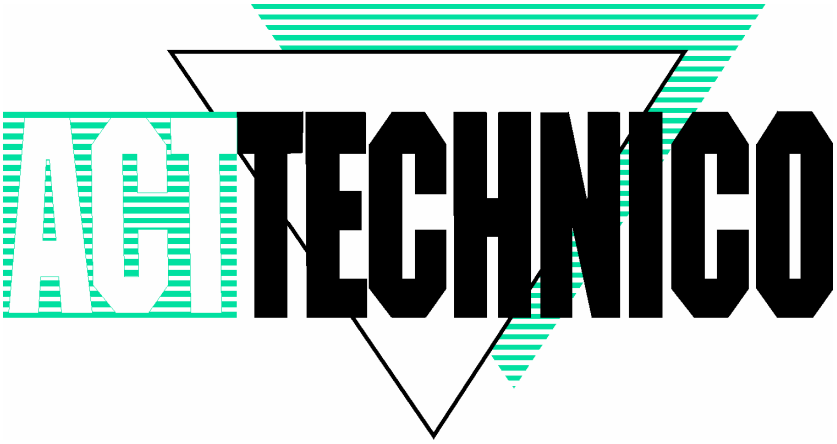

760 Veterans Circle, Warminster, PA 18974 – 215-956-1200

Technical Proposal

Submitted by:

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for

Conduction Cooled NAS

Revision –

4/3/07

CC/RAIDStor: Conduction Cooled Networked Attached Storage Device

1 Overview

The cc/RAIDStor is conduction cooled, rugged, Network Attached Storage device, hereafter referred to as the "NAS". It is implemented using a standard 6U by 160 mm VMEbus base board, requiring a single slot, with disk drives. The NAS uses rugged solid state Flash Disk Drives. One NAS board can hold two drives. The NAS operates over an extended temperature range from **–40C to +85C.**

1.1 Hardware Core

The hardware core is implemented using a high performance Motorola PowerPC processor, MPC7448. The processor operates over the full temperature range of the device at 1 GHz. Dual Gigabit Ethernet ports are present which are routed through P0 to provide redundant network connections into the NAS. The NAS supports two high performance SATA interfaces for interface to solid state Flash Disk Drives, where user data is stored within the device.

1.2 NAS Architecture

The NAS is Linux based. It is implemented using Ethernet and well known protocols such as NFS, and optionally CIFS/SMB to implement distributed Network Attached Storage. The NAS uses the TCP/IP protocol, and a robust Journaling file system to store information. The Client/Server model implemented, allows for central management and distribution of data within a network. Multiple client nodes can access the data from the NFS NAS server. The NAS appears on a standard Ethernet Network as an exported NFS volume, or volumes.

1.3 RAID

Two RAID modes are supported: RAID 0, or stripping, and RAID 1, mirroring. RAID 0 is used to increase capacity and performance, while RAID 1, data duplication is used for redundancy and data availability.

1.4 Capacity

The NAS is available in capacities from 16GB through 128 GB. Using RAID 0 with 64 GB drives provides a capacity of 128 GB. Using RAID 0 with 32 GB drives provides a capacity of 64 GB.

1.5 Power On BIT

Built in Test is resident in the onboard firmware. The BIT is started on Power Up or reset, and runs a known test list. The results of the BIT sequence are stored in globally accessible memory for later retrieval.

1.6.1 Boot Time

15 to 20 seconds running BIT and with NAS boot.

