CompactPCI® Serial
CompactPCI® Serial Space

Short Form Specification

Open Modular
Computing Specifications

NOTE: This short form specification is a subset of the CompactPCI® Serial specification PICMG CPCI-S.0 R3.0 / R4.0 and a subset of CompactPCI® Serial Space PICMG® CPCI-S.1 R1.0.

For complete guidelines on the design of CompactPCI® Serial compliant boards and systems, the full specifications are required.

1 General

1.1 About CompactPCI® Serial

The CompactPCI Serial specification defines a modular computer system, consisting of

- A backplane
- A system slot
- Up to 8 peripheral slots (more with custom backplanes)

CompactPCI® Serial defines the support of PCI Express, SATA, USB and Ethernet, concurrently. PCI Express, SATA/SATA Express and USB are arranged as a simple star architecture. Ethernet is a full mesh. Switch boards are not required. The backplane is passive.

The mechanical design is fully compatible to IEC60297-3-100 which specifies the basic dimensions of front panels, sub-racks, chassis, racks and cabinets of the 482,6 mm (19 inch) series. 3U and 6U boards are supported. For 3U cards, conductive cooling is introduced, which enables the use of boards in extreme harsh environments. The CompactPCI® Serial specification is based on Amphenol FCI AirMax proven and rugged backplane connectors.

Originally, CompactPCI® Serial only supported PCI Express up to Gen3. The updated CompactPCI® Serial Specification Revision 3 will support PCI Express Gen4, SATA Express at 16 Gb/s, 10GBASE-T and 10GBASE-KR Ethernet, and USB 3.0. To achieve higher data rates, the CPU will be equipped with the new AirMax VS High Speed connectors. This solution is fully upward and downward compatible.

Revision 4 goes even further. With the new AirMax VS connectors for all boards and the backplane, PCI Express Gen5 and higher as well as 25GBASE-KR Ethernet will be supported. The board-to-board pitch is increased to 25.4 mm (5 HP) instead of 20.32 mm (4 HP). Older boards can still be used, where the smaller front panel is extended by a bezel.

1.2 CompactPCI® Serial Revision History

This table shows the changes made to the CPCI-S.0 Specification

Revision	Date	Description
1.0	February 28, 2011	Initial release
2.0	February 2, 2015	Rear I/O for P6 added, further clarifications
3.0	planed for mid 2023	PCIE up to Gen 4, Ethernet 10KR4
4.0	planed for end 2023	PCIE Gen 5+, Ethernet 25KR4, 25.4 mm board-to-board pitch

1.3 About CompactPCI® Serial Space

CompactPCI® Serial Space is based on CompactPCI® Serialn however, some features were removed. CompactPCI Serial Space does not route USB or SATA signals over the backplane. CompactPCI Serial Space maintains the routing of PCI Express and Ethernet lines but defines these backplane links as physical connections not dedicated especially to Ethernet or PCI Express. This has the advantage that they can be used also for other transport protocols like SpaceWire, TTEthernet and EtherSpace for inter-board communication.

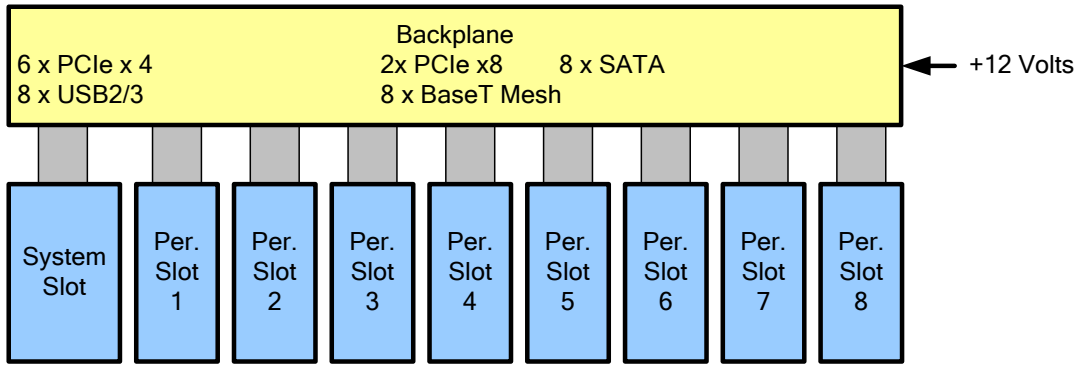
Like in CompactPCI® Serial, a full mesh network on the backplane is supported. All slots can have a connection to the full mesh network – a point-to-point connection from each slot to all other slots. CompactPCI® Serial Space backplane routing is similar to CompactPCI® Serial and additionally supports a second system slot. The dual star architecture improves the reliability, availability and flexibility of the system. Peripheral slot 8 is extended to be system slot B, the second system slot. This slot is identical to system slot A and can be used as peripheral or system slot. Each peripheral slot has a dedicated connection to system slot A and additionally a second point-to-point connection to system slot B.

A new introduced shelf controller can control the power supply of all boards separately. Also the shelf controller can check the status of the boards and can reset the boards individually. Two redundant CAN busses are available additionally as board management busses.

The mechanical design of CompactPCI® Serial Space is fully compatible with CompactPCI® Serial. However, the board-to-board pitch is 5HP (= 25,4 mm) only - for air cooled as well as for conduction cooled systems – which is also the case for CompactPCI® Serial Revision 4.

1.4 CompactPCI® Serial Architecture

Figure 1. CompactPCI® Serial Architecture



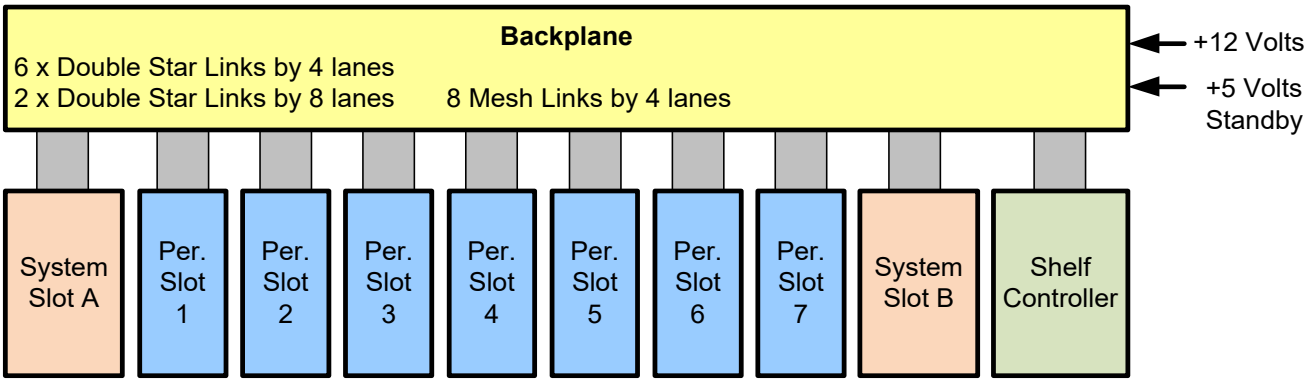
There is a dedicated system slot which provides the system with some minimal central infrastructure functions like reset and clock supply. This means that the smallest possible CompactPCI® Serial system consists of just one single slot, the system slot.

The peripheral slots are connected via modern high-speed serial point-to-point connections. A star architecture is implemented on the backplane for PCI Express, SATA and USB. The system slot is connected to each peripheral slot separately. A switch or hub board is not required. For Ethernet, a full mesh network is implemented on the backplane. This allows any board to communicate directly with any other board separately at full speed.

