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PowerPC™

7410

Single Board Computer

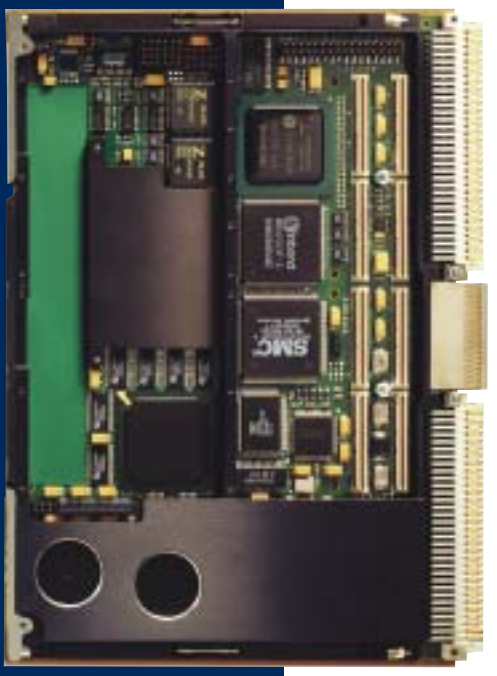
PPC4B

PowerXtreme™

POWER PC PROCESSOR

High Performance Air & Conduction-Cooled SBC

3rd Generation PPC4x with 64 bit 66 MHz PCI



- 7410 PowerPC Processor
- 64 bit 66 MHz PCI bus
- 100 MHz Main Memory Bus
- 200 MHz L2 Cache Bus
- CHRP based architecture
- 5 Air and Conduction-Cooled Ruggedization Levels
- Standard 6U form factor
- Radstone Software Support
- Key Features
  - PowerPC Processor with 2 Megabytes (MB) L2 Cache
  - Up to 192 MB 64 bit wide FLASH
  - Up to 512 MB SDRAM with EDC
  - 10/100 BASE-T or 10 BASE-5 Ethernet
  - Up to 4 serial ports/1 parallel port
  - 2 PMC slots
  - HW & SW Configuration Management
  - BSP's and ESP's for VxWorks and LynxOS
  - Radstone SilverChip and BIT

Product Overview

PPC4B is an integral member of Radstone's PowerXtreme family of PowerPC based Single Board Computers (SBCs). PPC4B combines high performance PowerPC processors with the same rich feature set of the previous SBCs in the PowerXtreme family, first introduced by Radstone in 1995.

This ultra high performance board features the latest PowerPC 7410 processor, SDRAM with Error Detection and Correction and a dedicated L2 Cache bus. The high data rates required to support PPC4B's advanced processors are satisfied by a 64 bit PCI bus clocked at 66 MHz, a 200 MHz Cache bus, and a 100 MHz memory bus.

Software support includes Radstone Built-In-Test (BIT) and SilverChip Firmware as well as Board Support Packages (BSPs) and Enhanced Support Packages (ESPs) for VxWorks/ Tornado from WindRiver Systems and LynxOS from LynuxWorks.

Radstone's clearly defined PowerPC roadmap protects investment in application software by maintaining a standard functional envelope with a clear performance upgrade path. This strategy for technology insertion enables maximum hardware and software component reuse across multiple applications and programs.

Radstone's experience in manufacturing SBCs across 5 environmental ruggedization levels make their boards the clear choice for Systems Integrators and Defense OEMs serving the market for leading edge Naval, Land based and Airborne embedded computing platforms.

