SPECTRUM SIGNAL PROCESSING

SDR-3000 Series

Software Defined Radio Transceiver Platform

cPCI

flexComm

Benefits

- Ultra high performance wireless processing engine
- Industry standard form factors allow easy integration with third party components
- Industry standard software APIs help preserve your software investment
- Fully re-programmable hardware allows pure software defined radios to be realized
- Dataflow optimized for software defined radio
- Designed to meet high availability requirements
- Modular design addresses multiple software defined radio applications
- Allows optimal partitioning of algorithms across FPGAs and signal processors
- Available as Integrated Development Systems (IDS), for rapid development

Applications

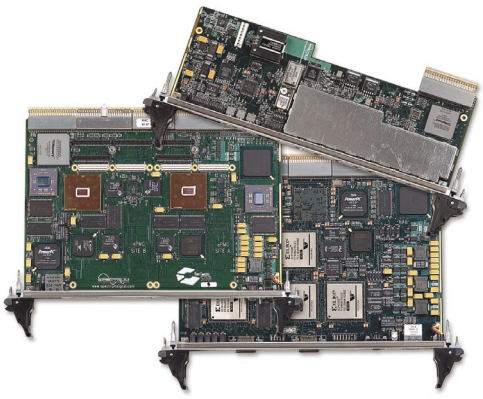
- Military communications (e.g. JTRS)
- Wireless intelligence and surveillance
- Electronic warfare
- Commercial wireless gateways
- Wireless test and measurement
- Wireless prototyping
- Beam forming and Smart Antennas

Features

- CompactPCI®-based architecture
- Combines Xilinx® Virtex-II FPGAs and PowerPC™ MPC7410 G4s, and optionally TI TMS320C64X DSPs, in a single system
- Supports IF sampling rates up to 212 MHz
- Supports 2-4 ADC channels and 2-4 DAC channels per slot
- *flex*Fabric - Serial RapidIO™-based switched fabric connects all boards with deterministic, low-latency 320 MB/s data paths
- Supports up to 1000 simultaneous transmit and receive communication channels per chassis
- Includes optional SCA core framework
- Supplied with full CORBA support (TAO)
- Supports the VxWorks® RTOS on every PowerPC node
- Supports Spectrum's *quic*Comm API for high-performance interprocessor communications and board setup/control
- Supports VSI/Pro, a VSIPL-compliant vector and image processing library optimized to the PowerPC G4
- Supports *quic*Wave for PowerPC, a powerful set of wireless application building blocks

Description

SDR-3000 is the latest in Spectrum's family of *flex*Comm platforms, designed specifically for the implementation of high-performance and/or high-density software defined radios. SDR-3000 supports hundreds of simultaneous transmit and receive channels, each with an independent air interface protocol. Virtually any air interface can be supported by SDR-3000, making it ideally suited for defense programs such as software defined military communications programs, signals intelligence, as well as commercial applications including cellular base stations, spectrum monitoring, test and measurement.



Hardware

The SDR-3000 hardware consists of a series of cPCI-based boards, including:

- PRO-3100: a front-end processing board supporting four user-programmable Xilinx Virtex-II FPGAs.
- PRO-3500: a signal processing board supporting two PowerPC G4 processors, up to two additional G4 or 'C64X procesors, and/or additional I/O.
- TM1-3300: an analog I/O board supporting four 80 MHz ADCs and four 160 MHz DACs.
- TM1-3350: an analog I/O board supporting two 212 MHz ADCs and two 212 MHz DACs.
- TM1-3902: an I/O reference design and high-performance digital I/O solution.

All boards are designed for use in high availability applications.

In order to achieve optimal dataflows, the following standard interconnects are used:

- All FPGAs and G4 processors are connected via *flex*Fabric, a serial RapidIO-based switched fabric that allows virtually any dataflow to be achieved when working with high-data rate front-end processing.

