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PowerPC™
750/7400
Single Board Computer

# PPC4B

RADSTONE VMEBUS SBC

## 3rd Generation PPC4x with 64bit 66MHz PCI



- Latest PowerPC Processors (750 & 7400 with AltiVec)
- 64 bit 66MHz PCI bus
- 100MHz Main Memory Bus
  Sustained memory bandwidth 457MB/s (800MB/s peak)
- 200MHz Cache Memory Bus
- CHRP based architecture
- 5 Air and Conduction Cooled Ruggedization Levels
- Standard 6U form factor
- Radstone Software Support
- Key Features
  - PowerPC Processor with up to 2Mbyte L2 Cache
  - Up to 144Mbytes 64bit wide FLASH
  - Up to 256Mbytes SDRAM with EDC
  - 10/100BaseT or 10Base 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

The PPC4B is the very latest addition to Radstone's family of PowerPC based Single Board Computers (SBC's). The PPC4B combines the very latest, high performance, PowerPC processors, with the same rich feature set of the previous SBC's in the PPCx family, first introduced by Radstone in 1995.

This ultra high performance board features the very latest PowerPC 750 and 7400 processors, SDRAM with Error Detection and Correction and a dedicated L2 cache bus. The high data rates required to support the PPC4B's advanced processors are satisfied by a 64bit PCI bus clocked at 66MHz, a 200MHz Cache bus, and a 100MHz memory bus yielding sustained memory transfer rates of up to 457 Mbyte/sec.

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

The PPC4B represents a major step along Radstone's clearly defined PowerPC roadmap, which protects your 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 SBC's 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 TECHNOLOGY

| Features | Advantages / benefits | |
|---|---|---|
| Latest PowerPC Processors (750 and 7400) | Access to the most performant processors currently available including 7400 with its AltiVec core | |
| 100MHz Main Memory Bus | Facilitates high bandwidth data rate between processor and main memory | Maximised 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 Cache Bus | Maximises data transfer rate between cache and processor | |
| 2Mbyte L2 Cache on 7400 options | Maximises utilisation of fast Cache bus | |
| Full Snooping supported | Maximises use of Cache and reduces memory bus use | |
| Up to 144Mbytes 64 bit wide FLASH | A wide range of FLASH capacities from which application code can be run directly | |
| 64bit 66MHz 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 (PMC's) | |
| 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

The PPC4B supports the PowerPC 750 and 7400(G4) family of microprocessors . 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 7400 features Motorola's new AltiVec technology with it's 128bit 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 the PPC4B, allows users to develop systems offering unprecedented performance.

## Memory

Up to 256Mbytes of SDRAM with EDC and 144 Mbytes of 64bit wide FLASH memory are supported by the MPC107 memory controller. The MP107 enables high speed memory accesses on a 64bit data bus running at 100MHz, enabling sustained memory bandwidth of up to 457Mbytes per second. Full snooping support is also offered, maximising use of Cache which is accessed on a 200MHz Level 2 Cache bus.

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

*Table 1: CPU Selection*

| CPU | Frequency | SPECint95 * | SPECfp95 * | CPU Typical (Watts) Consumption * | Power SBC Typical Power (Watts) Consumption † |
|---|---|---|---|---|---|
| 750 | 500 | 23.9 | 14.6 | 4.5 | |
| 7400 AltiVec | 450 | 21.4 | 19.5 | 8.0 | 22 |

* 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 | Memory bandwidth |
|---|---|---|---|
| SDRAM Options | 128 Mbytes<br>256 Mbytes | 64 bits wide<br>(all on board) | 457 Mbytes/sec Non EDC<br>457 Mbytes/sec With EDC |
| FLASH Options | 16 Mbytes, 80 Mbytes<br>144 Mbytes | 64 bits wide<br>(surface mounted) | 50 Mbytes/sec |
| Level 2 Cache | 1 Mbyte for 750<br>2 Mbytes for 7400 | Private backside<br>L2 Cache bus at up to 200MHz | 1.6 Gbytes/sec Pipelined Cache<br>1 Gbytes/sec Non-Pipelined Cache |
| User $E^2$PROM | 512kBytes on the internal ISA bus | | |
| Non-volatile RAM | 32 kBytes SRAM with 32 kBytes shadow E2PROM | | |