A system slot card can also be used in a peripheral slot to perform multiprocessing. The simplest way of communication in this case is via Ethernet. Rear I/O is also supported. Many pins are available and high-speed data communication is supported.

1.5 CompactPCI® Serial Space Architecture

Figure 2. CompactPCI® Serial Space Architecture



Like in CompactPCI® Serial, a full mesh network on the backplane is supported. The full mesh network is a high speed, high performance, point-to-point connection from each slot to all other slots.

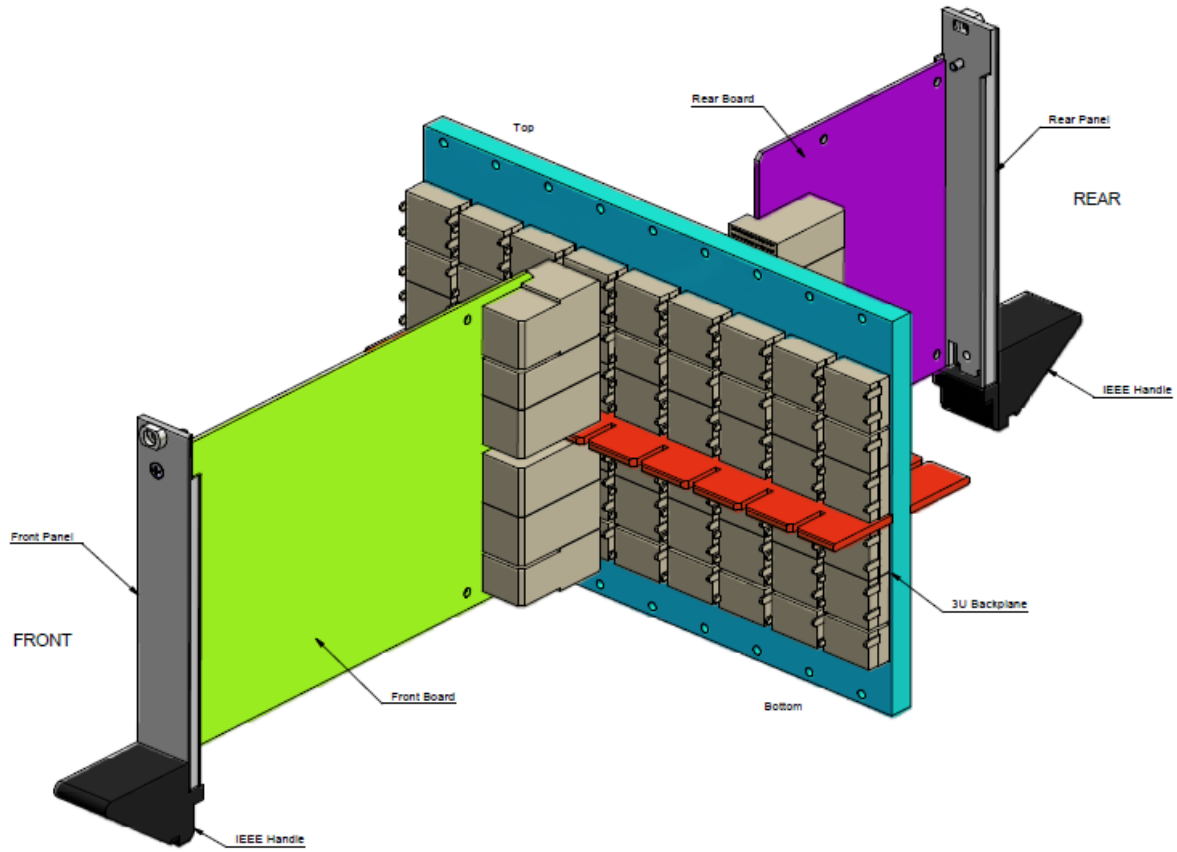
A CompactPCI® Serial backplane routes PCI Express as a single star (the system slot is the center of the star). CompactPCI® Serial Space backplane is based on dual star routing and additionally supports a second system slot. This complies with the CompactPCI® Serial base specification and is fully upward compatible.

The shelf controller can control the power supply, can check the status of the boards and can reset the boards individually. Two redundant CAN busses are available additionally as board management busses. Neither the shelf controller connector nor the shelf controller itself is specified in the specification.

1.6 3U Mechanical Overview

In the specification, 3U systems as well as 6U systems are defined. A passive backplane is used to connect all front and rear boards. Every board is supplied with a front and rear panel. A handle (two handles for 6U) allows the user to plug-in and to remove a board from a rack. A maximum of six discrete connectors forms a slot and the amount of connectors used can vary depending on the application. Maximum scalability and cost-effectiveness is thus achieved.

