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PowerPC™

755/7410
Single Board Computer

PPC6



PowerXpress™
POWER PC PROCESSOR

High Performance Air-Cooled SBC
With On-board Fibre Channel Option

- PowerPC Processors (755 & 7410 with AltiVec)
- 64 bit 66 MHz PCI bus
- High Bandwidth Main Memory Bus
- CHRP based architecture
- 2 Air-Cooled Ruggedization Levels
- Standard 6U form factor
- Radstone Software Support

Key Features

– PowerPC Processor with up to 2 Megabytes (MB) L2 Cache
– Up to 64 MB 64 bit wide User FLASH
– Up to 512 MB SDRAM with EDC
– 10/100 BASE-T or 10 BASE-5 Ethernet
– Front I/O for accessibility
– On-board Fibre Channel option
– 2 PMC slots
– Full Radstone software support including BIT, SilverChip, BSPs and ESPs for VxWorks and LynxOS

Product Overview

PPC6 is the latest addition to Radstone's PowerXpress family of PowerPC based Single Board Computers (SBCs), combining high performance PowerPC processors with the same rich feature set of previous SBCs in the PowerXpress family. As the direct successor to the popular PPC1A, PPC6 is ideal where **high performance and competitive cost** are required for service in the demanding environments found in many industrial, naval and vetronic applications.

This high performance board features either a Motorola 755 or 7410 processor, with SDRAM (with Error Detection and Correction) offering impressive sustained data transfer rates on a high bandwidth memory bus. The processor's demands for data are fully supported by a 64 bit 66 MHz PCI bus offering high data transfer rates between memory and the two on-board PMC sites.

PPC6 provides easily accessible front panel I/O and full functional compatibility with PPC1A, offering an optional audio interface in addition to the standard Radstone PowerXpress interfaces (SCSI, keyboard, mouse, floppy, parallel, Ethernet, 2 serial channels). An optional Fibre Channel interface offers additional high data rate I/O without having to use one of the PMC sites.

PPC6 follows Radstone's technology insertion strategy which offers a clear performance upgrade path by maintaining a standard functional envelope for its SBCs, protecting long-term investment in application software. Coupled with Radstone's 35+ years experience supplying rugged electronic systems for deployment in harsh environments, this makes Radstone's PPC6 the clear choice for Systems Integrators and Defense OEMs serving the market for leading edge embedded computing platforms.

RADSTONE
TECHNOLOGY

Features	Advantages	Benefits
PowerPC Processors (755 and 7410)	Access to two of the most performant processors currently available including the 7410 with its AltiVec core	High performance to satisfy high end processing and lower level DSP requirements
100 MHz Main Memory Bus	Facilitates high bandwidth data transfer 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	
1 or 2 MB L2 Cache (755/7410)	Maximizes utilization of fast Cache bus	
Full Snooping supported	Maximizes use of Cache and reduces memory bus use	
Up to 64 MB, 64 bit wide FLASH	Choice of FLASH capacities	A range of FLASH and SDRAM capacities offer the most cost effective and flexible memory solution
Up to 512 MB SDRAM	High capacity with low access times for high memory bandwidth	
64 bit 66 MHz PCI bus	Allows high data transfer between PMCs and processor/memory	Particularly suitable for applications requiring fast communication channels (Fibre Channel etc)
On-board Fibre Channel option	Available in addition to 2 PMC sites	
2 PCI Mezzanine card (PMC) sites	Allows system flexibility, particularly in conjunction with *PPzero* (PCI over P0)	Radstone's wide range of PMCs (Comms, Graphics etc.) combined with standard on-board I/O, offers widest range of I/O options
10/100 BASE-T Ethernet, SCSI, Parallel, 2 serial ports, audio	Range of I/O functions gives system flexibility	
2 Air-Cooled Ruggedization Levels	Designed for industrial and sheltered military applications	Performance upgrade path following technology insertion strategy. PPC1A compatibility, meeting exacting requirements without over-specification
Rear I/O on 5 row VME connectors	Compatible with pin-out of Radstone's PPC1A	
Front I/O	Easily accessible I/O for use in standard front I/O systems	
Radstone Software Support	COTS BIT, SilverChip firmware and BSPs and ESPs for VxWorks, LynxOS	Full hardware and software support for long term programs, satisfying the needs of real-world applications
Radstone Software Maintenance	Automatic SW revision updates and technical support	
Radstone Configuration Control	Unique part number system requiring customer notification or authorization for product changes	