2 Specifications

2.1 Physical

Form Factor: 6U x 160mm
Weight: TBD

2.2 Standards

VITA 1 – 1994 R2002
IEEE 1101.2 with extensions from ANSI/VITA 1.1-1977
Vita 20 Compliant
Vita 31.1 Ethernet

2.3 Mechanical

Aluminum Conduction Plate and Frame
Wedge Locks (Torque Limiting Wedge Lock to be used)
No Front Panel

2.4 Connectors

P0, P1, and P2

No VMEbus Interface on P1 and P2

2.5 NAS Hardware Description

2.5.1 Hardware Features

MPC7448 at 1 GHz
L1 caches: 32KB Inst. and 32KB Data with **parity**
1 MB of L2 integrated cache with **ECC**
512 MB DDR-**ECC** Memory
64 MB Nor Flash
128 KB SRAM
Two Gigabit Ethernet Ports (10/100/1000TX) on P0 (Vita 31.1)
Two SATA Ports to support SATA Flash Disks
One Console Serial Port On P0
No VMEbus Interface

2.5.2 Storage

Site for two 2 ½" 9.5mm rugged solid state flash disk drives

2.5.2.1 Storage Features

Architecture:

NAND Flash Arrays
Dynamic Wear Leveling
Bad Block Management
Error Correction Bits are included in blocks (**ECC)**
2,000,000 Write/Erase Cycles per Cell

2.5.2.2 Drive Interface

SATA Interface up to 150 MB/sec
Sustained drive throughput to 20 MB per second per drive
Controller supports Secure Erase Feature, for hardware driven memory erasure

2.5.2.3 Mechanical

Drives mount from the top to the conduction plates
Drives are removable without removal of the main conduction plate

2.5.2.4 Drive Power

Five Volt Only Operation
Low Power Consumption

2.5.2.5 Drive Reliability

MTBF: 8,000,000 Hours 25 C Ground Benign

2.5.2.6 Drive Environmental

Thermal: -40 C to +85 C Operational
Altitude: 80,000 feet
Shock: In excess of 1500 G's
Vibration: 16.3 G RMS Random 20 to 200H Hz, 3 Axes
Humidity: 5 to 95%

