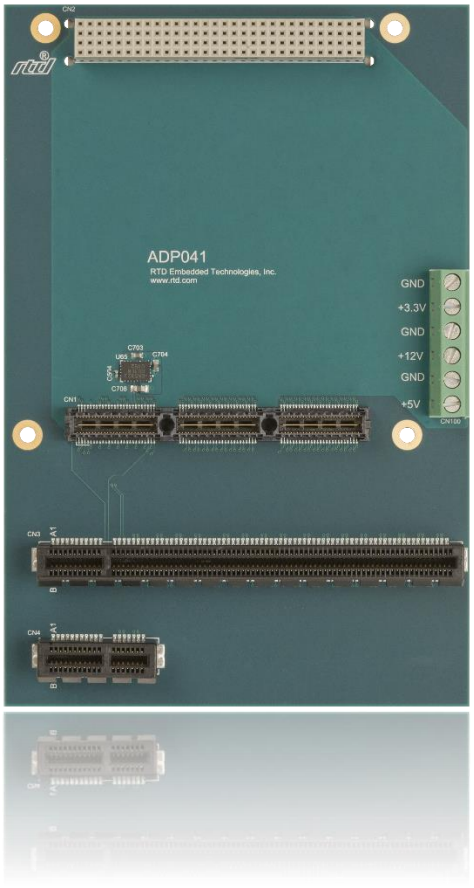
ADP041

PCIe/104 x1 and x16 Slot Adapter

User's Manual

BDM-610040014 Rev. A



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Revision History

Rev A	Initial Release

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1 Introduction

1.1 Product Overview

The ADP041 PCIe/104 to PCIe x1 and x16 slot adapter is a useful tool for developing PCI Express systems based on the PC/104 form factor. It allows users to connect PCIe slot boards to a PCIe/104 or PCI/104-Express stack.

1.2 Board Features

- PC/104 Compatible
- PCI/104-Express stackable bus structure
  - PCIe/104 Type 2 Connectors
  - Pass-through PCI-104 Connector
- Adapt PCIe/104 Type 1 CPU to standard PCIe slots[1]
- One PCIe x16 slot (accepts x1, x4, x8 or x16 cards)
- One PCIe x1 slot
- Auxiliary Input Power Connector provides alternate input for system power rails
  - +3.3 V, +5 V, and 12 V input connections
  - Screw terminal blocks
- Onboard generation of 3.3Vaux power supply
- Power signals passed through to the bottom PCIe/104 connector
- Stacks below the host cpuModule

1.3 Ordering Information

The ADP041 is available with the following options:

Table 1: Ordering Options

Part Number	Description
ADP041	Adapt PCIe/104 Type 1 to standard PCIe slots[1]

1.4 Contact Information

1.4.1 Sales Support

For sales inquiries, you can contact RTD Embedded Technologies sales via the following methods:

Phone: 1-814-234-8087 Monday through Friday, 8:00am to 5:00pm (EST).
E-Mail: sales@rtd.com

1.4.2 Technical Support

If you are having problems with you system, please try the steps in the Troubleshooting section of this manual.

For help with this product, or any other product made by RTD, you can contact RTD Embedded Technologies technical support via the following methods:

Phone: 1-814-234-8087 Monday through Friday, 8:00am to 5:00pm (EST).
E-Mail: techsupport@rtd.com

[1]Refer to section 4.2 for details about PCIe/104 Type 2 compatibility

2 Specifications

2.1 Operating Conditions

Table 2: Operating Conditions

Symbol	Parameter	Test Condition	Min	Max	Unit	Note
V_{cc5}[1]	5V Supply Voltage		n/a	n/a	V	1
$V_{cc5\text{-}STBY}$	5V Standby Voltage		4.75	5.25	V	
V_{cc3}[1]	3.3V Supply Voltage		n/a	n/a	V	1
V_{cc12}[1]	12V Supply Voltage		n/a	n/a	V	1
$V_{cc\text{-}12}$[1]	-12V Supply Voltage		n/a	n/a	V	1
T_a	Operating Temperature		-40	+85	C	
T_s	Storage Temperature		-55	+125	C	
RH	Relative Humidity	Non-Condensing	0	90%	%	