Processors

PPC6 supports the PowerPC 755 and 7410 microprocessors using the standard Radstone architecture, which provides a stable platform for system integrators, allowing development of high performance solutions today, while anticipating introduction of the very latest technology upgrades as soon as they enter production.

The 755 is the latest in Motorola's 75x series of processors and features a range of embedded architectural enhancements, further augmenting its already impressive performance. 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 requirements of today's – and tomorrow's – demanding applications.

Memory

The CPU is interfaced to the main memory via a 64 bit data bus running at up to 100 MHz, supporting up to 512 Megabytes (MB) of SDRAM with EDC, up to 64 MB of 64 bit wide User FLASH and 16 MB of Boot FLASH. A 64 bit 66 MHz PCI bus interfaces the processor to the PMC expansion slots, with a 32 bit 33 MHz PCI bus interfacing to the remaining I/O functions and utilities including the VMEbus, via the Universe II bridge device.

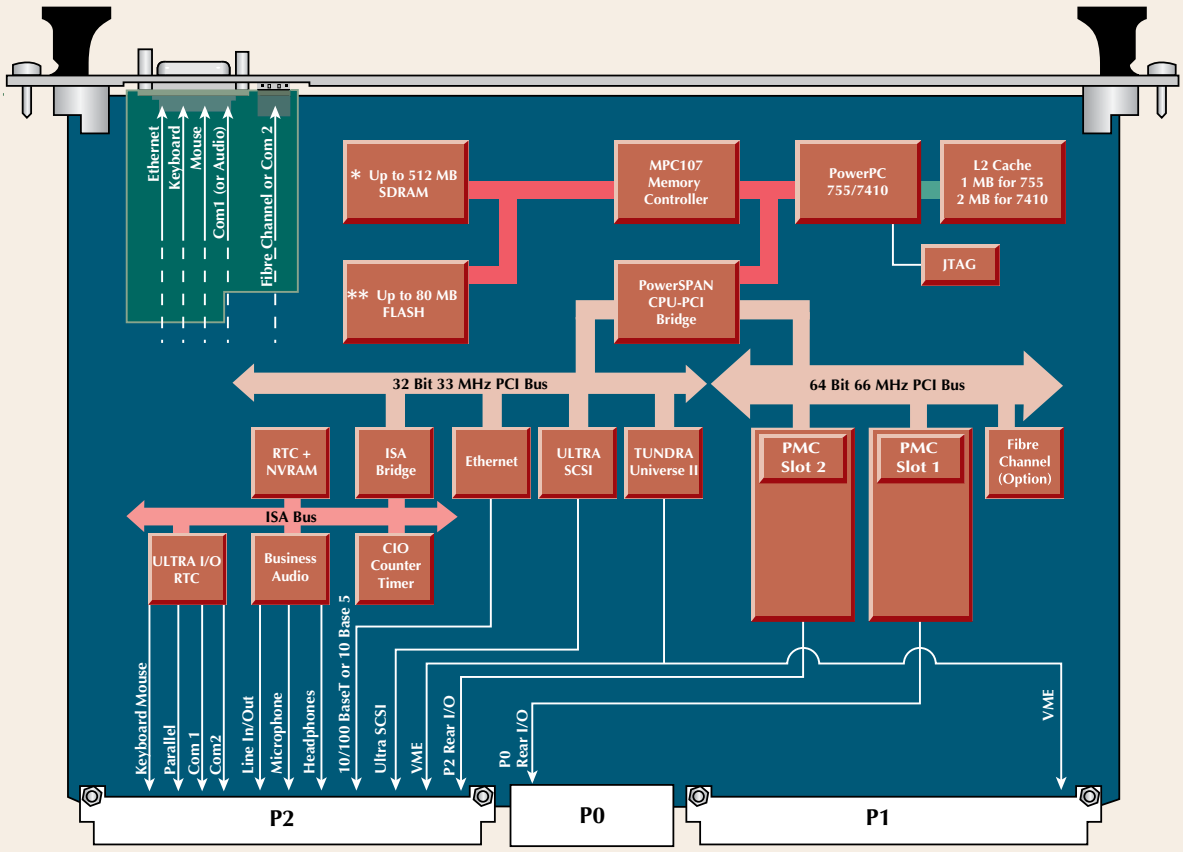
Table 1: CPU Selection

CPU	Frequency (MHz)	SPECint95 *	SPECfp95 *	CPU Typical (Watts) Consumption *	Power SBC Typical Power (Watts) Consumption †
755	400	18.8	12.3	4.5	18
7410 AltiVec	500	22.8	17.0	5.3	19

Note: *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, 256, 512 MB	64 bits wide (all on-board)
FLASH Options	BOOT: 16 MB	8 bits wide
	USER: 32 MB OR: 64 MB	32 bits wide 64 bits wide
Level 2 Cache	1 MB for 755 2 MB for 7410	Backside L2 Cache bus at up to 200 MHz
NVRAM	8 kB Battery Backed	



128 MB SDRAM fitted as standard. 256 MB or 512 MB can be fitted as a build option.