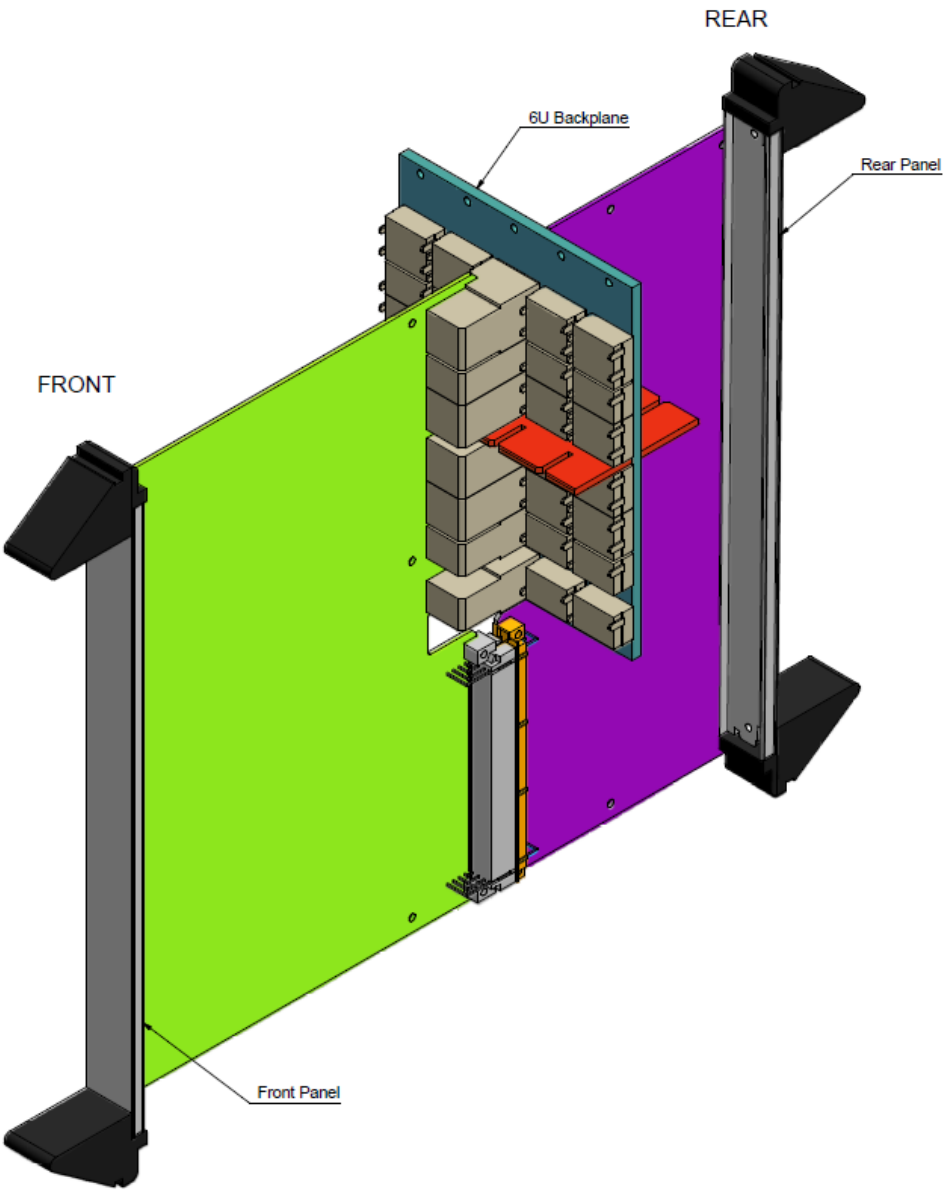
Mechanical Overview 3U Example



1.7 6U Mechanical Overview

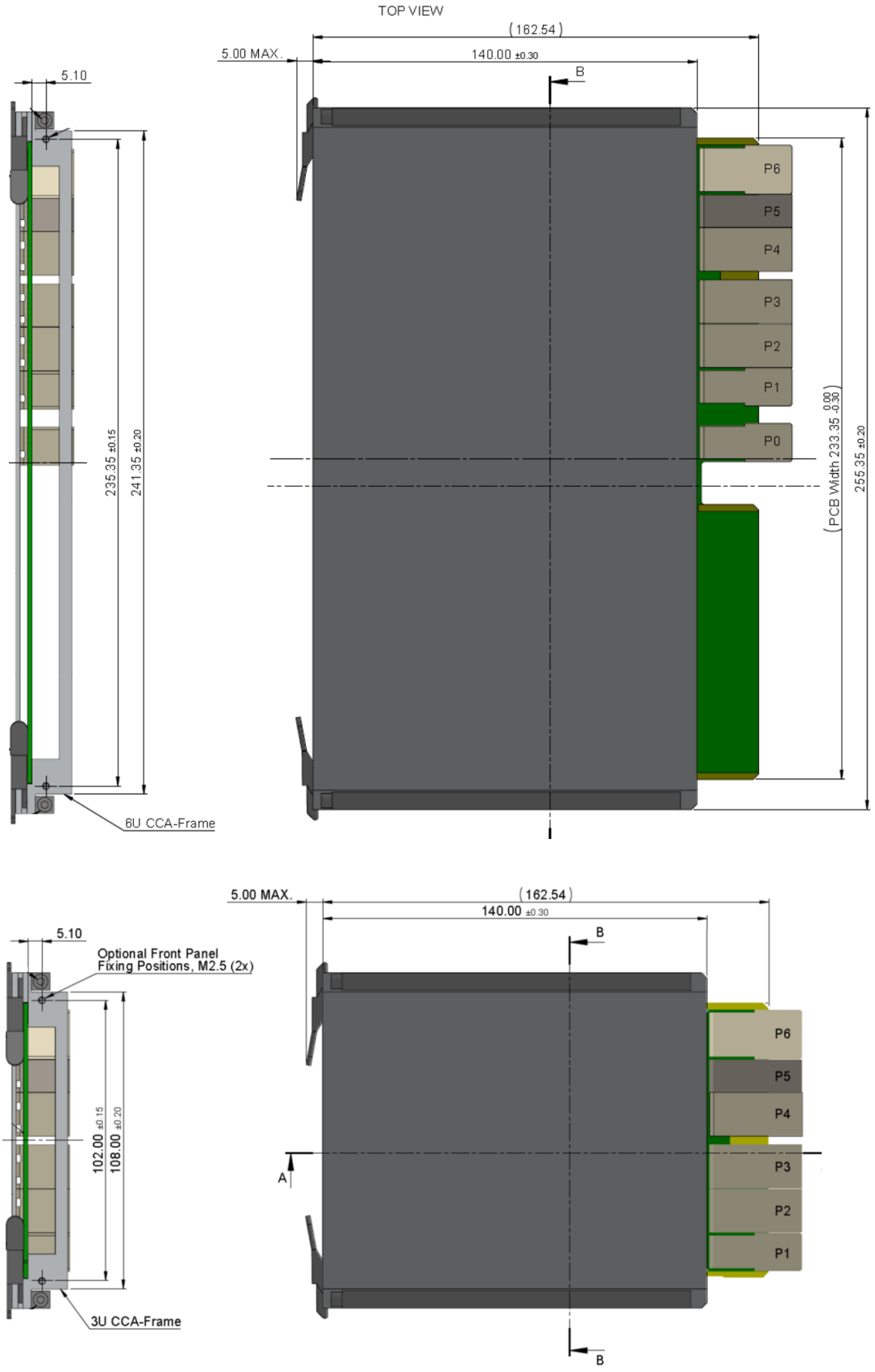
Front and rear boards are defined for the 6U form factor. Compared to a 3U system, one extra connector (J0/P0) is defined. This connector offers extra power (that will be needed in a 6U system) and also two further Ethernet connections, which can be used for system management (e.g. AMT). The backplane can be monolithic or split. Furthermore, it is possible to define a user backplane which is a mixture of both (see Figure 4 and 5).

Figure 3. Mechanical Overview 6U Example (Split-Backplane / Front view)



