# ATCA FlexChassis 12U (14-Slot) DC

## User Manual

Document CC08100

9450 Carroll Park Drive
San Diego, CA 92121-2256
858-882-8800
www.ccpu.com

# Table of Contents

# Figures

# Tables

# 1. Safety

**The intended audience of this User's Manual is system integrators and hardware/software engineers.**

## 1.1. Safety Symbols used in this document

| | |
|---|---|
|  | Hazardous voltage!<br>*This is the electrical hazard symbol. It indicates that there are dangerous voltages inside the Shelf.* |

| | |
|---|---|
|  | Caution!<br>***This is the user caution symbol. It indicates a condition where damage of the equipment or injury of the service personnel could occur. To reduce the risk of damage or injury, follow all steps or procedures as instructed.*** |

| | |
|---|---|
|  | Danger of electrostatic discharge!<br>*The Shelf contains static sensitive devices. To prevent static damage you must wear an ESD wrist strap.* |

## 1.2. General Safety Precautions

| | |
|---|---|
|  | Warning!<br>***Voltages over 60 VDC can be present in this equipment. As defined in the PICMG 3.0 Specification, this equipment is intended to be accessed, to be installed and maintained by qualified and trained service personnel only.*** |

- Service personnel must know the necessary electrical safety, wiring and connection practices for installing this equipment in a telecommunication environment.
- Install this equipment only in compliance with local and national electrical codes.
- For additional information about this equipment, see the PICMG 3.0 Specification (www.picmg.com).

## 1.3. References Documentation

These documents contain information and specifications related to the requirements listed in this document.

- Requirements as outlined in PICMG 3.0, AdvancedTCA Base Specification
- Requirements as outlined in PICMG® 3.0 R2.0 ECN-001 AdvancedTCA Specification
- Requirements as outlined in PICMG® 3.0 R2.0 ECN-002 AdvancedTCA Specification
- Pigeon Point Systems IPM Sentry User Guide and External Interface

## 1.4. Product Definition

The AdvancedTCA (ATCA) 14-Slot FlexChassis is a fault tolerant/high availability shelf designed for use in a 19” rack mount and occupies 12U of rack height, including a dedicated area for cable management.

The airflow is optimized for efficient cooling from the angled air entry to the patented Serial Parallel Fan Arrangement. This Shelf works with the 200W/board power dissipation capabilities of ATCA plug-in modules with low noise due to the speed controlled, IPMI based, hot pluggable fan trays.

Each of the redundant power entry modules (PEMs) protect and filter the potential 2800W that the plug-in modules may dissipate. The PEMs plug directly into the ATCA midplane and deliver power to the backplane in four segments.

The Pigeon Point IPM Sentry is the heart of the ATCA 14-Slot FlexChassis Shelf Management. Each ATCA slot as well as the fan trays, PEMs, and Shelf Alarm Panel communicate with the Shelf Management Modules via the IPMBs.

The midplane provides the communications path, not only for the plug-in boards, but the PEM, and shelf management modules (ShMM).

## 1.5. Part Number

| Part Number | Module |
|---|---|
| **5-02389** | FlexChassis ATCA 12U, 19", 14-slot, Dual Star, 2 PEMs, 3 Fan Tray Modules, 1 IPMI monitored air filter |

The Shelf Managers and the Shelf Alarm Panel are not included with the Shelf

## 1.6. Terms and Acronyms

**Table 1: Terms and Acronyms**

| Term | Definition |
|---|---|
| ATCA or AdvancedTCA | Advanced Telecom Computing Architecture |
| Backplane | Passive circuit board providing the connectors for the front boards. Power distribution, management and auxiliary signal connections are supported |
| CFM | Cubic Feet per Minute |
| Chassis | Physical structure containing boards, backplane, PEMs, etc.; same as Shelf |
| CPU | Computer Processing Unit |
| DC | Direct Current |
| EMI | Electromagnetic Interface |
| ESD | Electrostatic Discharge |
| ETSI | European Telecommunications Standards Institute |
| Fabric Board | A board intended for use in a star topology backplane that provides connectivity to a number of Node Boards within the backplane. |
| Fabric Slot | A slot in a backplane that is capable of supporting Fabric Boards, Mesh Enabled Boards or Node Boards. |
| FRU | Field Replaceable Unit |
| FTM | Fan Tray Module |

| | |
|---|---|
| HA | High Availability |
| I2C | Inter-integrated Circuit bus |
| I/O | Input/Output |
| IEEE | Institute of Electrical and Electronic Engineers |
| IPM | Intelligent Platform Management |
| IPMI | Intelligent Platform Management Interface |
| IPMB | Intelligent Platform Management Bus |
| IPMB-0 | This is the logical aggregation of the two IPMB busses called IPMB-A and IPMB-B. |
| JTAG | Joint Test Action Group |
| Kbps | Kilo Bits Per Second |
| LED | Light Emitting Diode |
| LFM | Linear Feet per Minute |
| NEBS | Network Equipment Building Standards |
| Node Board | A board intended for use in a star topology backplane that has connectivity to a Fabric Board within the backplane. |
| Node Slot | A slot supporting port connections to/from Fabric Slot(s). A Node slot is intended to accept a Node Board. |
| PCB | Printed Circuit Board |
| PEM | Power Entry Module |
| PICMG | PCI Industrial Computer Manufacturers Group |
| RTC | Real Time Clock |
| RTM | Rear Transition Module |
| SAP | Shelf Alarm Panel |
| SEL | System Event Log |
| Shelf | See Chassis |
| ShMC | Shelf Manager Carrier Board |
| Star | A backplane topology in which there is one or more dedicated channel connections between each node Slot and the Fabric Slots. |
| U | Unit of vertical pitch. 1 U = 1.75 inches = 44.45 mm |
| Zone 2 | ATCA terminology for the data interconnect portion (top) of the backplane. |
| Zone 3 | ATCA terminology for the open region above the backplane where front board and RTMs connect. |

## 1.7. Shelf Specification

The Shelf is 12U high and 19” rack mountable. The chassis is designed for easy access of any field replaceable units (FRU).

The chassis and subrack comply with ATCA 3.0 section 2.0 mechanical requirements and the subrack support fourteen 8U x 280mm front plug boards and 8U x 70mm rear transition modules.

The Shelf implements the following features:

- 14 slot ATCA Backplane, dual-star Base Interface and bused IPMB interface, supporting twelve node board slots and two hub slots
- Mounting brackets for 19” racks
- ESD Wrist Strap Terminals at front and rear
- Two dedicated slots for a Shelf Manager based on Pigeon Point ShMM-500R

- One dedicated slot for a Shelf Alarm Panel (SAP) that provides Telco Alarm interface, Alarm Status LEDs and serial interface for the Shelf Manager
- Three front pluggable fan trays with 4 high speed fans per tray
- Removable air filter that meets the requirements of the Telcordia GR-78-CORE specification
- Two rear pluggable Power Entry Modules

## 1.8. Shelf Dimensions

The Shelf height is 12U with a 14slot x 8U x 280mm card cage. The configuration allows for the Hub slots to be in physical slots 7 and 8. The rear transition area is 14slot x 8U x 70mm. The Shelf is front rack mountable and has provisions for mid mounting. The Shelf has been designed for easy access of field replaceable units (FRU).

## 1.9. Subrack

The Subrack complies per PICMG 3.0 section 2.0 for subracks to support fourteen 8U x 280mm front plug modules and fourteen 8U x 70mm rear transition modules. A slot zero is needed for the two Shelf Managers and one Shelf Alarm Panel.

The front and the rear of the Shelf provide for an ESD wrist strap terminal.

## 1.10. Top Front Cover Panel

The Shelf provides for a cosmetic front panel installed in front of the upper FTMs. This provides space for a logo and contains the labeling for the ATCA blade slots with their physical slot number, Hub slots 7 and 8 are labeled red.

## 1.11. Cable Management

The Shelf provides for a low profile cable management system.

## 1.12. Air Intake Panel

A lower front removable air intake panel provides the EMI containment for the lower section of the Shelf. The panel is easily removable via two fasteners.

## 1.13. Air Filter

The air filter is easily removable from beneath the card cage. This filter element is an open-cell polyurethane foam specially coated to provide improved fire retardation and fungi resistance. It features deep loading, large dust holding capacity, low air resistance, and complies with NEBSGR-63-CORE.

There is a switch to detect whether an air filter is installed. This switch is exposed to the Shelf manager as a presence sensor on the Power Entry Modules.

## 1.14. Rear Hex Panel

A removable rear hex panel allows for a low-impedance exhaust, attenuates EMI while providing protection from the rotating fans and helps prevent flames from exiting the Shelf in case of a fire.

## 1.15. Rear Lower Section

The lower rear section contains provisions for the Power Entry Modules. The structure allows for the FRUs to be easily removed and secured while also providing additional structural integrity to the Shelf.

## 1.16. ESD Wrist Strap Terminals

| | |
|---|---|
|  | **Danger of electrostatic discharge!**<br>*The Shelf contains static sensitive devices. To prevent static damage you must wear an ESD wrist strap.* |

One ESD Wrist Strap Terminal is located at the upper front side and one ESD Wrist Strap Terminal is located at the upper rear side of the chassis.

# 2. Board Specifications

Within the Shelf, there are three fixed boards:

- Midplane
- FTM Distribution board
- Interconnect board

These boards are completely passive and are not Field Replaceable Units. The Interconnect board provides power and signals from the Backplane to the FTM Distribution board and eliminates the use of cables within the chassis. This improves the reliability of the Shelf.

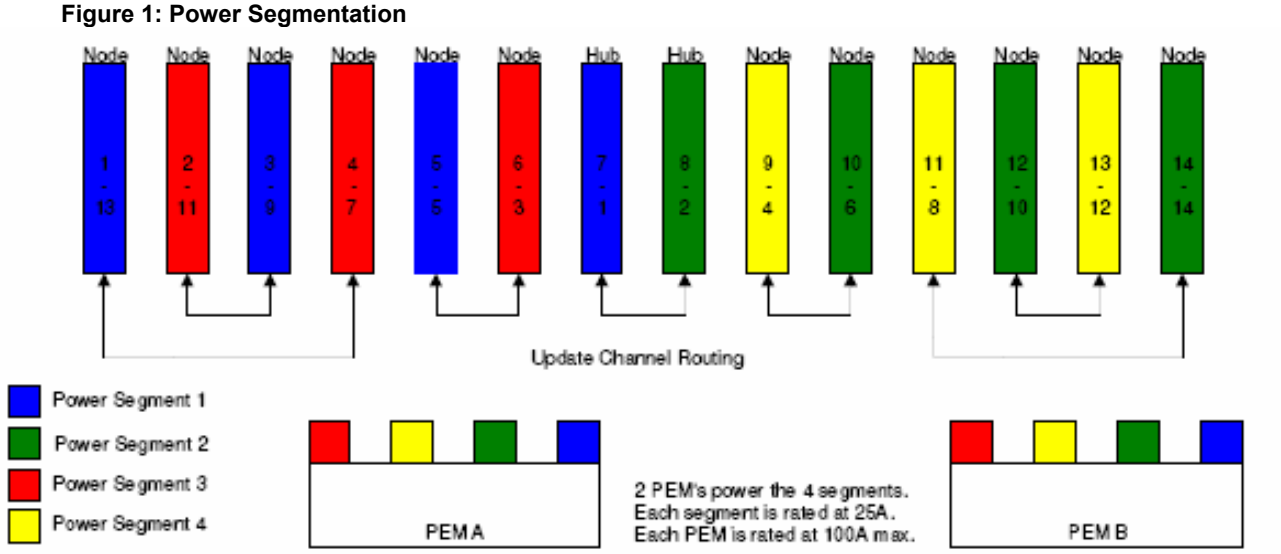
## 2.1. Midplane

The standard backplane is based upon PICMG 3.0 specifications for mechanical attachment to the card cage. The backplane is mounted in such a way as to allow for replacement with minimal chassis disassembly (requires removal of PEM, Payload boards, ShMC's, and Interconnect board), using only simple tools such as screw and nut drivers. The backplane is not a FRU. Hub slots (2) are located in physical slot 7 and slot 8. The backplane PCB is made from IS610 material and provides dual-star Base Interface and dual-star Fabric Interface connections at each node slot with Segmented power (Section 2.1.1), and direct mating to the PEM. Backplane tests show performance at 3.12Gb/s with margin up to 4Gb/s. The channel skews are less than 6ps. The Shelf Manager cards and Shelf Alarm Panel are designed to be installed via the right section of the backplane (slot 0). The PEMs are installed in the rear section of the backplane along with the Interconnect board.