*Table 3: PPZERO with the PPC4B*

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

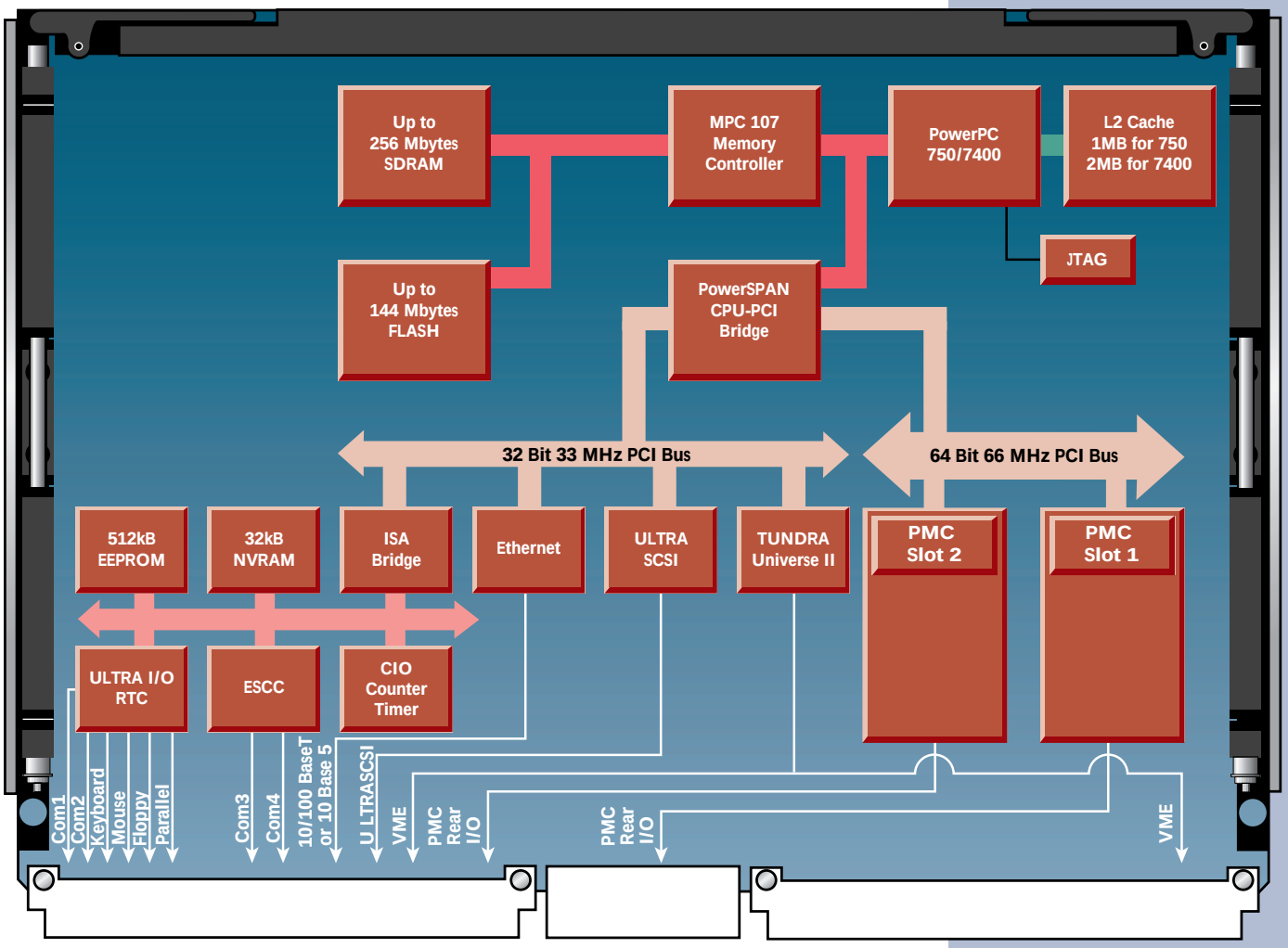



Figure 1: PPC4B Functional Block Diagram

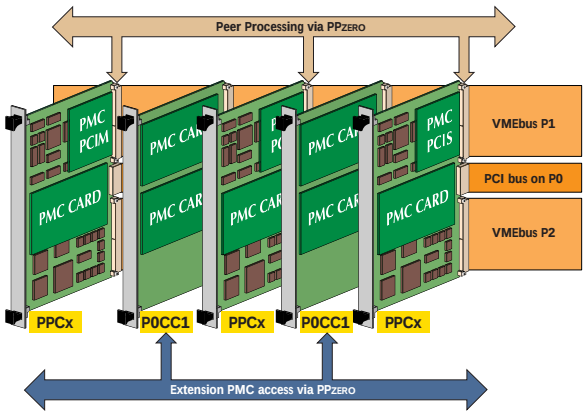
## PCI Sub-System

The PPC4B supports two air or conduction cooled PCI Mezzanine Cards (PMC's) 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 PMC's for applications including Graphics, additional asynchronous and fast synchronous serial channels, ATM, 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