RADSTONE

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Features	Advantages / Benefits	
Latest 7410 PowerPC Processor	High processor performance to satisfy high end processing and lower level DSP requirements	
100 MHz Main Memory Bus	Facilitates high bandwidth data rate between processor and main memory	Maximized bus bandwidths support the data rates of the latest Gbit network controllers, and the very latest processors, allowing customers to put together systems without data bottlenecks.
200 MHz L2 Cache Bus	Maximizes data transfer rate between Cache and processor	
2 MB L2 Cache	Maximizes utilization of fast Cache bus	
Full Snooping supported	Maximizes use of Cache and reduces memory bus use	
Up to 192 MB 64 bit wide FLASH	A wide range of FLASH capacities from which application code can be run directly	
64 bit 66 MHz PCI bus	High bandwidth facilitates high data transfer rate between PMC's and processor / memory	
2 PMC expansion slots	System Expansion using IEEE P1386.1 standard single or double width PCI Mezzanine Cards (PMCs)	
Radstone Software Support	COTS BIT, SilverChip firmware and BSPs / ESPs for VxWorks, LinxOS, Linux	
Radstone Configuration Management	Unique part number system requiring customer notification / approval for changes in product revision status	
Radstone SW Maintenance	Automatic SW revision updates and technical support	
5 Ruggedization Levels	Air and conduction-cooled Ruggedization Levels from industrial to full rugged allow widest system choice	

Processor

PPC4B supports the PowerPC 7410 microprocessor. The standard Radstone architecture provides a stable platform, facilitating development of high performance solutions today, while anticipating introduction of the very latest technology upgrades as soon as they enter production.

The 7410 features Motorola's AltiVec technology with it's 128 bit wide vector unit, demonstrating a new level of capability in handling the ultra-high bandwidth and computational demands of today's - and tomorrow's – demanding applications. AltiVec technology, as embodied on PPC4B, allows users to develop systems offering unprecedented performance.

Memory

Up to 512 Megabytes (MB) of SDRAM with EDC and 192 MB of 64 bit wide FLASH memory are supported by the MPC107 memory controller. The MP107 enables high speed memory accesses on a 64 bit data bus running at 100 MHz. Full snooping support is also offered, maximizing use of Cache which is accessed on a 200 MHz Level 2 Cache bus.

The PowerSPAN PCI bridge implements a 64 bit 66MHz PCI bus, interfacing the processor to the two PMC expansion slots and a 32 bit 33 MHz PCI bus interfacing to the remaining I/O functions and utilities including the Universe II VME bridge.

Table 1: CPU Performance

CPU	Frequency	SPECint95 *	SPECfp95 *	CPU Typical (Watts) Consumption *	Power SBC Typical Power (Watts) Consumption †
7410 AltiVec	500	22.8	17.0	5.3	19

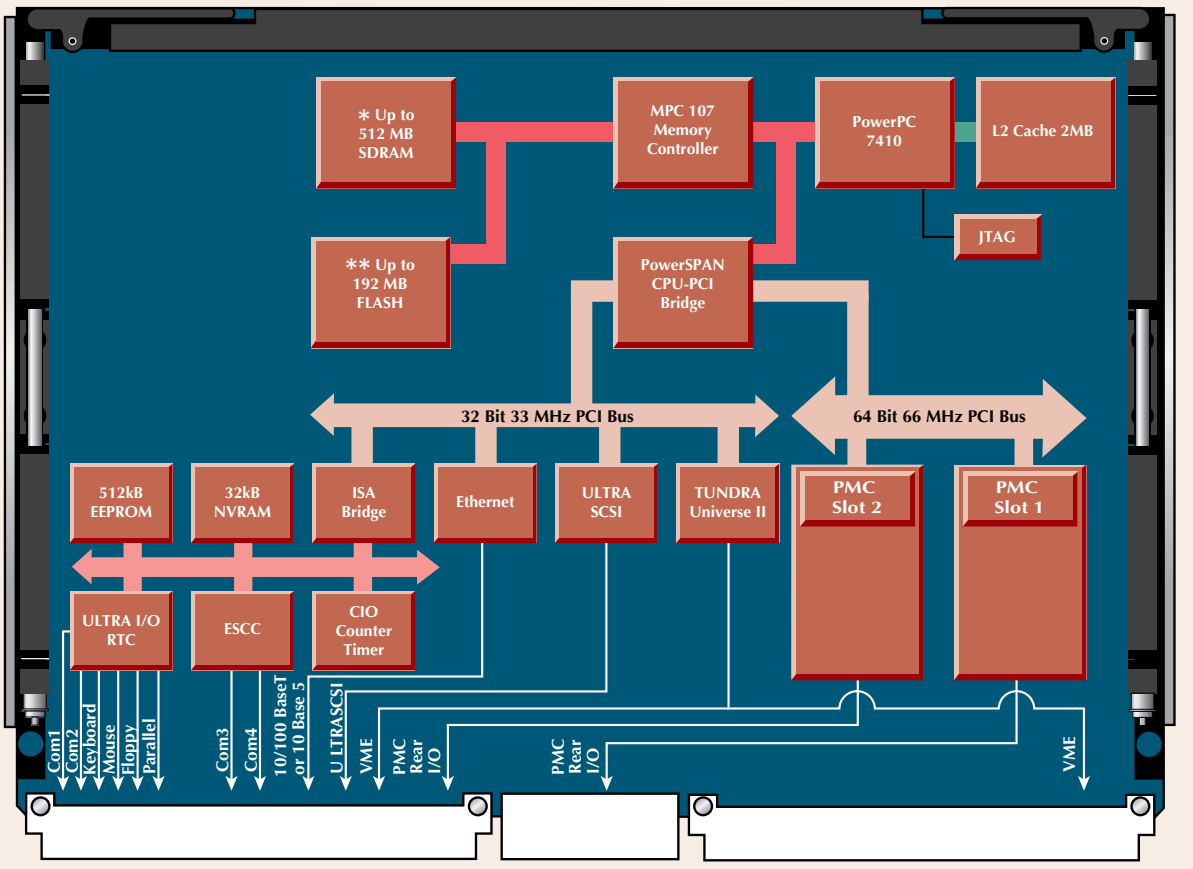
* Estimates of CPU performance & dissipation provided by PowerPC vendors. These figures are presented as a guide to illustrate relative CPU performance only. Radstone SBC performance may vary from these figures. † Actual power consumption may vary depending on the application and resource usage of the configured system.