**Table 2: 14-Slot ATCA backplane physical to logical slot mapping**

| | Node | Node | Node | Node | Node | Node | Hub | Hub | Node | Node | Node | Node | Node | Node |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical slot | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Logical slot | 13 | 11 | 9 | 7 | 5 | 3 | 1 | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| Hardware address (hex) | 4D | 4B | 49 | 47 | 45 | 43 | 41 | 42 | 44 | 46 | 48 | 4A | 4C | 4E |
| IPMB address (hex) | 9A | 96 | 92 | 8E | 8A | 86 | 82 | 84 | 88 | 8C | 90 | 94 | 98 | 9C |
| Update channel (physical slot) | 4→ | 3→ | ←2 | ←1 | 6→ | ←5 | 8→ | ←7 | 10→ | ←9 | 14→ | 13→ | ←12 | ←11 |
| Power segment | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 2 | 4 | 2 | 4 | 2 | 4 | 2 |

**Figure 1: Power Segmentation**




### *2.1.1. SEEPROMs*

The SEEPROMs are the repository of the shelf specific information capabilities of the system and other

user configurable options. The SEEPROMs contain the list of which slots are connected together, how the update channels are routed, how many slots are in the system, what the maximum power is to each slot, serial number of the shelf, backplane topology, etc. The Shelf Manager uses this information to provide functions such as electronic keying, controlling the power state of the system, etc.

The SEEPROMs receive redundant 3.3V power from each of the PEMs, which is diode-OR'd. As long as one PEM has power, the SEEPROMs are functional.

There are two locations in the Shelf where the chassis FRU data can be stored. The default configuration has the redundant SEEPROMs installed in sockets on the backplane. The Shelf also supports a second configuration where the chassis FRU data is stored in a SEEPROM located on each PEM.

The Shelf allows for 3 methods to chassis FRU data:

- An I2C connection from each Shelf Manager directly to the SEEPROMs on the backplane.
- SEEPROMs on the backplane exposed as a FRU of the PEMs.
- No SEEPROM on the backplane, but SEEPROM installed in each PEM, exposed as a FRU of the PEMs.

It is also possible to have SEEPROMs on the backplane and in the PEMs. In this configuration there are four redundant copies of the chassis FRU data.

The Shelf Managers cache the information that is stored in the SEEPROMs so that the SEEPROM is only needed when the Shelf Managers are first inserted or when the Shelf is first turned on. The redundant SEEPROMs ensure that if one is corrupt or non-functional, the second can provide the necessary information. The Shelf Manager determines which information is correct and then synchronizes the SEEPROMs from the internally cached copy of the SEEPROM information.

The Shelf Manager periodically accesses both SEEPROMs to ensure that they are responding properly. If a SEEPROM has failed, the Shelf Manager logs the error and raises an error condition to the upper-level software. When a blank replacement SEEPROM is inserted into the shelf, the Shelf Manager automatically detects the newly inserted SEEPROM and synchronizes it with the SEEPROM information internally cached on the Shelf Manager.

### *2.1.2. Shelf SEEPROM Locations*

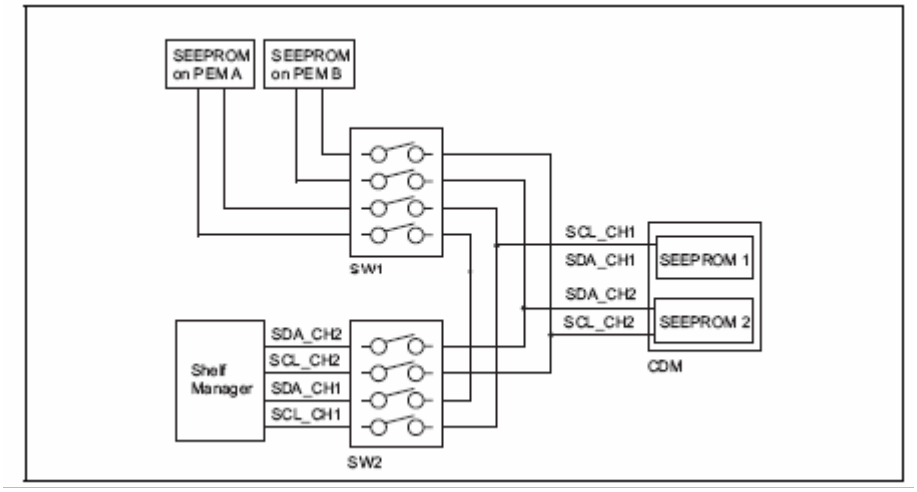
There are two locations in the Shelf for SEEPROMs. In the default configuration two redundant SEEPROMs are located on the Chassis Data Module (CDM). The CDM is a PCB at the upper rear side of the Shelf. The SEEPROMs are accessible through a removable panel. The I2C address for these SEEPROMs is 0xA4.

**Figure 2: Shelf SEEPROM Locations (1)**


The Shelf also provides a second configuration with a SEEPROM located on each PEM.

For the third configuration the I2C connections to the SEEPROMs are configurable by switches (SW1) and (SW2) on the Backplane.

**Figure 3: Shelf SEEPROM Locations (2)**

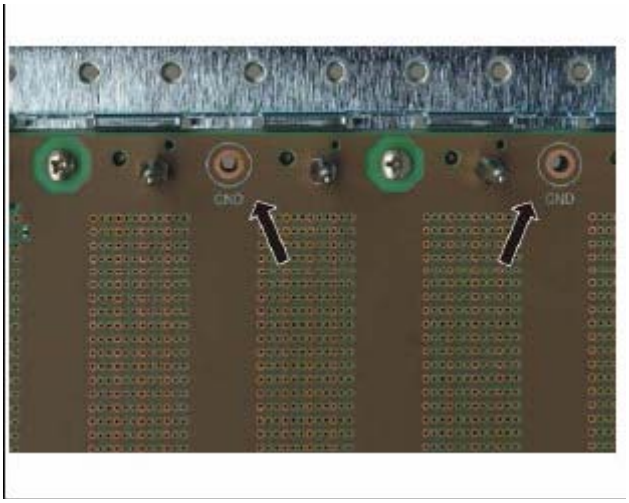



Default configuration is SW2 closed and SW1 open. The Shelf Mangers have access to the SEEPROMs via I²C-bus Channel 1 and Channel 2. In an alternate configuration SW2 is open and SW1 is closed so that the SEEPROMs on the CDM are connected to the internal I2C-bus on the PEMs.

### *2.1.3. Logic Ground*

The ATCA Backplane provides a mechanism to connect Logic Ground and Shelf Ground. To connect Logic Ground and Shelf Ground mount an additional backplane mounting screw (M3 x 12 mm) with an adequate washer at a position labeled with “GND“.

**Figure 4: Logic Ground**




## 2.2. FTM Distribution Board

The FTM distribution board provides the signal and power connections to the upper FTMs from the backplane.

## 2.3. Interconnect Board

The interconnect board connects the backplane to the FTM distribution board.

# 3. Shelf Manager

The Shelf Manager for ATCA 6- & 14-Slot DC-powered FlexChassis is a 78 mm x 280 mm board that fits into a dedicated Shelf Manager slot in an ATCA 12U, 14-Slot FlexChassis.

The Shelf Manager has two main responsibilities:

1. Manage/track the FRU population and common infrastructure of a Shelf, especially the power, cooling and interconnect resources and their usage.

2. Enable the overall System Manager to join in the management/tracking through the System Manager Interface, which is typically implemented over Ethernet.

The Shelf management based on the Pigeon Point Shelf management solution for ATCA products.

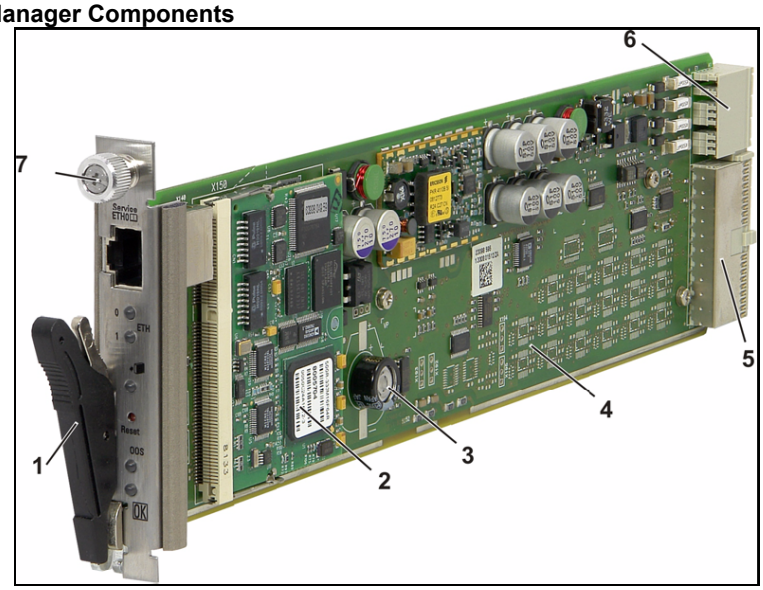
The Shelf management software executes on the Pigeon Point Shelf Management Mezzanine 500R (ShMM-500R), a compact SO-DIMM form-factor module, installed on the Shelf Manager Carrier board.

The Shelf Manager Carrier board includes several on-board devices that enable different aspects of Shelf management based on the ShMM-500R. These facilities include I²C-based hardware monitoring/control and GPIO expander devices.

The Shelf Manager Carrier board also provides the Fan Controller for up to 9 fans and individual Ethernet connections to both Base Hubs (ShMC cross connect), according to PICMG Engineering Change Notice ECN 3.0-2.0-001

The Shelf Manager communicates inside the Shelf with IPM controllers over the Intelligent Platform Management Bus (IPMB). The Shelf Manager also provides an IPMB interface for the non-intelligent FRUs in the ATCA 14-Slot FlexChassis. The Shelf Manager communicates with the non-intelligent FRUs over I²C busses and exposes the sensors for these FRUs at IPMB address 0x20.

**Figure 5: Shelf Manager Components**




| | | | |
|---|---|---|---|
| 1 | Extraction handle | 5 | Backplane connector (J2) |
| 2 | ShMM 500R | 6 | Backplane connector (J1) |
| 3 | RTC backup capacitor | 7 | Fixing screw |
| 4 | Carrier board | | |

Please refer to the separate user manual for Shelf Manager for ATCA 6- & 14-Slot DC-powered FlexChassis for more details.

# 4. Shelf Alarm Panel

## 4.1. Introduction

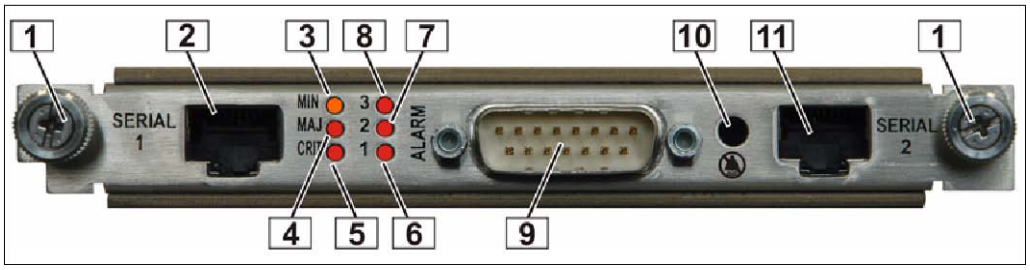
Some Shelf Manager I/O functionalities have been moved to a separate board called Shelf Alarm Panel (SAP). The Shelf provides provisions for one SAP location. The SAP major features are:

- 3 Shelf Alarm LEDs (MINOR, MAJOR, CRITICAL)
- The Telco Alarm connector (DB15-male)
- The Alarm Silence
- A serial console interface for Shelf Managers (RJ45 connector)