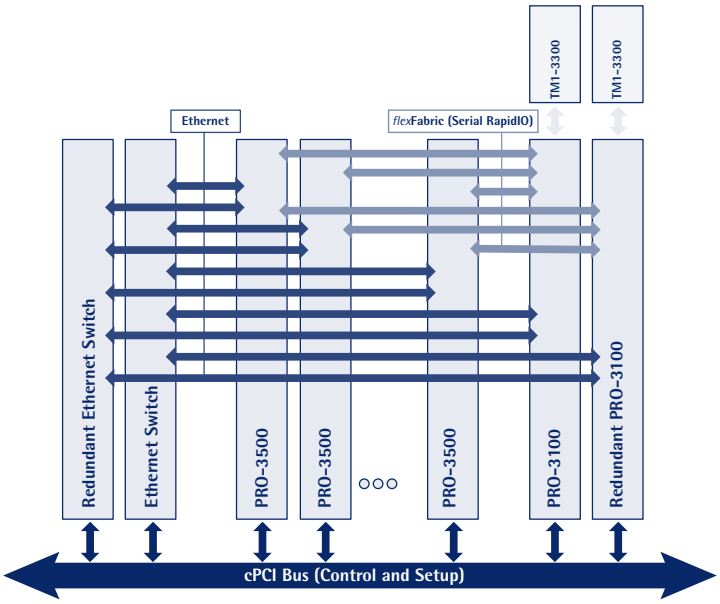


Figure 1. Example SDR-3000 Configuration (high availability)

- All processing boards (PRO-3100 and PRO-3500) are connected via a PICMG 2.16 switched Ethernet backplane, allowing simple network integration, efficient integration of development tools, and an efficient data path for lower speed payload data.
- Both the PRO-3100 and PRO-3500 have standard cPCI interfaces, allowing simple integration with any third-party cPCI boards, and an efficient control path that is independent from the data path.

These concepts are illustrated in Figure 1.

[PRO-3100]

The PRO-3100 is a cPCI board with four user-programmable Xilinx Virtex-II FPGAs, and is ideal for very high data rate front-end processing. These can support:

- Up to 160 narrowband down converter channels of 2 MHz bandwidth or less, or
- Up to 40 wideband channels of 40 MHz or less

The PRO-3100 contains a user-programmable embedded PowerPC 405GP controller to offload system control from the FPGA processors, which can then be dedicated to signal processing. It also provides a seamless network interface.

The following summarizes the external interfaces on the PRO-3100 board:

- TM1 interface (to the TM1-3300) – can handle 8 simultaneous 80 MSPS channels
- *flex*Fabric interface – supporting up to six 320 MB/s full-duplex switched fabric links
- PICMG 2.16 compliant switched Ethernet
- 66 MHz, 32-bit PCI via cPCI backplane

For more information on the PRO-3100, please see the PRO-3100 datasheet.

[PRO-3500]

The PRO-3500 is a signal processing engine with two PowerPC G4 processors, and support for two ePMC modules. Up to two additional G4s or additional I/O can be supported via additional ePMC modules.

The PRO-3500 contains a user-programmable embedded PowerPC 405GP controller to provide networking support, and to offload system control from the PowerPC G4 processors, which can then be dedicated to signal processing.

The following summarizes the external interfaces on the PRO-3500 board:

- *flex*Fabric interface – supporting up to two 320 MB/s full-duplex switched fabric links
- PICMG 2.16 compliant switched Ethernet
- 66 MHz, 32-bit PCI via cPCI backplane
- ePMC module sites: ePMC modules are PMC modules that are equipped with Solano~link ports to move high-speed data to the PRO-3500 via an additional connector. Four dedicated, full-duplex 200 MB/s data paths between the PRO-3500 and the ePMC module are supported. For more information on the PRO-3500, please see the PRO-3500 datasheet. Spectrum's ePMC-PPC and ePMC-8311 ('C64X) modules are currently supported.

[TM1-3300]

The TM1-3300 is a cPCI transition module supporting four 80 MHz ADCs and four 160 MHz DACs, for interfacing to any commercial RF front-end unit with an analog IF, or a baseband signal interface.

For more information on the TM1-3300, please see the TM1-3300 datasheet.

[TM1-3350]

The TM1-3350 is a cPCI transition module supporting two 212 MHz ADCs and two 212 MHz DACs, for interfacing to any commercial RF front-end unit with an analog IF, or a baseband signal interface.