2.2 Electrical Characteristics

Table 3: Electrical Characteristics

Symbol	Parameter	Test Condition	Max	Unit	Note
P_{VCC5}[1]	Power Consumption	V_{cc5} = 5.0V	0.0	mW	1
$P_{VCC5STBY}$	Power Consumption	$V_{cc5\text{-}STBY}$ = 5.0V; no +3.3Vaux load	1.0	mW	
Current to PCIe x1 (CN4) and x16 (CN3) Slots					
$I_{SLOT3.3}$		Both slots (combined)	5.5	A	
$I_{SLOT12\text{-}X1}$		PCIe x1 slot	0.5	A	
$I_{SLOT12\text{-}X16}$		PCIe x16 slot[2]	2.1	A	2
$I_{SLOT3.3\text{-}AUX}$		Per slot	375	mA	
Current Between PCIe/104 (CN1, CN5) and PCI-104 Bus (CN2) Connectors					
I_{BUS5}	5V Current		8.0	A	
$I_{BUS3.3}$	3.3V Current		3.6	A	
I_{BUS12}	12V Current		1.0	A	
$I_{BUS5\text{-}STBY}$	5V Standby Current		0.0[3]	A	3
Current Between Terminal Block (CN100) and PCIe/104 Bus (CN1, CN5) Connector					
$I_{AUX5\text{-}PCIe}$	5V Current		10.0	A	
$I_{AUX3.3\text{-}PCIe}$	3.3V Current		3.6	A	
$I_{AUX12\text{-}PCIe}$	12V Current		8.4	A	
Current Between Terminal Block (CN100) and PCI-104 Bus (CN2) Connector					
$I_{AUX5\text{-}PCI}$	5V Current		8.0	A	
$I_{AUX3.3\text{-}PCI}$	3.3V Current		10.0	A	
$I_{AUX12\text{-}PCI}$	12V Current		1.0	A	

[1] The 5V, 3.3V, 12V, and -12V rails are not used by the ADP041. Any requirements on these signals are driven by other components in the system.
[2] The PCIe x16 Slot is designed for 25W PCIe devices, and does not permit 75W x16 full-height graphics cards.
[3] +5V Standby ($V_{cc5\text{-}STBY}$) is connected to the PCIe/104 bus connector but not the PCI bus connector. This is by design, as usage of the PCIe x1 and x16 slots requires a PCIe/104 Type 2 bus connector. The PCI-104 bus connector exists to pass through the host's PCI bus to PCI peripheral devices above or below the ADP041.

3 Board Connection

3.1 Board Handling Precautions

To prevent damage due to Electrostatic Discharge (ESD), keep your board in its antistatic bag until you are ready to install it into your system. When removing it from the bag, hold the board at the edges, and do not touch the components or connectors. Handle the board in an antistatic environment, and use a grounded workbench for testing and handling of your hardware.

3.2 Physical Characteristics

STEP model is available upon request; contact RTD Tech Support for more information.

- Weight: Approximately 0.05 Kg (0.11 lbs.)
- Dimensions: 98.552 mm L x 148.209 mm W (3.880 in L x 5.835 in W)