Table 2: Memory Summary

Memory Type	Capacity	Comments
SDRAM Options	128 MB 256 MB, 512 MB	64 bits wide (all on-board)
FLASH Options	64 MB, 128 MB, 192 MB	64 bits wide (surface mounted)
Level 2 Cache	2 MB	Private backside L2 Cache bus at up to 200MHz
User E^2PROM	512 kBytes (kB) on the internal ISA bus	
Non-volatile RAM	32 kB SRAM with 32 kB shadow E^2PROM Autostore	

Table 3: PPZERO with the PPC4B

Function	Assembly Possibilities	PMC Slots	VME Slots
PMC extensions over PCI	PPC4B	2	1
	PPC4B/ PMCPCI/ P0CC1	3 to 9	2 to 5
Multi-processing over PCI	Combinations of PPC4B (or other PPCx boards) / PMCPCIM / PMCPCIS / P0CC1	1 per PPC4B 2 per P0CC1	2 to 5 2 to 5



*128 MB SDRAM fitted as standard. 256 MB or 512 MB can be fitted as a build option.
** 64 MB FLASH fitted as standard. 128 MB or 192 MB can be fitted as a build option.

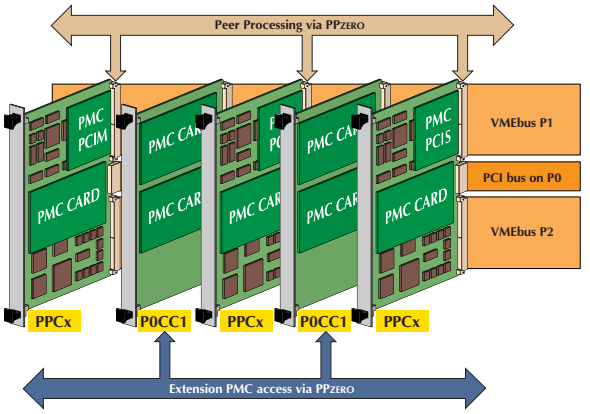
Figure 1: PPC4B Functional Block Diagram

PCI Sub-System

PPC4B supports two air or conduction-cooled PCI Mezzanine Cards (PMCs) with its on-board PMC slots but also supports PPzero, a Radstone solution providing for both high bandwidth peer multi-processing and extension PMCs.