For more information on the TM1-3350, please see the TM1-3350 datasheet.

[TM1-3902]

The TM1-3902 is both a reference design that facilitates the design of custom I/O as well as a high performance digital I/O solution for SDR-3000 systems.

For more information on the TM1-3902, please see the TM1-3902 datasheet.

[*flex*Fabric]

All signal processing devices, including FPGAs, G4's and 'C64X's, are connected via *flex*Fabric, a serial RapidIO-based switched fabric that allows virtually any dataflow to be achieved when working with high-data rate front-end processing. *flex*Fabric supports the following specific features:

- *flex*Fabric - Serial RapidIO-based switched fabric connects all boards with deterministic, low-latency data paths that can sustain payload data rates of 320 MB/s (full-duplex). A wide variety of application-specific topologies can be created using different backplanes and backplane overlays.
- Packet switches are built into the PRO-3100. This allows use of passive backplanes, eliminating the backplane as a single point of failure in high availability systems.

[Ethernet]

Both the PRO-3100 and PRO-3500 support 100 Mbps Ethernet via either of:

- PICMG 2.16 compliant CompactPCI Backplane
- Front panel

Software

SDR-3000 features a standards-based software stack, providing performance, code portability, and allowing choice with respect to which components are used in an application.

[TAO CORBA]

CORBA (Common Object Request Broker Architecture) is an industry standard means of developing distributed, multiprocessor, multi-OS, multi-vendor software systems.

Every PowerPC processor in the SDR-3000 platform is supplied with an Object Request Broker, or ORB, to facilitate CORBA development if required. Although different variants of CORBA are commercially available from various vendors, Spectrum selected the TAO open-source ORB due to its ideal combination of level of industry adoption, performance and price.

Although TAO CORBA is supplied as standard, its actual use is completely optional, and software applications can be built on the VxWorks and *quic*Comm layers.

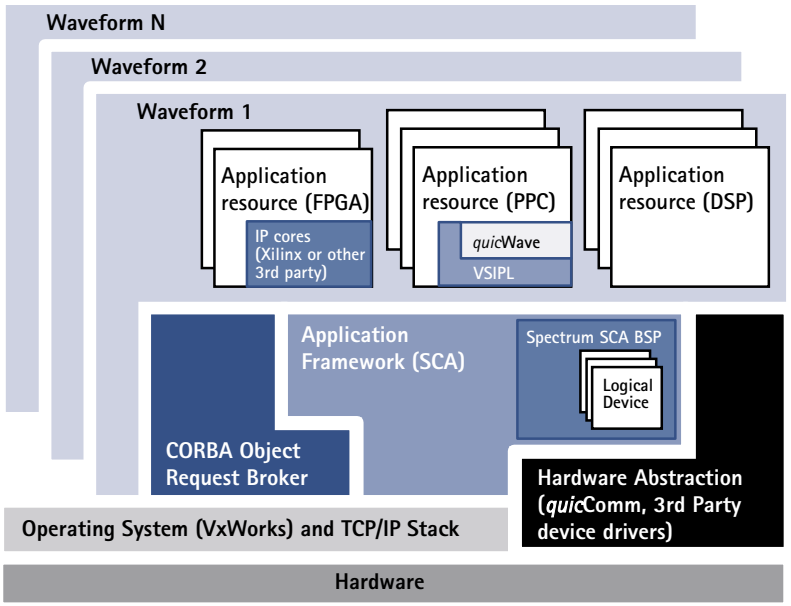


Figure 2. SDR-3000 Software Stack

[VxWorks and Tornado]

VxWorks, from Wind River Systems, is the leading real-time operating system in the embedded marketplace. The SDR-3000 series product line supports VxWorks on both the G4 processors as well as the on-board embedded controllers (405GPs).