**16 MB Boot FLASH fitted as standard. 32 MB User FLASH fitted as standard, 64 MB can be fitted as a build option.*

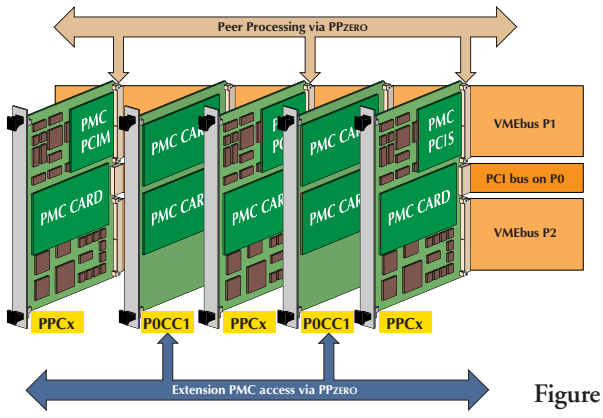
Figure 1: PPC6 Functional Block Diagram

PCI Sub-System

PPC6 supports two air-cooled PCI Mezzanine Cards (PMCs) with its on-board PMC slots. In addition, PPC6 also supports ***PPzero***, a Radstone solution providing for both high bandwidth peer multi-processing and extension PMCs, using a PCIbus routed over standard P0 capable VME backplanes.

Extension PMCs – a half size PMC board, the PMCPCI, can be used to extend the on-board PCIbus from any Radstone PowerPC, to be picked up by P0CC1 carrier cards, each of which support 2 PMCs. 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.

Peer multi-processing – two half PMC boards, the PMCPCIM and PMCPCIS can be used to extend the on-board PCIbus from any Radstone PowerPC, to be picked up by further Radstone processor boards, facilitating multi-processing over PCI for maximum system flexibility. Each system requires one PMCPCIM (master) and one PMCPCIS (slave) per additional processor. See the ***PPzero*** and P0CC1 data sheets for more details.



PPzero

- Provides high bandwidth access to peer main processor cards across PCI
- Genuine multi-processing, peers 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

Input/Output

The PPC6 is designed to provide both high-density Rear I/O and easily accessible Front I/O.

In order to maximize Rear I/O density, PPC6 features 5 row VME64 P1 and P2 connectors as well as a standard P0 connector for rear access to the on-board PMC Slot 1. Type A 80 way P0 connectors with guide pin and keying or type B 95 way P0 connectors may be fitted (specify type when ordering).