PPzero is implemented by two Radstone half-PMC boards, the PMCPCIM and PMCPCIS which extend the on-board PCIbus over P0 of the VMEbus. In its simplest form, PPzero can support from 2 to 9 PMC's within a standard VME chassis using one PMCPCIM and a number of P0CC1 PMC carrier cards. In more advanced form, PPzero can facilitate multi-processing over PCI for maximum system flexibility, each system requiring one PMCPCIM plus one PMCPCIS per additional processor (see the P0CC1 and PPzero data sheet for more details).

Radstone can offer a wide range of PMCs for applications including Graphics, additional asynchronous and fast synchronous serial channels, Gigabit Ethernet, Fibre Channel, MIL-STD-1553, FLASH and CompactFlash Memory.



PPzero

- Provides high bandwidth access to peer main processor cards across PCI
- Genuine multi-processing, peers each see the other's main memory
- Standard O/S backplane driver models supported for VxWorks and LynxOS
- Also provides access for up to nine standard PMC cards within five VME slots
- Easy expansion at low incremental cost

Figure: 2 PPzero Diagram

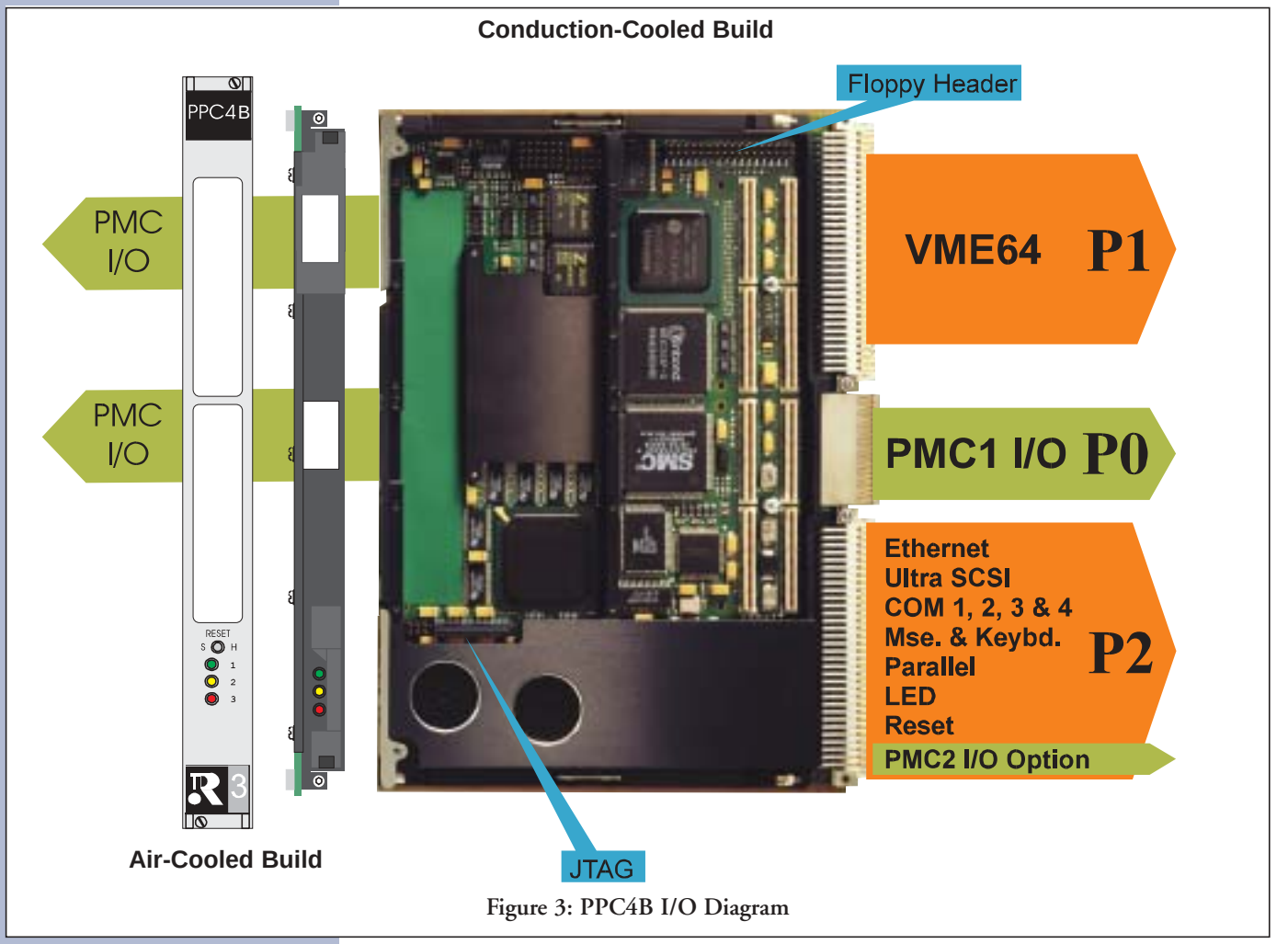


Figure 3: PPC4B I/O Diagram

Input/Output

PPC4B is designed to provide high-density rear I/O for systems requiring sealed box operation and simple card replacement routines for field maintenance and is fully I/O compatible with PPC4 and PPC4A . Front panel I/O is limited to the two on-board PMC slots (see Figure 3).

In order to maximize I/O density, PPC4B uses 5 row VME64 P1 and P2 connectors as well as a standard P0 connector for rear access to on-board PMC Slot1. PMC Slot2 may be configured to offer I/O on rows Z & D of the P2 connector. When this ruggedization option is specified, the COM 3 & 4 serial ports are no longer supported. Type B 95 way P0 connectors or Type A 80 way P0 connectors with guide pin and keying may be fitted for rear I/O for PMC slot 1. The required ruggedization option must be specified for all air and conduction-cooled ruggedization levels when placing your order. Please note that Type A and Type B connectors will not mate interchangeably with system backplanes of the opposite type.

Ruggedization Levels