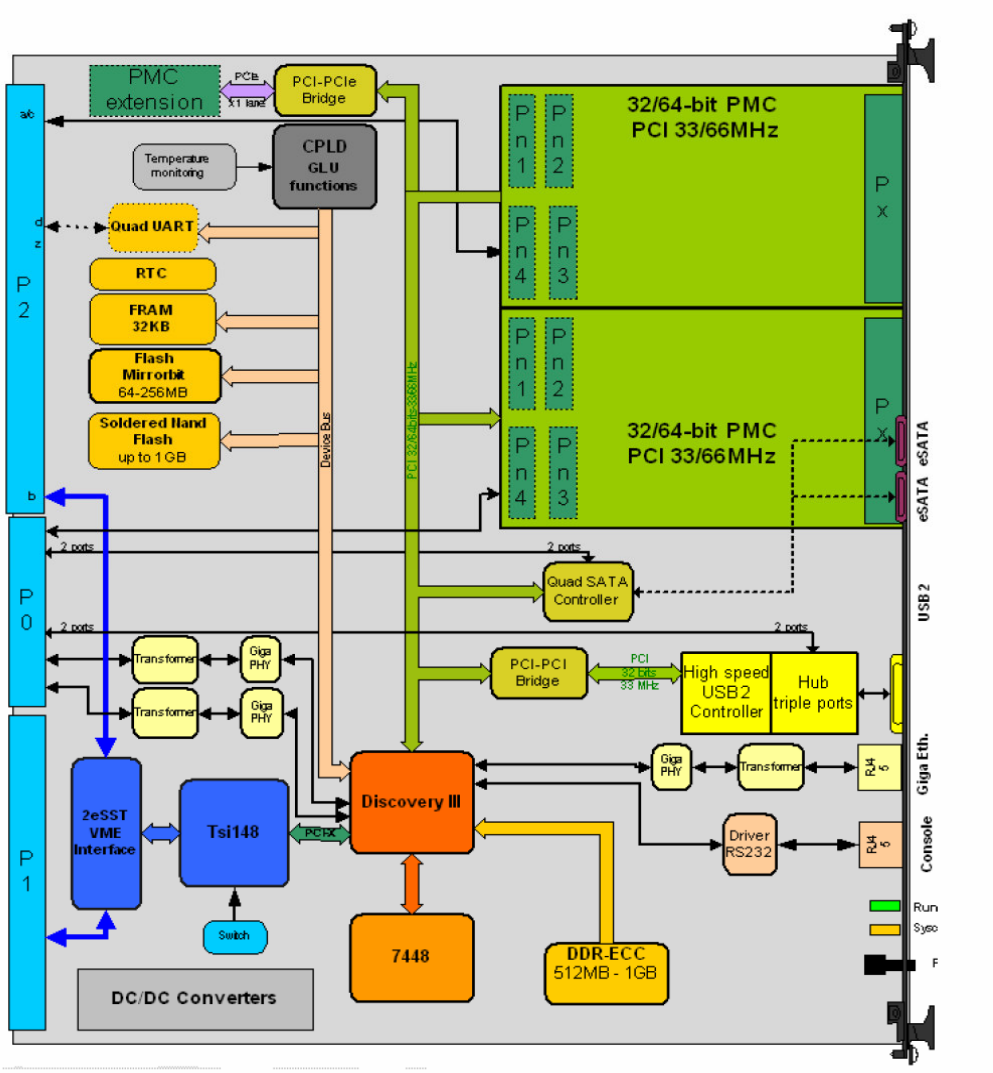

Figure 1: IC-e6-VMEa block diagram

Figure One: Basic Block Diagram of Base Board

Figure Two: Photo of Conduction Cooled NAS

Figure Three: Photo of base controller board with basic Conduction Plate

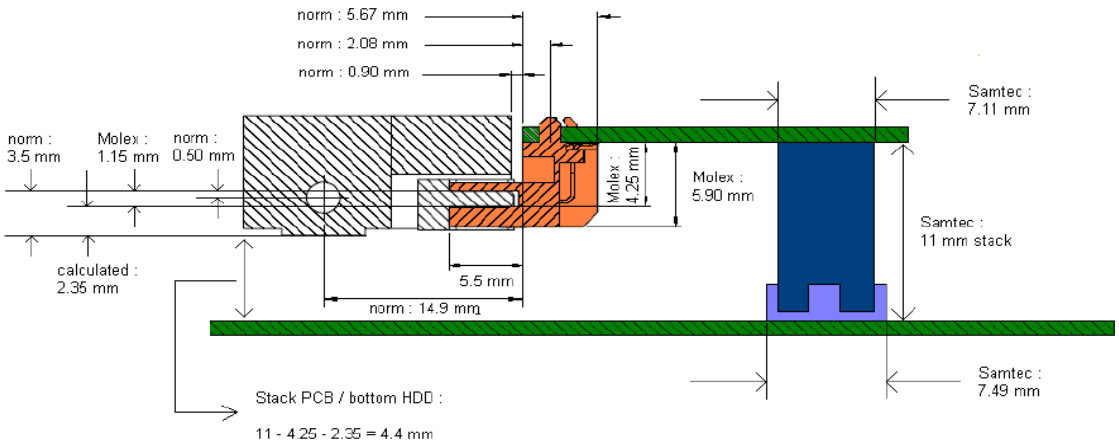

Figure Four: Side View SATA Interconnect Board with Flash Drive Cross Section

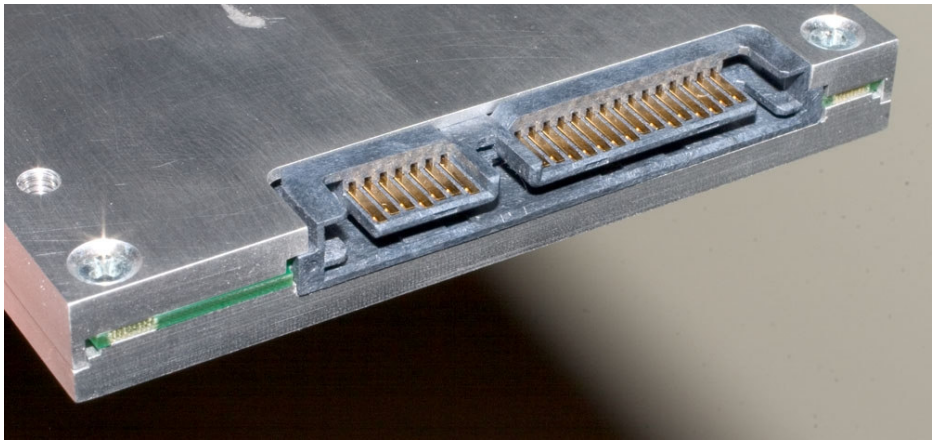

Figure Five: End View of SimpleTech 2 ½" SATA Flash Drive showing housing and connector

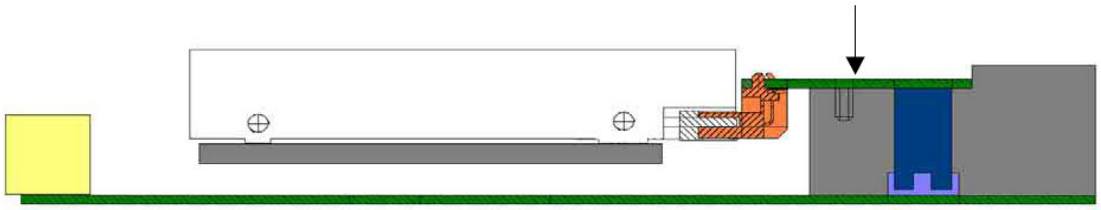