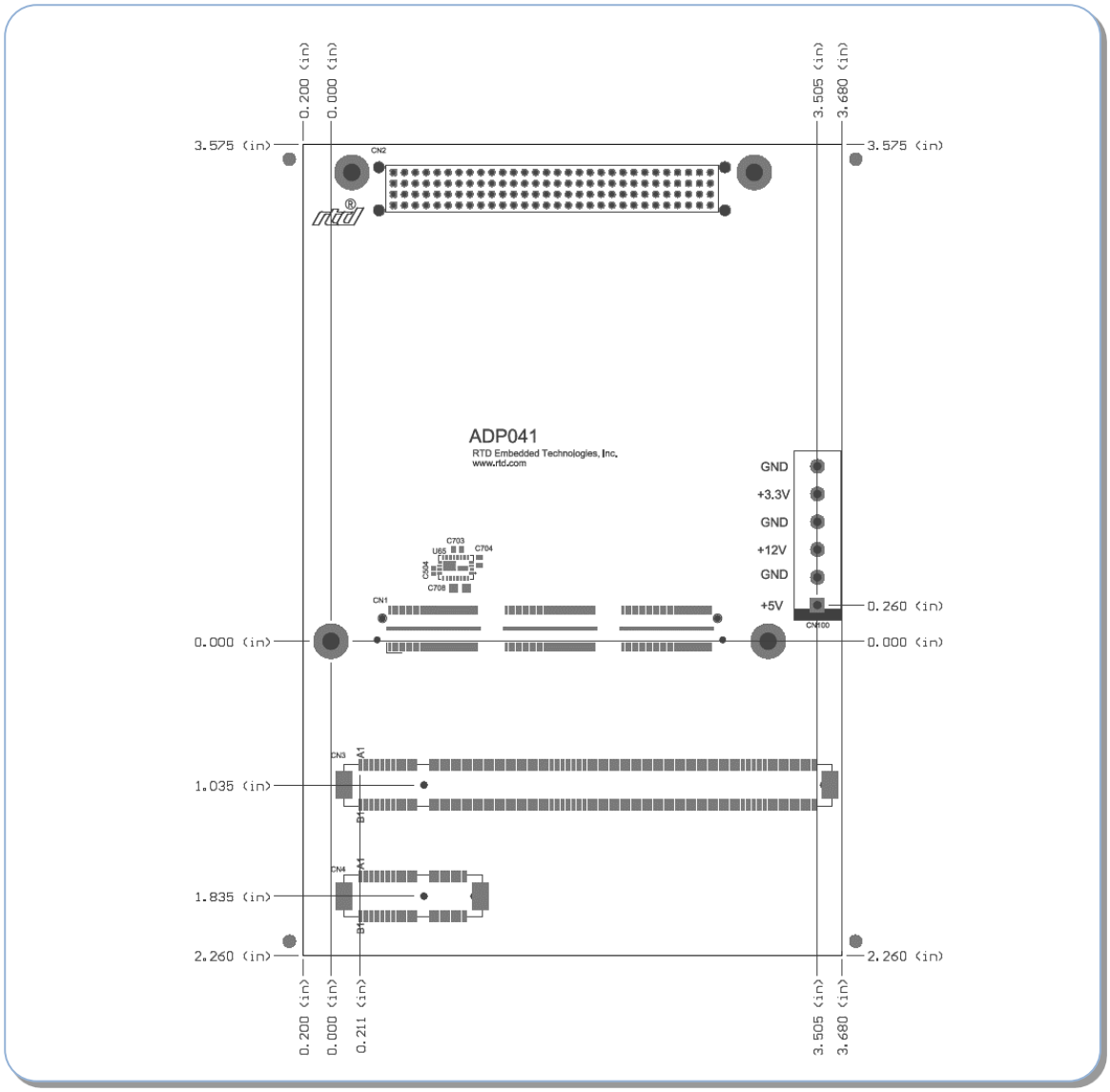

Figure 1: Board Dimensions (inches)

3.3 Connectors

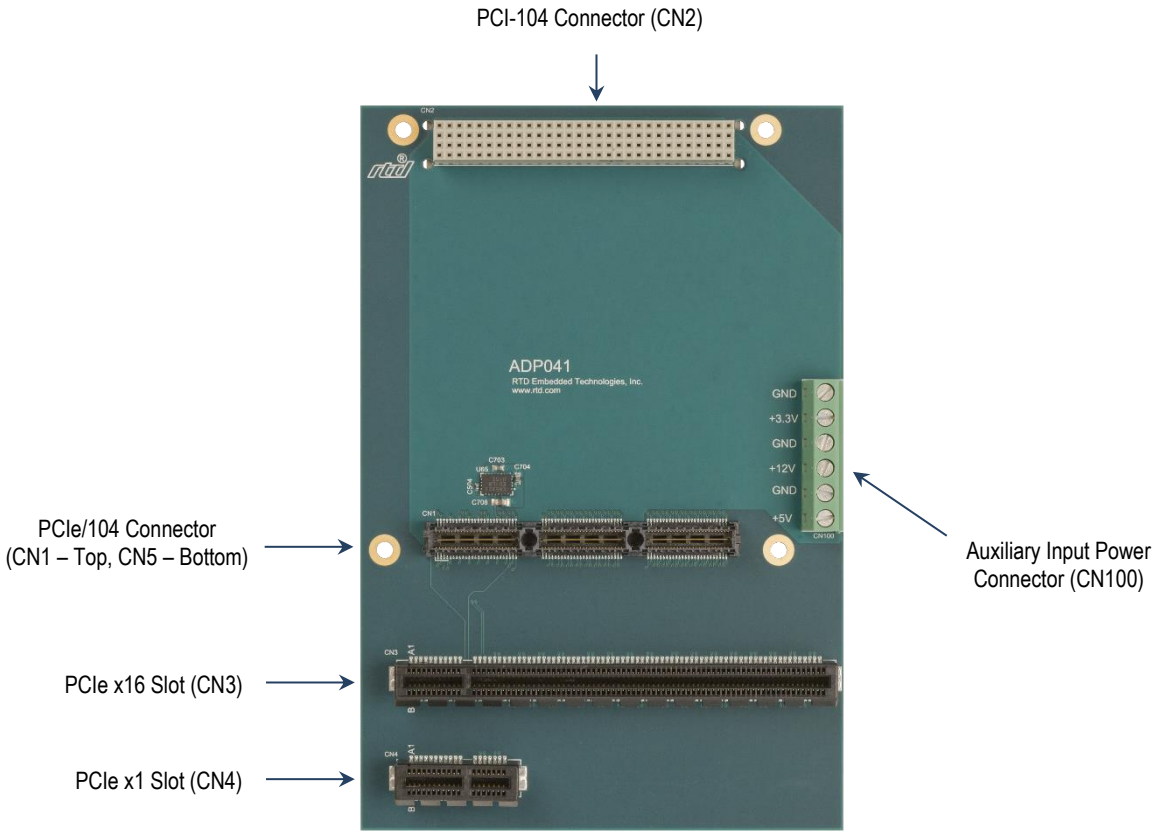

Figure 2: Board Connections

3.3.1 Bus Connectors

PCIe/104 Connector (CN1 – Top, CN5 – Bottom)

The PCIe connector is the connection to the system CPU. The position and pin assignments are compliant with the *PCI/104-Express & PCIe/104 Specification*. (See PC/104 Specifications on page 18.)