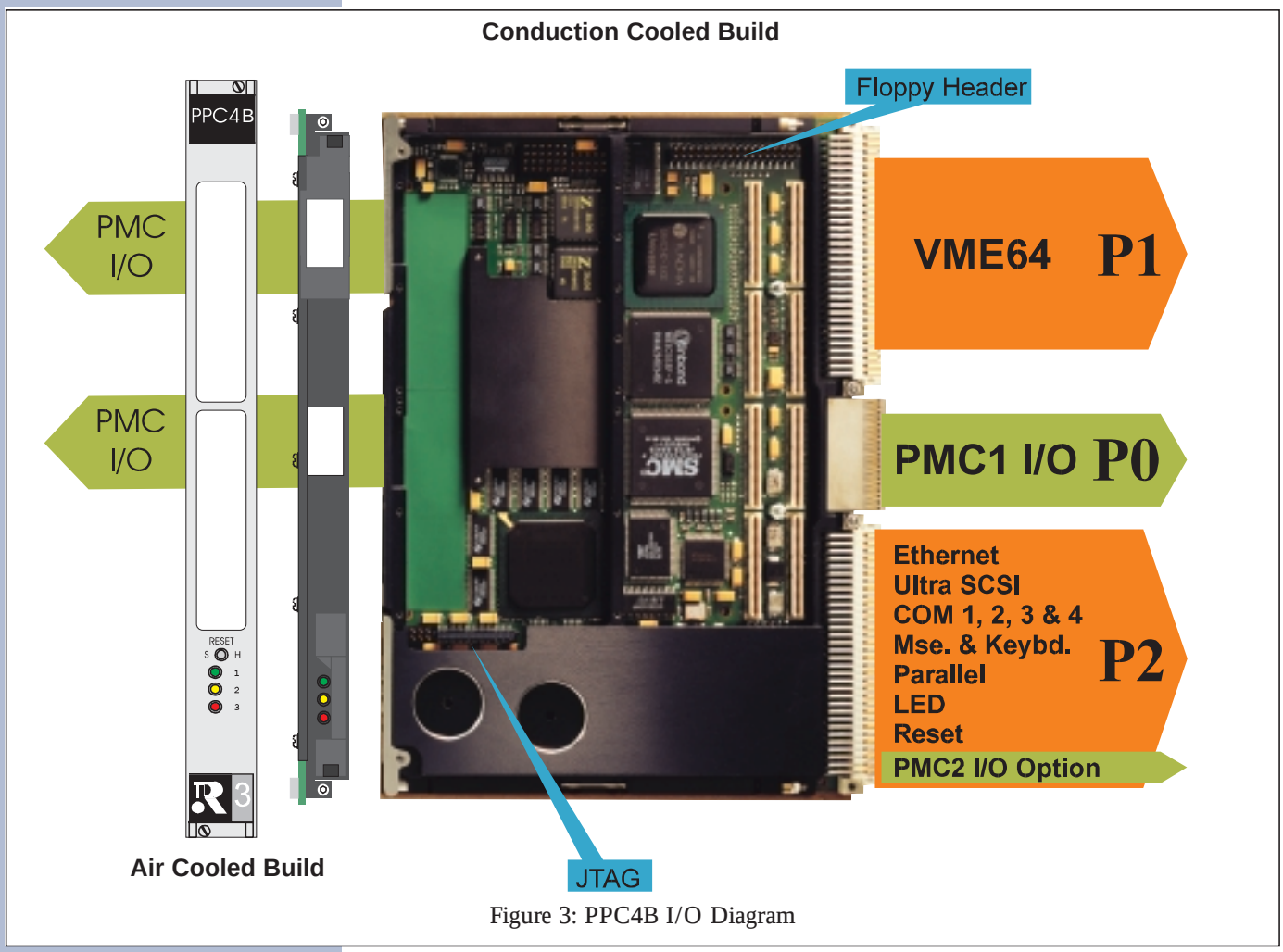



Figure 3: PPC4B I/O Diagram

## Input/Output

The 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 maximise 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 A 80 way P0 connectors with guide pin and keying or type B 95 way P0 connectors 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

ThePPC4B 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 | MPC7400 | 350 MHz and beyond |
| Memory Controller | MPC107 | 64bit Memory bus clocked at up to 100 MHz supporting EDC |
| PCI Bridge | Tundra PowerSpan | Supports 64bit 66MHz PCI bus and secondary 32bit 33MHz PCIbus |
| SDRAM | | 128 or 256Mbytes (all on board) |
| FLASH ROM | EEPROM | 16Mbytes surface mounted, 64 bit wide as standard (extendable up to 144Mbytes on board)<br>SW & HW write enable/disable |
| NVRAM | Simtek 11C88 | 32 kBytes SRAM with 32 kBytes shadow E2PROM |
| Level 2 Cache | SRAM | 2Mbytes on backside L2 bus |
| User E2PROM | ATMEL 28C040 | 512kBytes of non-volatile storage for user data |
| Ethernet | DEC 21143 | 10/100BaseT or 10Base5 (10Base2 with 3U transceiver module) |
| Ultra SCSI | Symbios 53C860 | 8 bit 20Mbytes/s 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 33MHz PCI bus interface, Integral FIFOs, Programmable DMA controller, 70Mbytes/s 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 |

## Software support

Radstone's software strategy for PowerPC is designed to allow fully integrated system level solutions to be realised easily and with confidence. Our off-the-shelf, layered software modules deliver the most from low-level hardware features while exploiting the best high-level debug and run-time functionality of the COTS Operating Systems.