Figure Six: Side view showing Flash Hard Drive mounting scheme

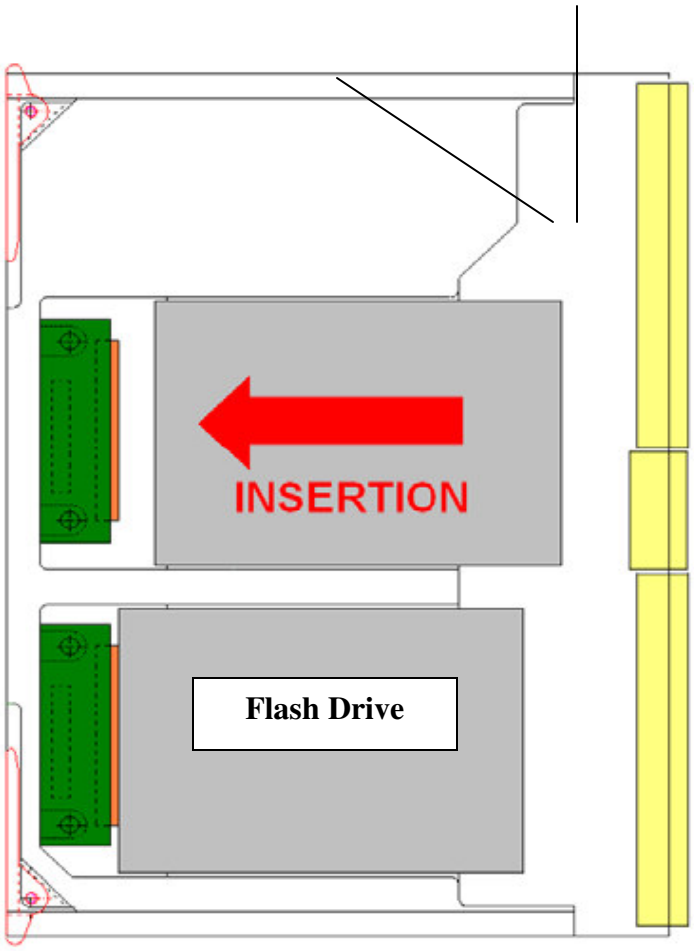

Figure Seven: Top View showing Hard Drive insertion and removal

3 NAS Functional Specifications

The cc/RAIDStor operates as Networked Attached Storage Repository. The NAS functionality is based on the Linux operating system. The NAS primarily uses the NFS 3.0 File System Protocol. TCP/IP is used as the transport protocol. To provide robust storage of the data the device supports a journaling file system through the use of the EXT3 file system.