*The I²C enabled DSAP can only be used together with Shelf Managers*

## 4.2. DSAP

**Figure 6: Front Panel DSAP**

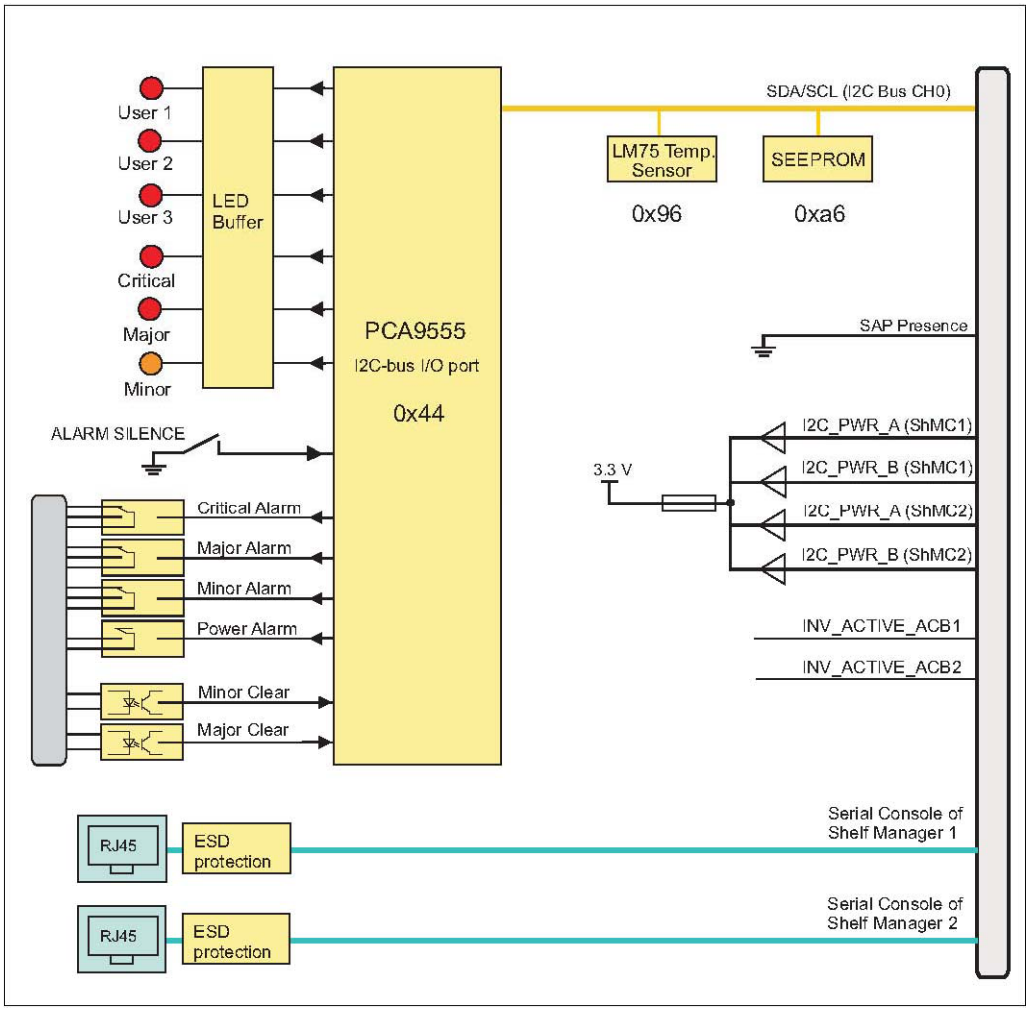



12706932

| | | | |
|---|---|---|---|
| 1 | Fixing screw | 7 | LED USER 2 |
| 2 | Serial Interface for Shelf Manager 1 | 8 | LED USER 3 |
| 3 | LED Minor Alarm (red) | 9 | Telco Alarm Connector |
| 4 | LED Major Alarm (red) | 10 | Alarm Silence button |
| 5 | LED Critical Alarm (amber) | 11 | Serial Interface for Shelf Manager 2 |
| 6 | LED USER 1 | | |

## 4.3. DSAP Block Diagram

**Figure 7: DSAP Block Diagram**




12706921

## 4.4. DSAP SEEPROM

The SAP SEEPROM is connected to the Master-Only I²C-bus and is a Microchip 24LC256 device.

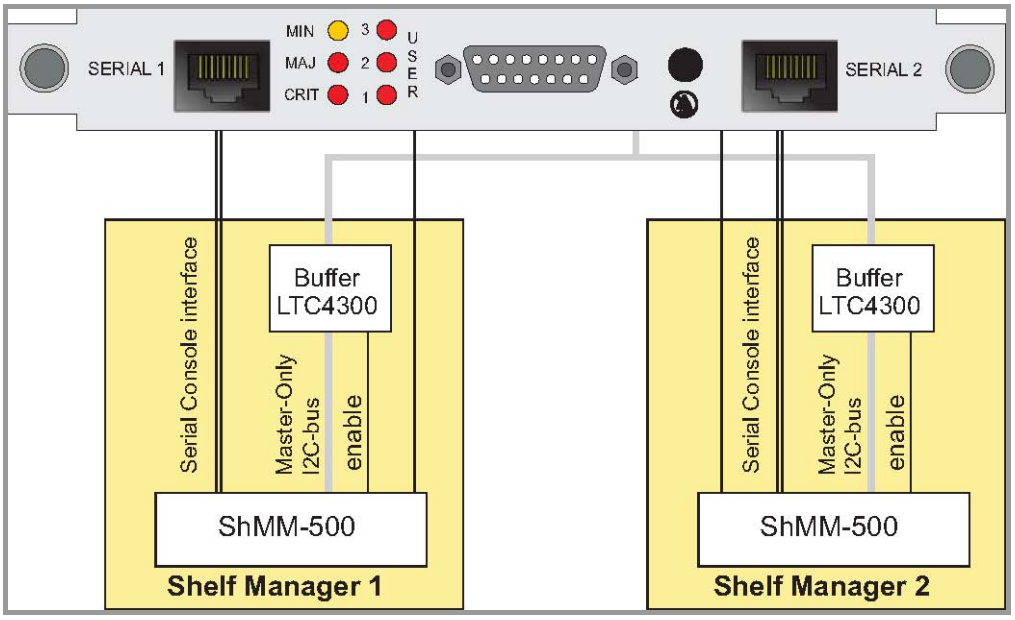
## 4.5. DSAP I²C Addresses

**Table 3: DSAP I²C Addresses**

| LM75 | SEEPROM | PCA9555 |
|---|---|---|
| 0x96/0x4b | 0xa6/0x53 | 0x44/0x22 |

## 4.6. Connection between Shelf Manager and DSAP

**Figure 8: Connection between Shelf Manager and DSAP**




12706933

## 4.7. SAP Telco Alarms

### *4.7.1. Telco Alarm Interface*

The SAP provides a Telco Alarm interface on the DB15-male connector. Three relay outputs are used for remote alarm distribution, reflecting the state of the three Alarm LEDs. The relays are capable of carrying 72 VDC or 1 A with a max. rating of 30 VA.

### *4.7.2. Telco Alarm LEDs*

The Shelf Alarm Panel provides the Telco Alarm LEDs. These LEDs indicate presence of Critical, Major and Minor alarms as follows:

**Table4: Telco Alarm LEDs**

| | State | Description |
|---|---|---|
| Off | | No alarm active |
| On | | Alarm active |
| Flashing | | Alarm active, but silenced |

### *4.7.3. Alarm Silence Push Button*

The Alarm Silence push button on the Shelf Alarm Panel faceplate deactivates the alarm relays. During the time Alarm Silence is activated, the Alarm LEDs flash. By pressing the Alarm Silence push button a second time, the alarm relays are reactivated and the Alarm LEDs are solid.

The **Alarm Silence** push button only activates the Alarm Silence state, but does not reset the

alarms. If the silence interval (default 600 s) is exceeded without resolving the alarms, the alarms will be re-initiated.

### *4.7.4. Alarm Reset*

**Hardware Reset:**

Two relay inputs at the DB15 connector are used to reset the Minor and Major alarm state.

The reset inputs accept timed pulse inputs for clearing Minor and Major alarm states. Reset is accomplished by asserting a voltage differential from 3.3 VDC to 72 VDC for between 200 ms and 300 ms. The acceptance voltage range is from 0 to 48 VDC continuous (handles up to 60 VDC at a 50% duty cycle). The current drawn by a reset input does not exceed 12 mA.

There is no hardware reset (reset input) for the Critical Alarm state.

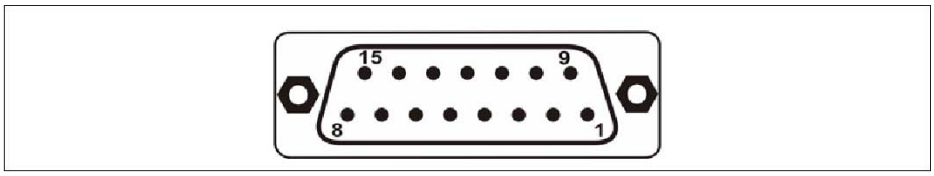
**Software Reset:**

The RMCP and CLI functions can be used to set and reset the Telco Alarms (incl. Critical Alarm). See the Pigeon Point Shelf Manager External Interface Reference for more information.

## 4.8. SAP Connectors

### *4.8.1. SAP Telco Alarm Connector (DB15-male) Figure 16: Telco Alarm Connector*

**Figure 9: Telco Alarm Connector (DB15-male)**



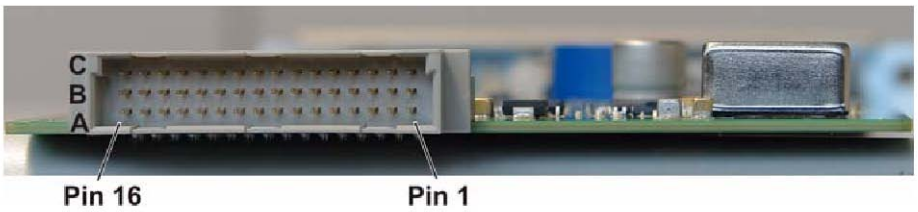

12705896

**Table 5: Telco Alarm Connector (CN2) Pin Assignment**

| CN2 Pin | Name | Description |
|---|---|---|
| 1 | AMIR+ | Minor Reset+ |
| 2 | AMIR- | Minor Reset |
| 3 | AMAR+ | Major Reset+ |
| 4 | AMAR- | Major Reset |
| 5 | ACNO | Critical Alarm - NO |
| 6 | ACNC | Critical Alarm - NC |
| 7 | ACCOM | Critical Alarm - COM |
| 8 | AMINO | Minor Alarm – NO |
| 9 | AMINC | Minor Alarm – NC |
| 10 | AMINCOM | Minor Alarm – COM |
| 11 | AMANO | Major Alarm – NO |
| 12 | AMANC | Major Alarm – NC |
| 13 | AMACOM | Major Alarm – COM |
| 14 | APRCO | Pwr Alarm – NO |
| 15 | APRCOM | Pwr Alarm - COM |
| Shield | Shelf-GND | Shelf Ground |

### *4.8.2. Shelf Alarm Panel Backplane Connector*

**Figure 10: Shelf Alarm Panel Backplane Connector**




12706926

**Table 6: Shelf Alarm Panel Backplane Connector Pin Assignment**

| | SAP ATCA Backplane Connector | | | | | |
|---|---|---|---|---|---|---|
| **Pin** | **A** | **Description** | **B** | **Description** | **C** | **Description** |
| 1 | -48V_A | -48 V Feed A | -48V_B | -48 V Feed B | | |
| 2 | | | | | VRTN_A | Voltage return Feed A |
| 3 | | | | | VRTN_B | Voltage return Feed B |
| 4 | | | | | | |
| 5 | | | I2C_PWR_A (1) | 3.6 V from Shelf Manager 1 | I2C_PWR_B (1) | 3.6 V from Shelf Manager 1 |
| 6 | GND | Ground | GND | Ground | I2C_PWR_A (2) | 3.6 V from Shelf Manager 2 |
| 7 | SDA_CH0 | Data I²C-bus Channel 0 (only DSAP) | GND | Ground | I2C_PWR_B (2) | 3.6 V from Shelf Manager 2 |
| 8 | SCL_CH0 | Clock I²C-bus Channel 0 (only DSAP) | INT | | GND | |
| 9 | INV_ACTIVE_B | Active signal from Shelf Manager 2 (right) | RXD0_ACB1 | Receive Data Shelf Manager 1 | RXD0_ACB2 | Receive Data Shelf Manager 2 |
| 10 | DSR_ACB1 | Data Set Read Shelf Manager 1 | DTR_ACB1 | Data Terminal Ready Shelf Manager 1 | DSR_ACB2 | Data Set Ready Shelf Manager 2 |
| 11 | CD_ACB2 | Carrier Detect Shelf Manager 2 | DTR_ACB2 | Data Terminal Ready Shelf Manager 2 | CD_ACB1 | Carrier Detect Shelf Manager 1 |
| 12 | CTS_ACB1 | Clear To Send Shelf Manager 1 | CTS_ACB2 | Clear To Send Shelf Manager 2 | RTS_ACB1 | Request To Send Shelf Manager 1 |
| 13 | TXD0_ACB2 | Transmit Data Shelf Manager 2 | TXD0_ACB1 | Transmit Data Shelf Manager 1 | SDA_B | Data IPMB_B (only ISAP |
| 14 | SDA_A | Data IPMB_A (only ISAP) | RTS_ACB2 | Request To Send Shelf Manager 2 | SCL_B | Clock IPMB_B (only ISAP |
| 15 | SAP_PRES | SAP Presence signal to Shelf Manager | SCL_A | Clock IPMB_A (only ISAP) | | |
| 16 | INV_ACTIVE_A | Active signal from Shelf Manager 1(left) | | | SHELF_GND | Shelf Ground |

## 4.9. SAP Temperature Sensor

The LM75 temperature sensor measuring the board temperature is located on the SAP PCB. The temperature sensor is either connected to the Master-Only I²C-bus (DSAP) or the internal I²C-bus and is accessible via IPMB (ISAP).