PPC4B is available in Radstone's 5 environmental ruggedization levels (see table 5). Air-cooled variants are designed to be used in standard industrial VME chassis. Conduction-Cooled builds are for use in Radstone or third-party ATR style enclosures. In addition to these COTS configurations, PPC4B may be supplied to meet the mechanical and thermal requirements of specific platforms with the addition of mission specific, to-type mechanics.

Radstone uses advanced thermal and mechanical design in the printed circuit board, metal work and assembly process in order to build in the required levels of ruggedness. Ruggedization level 2 and higher circuit card assemblies include Conformal Coating as standard. The PPC4x family is a direct successor to PPC2A, which has been successfully tested to shock and vibration levels far in excess of our COTS level 4 and 5 ruggedization standards in order to meet the requirements of specific defense programs. These tests included 400g shock pulses and wing mounted Fast Jet Pod vibration environments.

Table 4: PPC4B Ruggedization Levels

Ruggedization Level	1	2	3	4	5
Cooling Method	Convection			Conduction	
Conformal Coat	Optional	Standard	Standard	Standard	
Low Pressure Operational	15,000ft	15,000ft	15,000ft	70,000ft	
Low Pressure Storage	50,000ft 5	0,000ft	50,000ft	70,000ft	
Rapid Decompression			0-50,000ft	0-70,000ft	
High Temp Operational	55°C @ 300ft/min	65°C @ 300ft/min	75°C @ 600ft/min	75°C	85°C
				At card edge	
Low Temp Operational	0°C	-20°C	-40°C	-40°C	
High Temp Storage	85°C	85°C	100°C	100°C	
Low Temp Storage	-40°C	-40°C	-50°C	-50°C	
Temperature Shock	10°C/min over Ts	10°C/min over Ts	10°C/min over Ts	10°C/min over Ts	
Humidity	95% non-condensing	95% 10cycles 240hrs	95% 10cycles 240hrs	95% 10cycles 240hrs	
Salt Fog			5% Salt 48Hrs	5% Salt 48Hrs	
Acceleration	13.5g	13.5g	13.5g	13.5g	
Vibration Sine	10-500Hz 2g	10-500Hz 2g	5-2000Hz 5g	5-2000Hz 5g	
Vibration Random	0.002g²/Hz from 10-2000Hz	0.002g²/Hz from 10-2000Hz	0.04g²/Hz with a flat response to 1000Hz. 6dB/Oct roll-off from 1000-2000Hz	0.1g²/Hz with a flat response to 1000Hz 6dB/Oct roll-off from 1000-2000Hz	
Shock	20g Peak Sawtooth 11mSec Duration	20g Peak Sawtooth 11mSec Duration	20g Peak Sawtooth 1mSec Duration Bench Handling	40g Peak Sawtooth 11mSec Duration Bench Handling	