Front I/O is available from each of the two PMC sites and from three micro-D connectors mounted on the front panel. (This is reduced to two micro-D connectors plus a Fibre Channel connector, if the Fibre Channel option is selected). PPC6 also supports Radstone's FPX600-S front panel adapter which provides front I/O via industry standard connectors but occupies two VME slots. (see Radstone X600 manual for further details)

Optional Features

Fibre Channel – PPC6 can provide an optional rugged Fibre Channel adapter, suitable for accessing Fibre Channel fabrics in embedded systems, operating at data transfer rates up to 200 Megabytes per sec (MBps). Typical applications include radar and sonar processing, storage area networks (SANs), imaging, network backbones and high speed low latency data acquisition systems. Copper connectivity is offered via, easily accessible Front I/O.

Audio – PPC6 can provide an optional audio interface including Line In/Line Out, Microphone and Headphone, available via Front I/O.

Standard I/O

PPC6 provides a range of standard I/O features which are compatible with Radstone's PowerX range of SBCs. (See Table 3)

Table 3: Standard I/O

Port	Description	I/O Location
Parallel port	Centronics style printer port	Rear I/O
COM 1	RS232	Front or Rear I/O
COM 2	RS232/422/485 software selectable	Front or Rear I/O
Ethernet	10/100 BASE-T or 10 BASE-5	Front or Rear I/O
Keyboard and mouse	PS/2 compatible	Front or Rear I/O
SCSI	8 bits, 20 MBps	Rear I/O
Floppy	Floppy disk controller	Via on-board header

Note: PPC6 provides a range of standard I/O features which are compatible with Radstone's PowerX range of SBCs