## 4.10. SAP PCA9555

The PCA9555 device:

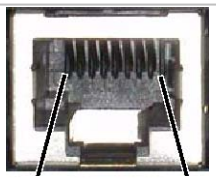
- controls the status of the LEDs
- reads the status of the Telco Alarm Cutoff push button
- controls the Telco Alarm relays

**Table 7: PCA9555 Device Function**

| PCA9555 I/O pins | Function | State |
|---|---|---|
| 0.0 | Power Alarm to telco relays output | 1 = relays powered |
| 0.1 | Minor Alarm to telco relays output | 1 = relays powered |
| 0.2 | Major Alarm to telco relays output | 1 = relays powered |
| 0.3 | Critical Alarm to telco relays output | 1 = relays powered |
| 0.4 | N/C | Pulled High |
| 0.5 | LED_MIN (Minor alarm LED) output | 1 = On |
| 0.6 | LED_MAJ (Major alarm LED) output | 1 = On |
| 0.7 | LED_CRIT (Critical alarm LED) output | 1 = On |
| 1.0 | Alarm Silence button input | 0 = push button pushed |
| 1.1 | Minor Clear input | 0 = voltage applied to input pins |
| 1.2 | Major Clear input | 0 = voltage applied to input pins |
| 1.3 | N/C | Pulled High |
| 1.4 | N/C | Pulled High |
| 1.5 | LED_USER3 output | 1 = On |
| 1.6 | LED_USER2 output | 1 = On |
| 1.7 | LED_USER1 output | 1 = On |

## 4.11. RS-232 Serial Console Interface on Shelf Alarm Panel

**Figure 11: RS-232 Serial Console Interface on Shelf Alarm Display**




12705811

The Shelf Alarm Panel provides a RS-232 serial console connector for the Shelf Manager 1 and Shelf Manager 2. The connector is a 8-pin RJ45 modular receptacle.

The DSAP provides two RJ45 connectors.

The ISAP provide just one connector for both Shelf Managers, only the active Shelf Manager has access to the connector!

A full set of RS-232 signals, including modem control is provided. The serial interface is implemented on the ShMM-500.

The RS-232 Serial Console Interface is available with EIA/TIA or Cisco pin assignment. The default configuration is Cisco pinout with:

- 115200 baud
- no parity
- 8 data bits
- 1 stop bit

**Table 8: RS-232 Serial Connector Cisco Pin assignment (default)**

| RJ45 Pin | RS-232 Signal | Type | Description |
|---|---|---|---|
| 1 | RTS | Out | Request To Send |
| 2 | DTR | Out | Data Terminal Ready |
| 3 | TxD | Out | Transmit Data |
| 4 | GND | REF | Logic Ground |
| 5 | GND | REF | Logic Ground |
| 6 | RxD | In | Receive Data |
| 7 | DSR | In | Data Set Ready |
| 8 | CTS | In | Clear To Send |

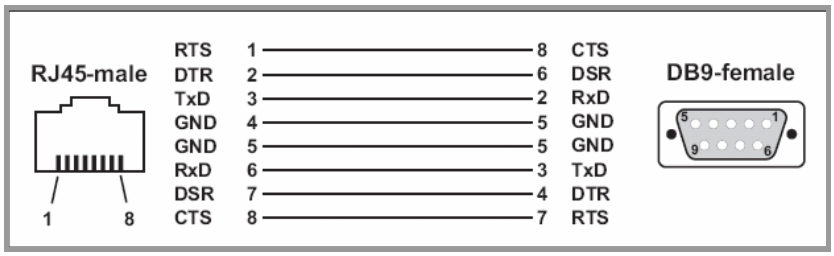
**Table 9: RS-232 Serial Connector EIA/TIA Pin assignment**

| RJ45 Pin | RS-232 Signal | Type | Description |
|---|---|---|---|
| 1 | DSR | In | Data Set Ready |
| 2 | CD | In | Carrier Detect |
| 3 | DTR | Out | Data Terminal Ready |

| | | | |
|---|---|---|---|
| 4 | GND | REF | Logic Ground |
| 5 | RxD | In | Receive Data |
| 6 | TxD | Out | Transmit Data |
| 7 | CTS | In | Clear To Send |
| 8 | RTS | Out | Request To Send |

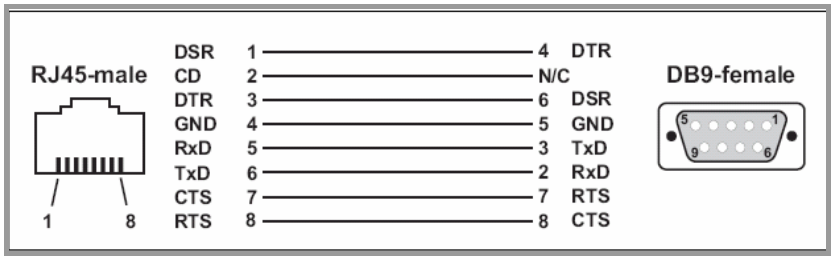
## 4.12. SAP Console Cable for the Shelf Manger Serial Interface

**Figure 12: RJ45 to DB9 Serial Console Cable Cisco option (default)**




12706929

**Figure 13: RJ45 to DB9 Serial Console Cable EIA/TIA option**




12706930

The connectors are shown with the cables pointing away.

*The serial console cable is not included with the Shelf.*

# 5. Fan Trays Modules

## 5.1. Introduction

The Shelf has upper Fan Tray Modules (FTM). Each FTM has four 92mm fans and the arrangement is based on the patented Pentair Electronic Packaging Serial-Parallel Fan Scheme for maximum volume air flow, even distribution, and fault resilience.

## 5.2. Functional Description

The fans in the FTM are controlled as a group, via an IPMB-based interface. The IPM Sentry Shelf Manager performs management of the FTM. The BMR-AVR is used as the IPM Controller in the FTM implementation.

The FTM has an Injector/Ejector handle that interfaces with a micro switch and signals the BMR-AVR for hot-swap. The handle has a tool accessible fastener that locks the FTM securely into the Shelf.

The Shelf Managers monitor the FTM through the two independent bussed IPMB connections.

When the FTM is first inserted into the system, the fans initially start at full speed and then decrease to 25% of full speed. The circuitry on-board the fan tray uses pulse-width modulation to set the speed of all the fans. Lower speeds reduce acoustics and increase the longevity of the fans.

The speed of each fan is monitored. If the fan speed drops below or increases above the desired fan speed, a system event log (SEL) entry is logged by the Shelf Manager. The Shelf Manager can be configured to then generate alerts and set alarm conditions as necessary.

The FTM does not negotiate for power with the Shelf Manager and it does not start out at Power Level 0 as specified in the PICMG 3.0 power management mechanism. This ensures that the fans start up immediately upon insertion.

## 5.3. Construction

The FTM is constructed of .060” aluminum with a chem-film finish. The FTM board is installed to the FTM and allows for easy access to the components on the board. Optimization of the FTM has minimized the number of parts to assemble and has been designed for low cost with high functionality and reliability.

Plastic buttons have been installed to the left side of the FTM to provide a smooth sliding mechanism against the steel walls of the Shelf and against the adjacent FTM.

An Injector/Ejector handle at the left provides the Hot-swap mechanism. The Handle locks directly to the FTM via a Phillips screw fastener.

Four 92mm high powered 150CFM fans are installed and harnessed directly to the FTM board.

## 5.4. Fan Tray Block Diagram

**Figure 14: Fan Tray Block Diagram**

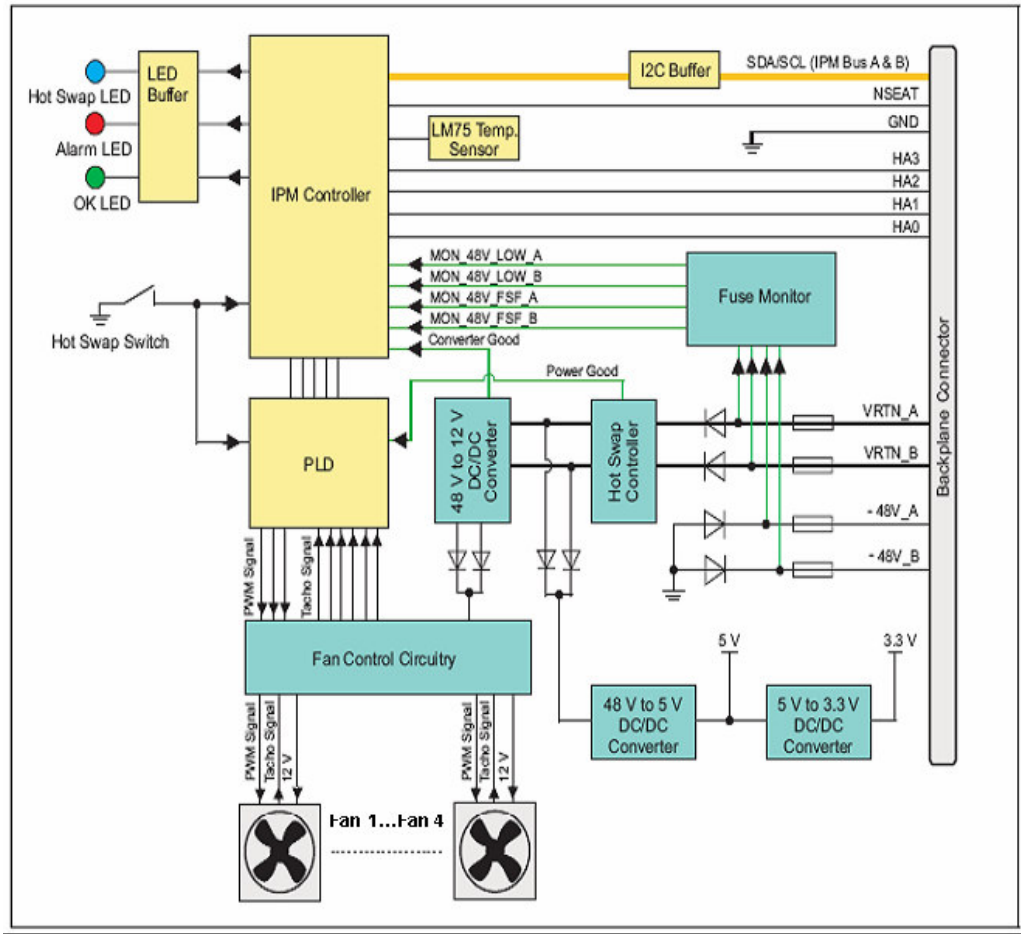



**Table 10: Fan Tray Backplane Connector pin assignment**

| Pin # | Signal | Description | Pin # | Signal | Description |
|---|---|---|---|---|---|
| 1 | NSEAT | Seated Signal for IPM Controller, grounded on Backplane | 13 | | |
| 2 | | | 14 | | |
| 3 | SGND | Shelf Ground | 15 | | |
| 4 | | | 16 | GND (Fan Presence) | Presence Signal for Shelf Manager |
| 5 | | | 17 | HA0 | Hardware Address |
| 6 | SCL_A | IPMB-A Clock | 18 | HA1 | Hardware Address |
| 7 | SCL_B | IPMB-B Clock | 19 | HA2 | Hardware Address |
| 8 | GND | Logic Ground | 20 | HA3 | Hardware Address |
| 9 | | | 21 | GND | Logic Ground |
| 10 | GND | Logic Ground | 22 | SDA_A | IPMB-A Data |
| 11 | | | 23 | SDA_B | IPMB-B Data |
| 12 | | | 24 | GND | Logic Ground |
| BLADE1 | -48V_A | -48 VDC Feed A | BLADE3 | -48V_B | -48 VDC Feed B |
| BLADE2 | VRTN_A | RTN Feed A | BLADE4 | VRTN_B | RTN Feed B |

## 5.5. Fan Tray Signals

The Fan Tray provides signals for:

- Voltage monitoring
- Status of the Hot Swap Controller
- Status of the 12 V DC/DC converter
- Fan Speed
- Temperature

These signals are controlled by the IPM Controller devices on the Fan Tray PCB. The Shelf Manager has access to these signals via IPMB.

