

SDR-3000 Series

Software Defined Radio Transceiver Subsystems



Preliminary





- Ultra high performance wireless processing engine
- Supports signal bandwidths in excess of 32 MHz
- 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
- Comprehensive algorithm libraries available
- 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, ACN, WIN-T, FCS Comms, FAB-T, Advanced EHF SatCom, JSF Communications), Wireless intelligence and surveillance, Commercial wireless (e.g. Satellite gateways, 3G cellular base stations), Wireless test and measurement, Wireless prototyping

Features

- CompactPCI[®]-based hot swap architecture
- Supports up to 1000 simultaneous transmit and receive communication channels per chassis
- Combines Xilinx Virtex-II FPGAs and PowerPC[™] MPC7410 G4s in a single system
- Supports 4 ADCs (80 MHz) per slot
- Supports 4 DACs (160 MHz) per slot
- *flex*Fabric Serial RapidIO[™]-based switched fabric connects all boards with deterministic, low-latency 320 MB/s data paths
- All hardware and software is 100% SCA compliant
- Supplied with full CORBA support (TAO)
- Supports the VxWorks[®] RTOS on every PowerPC node
- Supports Spectrum's quicComm 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 quicWave 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 JTRS, WIN-T, Adaptive C4I Node, Future Combat System, FAB-T and Advanced EHF Satcom, as well as commercial applications such as cellular base stations, spectrum monitoring, and test and measurement.

Hardware

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

- TM1-3300: an analog I/O board supporting four 80 MHz ADCs and four 80 MHz DACs
- PRO-3100: a front-end processing board supporting four user-programmable Xilinx Virtex-II FPGAs
- PRO-3500: a signal processing board supporting up to four PowerPC G4 processors, and/or additional I/O

All boards are designed for hot swap allowing use in high availability applications.

In order to achieve optimal data flows, 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.
- 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:

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

[TM1-3300]

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

The DACs also contain 2x interpolation filters (to 160 MSPS), which allows direct generation of 70 MHz IF signals.

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

[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.
- flexFabric 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 data sheet.

[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:

- flexFabric 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 data sheet.

[flexFabric]

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. *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). Up to 7 PRO-3100 and PRO-3500 boards can be connected in any combination.
- Packet switches are built into PRO-3100. This allows use of passive backplanes, eliminating the backplane as a single point of failure in high availability systems.

Spectrum is a member of the PICMG working group that is setting the various RapidIO standards, and will ensure that the SDR-3000 platform conforms to the latest specifications as they evolve.

[Ethernet]

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

- PICMG 2.16 compliant CompactPCI Backplane
- Front panel

Software



Figure 2. SDR-3000 Software Stack

[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 SDR-3000 subsystems 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.

[VxWorks]

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 development environment, a comprehensive set of tools ideally suited to embedded, real-time development. For more information, please see the "Tornado development environment" section.

VxWorks board support packages (BSPs) for all appropriate hardware PowerPC systems are available from Spectrum.

[quicComm]

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

- High-performance interprocessor communication: quicComm provides high-level software links and signals between all processors allowing a simple, yet extremely powerful programming model
- Booting functions for PowerPCs and user programmable FPGAs
- 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.

[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.

[quicWave 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.



Figure 3. Waveform (wireless modem) - PowerPC processing portion

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 the Digital Down Converter (DDC) LogiCORE: This can perform both narrowband and wideband down conversion and has been verified to work on the PRO-3100.

A Digital Upconverter (DUC) will be made available by the end of 2002. For more information, please contact your Spectrum sales representative.

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.

[Tornado Development Environment]

Tornado II is the VxWorks development toolset from Wind River Systems, and is available from Spectrum as an optional package. The package available from Spectrum includes:

- WinNT or Win2000 development environment (specified by customer)
- C or C++ compiler (specified by customer)
- Editor, debugger, simulator, launcher, browser
- VxWorks OS
- WindView[™], a tool enabling the dynamic task execution to be viewed in real time
- PerformancePak[®], an add-on tool providing dynamic execution profiling and memory leak detection
- ScopePak, an add-on tool allowing variables to be viewed and plotted in real time
- In a typical SDR-3000 system, VxWorks will run on:
- The PowerPC 405GPs (embedded controllers) on both the PRO-3100 and PRO-3500



- The PowerPC G4s (signal processors) on the PRO-3500, and any installed ePMC-PPC modules
- 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)	Tornado/VxWorks (specific components required unless already purchased)
quicComm for all hardware	VSI/Pro
VxWorks BSPs for all applicable hardware	quicWave for PowerPC

Future direction s

This section illustrates the future direction of the SDR-3000 product family. Although these product enhancements are not yet available for order, you should contact your Spectrum sales office if you require any of them:

[Customizable System Configurations]

The early development product consists of SDR-3001, a fixed system configuration designed to allow rapid development within a controlled environment. In future, boards can be ordered separately, and customers will be able to install them into their own chassis.

[SCA Core Framework]

The SDR-3000 product family is fully compliant with the SCA (Software Communications Architecture) as propagated by the US DoD and adopted by the international SDR Forum.