Table 5: Hardware Technical Summary

Feature	Component	Comments
Processor	MPC 7410	500 MHz and beyond
Memory Controller	MPC 107	64 bit Memory bus clocked at up to 100 MHz supporting EDC
PCI Bridge	Tundra PowerSpan 2	Supports 64 bit 66 MHz PCI bus and secondary 32 bit 33 MHz PCIbus
SDRAM		128, 256 or 512 MB (all on-board)
FLASH ROM	EEPROM	64 MB surface mounted, 64 bit wide as standard (extendable up to 192 MB on-board) SW & HW write enable/disable
NVRAM	Simtek 14C88	32 kBytes (kB) SRAM with 32 kB shadow E²PROM and AutoStore
Level 2 Cache	SRAM	2 MB on backside L2 bus
User E2PROM	ATMEL 28C040	512 kB of non-volatile storage for user data
Ethernet	DEC 21143	10/100 BASE-T or 10 BASE-5 (10 BASE-2 with 3U transceiver module)
Ultra SCSI	Symbios 53C860	8 bit 20 Megabytes per second (MBps) synchronous
ISA Bridge	Winbond 83C553	7 Channel DMA, Timer & Interrupt Controller
Real-Time Clock	SMC FDC37C93X Ultra I/O	T.O.D/Calendar, configurable 16 or 32 bit timers. Backed up by VME 5VSTDBY
Watch Dog Timer		1.6 second interval
Parallel Port		IEEE P1284 compatible
Keyboard & Mouse		PS/2 compatible with Phoenix BIOS
Floppy Disk Controller		Available via on-board header
COM 1 & 2 (RS232)		INS8250N-B, PC16550A & PC16450 compatible
Timer Counters	Zilog 85C36 CIO	3 independent 16 bit timers with 333ns resolution. 2 of them may be linked to form a 32 bit counter/timer
COM 3 & 4	Zilog Z85230 ESCC	RS422/485 is standard. RS232 is available as a ruggedization option
VME64 to PCI Bridge	Tundra UNIVERSE'	64 bit VME, 32 bit 33 MHz PCI bus interface, Integral FIFOs, Programmable DMA controller, 70 MBps burst data transfer
VME Compliance:	Master / Slave	A16, A24, A32, ADO, ADOH A16:LCK, A24:LCK, A32:LCK D08(EO), D08(EO):RMW, D08(EO):BLT D16, D16:RMW, D16:BLT, D32, D32:RMW, D32:BLT, D64:MBLT, D32:UAT
	Interrupt Handler	D08(O), IH(1-7), I(1-7)
	Interrupter	SGL, RRS, PRI, BCLR* generation
	VMEBus Arbiter	ROR, RWD, early BSY* release, Bus capture & hold
	VMEBus Requester	IACK* daisy chain driver, SYSCLK driver
	Auto Slot ID	Slot 1 detector and Auto ID
Power Requirements		+5V (+5%, -2.5%), ±12V for PMC feed, +12V for Ethernet feed only on P2
Weight		Approximately 580 grams

Deployed Test Software

The PPC4B features the most effective deployed test strategy in the industry, highly adapted to the characteristics of modern COTS silicon and COTS operating systems (O/Ss). This strategy is implemented through our Built In Test (BIT) and Background Condition Screening (BCS) components.

To facilitate smooth technology insertion the object code modules, for BIT and BCS, run on all PowerX board family members of any age and variant produced since the family's inception in 1995.