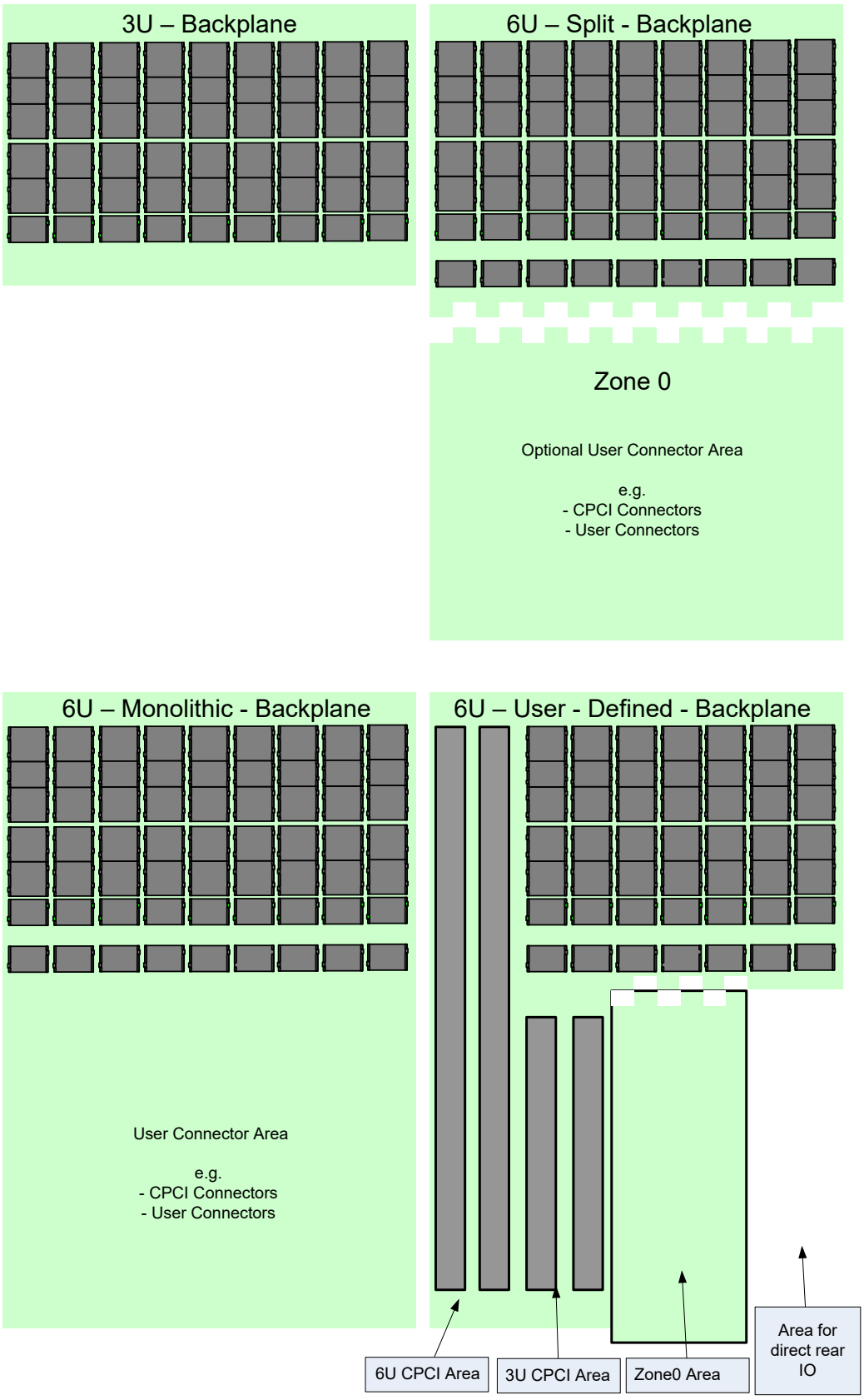
1.8 Conductive Cooling

Figure 4. Conductive Cooling Frames



1.9 Backplane Examples

Figure 5. Backplane Example Drawings of 3U vs. 6U Variants



1.10 Mezzanine Board

Implementation of the full mesh connection in a system can be done with a mezzanine board. Thanks to this concept, more flexibility is achieved, because the usage of the full mesh connection does not depend on the system board itself. Furthermore, different mezzanine boards can offer different mesh connections, thereby obtaining maximum scalability. If this concept is implemented, the CompactPCI® Serial board becomes a mezzanine host, and the mezzanine board can be plugged onto this host. The connector P6 is then placed on the mezzanine board and a cut-out on the mezzanine host is provided. Only the interconnection between the mezzanine host to the CompactPCI® Serial backplane will be specified within this specification. As shown in Figures 9 and 10, the mezzanine concept can be implemented within a 3U and a 6U system.

Figure 6. 3U Mezzanine Concept

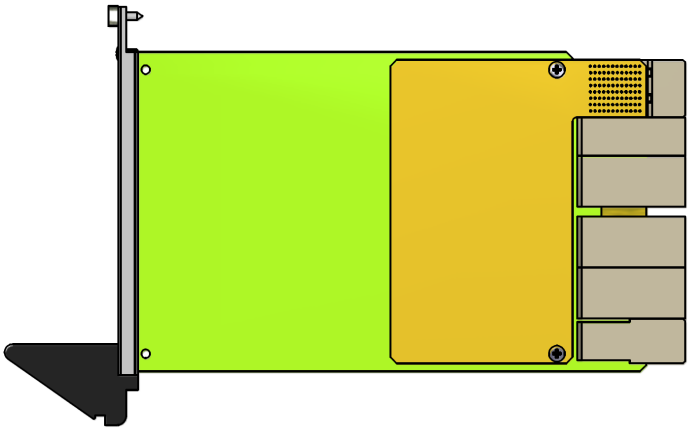
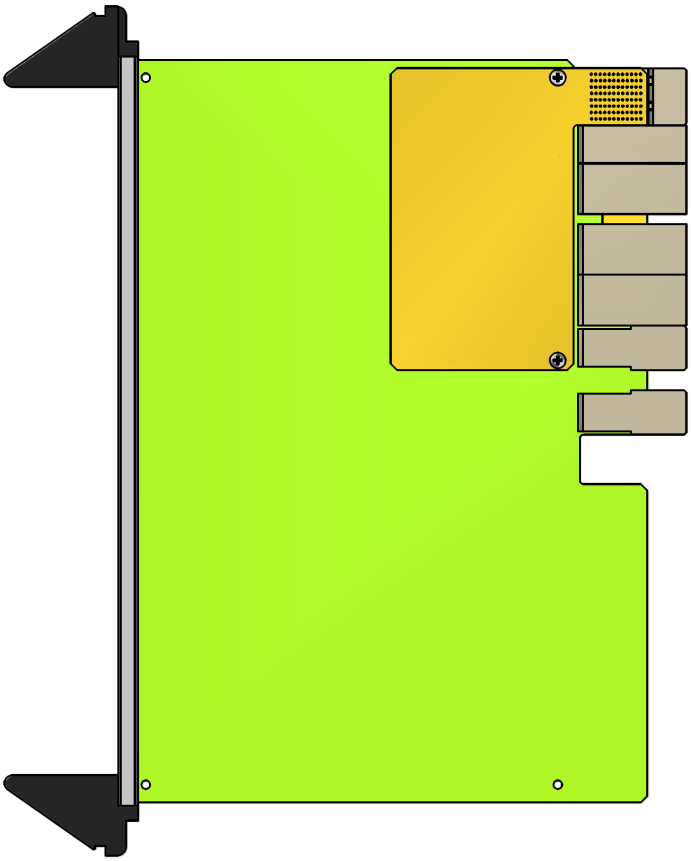


Figure 7. 6U Mezzanine Concept



1.11 Connector Types

Connectors used for CompactPCI® Serial are optimized for high-speed differential signal transmission. Shielding and impedance control is maintained through the connectors. The connector is arranged in rows with 12 pins each. 12 pins are sufficient for 4 high speed signal pairs. 4 pins in a row are required for ground. The pins within the connector are not specialized however, so a pin can be used for signals (differential or single ended), for ground, as well as for the supply voltage.