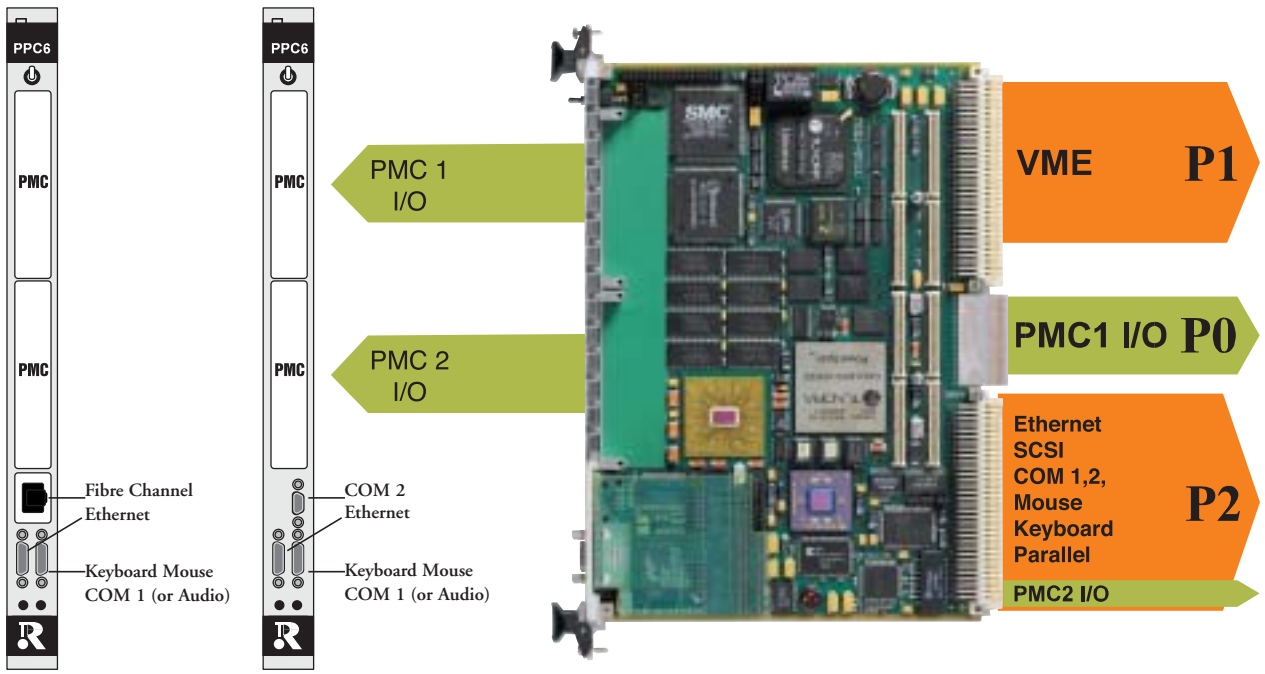


Figure 3: PPC6 I/O Diagram

Ruggedization Levels for PPC6

Available in 2 air-cooled ruggedization levels which offer options for extended temperature range and conformal coating. Designed to meet environmental requirements ranging from industrial to 'sheltered' military, which typically include many naval and vetronic programs.

Radstone have used advanced thermal and mechanical design techniques in the printed circuit board, metal work and assembly processes to achieve the required levels of ruggedization, while at the same time minimizing costs. This has resulted in a cost effective solution for real-world applications in the target market place.

Table 4: Ruggedization Levels

Ruggedization Levels	1	2
Conformal Coat	Optional	Standard
Low Pressure Operational	15,000ft	15,000ft
Low Pressure Storage	50,000ft	50,000ft
High Temp Operational	55°C @ 300ft/min	65°C @ 300ft/min
Low Temp Operational	0°C	-20°C
High Temp Storage	85°C	85°C
Low Temp Storage	-40°C	-40°C
Temperature Shock	10°C/min over Ts	10°C/min over Ts
Humidity	95% non-condensing	95% 10cycles 240hrs
Vibration Sine	5-500Hz 2g	5-500Hz 2g
Vibration Random	0.002g²/Hz from 10 2000Hz	0.002g²/Hz from 10-2000Hz
Shock	20g Peak Sawtooth, 11mSec Duration	20g Peak Sawtooth, 11mSec Duration

Table 5: Hardware Technical Summary

Feature	Component	Comments
Processor Options	MPC755	400 MHz
	MPC7410	500 MHz
Memory Controller	MPC107	64 bit Memory bus clocked at up to 100 MHz supporting EDC
PCI Bridge	PowerSpan2	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	Boot FLASH : 16 MB, 8 bits wide User FLASH : 32 MB, 32 bit wide as standard (extendible up to 64 MB, 64 bits wide). SW & HW write enable/disable
NVRAM	M48T18	8 kB battery backed SRAM
Real-Time Clock		T.O.D/Calendar battery backed
Level 2 Cache	SRAM	1 or 2 MB on backside L2 bus
Audio (Optional)	CS4231	16 bit CODEC, stereo headphone, microphone, line-in, line-out
Fibre Channel (Optional)	Qlogic ISP2200	Intelligent Fibre Channel processor, 200 MBps
Ethernet	DEC 21143	10/100 BASE-T or 10 BASE-5 (10 BASE-2 with 3U transceiver)
Ultra SCSI	Symbios 53C860	8 bit 20 MBps synchronous
ISA Bridge	Winbond 83C553	7 Channel DMA, Timer & Interrupt Controller
Watch Dog Timer	MAX706	1.6 second interval
Parallel Port	SMC FDC37C93X Ultra I/O	IEEE P1284 compatible
Keyboard & Mouse		PS/2 compatible with Phoenix BIOS
Floppy Disk Controller		Available via on-board header
COM 1 (RS232)		INS8250N-B, PC16550A & PC16450 compatible
COM 2 (RS232/422/485)		
Timer Counters	MPC107	4 independent 32 bit timers with 96ns resolution.
	Zilog 85C36 CIO	3 independent 16 bit timers with 333ns resolution. 2 of them may be linked to form a 32 bit counter/timer
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 and +3.3V for PMC feed, +12V for Ethernet feed only on P2
Weight		Approximately 400 grams

Deployed Test Software

The PPC6 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 the PPC6. 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."

