC at up to 800 MWords/s
- NAND flash controller 64-bit + Reed-Solomon ECC at up to 200 MWords/s
- Twelve high-speed serial links, 60 Gbit/sec I/O aggregate data rate, optimized for RC64-to-RC64 interconnect on same PCB
- Serial Rapid IO and SpaceFibre protocols
- 48 LVDS links at 800 MWords/s for ADC/DAC
- Two SpaceWire links for code, commands and data download and for status and data upload
- Twelve SpaceWire links for instruments data and control
- Pinout modes for NAND flash, LVDS, SpW
- Supports task-based parallel programming
- Power consumption: 7 Watts
- Package: 624 pins CCGA (optional PBGA)
- Temperature range: -55°C to +125°C
- Temperature monitoring and stabilization
- Radiation hardness:
  - TID 300Krad(Si)
  - SEL LET > 106 Mev/cm²/mg
  - SEU rate < 1E-12 per bit-day
  - EDAC protected on/off-chip memories
  - Detectors of SET, SEU and SEFI
  - Memory scrubbing

Planned Availability
Prototypes in 2016
EM in 2017
FM in 2018
**RC64 Applications**

RC64 is easily programmable using task-oriented programming model.

- High performance space computing is enabled by using a single RC64 or by clustering together multiple RC64 units on standard or customized boards and systems.
- High speed inter-chip links enable smooth exchange of data among the multiple RC64 chips.
- High capacity external DDR3 memories enable buffering and large data management.
- High bandwidth communications to other satellite systems such as sensors, antennae and telecommunications is enabled by interfaces to multiple standard SERDES interfaces.
- High bandwidth interfaces to ADC and DAC are designed to support high speed data I/O.
- High speed SpaceWire links enable control & data interface to standard space computers and instruments.

**Software Development Tools**

- Integrated development environment
  - Code editor
  - Compiler, assembler, linker
  - Many-core simulator
  - Debugger for simulator and hardware
  - Profiler
- Libraries
  - Libraries for frequently used functions
  - APIs for chip interfaces configuration and control
  - APIs for host control and monitoring

**Hardware Evaluation Platform**

- Based on DiniGroup DNV7F1A board
- Based on Xilinx Virtex7 2000-T FPGA

**Sample Applications**

**Communication satellites**

- Communication payload
- Digital/smart phased array antenna for communication and SAR satellites
- Flexible DVB-S2 and variations
- Communication jamming immunity
- Cyber protection
- Software defined radio
- IP routing in telecomm satellites
- Layers 4—7 network processing
- Deep packet inspection
- Transparent switching in telecomm satellites
- Regenerative switching in telecomm satellites
- Two-way high data rate flexible modems in telecomm satellites
- Digital beam forming
- Encryption & decryption
- Data modulation & encoding for telemetry

**Earth observation, science and other satellites**

- Image compression in EOS
- Image processing in EOS
- Light stream image focusing
- Range processing
- Moving object identification
- Data exploitation
- Data fusion
- Mass Memory management & control
- Signal transforms
- Back propagation algorithms
- Autonomous formation space flight
- Collision alert and avoidance
- Space situation awareness
- Navigation receivers & correlators
- In-orbit interference detection
- Inter-satellite orbit determination
- Flash-based mass memory controller
- DDR3-based mass memory controller
- Cyber protection
Rad-hard RC64 many-core architecture: 64 cores, scheduler, shared memory and rich interfaces

PCB Architecture with four RC64 chips and analog interfaces
High-performance PCB, 16 high-speed interconnected RC64 units in a reprogrammable ensemble

Ramon Chips recommends its GR712RC dual-core rad-hard micro-processor for use as control CPU in RC64 systems. GR712RC is available from Aeroflex Gaisler (www.gaisler.com)