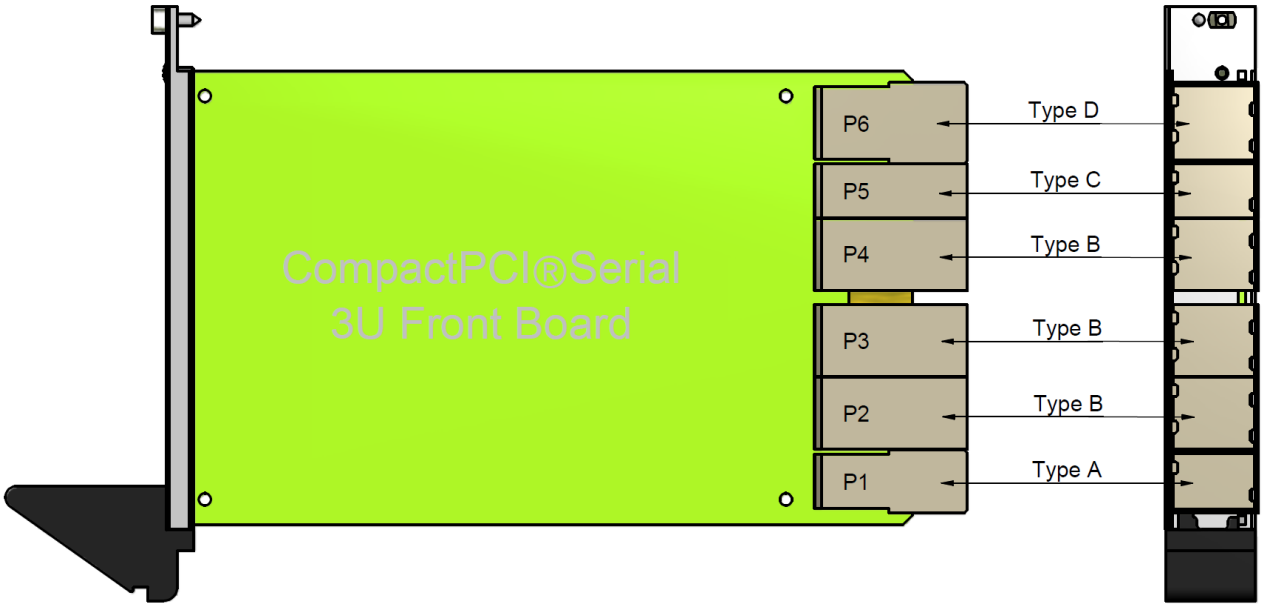
For front boards, receptacle connectors are used on the backplane, and right angle headers are used on the plug-in boards. On rear boards it is vice-versa. All connector types are designed for press-fit mounting. The press-in pin length in the PCB is just 1.6 mm to minimize the stub lengths thereby enhancing the signal integrity. To realize rear I/O, a plug connector is pressed on to the back of the backplane. This mirrors the pin assignment from the front to the back side.

To connect the front boards to the backplane, four different plug types of the same connector family are used.

Table 1. Front Board Connector Types

Designator	Type	Number of Rows	Number of Walls	Usage
P0	A	6	4	Optional
P1	A	6	4	Mandatory
P2	B	8	2	Optional
P3	B	8	2	Optional
P4	B	8	2	Optional
P5	C	6	2	Optional
P6	D	8	4	Optional

Figure 8. 3U Connector Plug Types A, B, C and D on Front Boards



1.12 Rear Board Connector Types and Reference Designation

To connect the rear boards to the backplane, two different receptacle types of the same connector family are used.

Table 2. Rear Board Connector Types

Designator	Type	Number of Rows	Number of Walls	Usage
rJ2	H	6	2	Optional
rJ3	G	8	2	Optional
rJ4	G	8	2	Optional
rJ5	H	6	2	Optional

Figure 9. Connector Plug Types H and G on Rear Boards

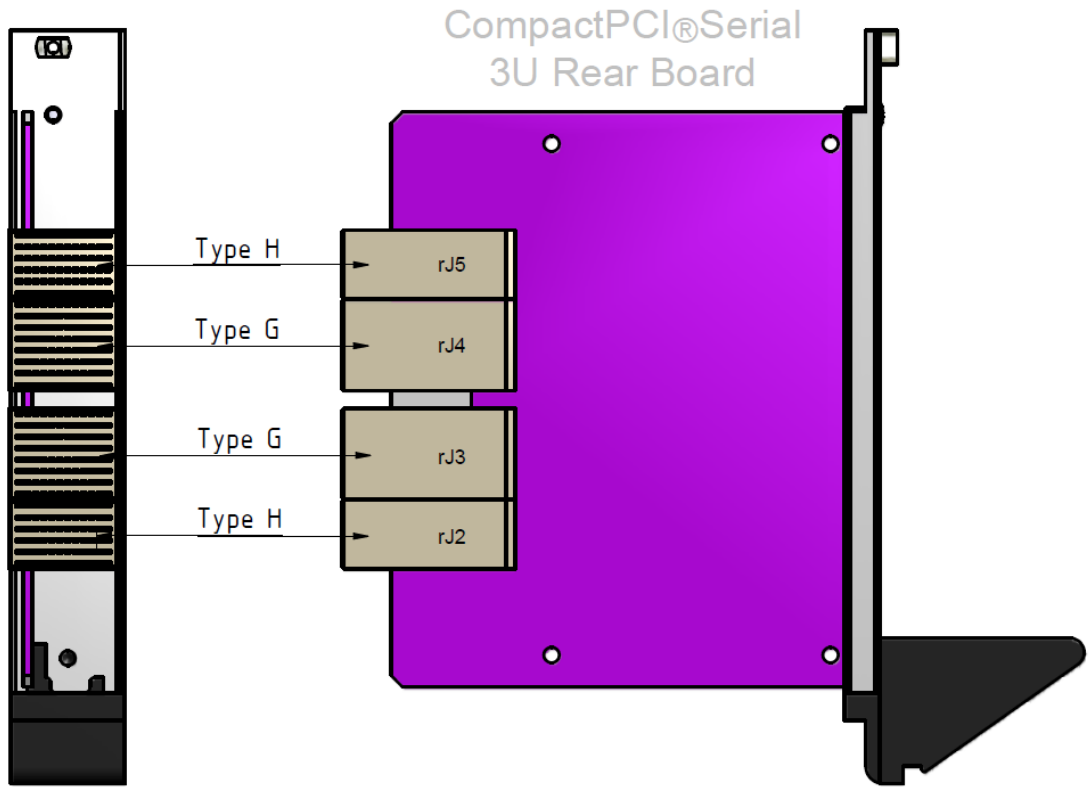


Table 3. Rear Backplane Connector Types

Designator	Type	Number of Rows	Usage
rP2	J	6	Optional
rP3	I	8	Optional
rP4	I	8	Optional
rP5	J	6	Optional

1.13 ESD Protection

A CompactPCI® Serial system is equipped with an ESD strip and an ESD clip. When a board is inserted into an enclosure, the ESD strip connects with an ESD clip on the card guide which is connected to chassis ground. The ESD strip is separated into three segments to achieve a “controlled discharge”. The first segment is connected to the front panel through a 10 MOhm resistor to discharge any built-up static charge from the board or user. The resistor is used to limit the amount of discharge current. The second segment discharges the board’s ground planes as it is inserted further into the card guide, again through a 10 MOhm resistance. The final third segment has a direct connection to the front panel. This provides a discharge path as the backplane connectors engage and when the board comes to rest after being completely installed. The third segment also provides a discharge path from the front panel to chassis ground when the entire system is assembled making it safe for handling and operation. The ESD card guide clip contacts the board edge as the board is inserted in the system and provides a path for ESD energy on the board to be discharged into the chassis.

2 Electrical Requirements

2.1 Backplane Power Distribution

CompactPCI® Serial relies on a single rail +12V main power supply. +5V standby is optionally available. -48V optional voltage is available within a 6U system only. The backplane distributes the supply voltages to the front boards. Rear boards are indirectly supplied by the corresponding front board.