**Table 11: Fan Tray Sensors**

| Sensor Name | Description | Sensor # | Normal | Thresholds | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Lower Critical | Lower Non-Critical | Lower Non-Recoverable | Upper Non-Critical | Upper Critical | Upper Non Recoverable |
| Hot Swap | M State Information | 0 | M4 | M1, M2, M3, M5, M6, M7 | | | | | |
| IPMB Physical | IPMB Physical | 1 | | | | | | | |
| +3.3V | +3.3 V | 12 | 3.3 V | +2.97 | +3.135 | 2.91 | +3.465 | +3.63 | 3.7 |
| +5.0V | +5 V | 13 | 5.0 V | +4.5 | +4.75 | 4.4 | +5.25 | +5.5 | 5.6 |
| +12.0V | +12 V | 14 | 12.0 V | +9 | +10 | 8.03 | +13.5 | +14.5 | 15.52 |
| LM60 Temp | Temperature Sensor | 15 | 25 | N/A | N/A | N/A | 61.34 | 67.55 | 75.83 |
| Fan 1 | RPM | 2 | On | 600 | | | | | |
| Fan 2 | RPM | 3 | On | 600 | | | | | |
| Fan 3 | RPM | 4 | On | 600 | | | | | |
| Fan 4 | RPM | 5 | On | 600 | | | | | |
| -48V fuse A | -48 V Fuse A | 8 | Asserted | | | | | | |
| -48V fuse B | -48 V Fuse B | 9 | Asserted | | | | | | |
| -48V rtn fuse A | RTN Fuse A | 10 | Asserted | | | | | | |
| -48V rtn fuse B | RTN Fuse B | 11 | Asserted | | | | | | |

## 5.6. Fan Tray Temperature Sensor

The temperature sensors (LM75) in the Fan Trays measure the input and exhaust temperatures of the Shelf.

## 5.7. Fan Tray Connectors and Indicators

The front panel includes the following indicators:

- Green LED – “In-Service”
- Red LED – “Out of Service”
- Blue LED – “Hot-Swap”

The Hot-Swap switch indicates to the Shelf Managers that the Fan Tray is about to be removed. Its use is optional, but it is provided so that service personnel can be trained to look for a blue LED to be illuminated on any active component before removing it from the system. Once the operator releases the Hot-Swap switch, the Shelf Manager is informed of the pending extraction. When the Shelf Manager feels it is “safe” to remove the Fan Tray, the blue Hot-Swap LED illuminates solid.

**Table 12: LEDs on Fan Tray front panel**

| Color | Description | Status | Condition |
|---|---|---|---|
| Green | In-Service LED | Off<br>Solid Green | Fan Tray is inactive<br>Normal Operation |
| Red / Amber | Out-of-service LED | Off<br>Solid Red | No error<br>Error condition |
| | Warning LED | Solid Amber | {not used} |
| Blue | Hot Swap LED | Off<br>Long blink<br>Short blink<br>Solid blue | Fan Tray is active<br>Request for activation<br>Request for deactivation<br>Fan Tray is inactive |

## 5.8. Fan Tray IPMB Addresses

Geographic address pins (HA0, HA1, HA2, HA3) at the Fan Tray Backplane connector determine the hardware addresses of the devices.

**Table 13: Fan Tray IPMB Addresses**

| | | |
|---|---|---|
| Fan Tray left | 0x2E (Hardware) | 0x5C (IPMB) |
| Fan Tray middle | 0x2D (Hardware) | 0x5A (IPMB) |
| Fan Tray right | 0x2C (Hardware) | 0x58 (IPMB) |

## 5.9. Redundancy

The fan tray has been designed to maximize redundancy within a single fan tray.

- Power draw from A & B feeds with lines individually fused.
- The control circuit is designed so that if the management circuitry does not provide the proper control signals, the fans default to full speed.
- When the fan tray is first installed in the system, the fans spin at full speed.
- The fan tray has redundant IPMB connections for better management communication reliability.
- The system is designed to run indefinitely with any single fan failure. The circuitry on the controller board monitors the speed of each fan. When one fan fails, all other fans are increased to full speed. The fan tray has sufficient cooling capacity to keep the chassis cooled with a single fan failure. The hybrid serial parallel cooling scheme ensures that the airflow path within each slot is not substantially affected with a fan failure.

# 6. Power Entry Module (PEM)

| | |
|---|---|
|  | **Hazardous voltage!**<br>*Before working ensure that the power is removed from the power connection cables. When the system is powered on, do NOT touch the power terminals.* |
|  | **Warning!**<br>*Although there are fuses in the power entry circuit of the Shelf, the power lines have to be protected on rack level with 40 A breakers.* |

*The Shelf can be powered using a regular telecommunication power supply of -48 VDC / -60 VDC with a voltage return. The specified voltage range is from -40.5 VDC to -72 VDC.The Shelf supports redundant power sources but the two sources should be independently powered.*

## 6.1. Introduction

The Power Entry Modules (PEMs) are intelligent FRUs controlled by the Shelf Manager via IPMB. Two pluggable redundant Power Entry Modules (PEMs) are located at the left and right rear side of the Shelf. The PEMs have an Injector/Ejector handle that interfaces with a mechanical switch and signals the IPM Controller for hot-swap. The handle has a captive thumbscrew that activates the hot-swap switch and locks the handle securely on the front panel.

## 6.2. Construction

The PEM is constructed of .060” aluminum with a chem-film finish. The top panel is easily removable to provide access to the fuses and headers boarding the PEM.

EMI gaskets have been installed to all sides of the PEM.

The PEM is securely attached to the Shelf via two Phillips screw fasteners. An Injector/Ejector handle at the lower right provides the hot swap mechanism. The Handle locks directly to the PEM via a Phillips screw fastener.

## 6.3. Dimensions

3.00”H X 7.5”W X 8.00”D

## 6.4. Cabling

The PEM terminals meet the accessibility and spacing requirements of IEC 60950 Sub clause 2. A dual stud connection is available for each cable. These studs are ¼ in. studs with 5/8 in. spacing between stud centers. The dual studs prevent the power cables from rotating and provide additional secure contacts for the cable lug.

A plastic housing covers the dual stud power feeds and returns to prevent against accidental shorting. The housing is attached via 1 screw and is removable with a Philips screwdriver.

## 6.5. Compliance

### *6.5.1. Surge Compliance*

The PEM remains operational during a 500 V 8/20□s surge transient from -48V/-48V_RTN to Earth

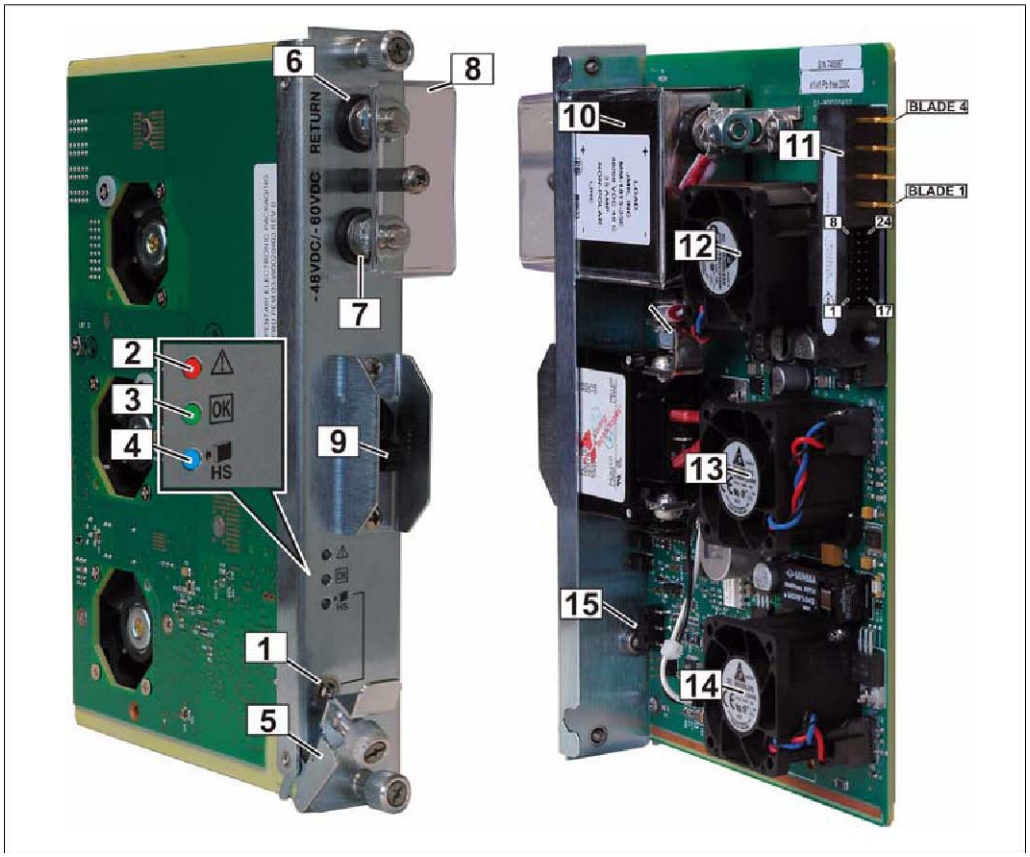
ground, as defined in EN61000-4-5 and provides protection for the shelf against EN61000-4-5 surge transients. The PEM reduces the EN61000-4-5 surge transients to under -100V for a maximum duration of 10□s, and under -200V for a maximum duration of 5□s.

### *6.5.2. EFT Compliance*

The PEM remains operational during a 500V 5/50ns EFT transient from -48V/-48V_RTN to Earth ground as defined in EN61000-4-4 and provides protection for the shelf against EN61000-4-4 EFT transients.

## 6.6. PEM Components

**Figure 15: PEM Components**

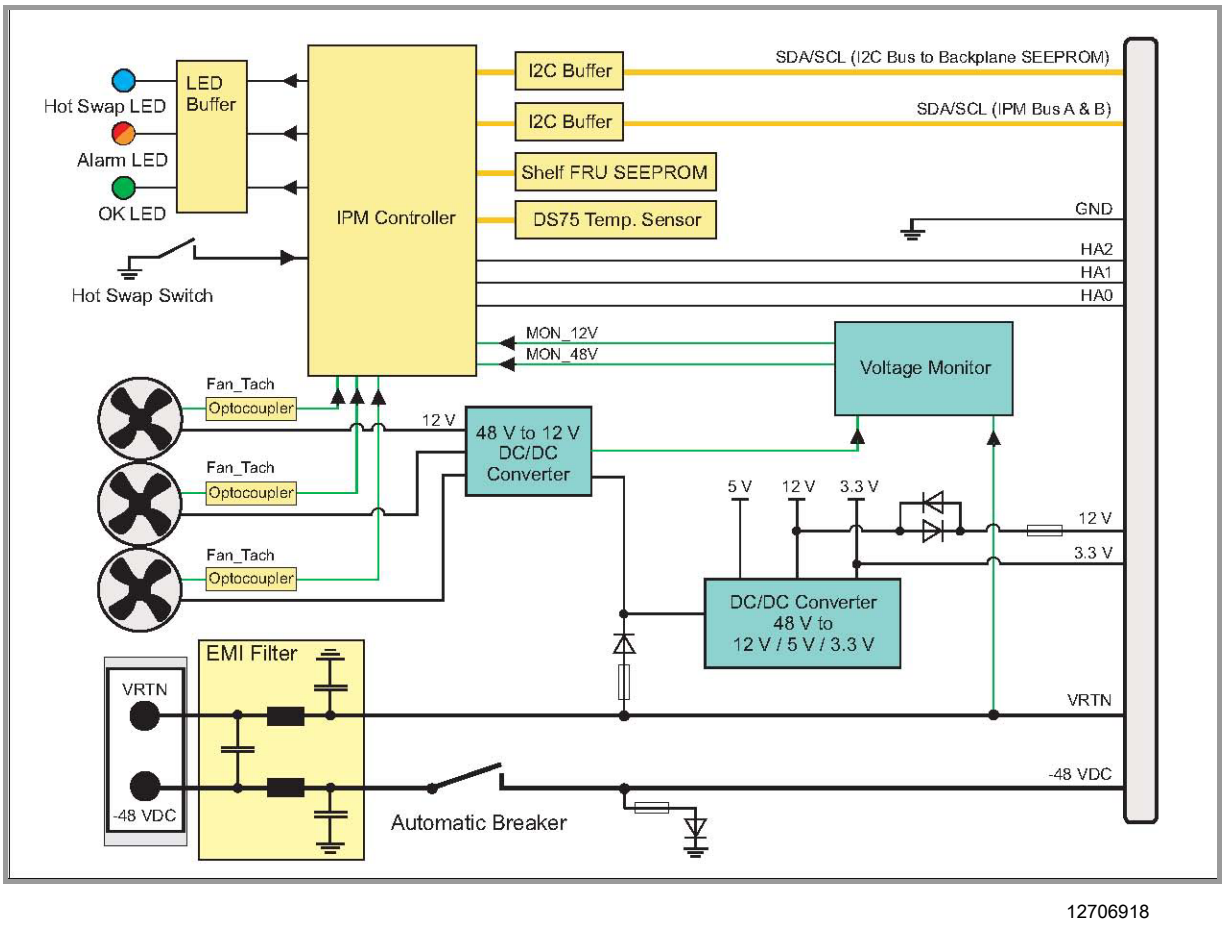



12707803

| | | | |
|---|---|---|---|
| 1 | Hot Swap Switch Access | 9 | Circuit Breaker Switch |
| 2 | Out Of Service LED (red/amber) | 10 | EMI Filter |
| 3 | In Service LED (green) | 11 | Backplane Connector |
| 4 | Hot Swap LED (blue) | 12 | Fan#1 |
| 5 | Injector/Ejector Handle | 13 | Fan#2 |
| 6 | VRTN Terminal | 14 | Fan#3 |
| 7 | -48/-60 VDC Terminal | 15 | Hot Swap Switch |
| 8 | Power Terminal cover | | |