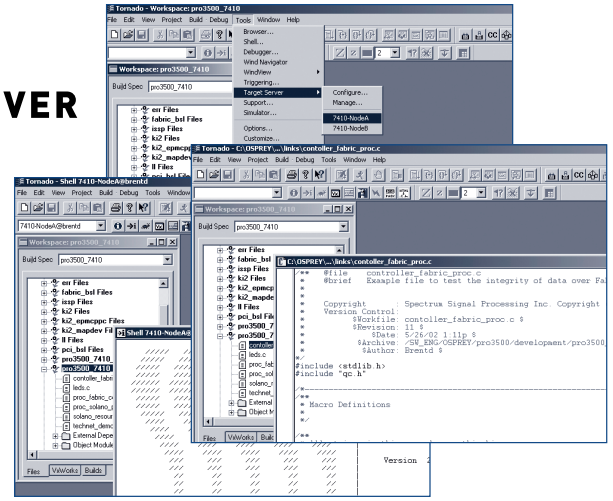
Features of the VxWorks RTOS include:

- Scaleable, high-performance wind® microkernel
- Advanced networking support
- File system and I/O management

VxWorks is bundled with the Tornado II development toolset from Wind River Systems, also available from Spectrum.
The package available from Spectrum includes:

- Win2000 development environment
- C/ C++ compiler
- Editor, debugger, simulator, launcher, browser
- The VxWorks operating system
- A choice of the supplemental development tools, including WIND®VIEW, VxSim, StethoScope, TraceScope, MemScope, ProfileScope, Real-time Visualisation Pack, CoverageScope, CodeTEST and Visual SlickEdit

WIND RIVER



[*quic*Comm]

*quic*Comm is Spectrum's high-performance library for all board-level functions. These include:

- High-performance interprocessor communication: *quic*Comm provides high-level software links and signals between all processors allowing a simple, yet extremely powerful programming model
- Booting functions for PowerPCs, user programmable FPGAs and 'C64X DSPs
- Flash programming tools for both the PRO-3100 and PRO-3500
- Control of all I/O not covered by the operating system (e.g. control of digital radio hardware)

*quic*Comm is available on all generations of *flex*Comm products released since 2000, and will be available on all future generations, allowing maximum code portability and reducing the learning curve.

[Software Communications Architecture (SCA)]

The SCA is an open specification sponsored by the Joint Tactical Radio System (JTRS) program. It specifies software, hardware, security, and networking architecture requirements for open, programmable Software Defined Radio (SDR) systems with flexible, re-programmable communication capabilities.

Specifically, the SCA specifies a common framework to build-up, configure, connect and tear down distributed, embedded radio applications while maximizing waveform portability.

Spectrum has partnered with Harris Corporation to provide a mature, fully functional SCA core framework, in conjunction with Spectrum's SCA BSP, which implements those portions of the SCA core framework specific to the SDR-3000.

For full details, please see the "Harris dmTK and Spectrum SCA BSP" datasheet.

[VSI/Pro]

Spectrum has partnered with MPI Software Technology to bring you VSI/Pro, a vector and image processing library, specifically optimized to the PowerPC G4.

The library is fully compliant with the VSIPL API standard, as published by the VSIPL forum, maximizing code portability via an efficient programming interface. For further details on the VSIPL forum, please see: www.vsipl.org.

VSI/Pro contains optimized functions for common signal processing tasks such as FFTs, FIR filters, dot products and trigonometric/algebraic functions.

Full details of VSI/Pro can be found at www.mpi-softtech.com.

[*quic*Wave for PowerPC]

*quic*Wave for PowerPC is a library of building blocks for the development of wireless modems (waveforms). These building blocks can be combined with user-defined and other *quic*Wave blocks to create a complete PowerPC-based wireless application.

Typical blocks would include modulation and demodulation, carrier recovery, symbol rate recovery, forward error correction (FEC) and decision circuits.

*quic*Wave for PowerPC is built on top of the VSIPL industry standard interface for signal processing functionality. This allows the library to be optimized to the PowerPC G4 Altivec engine simply by linking with VSI/Pro.

For full details, please see the *quic*Wave for PowerPC datasheet.

[FPGA Cores]

A comprehensive selection of FPGA cores is available, many of them free, from the Xilinx IP center at http://www.xilinx.com/ipcenter/index.htm.

These include both the Digital Downconverter (DDC) and Digital Upconverter LogiCOREs.

Please note that Spectrum routinely develops custom cores for clients when these are otherwise unavailable. If you have such a requirement, please contact your Spectrum sales representative.