3.1 Capacity

The NAS capacity will be: 16 GB, 32 GB, 64 GB, or 128 GB

3.2 Drive Bandwidth

The native Flash Disk bandwidth is 20 MB per second.

3.3 Network NAS Bandwidth

Configured with drives in RAID 0 Mode:

15 to 20 MB/sec Write
20 to 30 MB/sec Read

Note: End to End performance will be a function of the Client Node NFS performance. In this case VxWorks implemented within a specific user processor.

3.4 Operating System

Based on Linux 2.6.13 Kernel

3.5 Supported Protocols and File System

- Network File Protocols

  NFS – Version 3 or higher – Unix/Linux

Optionally Supports:

  CIFS/SMB – Microsoft

- Transport Protocols

  TCP/IP, UDP, IPX

- IP Protocol

  IPV4 and IPV6

- Boot Protocols

  FTP, DHCP, BootP

- Files Systems

  UFS, Journal FS, (EXT3) Standard

  Microsoft formats:

  NTFS, FAT32

3.6 RAID Services

RAID services are supported to implement RAID 0 (Striping), or RAID 1 (Mirroring). In the configuration bid, RAID 0 will be supported. RAID 0 effectively doubles the storage capacity of the NAS. Further, using RAID 0 increases the read and write performance to the Flash Disks, since the data is interleaved between the two devices. Therefore, higher read and write performance, approaching twice the native rate of the Flash Drive is possible on a local basis.

3.7 Software Model

The diagram below represents the software model used to implement the NAS. Linux Serves s the operating system, with disk services, network drivers, protocols stacks, the file system, and RAID services sitting on top of the O/S.