Figure 10. Backplane Power Distribution Example in a CompactPCI® Serial System

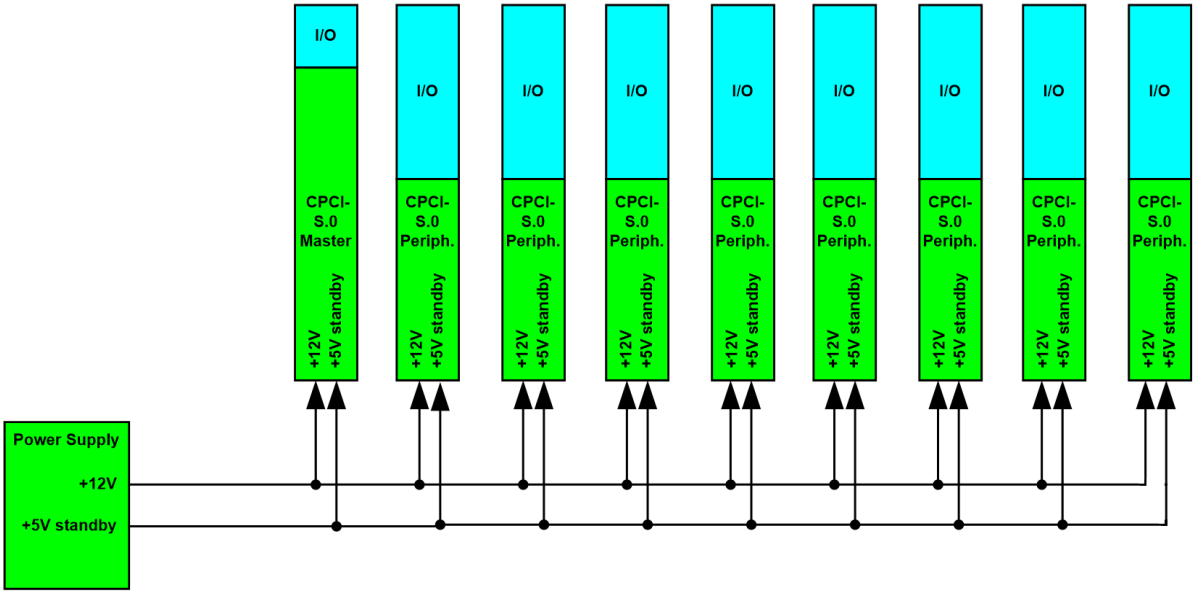
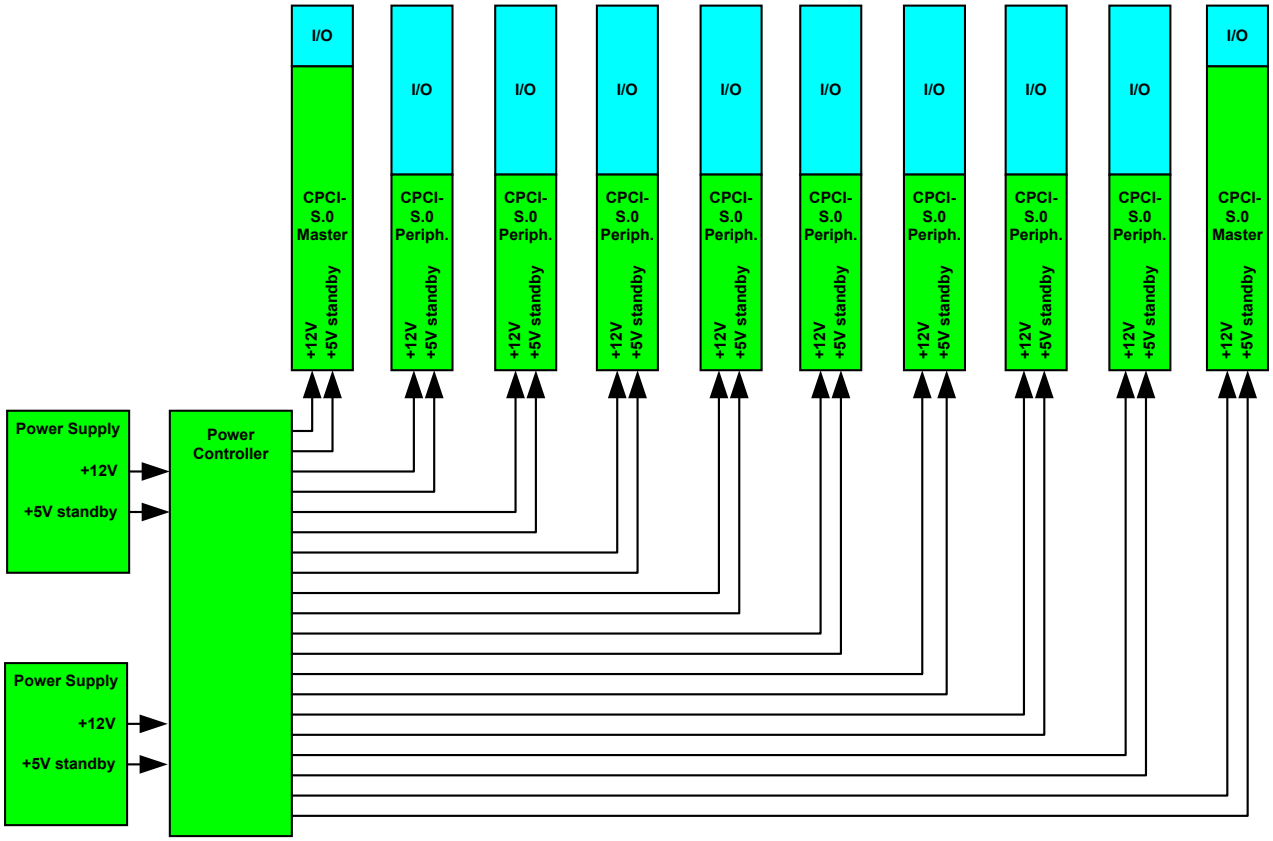


Figure 11. Backplane Power Distribution Example in a CompactPCI® Serial Space System



2.2 Power Control

The power control signals PS_ON#, PWRBTN#, PWR_FAIL# are routed from the system slot to a utility connector.

PS_ON# allows a system board to remotely control the power supply in conjunction with features such as soft on/off, Wake on LAN, or wake-on-modem. The PWRBTN# signal may be used to control the power supply's PS_ON# signal. Furthermore it could be used to shut down the operating system etc.. Power supplies providing the PWR_FAIL# signal show that the output voltage will leave the rated output value in short time. System boards can use this information to shut down the system in a defined way. This specification does not define details about this behavior.

2.3 Platform Control Signals

2.3.1 Reset Signals

The PRST# signal of the system slot is routed to a utility connector. The RST# output signal of the system slot is routed to all RST# input signals of the peripheral slots.