## 6.7. PEM Block Diagram

**Figure 16: PEM Block Diagram**




## 6.8. PEM IPMB addresses

Geographic address pins (HA0, HA1, HA2) on the PEM Backplane connector determine the IPMB addresses of the PEM.

**Table 14: PEM IPMB addresses**

| PEM Location | |
|---|---|
| PEM B (Right, view from front) | 0x66 |
| PEM A (Left, view from front) | 0x68 |

## 6.9. Power Distribution

The power distribution within the Shelf originates from each PEM and powers all the blades, the Shelf Managers, the Fan Trays and the SAP. For maximum fault tolerance, the two PEMs should be independently powered by a separate Feed A and Feed B.

A single PEM is capable of supplying the 200 watts of power to each blade slot and the necessary power for the

Fan Trays and system management.

If two PEMs are in service, each PEM is hot-swappable after removing the power input cables from the PEM.

The PEM has an on-board DC-DC converter to change -48 V to 12 V / 5V / 3.3 V to power the IPM controller and other on-board devices.

The 12 V and the 3.3 V feeds are also routed to the Backplane connector.

- The 12 V feed is routed to the other PEM as backup power for the IPM controller. This configuration allows the Shelf Manager to communicate with both PEMs even if power is lost to one PEM.
- The 3.3 V feed is routed to the CDM connector on the Backplane to provide power to the Shelf SEEPROM.

## 6.10. Specification for the power connection cables

**Required wire size:**

Diameter 10 mm² resp. AWG8

max. length 2.5 to 3.0 m

suitable for 40 A at 50 °C ambient temperature.

## 6.11. PEM Signals

The PEM provides signals for:

- Voltage monitoring
- Status of the DC/DC converter
- Fuse Monitoring
- Temperature

These signals are controlled by the IPM Controller devices on the PEM PCB. The Shelf Manager has access to these signals via IPM-Bus.

**Table 15: PEM Sensors**

| Sensor Name | Description | Sensor # | Normal | Thresholds | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Lower Critical | Lower Non-Critical | Lower Non-Recoverable | Upper Non-Critical | Upper Critical | Upper Non-Recoverable |
| Hot Swap | FRU State Information | 0 | M4 | M1, M2, M3, M5, M6, M7 | | | | | |
| ShelfFRU HotSwap | FRU State Information | 1 | M4 | M1, M2, M3, M5, M6, M7 | | | | | |
| Version change | Version change | 2 | | | | | | | |
| IPMB Physical | IPMB bus state | 3 | | | | | | | |
| +3.3V | Voltage Sensor | 4 | 3.3 V | +2.97 | +3.135 | 2.9 | +3.465 | +3.63 | 3.70 |
| +5.0V | Voltage Sensor | 5 | 5.0 V | +4.5 | +4.75 | +4.4 | +5.25 | +5.5 | +5.7 |
| +12.0V | Voltage Sensor | 6 | 12.0V | +9.0 | +9.4 | +8.5 | +12.6 | +13.2 | +13.5 |
| fuse FS11 | Fuse | 7 | Asserted | Asserted | | | Deasserted | | |
| Fuse | 8 | Asserted | | | | | | | |
| Fuse | 9 | Asserted | | | | | | | |
| Fuse | 10 | Asserted | | | | | | | |

| Air Filter | Filter Presence | 11 | Device present | Device present | | | Device Removed / Device Absent | | |
|---|---|---|---|---|---|---|---|---|---|
| DS75 Temp | Temperature Sensor | 12 | | N/A | N/A | N/A | 60 | 67 | 80 |
| -48.0V #1 | Voltage Sensor | 13 | -48.0 V | -72 | -60 | -73 | -40 | -36 | -35 |
| -48.0V #2 | Voltage Sensor | 14 | -48.0 V | -72 | -60 | -73 | -40 | -36 | -35 |
| -48.0V #3 | Voltage Sensor | 15 | -48.0 V | -72 | -60 | -73 | -40 | -36 | -35 |
| -48.0V #4 | Voltage Sensor | 16 | -48.0 V | -72 | -60 | -73 | -40 | -36 | -35 |

## 6.12. PEM Connectors and Indicators

The front panel includes the following indicators:

- Green LED – "In-Service"
- Bicolor Red and Amber LED – "Out of Service"
- Blue LED – "Hot-Swap"

The PEMs have an Injector/Ejector handle that interfaces with a mechanical switch and signals the IPM Controller for hot-swap. Once the operator opens the handle, the switch is released and the Shelf Manager is informed of the pending extraction. When the Shelf Manager feels it is "safe" to remove the PEM, the blue Hot-Swap LED illuminates solid.

**Table 16: LEDs on PEM front panel**

| Color | Description | Status | Condition |
|---|---|---|---|
| Green | In-Service LED | Off<br>Solid Green | PEM is inactive<br>Normal Operation |
| Red / Amber | Out-of-service LED | Off Solid Red | No error<br>Error condition |
| | Warning LED | Solid Amber | -48Vdc not connected |
| Blue | Hot Swap LED | Off<br>Long blink<br>Short blink<br>Solid blue | PEM is active<br>Request for activation<br>Request for deactivation<br>PEM is inactive |

## 6.13. PEM Connector Pin Assignment

**Table 17: PEM Connector pin assignment**

| Pin # | Signal | Description | Pin # | Signal | Description | Pin # | Signal | Description |
|---|---|---|---|---|---|---|---|---|
| A1 | - | *{no connection}* | C1 | - | *{no connection}* | Blade A1 | M48VRTN_1 | -48V return |
| A2 | PROM_SDA | Local I2C data | C2 | HA1 | Hardware Address line 1 | | | |
| A3 | PROM_SCL | Local I2C clock | C3 | FFP | Fan Filter presence signal | Blade A2 | M48VRTN_2 | -48V return |
| A4 | P12V_Y2 | 12V | C4 | | | | | |
| A5 | SHELF_GND | Chassis ground | C5 | VCC3 | 3.3 volts | Blade A3 | M48VRTN_3 | -48V return |
| A6 | | | C6 | GND | Digital ground | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B1 | - | *{no connection}* | D1 | - | *{no connection}* | Blade A4 | M48VRTN_4 | -48V return |
| B2 | HA2 | Hardware Address line 2 | D2 | SCL-A | IPMB-A clock | Blade B1 | M48V_1 | -48 volts |
| B3 | HA0 | Hardware Address line 0 | D3 | SDA_A | IPMB-A data | Blade B2 | M48V_2 | -48 volts |
| B4 | | | D4 | SCL_B | IPMB-B clock | Blade B3 | M48V_3 | -48 volts |
| B5 | VCC3 | 3.3 volts | D5 | SDA_B | IPMB-B data | Blade B4 | M48V_4 | -48 volts |
| B6 | GND | Digital ground | D6 | - | *{no connection}* | | | |

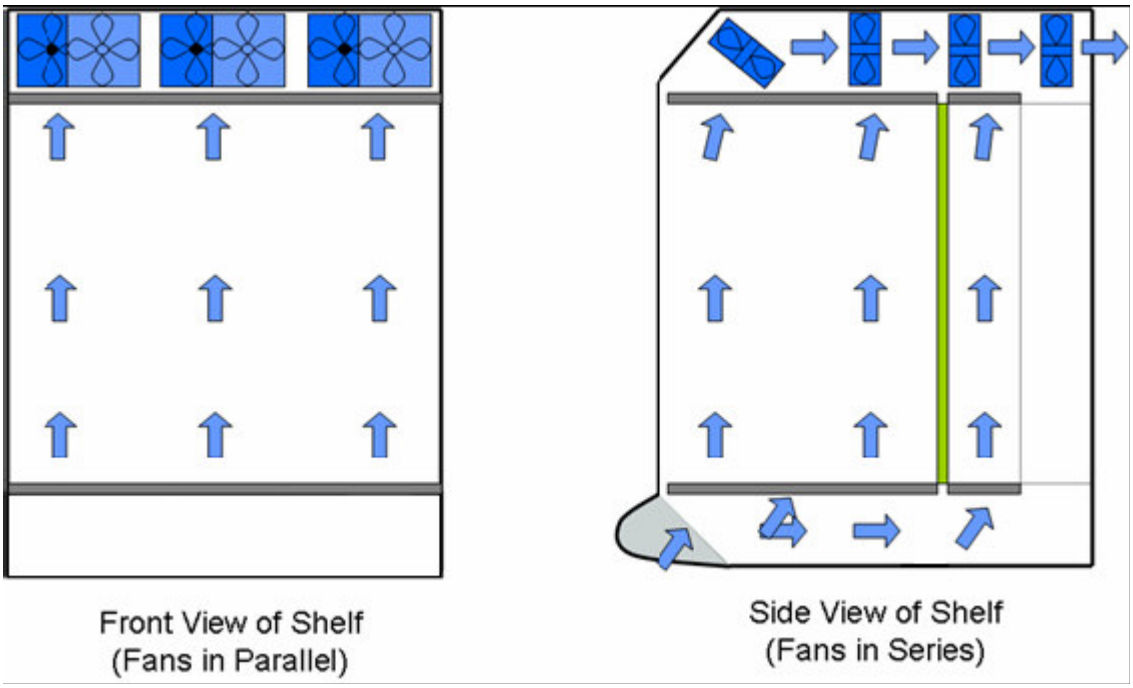
# 7. Thermals

The ATCA 12U, 14-Slot FlexChassis incorporates a patented Hybrid Serial Parallel (HSP) cooling architecture. HSP takes advantage of both the fan laws below while best utilizing the available space in a 12U shelf.

**Fans in Parallel Law:** Flow rates are additive while pressure remains that of a single fan.
**Fans in Series Law:** Pressures are additive while flow rate remains that of a single fan.

The system provides cooling for the front card cage, and rear card cage. Maximum air volume is achieved with a convex intake area located at the lower front of the Shelf. Air is exhausted through a Hexcel honeycomb bezel with 97% open area and low impedance. Design is optimized for beyond 200W/board and is Fault Tolerant using the HSP fan arrangement scheme that provides uninterrupted cooling.

**Figure 17: General airflow path for the 12U 14-slot ATCA Shelf**




From the shelf front view, the fans are staggered in each fan module thereby achieving a parallel configuration. From the shelf side view, the fans are placed in a serial configuration. This HSP combination exploits the best of both fan laws; high flow rates and high pressure. HSP has many other advantages such as superior fault tolerance and uniform airflow distribution.

HSP is fully compliant with PICMG section 5.1 because the airflow is front to rear and bottom to top. This requirement ensures that heated exhaust air from a lower shelf in a frame does not impose heated air into the shelf above it.