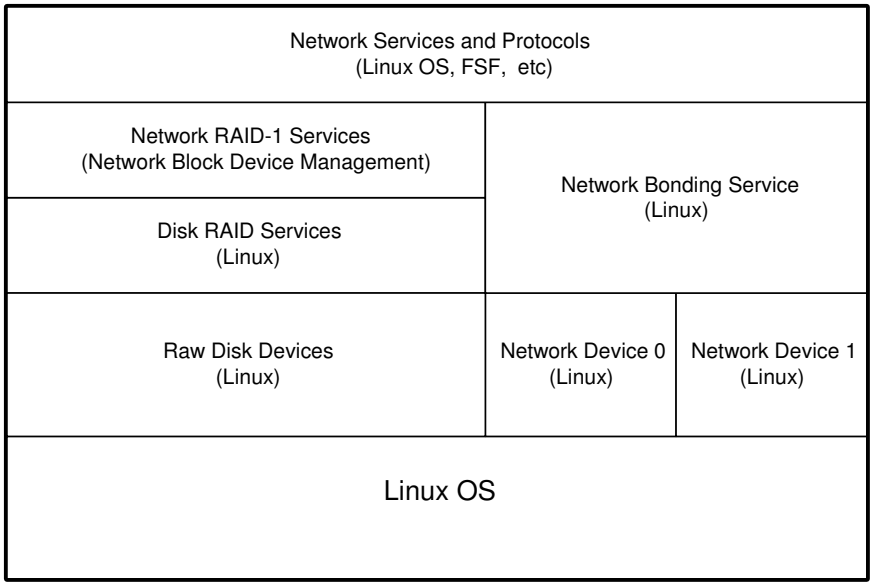

Figure Eight: Network and Storage Device Software Model

3.8 Network Model and Device Model of the NAS

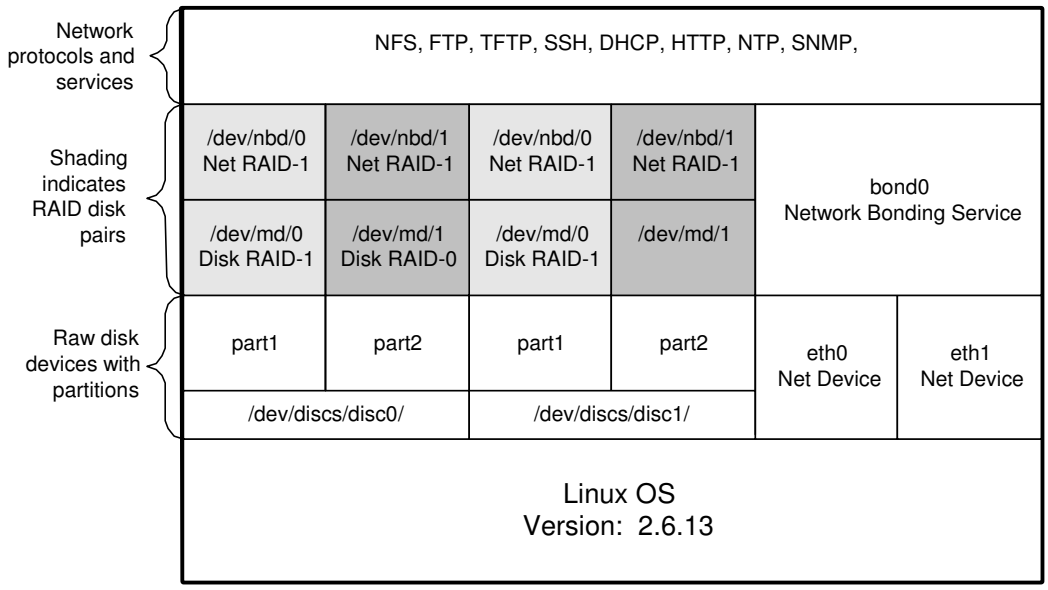

Figure Nine: Network Protocols, Network Device, RAID Configuration, and Raw Drive Partition Model

4 Power On Built In Test Firmware

The table below summarizes a list of built in tests:

Family	Test		Self tests	Acceptance tests	Unitary tests	Endurance tests
User led	Visual test			X	X	
CPLD	Identifier test		X	X	X	X
Ethernet led	Visual test			X	X	
Ethernet port	Asynchronous test	Int lpb	X		X	X
		Ext lpb		X	X	X
Flash	Private area coherency		X	X	X	X
	Access test		X	X	X	X
	Data bus test			X	X	
	Address bus test			X	X	
Memory	Pattern test		X		X	
	Address in address test				X	X
	Full test				X	
	Marching test				X	
	Data bus test		X	X	X	
	Address bus test		X	X	X	
	DMA test				X	
FRAM	Access test		X	X	X	X
Temperature	Access test		X	X	X	X
RTC	Access test		X	X	X	X

Table One: BIT Test Summary

Note: A SATA device test for each drive will be added to this table.

4.1 User Led Test

Visual test

This test provides a visual way to validate the user LEDs.

4.2 CPLD Test

Identifier test

The CPLD test consists of reading the identifier and comparing it with a reference to check the CPLD access.

4.3 Ethernet Port Led Test

Visual test

This test provides a visual way to validate the Ethernet port LEDs.

4.4 Ethernet Port Test

Asynchronous test

The asynchronous test consists of sending frames and checking frame receipt.

4.5 Flash Tests

Private area coherency test (Boot area)
This test calculates the 32bit CRC of the boot area and compares it with the stored CRC.

4.6 Flash access test (Boot or User area)

This test reads the flash identifier.