Figure 12. CompactPCI Serial Backplane Routing Reset

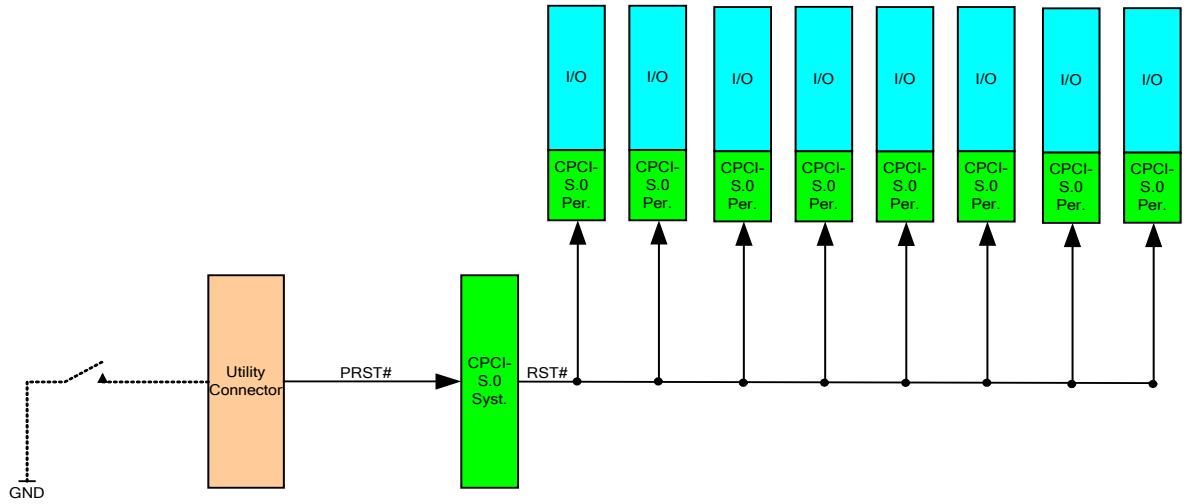
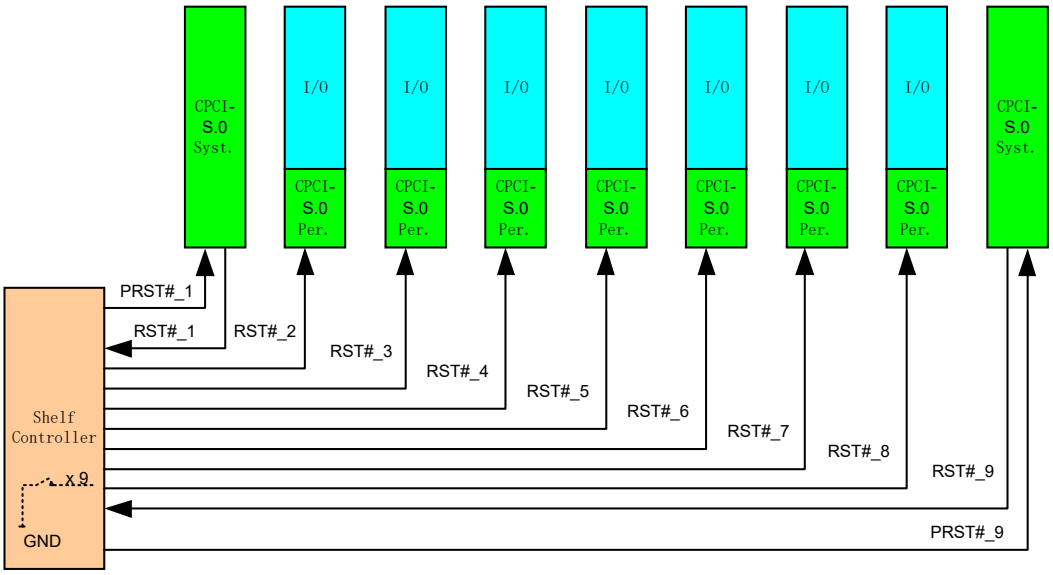


Figure 13. CompactPCI Serial Space Backplane Routing Reset



2.3.2 System Slot Detection

Every slot at the backplane provides a System Slot Identification pin (SYSEN#). The SYSEN# pin is connected to GND at the system slot and left open on peripheral slots. Boards capable of system slot support detect SYSEN# low to activate system slot functionality, e.g. RST#, PS_ON# etc.

2.3.3 Geographical Addressing

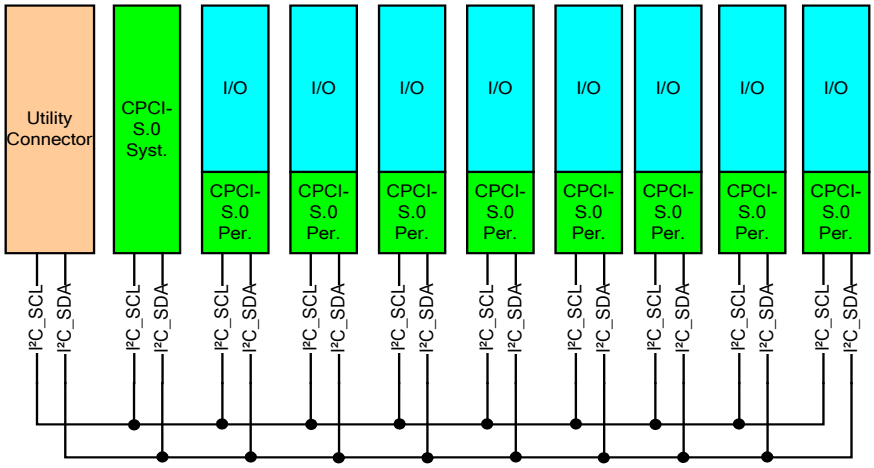
Due to the fact that within CPCI-S.0, each physical SATA port always needs the same geographic address (because of SGPIO), geographical addresses do not follow the physical slot numbers, but the SATA filling order. Backplanes support the GA[3:0] geographic addressing signals for unique slot identification. The highest slot number within a CPCI-S.0 system has geographic address 0. The next lower slot number has geographic address 1 up to the first peripheral slot. Peripheral boards can use geographical addressing based on GA[0], GA[1] and GA[2]. GA[3] can be used for systems with more than 8 peripheral slots.

2.4 Management Interfaces

2.4.1 I²C System Management Bus

The I²C System Management Bus is electrically compliant to the SMBus specification. The System Management Bus I²C_SCL and Bus I²C_SDA signals are bussed to every slot and the utility connector.

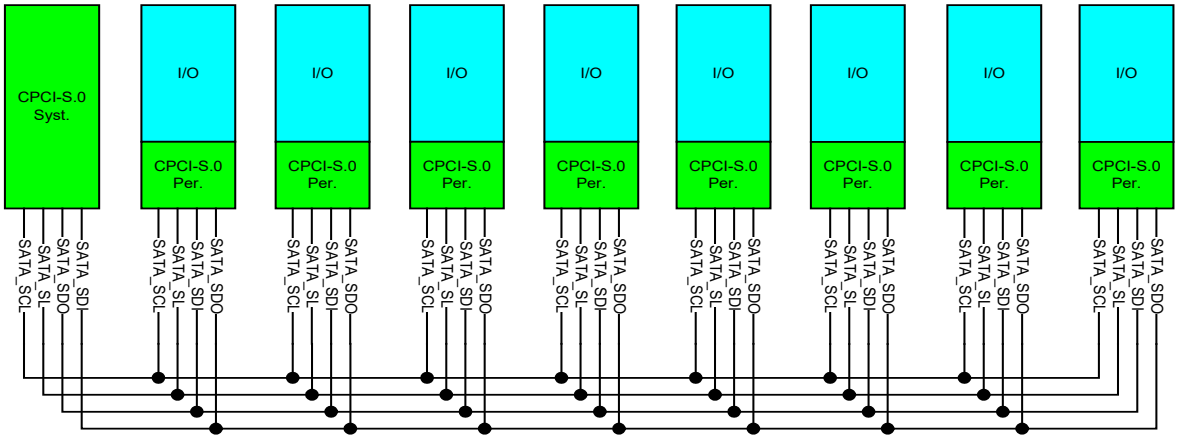
Figure 14. System Management Bus Signal Routing



2.4.2 Serial GPIO

The SATA_SCL, SATA_SL, SATA_SDO, SATA_SDI signals from the system slot are bussed to the respective signals on the peripheral slots.