Built-In-Test (BIT)

BIT provides an initialization test for all on-board functional areas of PPC4B. Highest possible coverage, 95%, is achieved by the use of intrusive testing, with BIT assuming exclusive use of device resources. BIT executes before any COTS O/S, and passes control to the O/S upon completion. Testing in conjunction with a COTS O/S is accomplished by BCS, see top of page.

BIT is a highly configurable component, with options for individual tests and sub-tests. System wide coverage to Radstone PMCs or other Radstone VME boards is handled. Custom tests for bespoke equipment can readily be added.

Test results are stored in FLASH for later analysis by the application, in addition to visual indication. Radstone BIT features 'Fast Start', whereby if BIT detects a state change of a particular backplane pin, it skips all tests. The backplane pin is usually connected to an electro-mechanical 'brown-out' detector.

Coverage methodology and proofs for PowerX boards are available. Please request our brochure "BIT coverage – a straightforward guide".

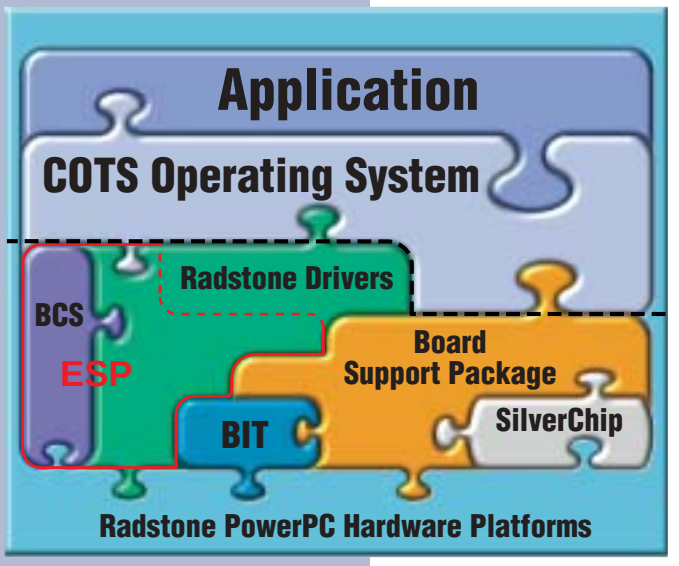


Figure 4: Software Support Model

Background Condition Screening (BCS)

BCS provides continuous, online health monitoring. It runs as a task thread, featuring non-intrusive tests that are specifically designed to be co-operative with the normal functioning of the COTS O/S that is running the application. In addition to providing minimal impact on system latency, this method avoids a difficulty that arises when 'calling back' into a traditional, stand-alone test firmware, written in ignorance of the O/S and probably assuming exclusive use of board resources. Such firmwares may not gaurantee the restoration of the entire and complex machine state as the O/S left it. BCS works chiefly through O/S mechanisms and doesn't compromise the machine state imposed by the O/S.

Radstone's BCS for VxWorks is downloadable or can be linked to the VxWorks O/S executable image. It can be launched from the VxWorks shell or from an application. Configuration can be static, via the Tornado Project Tool, or dynamic via an interactive menu.

Configurable parameters include the thread priority to run BCS at, plus various test options and other characteristics. An error log is stored in FLASH, in addition to visual indication of a detected failure. An application interface is provided for immediate invocation of individual tests in addition to the default running of tests in background mode.

- Logs and scrubs single bit errors
- Comprehensive main memory test. By dedicating small segments per bank for exclusive BCS usage, and in conjunction with ECC circuitry, all failure modes throughout all the memory can be detected without destructive action outside of the BCS segments.
- System and User background FLASH checksumming
- NVRAM checksum
- PCIbus error condition monitoring
- Preset PCI configuration verification
- Temperature monitoring (board and CPU)
- Temperature throttling
- Network connectivity
- SCSI connectivity
- Bus memory probing
- Real-Time clock test
- Global hardware register verification
- Tests of 8250-compatible COM port devices
- Altivec and FPU tests
- Custom tests can be integrated

Operating System Support

A number of of mission critical, real-time operating systems are supported on PPC4B:-

VxWorks; A highly scaleable and deterministic run-time system. Distributed backplane and networking support. Large base of third-party support. The PowerX BSP & ESP from Radstone both run PPC1A/2A/4/4A/6/7A from one object code.