4.7 Data bus test

4.8 Address bus test

4.9 Memory Test

Pattern test
Address in address test
Full test

This test initializes the selected space (defined by the start address and the size of the space to test) with the pattern. For each address of the space, the complement of the pattern is written; the written value and the other addresses are verified (complement of the pattern for the written value, pattern for the other addresses). This test is executed with 32-bit words. If the data are not correctly written in the space for each address, the test is failed; if the data are correctly written, the test is successful.

Marching test
Data bus test
Address bus test
DMA test

4.10 FRAM Test

Access test

4.11 Temperature Sensor Test

4.12 Real Time Clock test

Access test
The test reads current date, sets an alarm to current date plus 1 minute.

5 Environmental

Altitude: 80,000 feet

Criterion	Standard Grade	Extended Grade (*)	Rugged Grade (*)	Conduction cooled grade (*)
Coating	Optional	Standard	Standard	Standard
Operational Temp.	0 to +55°C	-20 to +65°C	-40 to +75°C	-40 to +75°C (at thermal interface)
Recommended airflow	1 m/s	1,5 m/s	2 m/s	
Operational HR% Non condensing	5 to 90%	5 to 95 %	5 to 95%	5 to 95%
Storage Temp.	-45 to +85°C	-45 to +85°C	-45 to +100°C	-45 to +100°C
Sinusoidal Vibration	2G [20..2000]Hz	2G [20..2000]Hz	5G [20..2000]Hz	5G [20..2000]Hz
Random Vibration	0.002g²/Hz [10..2000]Hz	0.002g²/Hz [10..2000]Hz	0.05g²/Hz [10..2000]Hz	0.1g²/Hz [10..2000]Hz
Shock ½ Sinus 11ms	20G	20G	40G	40G

Table Three: Environmental Specifications
(Table error: Operating temperature is -40 to +85C)

6 Electromagnetic Characteristics

Nature of perturbations	Norms	Severity	Comments
ESD discharge	EN61000-4-2	TT/TR	+/-6kV (contact), +/-8kV (air)
HF radiation	EN61000-4-3	10V/m	80 to 1000Mhz
Fast transient burst	EN61000-4-4	+/-2kV	on buses
Shock waves	EN61000-4-5	+/-2kV	on buses
Common HF tests	EN61000-4-6	CT/CR	
Electromagnetic emission	EN55022	B	conduction
Electromagnetic emission	EN55022	B	radiation

Table Four: Electromagnetic Specifications

7 Power Base Board

5 Volts : 2 Amps 10 Watts Max
3.3 Volts: 3 Amps 6 Watts Max

Power Adder for Drives

64 GB: 5 Volts at .5 amps each for sustained read/write
Add 5 Watts for two 64 GB drives, worst case sustained read/write.

Power Assembly: Total Worst Case Power Supply: 21 Watts

8 NAS Assembly MTBF

181,384 Hours 25C Ground Benign

9 Identification of Major Components

ACT/Technico has collaborated with Interface Concept to create the base Single Board Computer optimized for the NAS application. The IC-E6-VMEA is in its third iteration, includes the following modifications for the NAS base platform:

1. Use of the MPC7448 PowerPC Chip for better performance, inclusive of large caches.
2. Modified Conduction plate accommodating a mounting and cooling scheme as delineated here in.
3. The addition of SATA 1 ports that allow interface to standard 2 ½" SATA Flash Drives.
4. Parallel I/O to allow logic level inputs for the Secure Erase function.

SimpleTech Flash Drives

32 or 64 GB 21/2" SATA Flash Drives from SimpleTech
Industrial Temperature Range –40 to +85
SATA Interface

NAS Software Application

Key modules are ported from ACT/Technico's existing RAIDStor, cPCI NAS blade.

10 Quality Certification

ACT/Technico is an ISO Certified company. We are certified to ISO 9001:2000 through KEMA.