## 7.1. Typical Airflow Velocities through the slots

**Figure 18: Front slot Air Velocities**

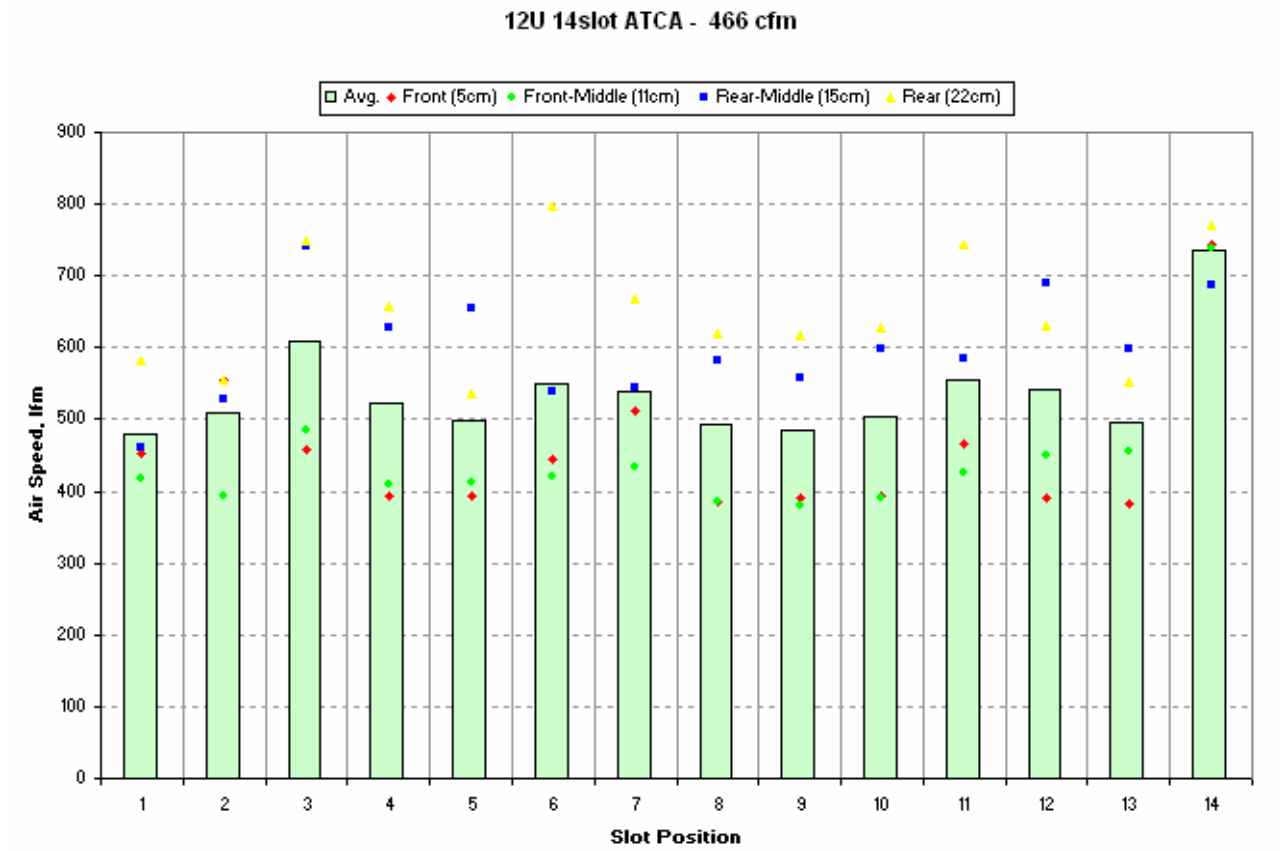
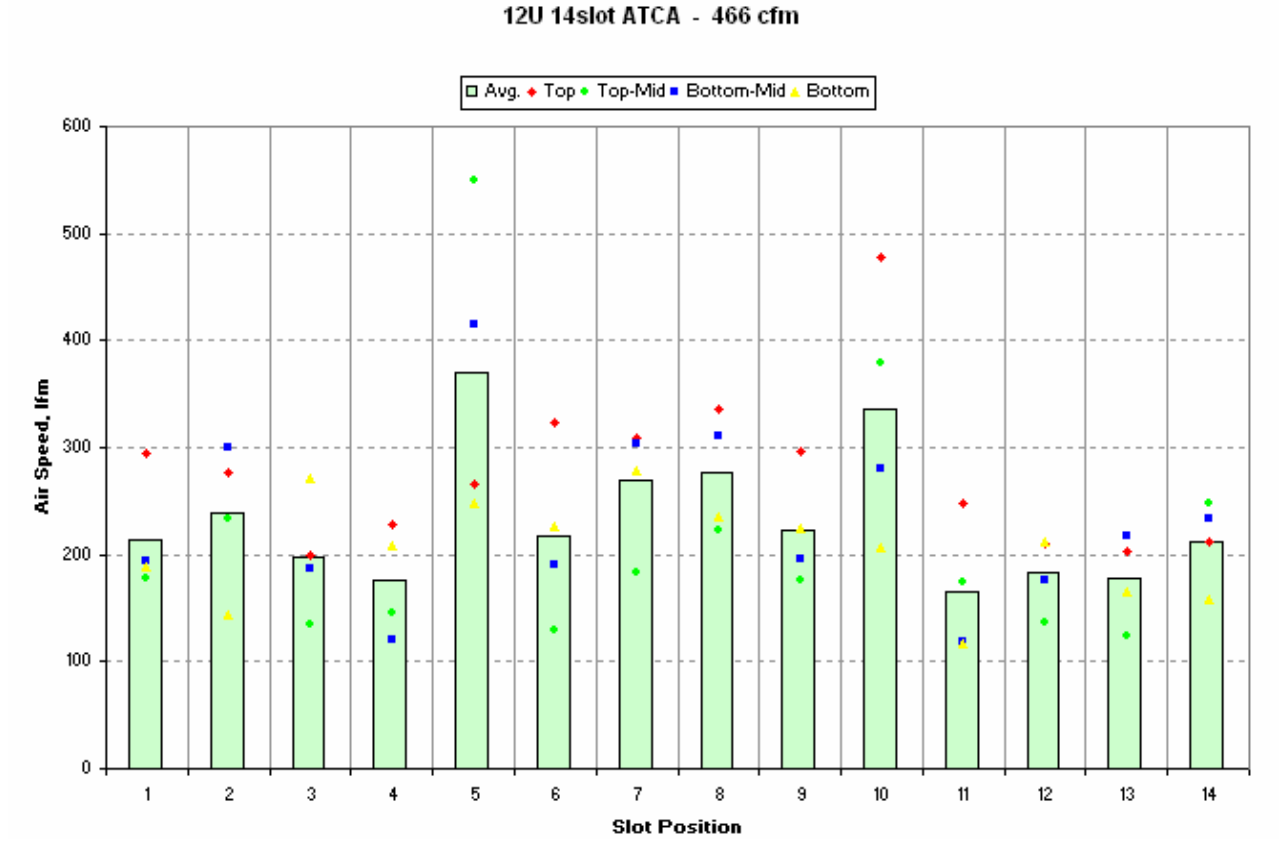


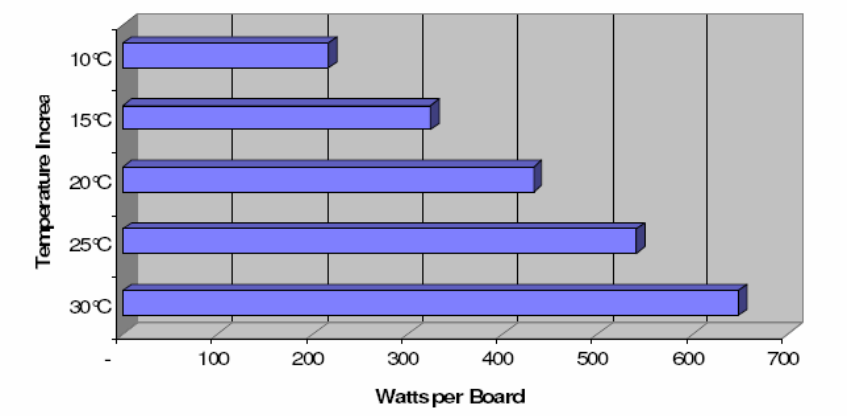

**Figure19: Rear slot Air Velocities**



## 7.2. Thermal Power Dissipation at Various ΔT

Figure 20 shows the approximate cooling capabilities of the Shelf per slot based on different temperature increases across the board with standard air. For example, with a 15C rise, 310W could be achieved on an ATCA board.

**Figure 20: Thermal Power Dissipation at Various ΔT**




## 7.3. Fan Failure Mode

The HSP cooling architecture was designed with a fan failure in mind. HSP allows air to flow through and around a locked fan. In addition the entire fan module serves as an intake for air flow. If one of the four fans in a fan module fails the worst case reduction in velocity or flow rate is less than 15%. The shelf can operate indefinitely with a fan failure at low operating temperatures.

# 8. Service Interval

The purpose of this is to develop an analytical model to estimate the transient response of a typical ATCA blade and heat sink assembly for various field service events. An example of a field service event would be the replacement of a fan tray while the system is operational. A service interval is defined as the allowable time a technician has to replace a fan tray without overheating the system. Several simplifications and assumptions must be made and are listed below:

- Temperature gradients in the heat sink are negligible. (Good assumption for heat sinks with high efficiency fins and base plates of high thermal conductivity). The biot number must be lower than 0.1.
- Thermal mass of heat sink is much larger than heat source/processor. Good assumption for large heat sinks.
- No heat loss due to radiation. Good assumption for case temperature below 100C and high flow rates.
- All the heat flows from the source/processor to the heat sink. This ignores heat transfer to the board. This is a worst case assumption.
- Values for heat sink thermal resistance and mass must be known from experimentation, simulation or a catalog for various airflow rates.
- No preheated air upstream of heat sink. Good assumption for heat sinks on the leading edge of card.

## 8.1. Calculations

From conservation of energy:

$$-\dot{E}_{out} = \dot{E}_{st} + \dot{E}_g$$

Insert Newton's law of cooling and thermal rate of change;

$$\frac{-1}{R_{hs}}(T - T_\infty) - \dot{E}_g = mc\frac{dT}{dt}$$

Substitute:

$$\vartheta = T - T_\infty \qquad \frac{d\vartheta}{dt} = \frac{dT}{dt}$$

Yields the following first order linear differential equation:

$$\frac{d\theta}{dt} + \frac{\theta}{mcR_{hs}} = -\frac{\dot{E}_g}{mc}$$

Solution by integrating factor gives the general solution:

$$\theta = -\dot{E}_g R_{hs} + d\, e^{-\frac{t}{R_{hs}mc}}$$

or:

$$T = T_\infty - \dot{E}_g R_{hs} + d\, e^{-\frac{t}{R_{hs}mc}}$$

Apply initial condition:

$$T(0) = T_i$$

Solve for d:

$$d = T_i - T_\infty + \dot{E}_g R_{hs}$$

Final particular solution is:

$$T = T_\infty - \dot{E}_g R_{hs} + (T_i - T_\infty + \dot{E}_g R_{hs})\, e^{-\frac{t}{R_{hs}mc}}$$

Biot # must be below 0.1:

$$Bi = \frac{L_c}{R_{hs}kt_b w_b}$$

$E_g$ ----Heat dissipation of source/processor
$c$ ----Heat capacity of heatsink material
$m$ ----Mass of heatsink
$Bi$----Biot number
$t$ ----Time
$R_{hs}$ --- Heatsink resistance to air
$L_c$ ----Characteristic length of heatsink
$t_b$ ----Thickess of heatsink base
$w_b$ ----Characteristic width of heatsink base
$d$ ----constant needed for general solution
$k$ ----Thermal conductivity of heatsink
$\theta$ ----temporary variable for temperature difference
$T$ ----Temperature of heatsink
$T_i$ ----Initial heatsink temperature
$T_\infty$ ----Ambient temperature