Basic Package vs. Optional Extras

Note that developers can use as much or as little of this software stack as they choose. The following table illustrates which components are supplied as part of the basic SDR-3000 package vs. optional extras:

Basic SDR-3000 Software Package	Optional Extras
TAO CORBA (use is optional) *quic*Comm for all hardware VxWorks BSPs for all applicable hardware *quic*Wave for PowerPC	Tornado/VxWorks (specific components required unless already purchased) Xilinx ISE (required unless already purchased) VSI/Pro SCA Core Framework (dmTK and SCA BSP)

[Hot-Swap]

Future SDR-3000 releases will be PICMG 2.1 hot-swap compliant. Please contact your Spectrum Sales Representative for further information.

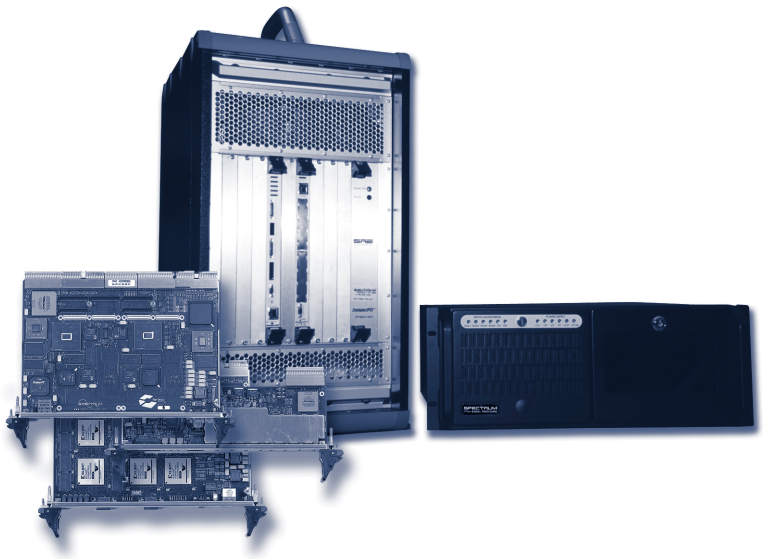
SDR-3001 Integrated Development System

In order to allow customers to begin developing immediately with minimal risk, Spectrum has made the SDR-3001 Integrated Development System available. The SDR-3001 IDS includes:

- One complete board set (PRO-3100, PRO-3500, and TM1-3300)
- A rackmount CompactPCI chassis
- 3-slot *flex*Fabric passive backplane, allowing a level of system expansion
- Tornado and VxWorks board support package
- *quic*Comm software
- *quic*Wave component libraries for PowerPCs
- TAO CORBA
- Windows 2000 development PC with all software tools installed and tested
- All necessary cables and documentation

Other hardware and software can be integrated into the SDR-3001 IDS according to your needs. These include but are not limited to:

- Tornado II / VxWorks 5.4
- FPGA cores for Virtex-II FPGAs
- VSI/Pro
- Additional PRO-3100, PRO-3500, TM1-3300, TM1-3350 or TM1-3902 boards



[Customer Training]

In order to accelerate early development efforts, Spectrum offers a unique customer training service, which can be purchased with any integrated development system (IDS).

The standard SDR-3000 training consists of three days of time with a Spectrum Applications engineer, working with actual hardware. An additional three day course covers the dmTK and SCA BSP, if this option is included. Alternatively a five day course is offered covering both SDR-3000 and the SCA components. Training typically consists of:

- Descriptions of over-all system functions and data paths
- Demonstrations of the Development Tools
- Training on how to run and rebuild software examples
- Formal training modules (presentations and hands-on)

Should you have any specific areas that need to be covered in greater detail these can be requested ahead of time (recommended), or at the training.

Experience thus far has shown this service to be an invaluable tool that generates significant cost savings and reduces risk for Spectrum customers.

Training can be done either at Spectrum's head office in Burnaby, B.C., Canada, or it can be done at additional cost at the customer site.

[Custom Application Development]

Spectrum has a long established capability in developing custom application software for its clients. Should you require all or part of your application code to be outsourced, please contact your Spectrum sales representative.