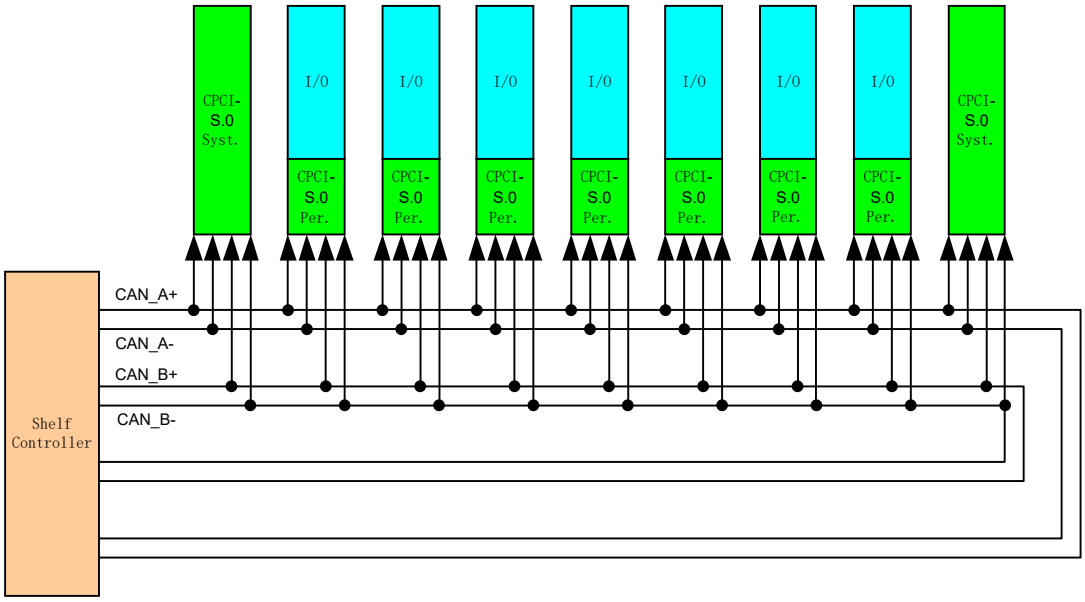
Figure 15. Serial GPIO Signals Backplane Routing



2.4.3 CAN bus

The CAN bus can be used as System Management Bus for CompactPCI Serial Space Systems as well. The CAN bus signals are redundant bussed to every slot and the shelf controller.

Figure 16. CAN bus Signals Backplane Routing for CompactPCI Serial Space Systems



2.5 High Speed Interfaces

2.5.1 Star and Dual Star Interconnect

CompactPCI Serial base specification defines a single star architecture for PCI-Express. CompactPCI Serial Space doubles the usage of these interconnects in a symmetrical way. Beside the system slot (A) on the left side of the system, a second system slot (B) on the right hand side of the system uses the same way of routing. All seven peripheral slots are connected to both system slots. Also, both system slots are connected between each other.

Figure 17. CompactPCI Serial Star Interconnect for PCIE

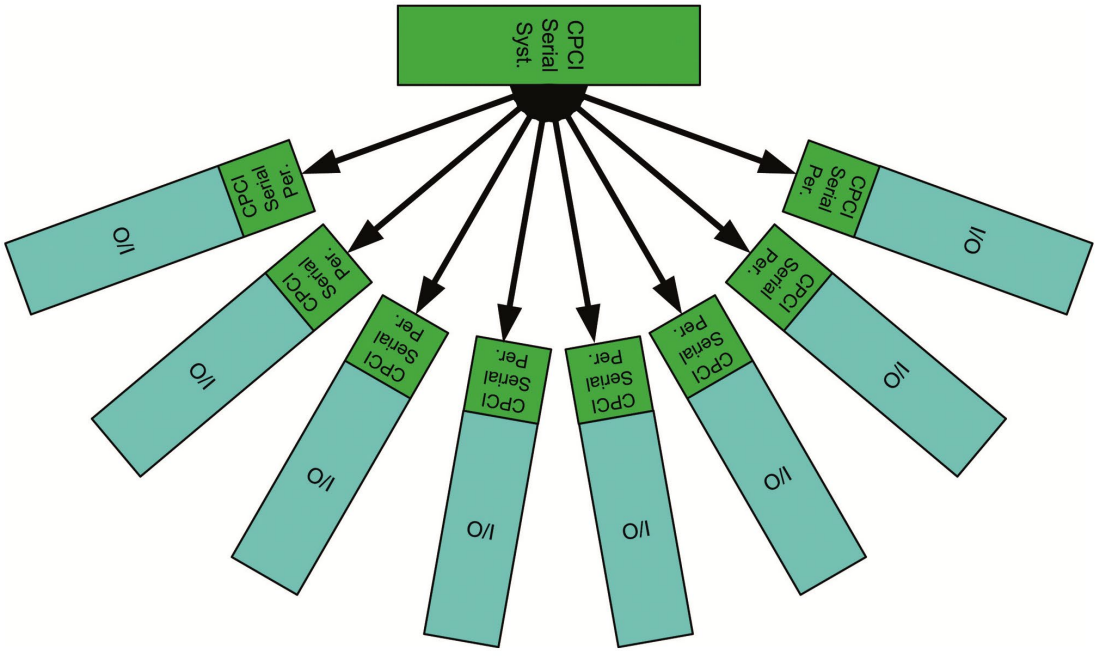
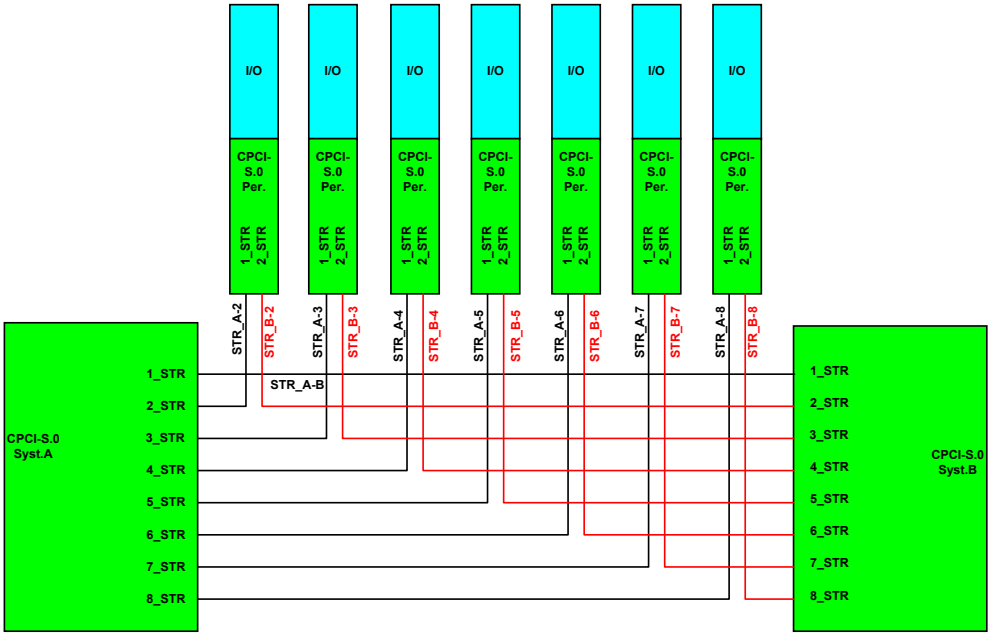


Figure 18. Serial CompactPCI Serial Dual Star Interconnect



2.5.2 Mesh Interconnect

The standard as well as CompactPCI Serial Space Backplane supports full mesh interconnect. Every slot is connected to every slot independently. In a standard CompactPCI Serial system, its interconnect is dedicated to Ethernet. In a Space System, the interface usage is more open and besides Ethernet, TT-Ethernet, EtherSpace and SpaceWire are also defined.

Figure 19. CompactPCI Serial Star Interconnect