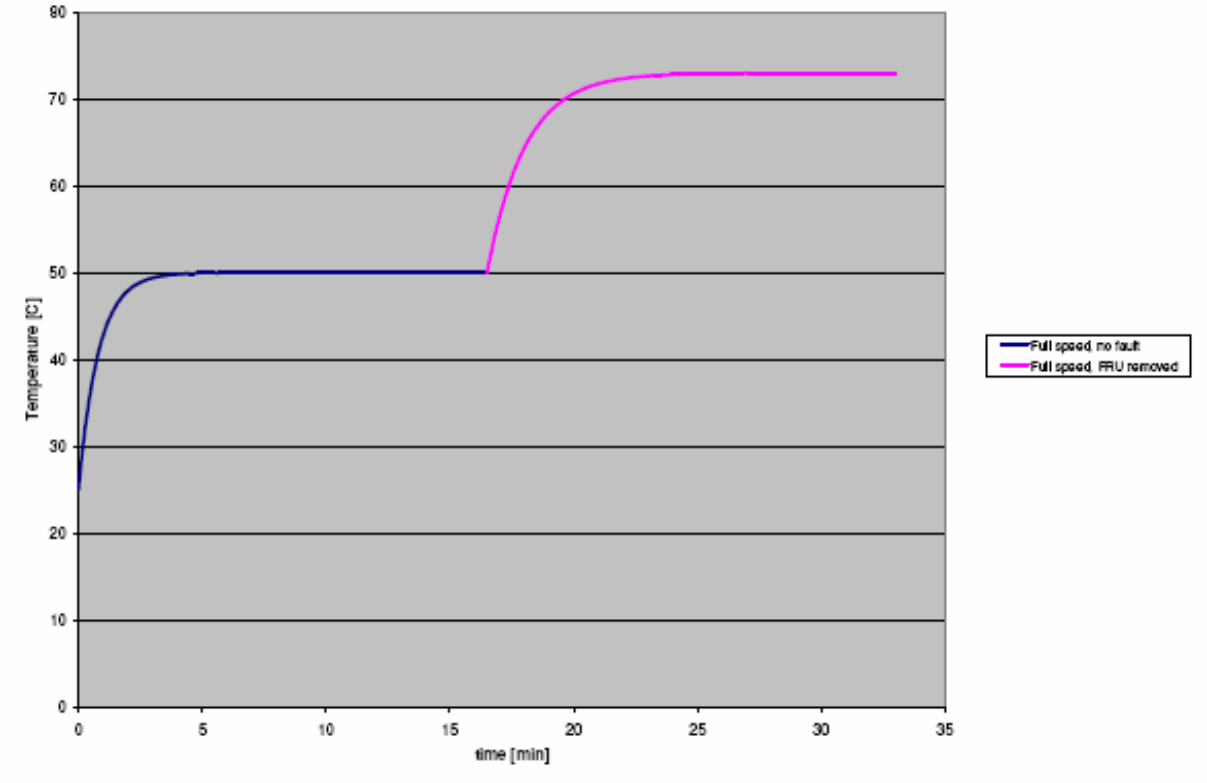
### *8.1.1. 25C Ambient Temperature*

This is an example of the service interval given the following parameters during a normal operating condition of 25C.

| $T_\infty$ | $T_i$ | $R_{hs}$ | m | c | $E_g$ |
|---|---|---|---|---|---|
| [K] | [K] | [K/W] | [kg] | [J/kgK] | [W] |
| 298 | 298 | 0.625 | 0.2 | 385 | -40 |

During service interval at time = 16.5 minutes. $R_{hs}$ increases due to reduced flow.

| $T_\infty$ | $T_i$ | $R_{hs}$ | m | c | $E_g$ |
|---|---|---|---|---|---|
| [K] | [K] | [K/W] | [kg] | [J/kgK] | [W] |
| 298 | 323 | 1.2 | 0.2 | 385 | -40 |



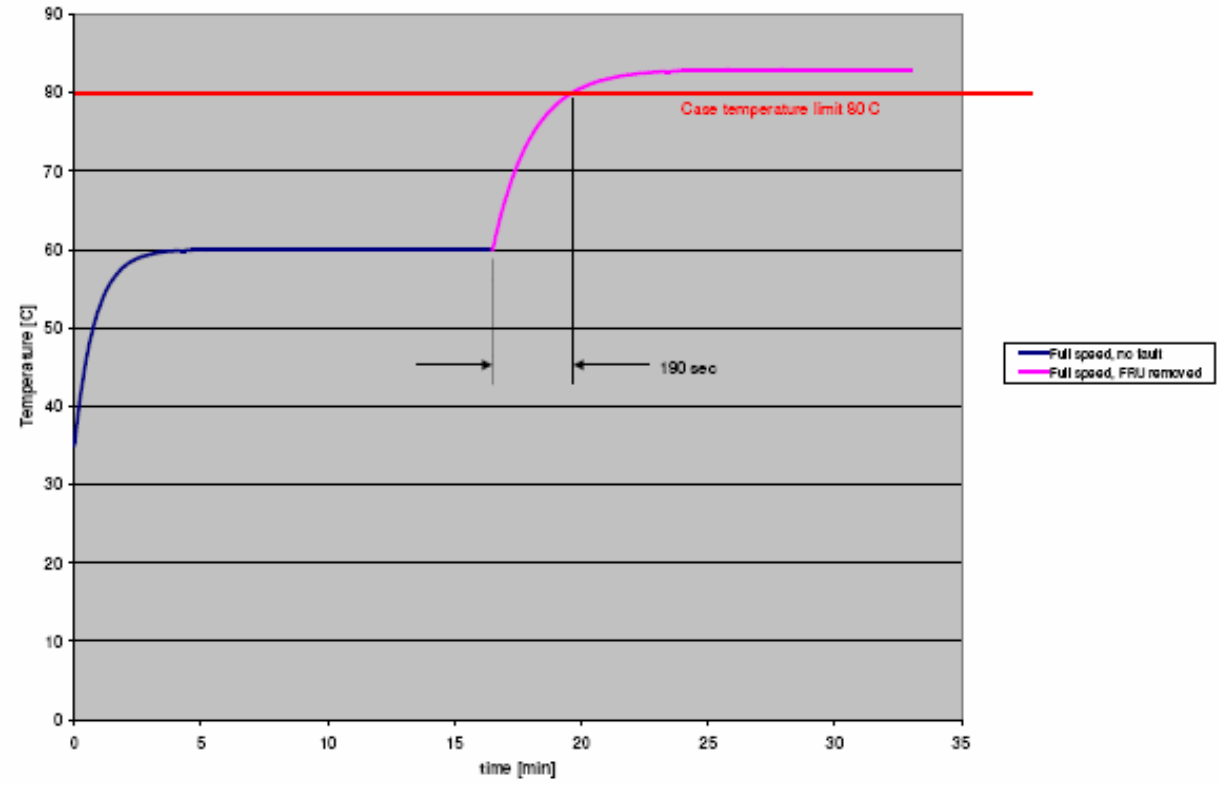
### *8.1.2. 35C Ambient Temperature*

This is an example of the service interval given the following parameters during an operating condition of 35C.

| $T_\infty$ | $T_i$ | $R_{hs}$ | m | c | $E_g$ |
|---|---|---|---|---|---|
| [K] | [K] | [K/W] | [kg] | [J/kgK] | [W] |
| 308 | 308 | 0.625 | 0.2 | 385 | -40 |

During service interval at time = 16.5 minutes. $R_{hs}$ increases due to reduced flow.

| $T_\infty$ | $T_i$ | $R_{hs}$ | m | c | $E_g$ |
|---|---|---|---|---|---|
| [K] | [K] | [K/W] | [kg] | [J/kgK] | [W] |
| 308 | 333 | 1.2 | 0.2 | 385 | -40 |

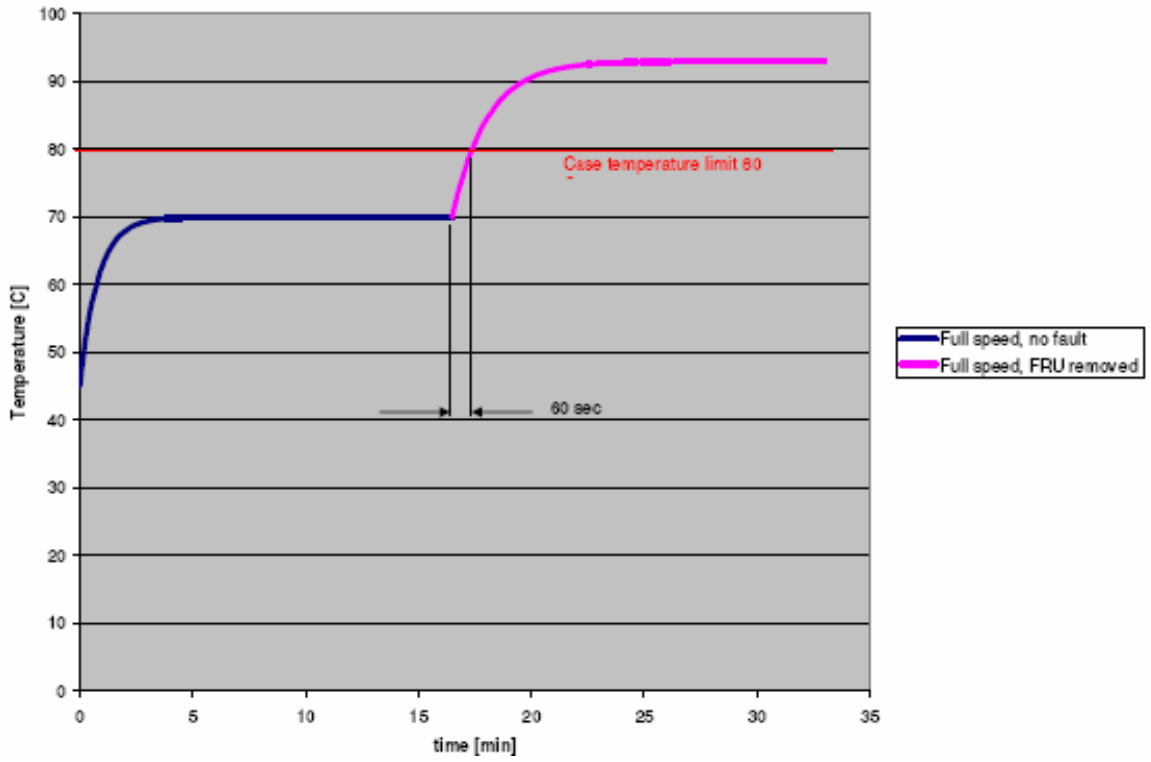


### *8.1.3. 40C Ambient Temperature*

This is an example of the service interval given the following parameters during an operating condition of 40C.

| $T_\infty$ | $T_j$ | $R_{hs}$ | m | c | $E_g$ |
|---|---|---|---|---|---|
| [K] | [K] | [K/W] | [kg] | [J/kgK] | [W] |
| 318 | 318 | 0.625 | 0.2 | 385 | -40 |

| $T_\infty$ | $T_j$ | $R_{hs}$ | m | c | $E_g$ |
|---|---|---|---|---|---|
| [K] | [K] | [K/W] | [kg] | [J/kgK] | [W] |
| 318 | 343 | 1.2 | 0.2 | 385 | -40 |




## 8.2. Summary

The assumptions made in this calculation are good enough to estimate the transient response of an ATCA board and heat sink assembly. The Biot number for the calculations above is near 0.1 which means the analytical model is valid. Previous simulations showed that temperature gradients in the heat sink were small. As flow rates increase or base plate thickness decreases this analytical model will no longer be accurate. The Biot number should always be checked before additional analysis is performed.

At ambient conditions of 25C the service interval is indefinite. At 35C the service interval is just over 3 minutes. At 40C the service interval is one minute. This calculation does not account for which FRU is removed, however it only takes into account the new heat sink resistance resulting from reduced airflow. It is recommended that experimental work to be performed to evaluate the actual ATCA board and heat sink thermal resistance in the chassis to accurately predict service interval.

# 9. Technical Data

**Table 18: Technical Data**

| | |
|---|---|
| **Physical Dimensions** | |
| Height | 20.97” (12 U) |
| Width | 17.66” (19” rack mount) |
| Depth (with PEM Covers and handles) | 18.53” |
| **Weight** | |
| Weight | 66 pounds |
| **Power** | |
| Input voltage | 40 – 72VDC, Dual Feed |
| **Cooling Capacity** | |
| Front Boards | min. 200 W / Board |
| RTM | min. 25 W / Board |
| **Power Consumption** | |
| Shelf Manager | 10W / Board |
| Fan Trays (x3) | 390W at full speed or 180W at low speed |
| DSAP | 10W |
| PEMs | 3W / PEM |
| EEPROM Board | 1W |
| **Regulatory** | |
| RoHS | Designed to meet 6/6 |
| Safety | Designed to meet:<br>• IEC60950-1, First Edition<br>• EN 60950-1, First Edition<br>• UL 60950-1, First Edition<br>• CSA 22.2, No. 60950-1-03, First Edition |
| EMI Conducted and Radiated | Designed to meet EN55011/CISPR22, Class A |
| Environmental | Designed to meet:<br>• Ambient temperature normal operating +5°C…+45°C (41°F to 113°F)<br>• Ambient temperature transient operating +5°C…+55°C (41°F to 131°F)<br>• Humidity +5%...+85%, no condensation |