The result is standard software support across the widest selection of PowerPC SBC's available in either industrial or extended temperature, ruggedized build levels..

We have invested more than 50 man-years of engineering talent in the PowerPC architecture so that our customers can develop market-leading products using the O/S and development environment best suited to their long-term program requirement.

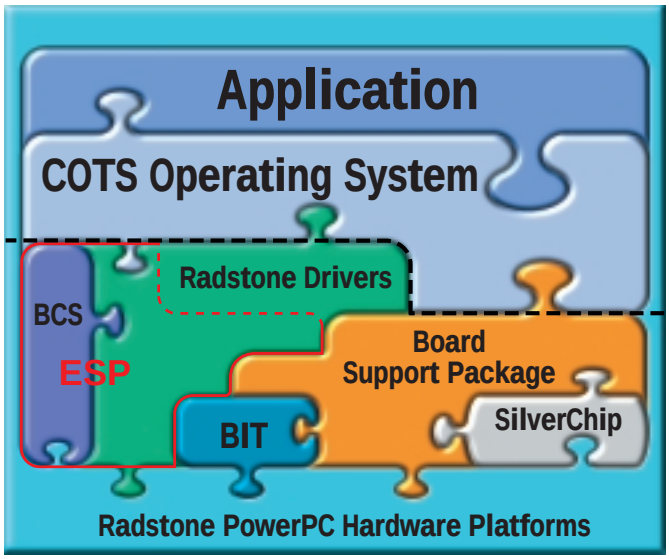



Figure 5: Software Support Model

## COTS Software Products for PPC SBCs

The following software products are available for the entire PPCx family, including PPC4B, providing a common look, feel and interface for technology inserts:

## Built-In-Test for PowerPC

PPC BIT executes in layers from MPE (Minimum Processing Environment) outwards, probing from the lowest on-card hardware up to Line Replaceable Unit (LRU) level within a system, ensuring the highest degree of confidence in system integrity. BIT includes comprehensive configuration facilities, allowing automatic power-up tests to be defined, for the desired mix of system functionality and options. Further tests can be invoked interactively, also giving BIT a valuable role as a field service tool. Both Object and Source code products are available. For more details please ask for the "BIT for the Radstone PowerPC family" data sheet.