LynxOS; Hard real-time Unix with full memory management support. Conforms to full POSIX standards. Features Linux binary compatibility at 4.0. The PowerX BSP & ESP from Radstone both run PPC1A/2A/4/4A/6/7A from one object code.

INTEGRITY; Maximum reliability, royalty-free real-time operating system. Support for Radstone boards including PPC1A/4/4A/6/7A is available direct from our technology partner, Green Hills Software Inc

WindRiver® SYSTEMS

VxWorks : Flexible, scalable run-time component adapts to broad range of mission-critical applications

VxWorks, the run-time component of the Tornado II embedded development platform, is the most widely adopted real-time operating system (RTOS) in the embedded industry. Tornado II also includes a comprehensive suite of core and optional cross-development tools and utilities, and a full range of communications options for the target connection to the host.

The VxWorks RTOS comprises the core capabilities of the WindRiver microkernel along with advanced networking support, powerful file system and I/O management, and C++ and other standard run-time support.

Radstone Board Support Packages (BSPs) provide hardware support for VxWorks exactly as defined by WindRiver. Radstone Enchanced Support Packages (ESPs) provide comprehensive hardware support additional to that defined by WindRiver, including DMA engine support, synchronous serial support, BCS, and more.

LYNUXWORKS™

LynxOS : Real-time Operating System based on open standards and featuring Linux binary compatibility

LynxOS 4.0 is the most open hard real-time O/S available today. Its native interfaces are those of Linux, UNIX and POSIX.

Summary: Hard real-time determinism; complete MMU based protected address spaces for tasks; Linux application binary interface (ABI) personality; Linux binaries run unchanged on LynxOS v4.0; Comprehensive POSIX API conformance 1003.1, .1b & .1c; LynxOS 4.0 also exhibits true linear scalability.

Radstone Board Support Packages (BSPs) provide hardware support for LynxOS exactly as defined by LynuxWorks. Radstone Enchanced Support Packages (ESPs) provide comprehensive hardware support additional to that defined by LynuxWorks, including enhanced VME functionality, extended FLASH support, synchronous serial support, and more.

INTEGRITY

INTEGRITY : A real-time O/S providing secure, maximum reliability operation for use in mission-critical embedded systems

The royalty free INTEGRITY RTOS uses hardware memory protection to isolate and protect itself, and user tasks, from incorrect operation caused by accidental errors or malicious tampering.

Without the burden of compatibility with 1980's vintage products, INTEGRITY was designed from the ground up for 32-bit and 64 bit embedded processors, and employs the latest in RTOS technology.

INTEGRITY achieves unprecedented levels of reliability, availability and serviceability for applications in tele-communications, defense, networking and medical equipment along with many other industries. BSPs for Radstone boards are available from our technolgy partner, Green Hills Software Inc.

PPC4B Standard Ordering Information

Sales Code	500 MHz PowerPC 7410 128 MB SDRAM / 64 MB FLASH
PPC4B-7410-1D10B0x	500 MHz PowerPC 7410 6U VME SBC, Level 1, 128 MB SDRAM, 2 MB L2 Cache, 64 MB FLASH, 512 kB EEPROM, RTC, 10/100 BASE-T, Ultra SCSI, Mouse & Keyboard I/F, Floppy, Parallel, 2 x RS232 & 2 x RS422 ports, 2 PMC slots, 5 Row P1 & P2 (no P0 fitted)
PPC4B-7410-2D10B0x	Air-cooled Level 2 as above with conformal coating
PPC4B-7410-3D10B0x	Air-cooled Level 3 as above with conformal coating
PPC4B-7410-4D10B0x	Conduction-cooled Level 4 as above
PPC4B-7410-5D10B0x	Conduction-cooled Level 5 as above

X=Software options

NOTE: The standard ordering information (above) defines the standard build variant. Consult your local Radstone sales office for availability of further build options.

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