Future releases of the SDR-3000 product family will include a complete SCA Core Framework, in accordance with the latest specifications released by the US Joint Program Office (JPO) and Object Management Group (OMG). Spectrum is a member of the SDR Forum and is actively involved in the development and commercialization of the SCA.

[Linux Support]

Future releases of SDR-3000 will allow customers to choose between the VxWorks and Real-time Linux operating systems.

[Larger Virtex-II FPGA Sizes]

The PRO-3100 board has been designed to accommodate the larger Virtex-II sizes, such as the XC2V8000, as they are released by Xilinx.

[Support for Other I/O]

Additional analog and digital I/O will be added to the SDR-3000 product line over time. This will include Spectrum's standard range of ePMC modules, which are compatible with the PRO-3500. In addition, a TM1 reference design will be published in order to allow Spectrum's customers to design their own I/O, for use with the PRO-3100 and/or PRO-3500 platforms.

Please note that Spectrum routinely designs custom I/O for its clients.

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 (TM1-3300, PRO-3100 and PRO-3500)
- A rackmount CompactPCI chassis
- 3-slot *flex*Fabric passive backplane, allowing a level of system expansion
- Tornado and VxWorks board support package
- quicComm software
- TAO CORBA
- Industrial 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
- quicWave component libraries for PowerPCs
- FPGA cores for Virtex-II FPGAs
- VSI/Pro
- Additional PRO-3100, TM1-3300 or PRO-3500 boards



[Customer Orientation and Training]

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

The service consists of two days of time with a Spectrum Applications engineer, working with the customer's actual development system. It 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)

If the customer has specific areas that need to be covered in greater detail these can be requested ahead of time (recommended), or at the orientation.

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

Orientation 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	(assu	umes 1xTM1-3300, 1xPRO-3100, 1xPRO-3500)	
[general]	Form Factor	6U CompactPCI		
10	Analog I/O	4 x A/D channels, 14-bit, 80 MSPS, 4 x D/A channel	els, 14-bit, 80 MSPS	
	Processors	s 4 x user programmable Xilinx Virtex-II FPGAs (XC2V1000/6000 options available)		
		2 x PowerPC MPC7410 G4 on PRO-3500, plus additional 2 G4s via ePMC sites PowerPC 405GP embedded controllers on both PRO-3100 and PRO-3500		
[buses]	Host	CompactPCI bus: 32-bit /66 MHz		
[]		Compliant with PICMG 2.1 hot swap specification		
[external interfaces]	flexFabric	flexFabric Serial Rapid I/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 or front panel	2.16 packet switched backplane	
	Serial port	RS-232 ports of embedded controllers are routed to and PRO-3500	ts of embedded controllers are routed to the front panels of the PRO-3100 500	
	User-defined I/O	Sixteen user-defined pins from each Virtex-II FPGA routed to front panel		
[performance]	Peak Data Transfer Rates	Between TM1 interface and each Virtex-II FPGA	640 MB/s	
		Between Virtex-II processors	400 MB/s	
		From PRO-3100 to other boards via flexFabric	20 MB/s per link	
		Virtex-II to embedded controller	10 MB/s	
		Between PowerPC G4s via Solano	200 MB/s	
[host requirements]	Host	Motorola CPV5350 (optional)		
[software]		quicComm, TAO CORBA, VxWorks, VSI/Pro, quicWave for PowerPC		
[environmental]	Temperature	Operating temperature range of 0 to 50 °C		
[quality]	MTBF	100,118 hours		
[ordering information]		Currently, the early development product can be ordered as follows: duct: 599-00073 SDR-3001 Integrated Development System AFED and one of: Training-010 2-Day Orientation/Training – Spectrum Burnaby Training-011 2-Day Orientation/Training – North America Training-012 2-Day Orientation/Training - World		
	Base product:			
	Optional: Tornado development seats (per developer) – chose one of: 100-00369 Tornado 2.X For WIN2K/C Pro. Dev. Seat + Ma 100-00366 Tornado 2.X For WIN2K/C++ Pro. Dev. Seat +		one of: at + Maintenance or, Seat + Maintenance	
		405GP and MPC7410 VxWorks OEM licenses (per processor type) – choose one "1st" and one "2nd" license from:		
		 100-00412 VxWorks OEM License (1st PPC 4XX) + Maintenance 100-00413 VxWorks OEM License (2nd PPC 4XX) + Maintenance 100-00368 VxWorks OEM License (1st MPC74XX) + Maintenance 100-00386 VxWorks OEM License (2nd MPC74XX) + Maintenance 		
		VSI/PRO development seats (per developer) and runtime licenses (per target processor): 100-00391 VSIPL: MPI VSI/Pro Devst w/1yr 20% Main 100-00394 VSIPL: MPI VSI/Pro RTL (per proc) w/1yr 20% Main		
		quicWave for PowerPC project license (per project) and runtime license (per target processor): 100-00387 quicWave for PowerPC and Project License		
		109-00023 quicWave for PowerPC RTL (per processo	or)	
		SDR-3001 Development PC Industrial PC, with the following minimum specs:		
		controller slot, 1 PICMG SBC, with 1 GHz Pentium-III processor, 256 MB SDRAM Windows 2000		
[availability]		June 2002		
[custom configurations]		For custom configuration options, please contact Sp	ectrum Sales	

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