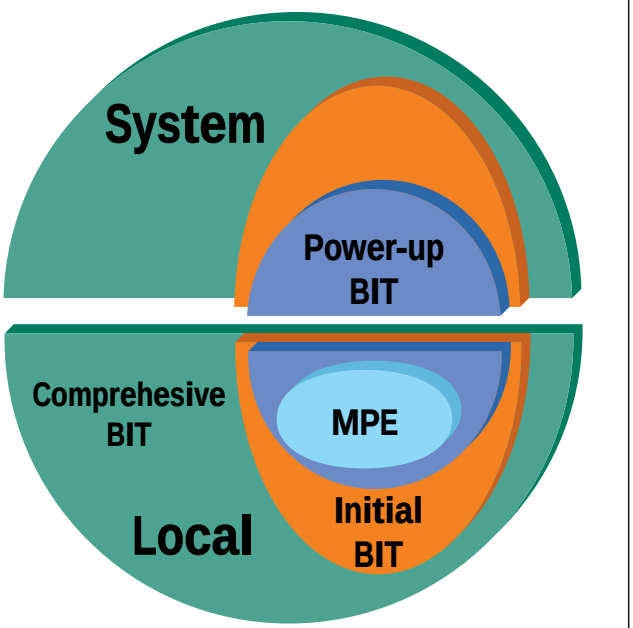



Figure 4: Built-In-Test Hierarchy

## SilverChip firmware

Developed as an integral part of COTS product strategy, SilverChip firmware provides a foundation layer to interface between the raw PowerPC board hardware, with it's highly programmable device set-ups and flexibility, and the supported Operating Systems (O/S's) which require a straight-forward booting and device interface model. (Figure 5)

SilverChip includes: comprehensive configuration facilities, interactive or auto-boot sequencing from a range of device types, automatic PCI resource allocation at initialisation, PCI display/interrogation utilities plus other valuable features for system integrators.

Memory or other speed and feature enhancements are seamlessly absorbed by SilverChip giving the same look and feel to the O/S and the user application as the Radstone PowerPC hardware advances (PPC1, PPC1A, PPC2, PPC2A, PPC4A, PPC4B, etc). Where particular O/S's define the use of alternate boot methods (e.g. VxWorks bootroms) SilverChip technology is absorbed into such boot methodology. Please ask for the "Radstone SilverChip" data sheet for more details.

## Board Support Packages

In-house porting expertise for PPCx boards is focused on key Operating Systems, including VxWorks/Tornado from WindRiver Systems and LynxOS from LynuxWorks. Other O/S ports, drivers for third party hardware, and layered products, including RTEMS from OAR are provided through strategic partnerships with dedicated third party vendors, who are able to offer high quality products and services complementary to the Radstone range. State-of-the-art development environments and debug tools, available with the above software products, are thus leveraged for use on Radstone's high performance hardware architecture.

## Enhanced Support Package

Enhanced Support Packages (ESP's) offer comprehensive hardware support additional to that defined by O/S vendors for BSP's. This allows users to implement a verifiable BSP standard and yet not be locked out of using valuable extra features, which will adapt the BSP but shorten development times. ESP features may be added or removed as desired in development.

Typical features include VME DMA for VxWorks (not included in WindRiver's BSP definition), and VME enhancements like dynamic windowing and interrupt generation for LynxOS (not included in LynuxWorks BSP definition). Background Condition Screening (BCS) is also part of the ESP.

## Background Condition Screening (BCS)

BCS supplements the high test coverage obtained at initialisation by BIT (see above) with further health screening that is able to co-exist with a standard COTS Operating System. Whilst the intensity and coverage of a true traditional BIT style test makes it destructive to O/S's, the configurable BCS package allows functions such as periodic checksumming, memory scrubbing, and others to be tailored for operation alongside the application in on-line conditions. Results are stored in Flash in the same format as BIT results. Code is available for reading out BIT/BCS results under LynxOS and VxWorks.