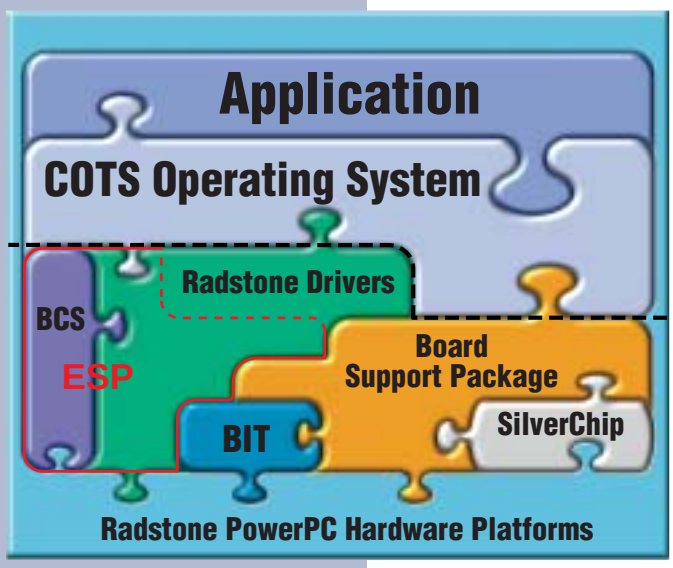


Figure 4: Software Support Model

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 PPC6:-

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 the 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, 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.

PPC6 Standard Product Options

	500 MHz PowerPC 7410 128 MB SDRAM
PPC6-7410-1412B0xx	500 MHz PowerPC 7410 6U VME SBC, Level 1; 128 MB SDRAM, 2 MB L2 Cache, 16 MB Boot FLASH; 32 MB User FLASH; RTC, 10/100 BASE-T, ULTRA SCSI, Mouse & Keyboard I/F, Floppy, Parallel, RS232 port, RS232/422/485 port, 2 PMC slots, 5 row P1 & P2 (no P0)
	Level 2 : as above with conformal coating
	400 MHz PowerPC 755 128 MB SDRAM
PPC6-755-1512B0xx	400 MHz PowerPC 755 6U VME SBC, Level 1; 128 MB SDRAM, 1 MB L2 Cache, 16 MB Boot FLASH; 32 MB User FLASH; RTC, 10/100 BASE-T, ULTRA SCSI, Mouse & Keyboard I/F, Floppy, Parallel, RS232 port, RS232/422/485 port, 2 PMC slots, 5 row P1 & P2 (no P0)
	Level 2 : as above with conformal coating
	500 MHz PowerPC 7410 128 MB SDRAM-Fibre Channel Interface
PPC6-7410-1412D0xx (with Fibre Channel option)	500 MHz PowerPC 7410 6U VME SBC, Level 1; 128 MB SDRAM, 2 MB L2 Cache, 16 MB Boot FLASH; 32 MB User FLASH; RTC, 10/100 BASE-T, ULTRA SCSI, Mouse & Keyboard I/F, Floppy, Parallel, RS232 port, RS232/422/485 port, 2 PMC slots, 5 row P1 & P2 (no P0), Fibre Channel Interface
	Level 2 : as above with conformal coating
	400 MHz PowerPC 755 128 MB SDRAM-Fibre Channel Interface
PPC6-755-1512D0xx (with Fibre Channel option)	400 MHz PowerPC 755 6U VME SBC, Level 1; 128 MB SDRAM, 1 MB L2 Cache, 16 MB Boot FLASH; 32 MB User FLASH; RTC, 10/100 BASE-T, ULTRA SCSI, Mouse & Keyboard I/F, Floppy, Parallel, RS232 port, RS232/422/485 port, 2 PMC slots, 5 row P1 & P2 (no P0), Fibre Channel Interface
	Level 2 : as above with conformal coating

xx= Software/Micro D Front panel I/O option

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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