Specifications

(assumes 1xPRO-3100, 1xPRO-3500, 1xTM1-3300 or TM1-3350 or TM1-3902)

[general]	Form Factor	6U CompactPCI
	I/O	4 x A/D channels, 14-bit, 80 MHz, 4 x D/A channels, 14-bit, 80 MHz (with 2x interpolation to 160 MSPS), or
		2xA/D channels, 12-bit, 212 MHz, 2xD/A channels, 14-bit, 212 MHz, or
		I/O Reference design/Digital I/O, 640 MB/s bidirectional or 1500 MB/s input only
	Processors	4 x user programmable Xilinx Virtex-II FPGAs (XC2V6000 or XC2V3000)
		2 x PowerPC MPC7410 G4 on PRO-3500, plus additional 2 G4s or 'C64X's via ePMC sites
		PowerPC 405GP embedded controllers on both PRO-3100 and PRO-3500
[buses]	Host	CompactPCI bus: 32-bit /66 MHz
[external interfaces]	*flex*Fabric	*flex*Fabric Serial RapidI/O switched fabric for interboard communications. Six 320 MB/s links are supported on the PRO-3100 while two are supported on the PRO-3500.
	ePMC	Dual 33 MHz, 32-bit PMC sites with Solano enhanced capability
	Ethernet	10/100-BaseT Ethernet supported via either: PICMG 2.16 packet switched backplane or front panel
	Serial port	RS-232 ports of embedded controllers are routed to the front panels of the PRO-3100 and PRO-3500
	User-defined I/O	Sixteen user-defined pins from each Virtex-II FPGA routed to front panel
[performance]		Please consult individual board datasheets for block diagrams:
	Peak Data Transfer Rates	Between TM1 interface and each Virtex-II FPGA — 640 MB/s bidirectional or 1500 MB/s input
		Between Virtex-II processors — 376 MB/s
		From PRO-3100 to other boards via flexFabric — 320 MB/s per link
		Virtex-II to embedded controller — 10 MB/s
		Between PowerPC G4s via Solano — 200 MB/s
[software]		*quic*Comm, TAO CORBA, VxWorks, VSI/Pro, *quic*Wave for PowerPC
[environmental]	Temperature	Operating temperature range of 0 to 45 ˚C
[quality]	MTBF	100,118 hours
[ordering information]		You should contact your Spectrum Sales Representative for specific ordering information. You can expect to cover the following items:
	Development PC	Minimum specifications: 2.5 GHz Pentium-IV processor, 512 MB SDRAM, Windows 2000
	Hardware	Configurations can be constructed from a combination of chassis, PRO-3100, PRO-3500, TM1-3300, TM1-3350, TM1-3902 and *flex*Fabric backplane.
	SDR-3000 Base Software and Documentation	Includes *quic*Comm software for all SDR-3000 series boards, plus *quic*Wave, VxWorks BSP's and ACE/TAO CORBA. Licensed on a per site, per project basis.
	Tornado/VxWorks	Tornado/VxWorks is ordered on a development seat basis (per developer), plus an OEM license (per processor type). 7410 and 405GP PowerPC processors require separate OEM licenses. All pricing includes first year maintenance, while run-time licensing applies (per processor) for production systems only.
	SCA Core Framework	The SCA core framework comprises Harris dmTK and Spectrum's SCA BSP. The dmTK is licensed on a per developer basis while the SCA BSP is licensed on a per project, per site basis.
	VSI/Pro	VSI/Pro is ordered on a development seat basis and is optional. Run-time licensing applies (per processor), for both development and production systems.
	Xilinx ISE	Xilinx ISE 6.1 is recommended for FPGA development, and can be ordered from Spectrum as an option. ModelSim 5.8 PE with both VHDL and Verilog licenses is required to use the supplied simulation environment.
	Training	Initial SDR-3000 and SCA orders require compulsory training, either at Spectrum's headquarters or at your site. Options include: SDR-3000 training (3-days), SCA training (3-days) and combined SDR-3000/SCA training (5-days).
[custom configurations]		For custom configuration options, please contact Spectrum Sales

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SPECTRUM SIGNAL PROCESSING

Rev 05/04

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