## RTEMS™

Free Operating System - RTEMS

Developed by OAR Corp., Huntsville, AL for the US Army Missile Command, RTEMS provides all the power and flexibility of real-time executives available on the commercial market today, but without the cost of source code and royalties. RTEMS is freely available from the Internet with no royalties attached. RTEMS is a high performance, object-oriented, multiprocessing executive that forms the cornerstone of re-usable software solutions for today's embedded systems development.

## ADA™

Several ADA vendors now offer comprehensive environments layered over standard O/S's such as VxWorks/Tornado and LynxOS. These environments run on any Radstone SBC for which the O/S is supported, without any alteration to the board's regular Board Support Package for the O/S.

## Licensing, Maintenance and Support

Radstone supplies the BSPs and drivers necessary to support our hardware for the selected Operating Systems noted above, under license RT5088. Embedded firmwares such as BIT and SilverChip are supplied under license RT5087. Standard Maintenance Contracts are also available for these modules under our Agreement RT5090. Please contact your local sales channel for details.

## VxWorks Tornado™

VxWorks/Tornado Distributed Real-Time Operating System

- Fully integrated Workstation or PC Development Environment
- High performance, deterministic, highly scaleable run-time system
- ATM, Ethernet and backplane networking
- Comprehensive debug/analysis tools

Tornado represents the latest generation of development and execution environments for embedded and real–time applications. The Tornado suite, which includes the VxWorks operating system, brings a superior development and deployment platform to the embedded developer, based on solid core technology yet adding an evolutionary development interface.

Radstone Board Support Packages (BSPs) that enable VxWorks operation on the PPC4B have been passed using the WindRiver validation suite for the greatest confidence and ease of use. In addition, many of Radstone's I/O and graphics products are also supported by VxWorks libraries and drivers. Please see the "Radstone/VxWorks" data sheet for more details.

LynxOS Real-time Operating System

- Conforms to POSIX standards
- Self-hosted, SunOS, or BlueCat Linux development environments
- Designed for hard real-time
- Full MMU support

LynxOS is a UNIX-compatible, POSIX-compliant, multi-process, and multi-threaded operating system designed for complex real-time applications that require fast, deterministic response. The LynxOS kernel was specifically designed for hard real-time applications. Since its first release in 1988, LynxOS has been fully pre-emptible, re-entrant, and compact. The powerful PosixWorks environment complementing LynxOS provides high specification development tools including source debug, real-time analysis, code control, and other rich features. Support is available for Radstone's leading edge family of COTS PowerPC platforms spanning a wide environmental range with drivers/libraries for various compatible I/O products. Please see the "Radstone/ LynxOS"data sheet for more details.

# PPC4B Standard Ordering Information

| Sales Code | 400 MHz PowerPC 7400<br>128MB SDRAM / 16MB FLASH |
|---|---|
| PPC4B-7400-1A10B | 400 MHz PowerPC 7400 6U VME SBC, Level 1, 128MB SDRAM, 2MB L2 Cache, 16MB Flash, 512kB EEPROM, RTC, 10/100BaseT, 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-7400-2A10B | Air-cooled Level 2 as above with conformal coating |
| PPC4B-7400-3A10B | Air-cooled Level 3 as above with conformal coating |
| PPC4B-7400-4A10B | Conduction cooled Level 4 as above |
| PPC4B-7400-5A10B | Conduction cooled Level 5 as above |
| | 400 MHz PowerPC 7400<br>256MB SDRAM / 144MB FLASH |
| PPC4B-7400-1A21B | 400 MHz PowerPC 7400 6U VME SBC, Level 1, 256MB SDRAM, 2MB L2 Cache, 144MB Flash, 512kB EEPROM, RTC, 10/100BaseT, 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-7400-2A21B | Air-cooled Level 2 as above with conformal coating |
| PPC4B-7400-3A21B | Air-cooled Level 3 as above with conformal coating |
| PPC4B-7400-4A21B | Conduction cooled Level 4 as above |
| PPC4B-7400-5A21B | Conduction cooled Level 5 as above) |
| Further Options | For information on other options, including latest available processor types, memory capacities, serial I/O configurations, ethernet options etc., contact your local sales office or explore the web site at www.radstone.com |


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