The ADP041 is a Type 1 board, and must connect to a Type 1 PCIe/104 connector. For PCIe/104 Type 2 compatibility, refer to section 4.2.

PCI-104 Connector (CN2)

The PCI-104 connector provides a pass-through connection for the host and PCI peripheral modules. The position and pin assignments are compliant with the *PCI/104-Express Specification* (see PC/104 Specifications on page 18).

The table below shows pin connections used on the ADP041, indicated by the white cells. Shaded cells are pass-through only, not utilized by the ADP041, and are indicated for reference only.

Table 4: PCI-104 Bus Signal Assignments

Pin	A	B	C	D
1	GND	+5V_STBY	+5 V	AD00
2	VIO	AD02	AD01	+5 V
3	AD05	GND	AD04	AD03
4	C/BE0#	AD07	GND	AD06
5	GND	AD09	AD08	GND
6	AD11	VIO	AD10	M66EN
7	AD14	AD13	GND	AD12
8	+3.3 V	C/BE1#	AD15	+3.3 V
9	SERR#	GND	PSON#	PAR
10	GND	PERR#	+3.3 V	PME#
11	STOP#	+3.3 V	LOCK#	GND
12	+3.3 V	TRDY#	GND	DEVSEL#
13	FRAME#	GND	IRDY#	+3.3 V
14	GND	AD16	+3.3 V	C/BE2#
15	AD18	+3.3 V	AD17	GND
16	AD21	AD20	GND	AD19
17	+3.3 V	AD23	AD22	+3.3 V
18	IDSEL0	GND	IDEL1	IDSEL2
19	AD24	C/BE3#	VIO	IDSEL3
20	GND	AD26	AD25	GND
21	AD29	+5 V	AD28	AD27
22	+5 V	AD30	GND	AD31
23	REQ0#	GND	REQ1#	VIO
24	GND	REQ2#	+5 V	GNT0#
25	GNT1#	VIO	GNT2#	GND
26	+5 V	CLK0	GND	CLK1
27	CLK2	+5 V	CLK3	GND
28	GND	INTD#	+5 V	RST#
29	+12 V	INTA#	INTB#	INTC#
30	-12 V	REQ3#	GNT3#	GND

3.3.2 PCIe Slot Connectors

PCIe x1 Slot Connector (CN4)

The PCIe x1 slot connector (CN4) connects to the highest order x1 link on the top-side PCIe/104 connector (CN1). Adhering to the PCIe/104 specification, this allows the ADP041 to map the first available PCIe x1 link of a host CPU connected to the PCIe x1 slot connector (CN1).

The signal assignments for CN4 are shown in Table 5. Shaded cells are not connected on the ADP041, and are indicated for reference only.

Table 5: PCIe x1 Slot Connector Signal Assignments

Pin	Side B	Side A
1	+12 V	PRSNT#1
2	+12 V	+12 V
3	+12 V	+12 V
4	GND	GND
5	SMCLK	JTAG2
6	SMDAT	JTAG3
7	GND	JTAG4
8	+3.3 V	JTAG5
9	JTAG1	+3.3 V
10	3.3Vaux	+3.3 V
11	WAKE#	PERST#
Mechanical Key		
12	RSVD	GND
13	GND	REFCLK+
14	HSOp(0)	REFCLK-
15	HSOn(0)	GND
16	GND	HSIp(0)
17	PRSNT#2	HSIn(0)
18	GND	GND

PCIe x16 Slot Connector (CN3)

The PCIe x16 slot connector (CN3) connects to the x16 link on the top-side PCIe/104 connector (CN1). In addition to supporting PCIe x16 slot cards, x1, x4, and x8 devices are also supported.

NOTE: The PCIe x16 Slot is designed for 25W PCIe devices, and does not permit 75W x16 full-height graphics cards. For more information on the Electrical Characteristics of the ADP041, refer to section 2.2.

Table 6 shows the signal assignments for CN3. Shaded signal names are not connected on the ADP041, and are indicated for reference only.

- Pins 1 through 18 are used by the x1 PCIe links
- Pins 1 through 32 are used by the x4 PCIe links
- Pins 1 through 49 are used by the x8 PCIe links
- Pins 1 through 82 are used by the x16 PCIe links

Table 6: PCIe x16 Slot Connector Signal Assignments

Pin	Side B	Side A
1	+12 V	PRSNT#1
2	+12 V	+12 V
3	+12 V	+12 V
4	GND	GND
5	SMCLK	JTAG2
6	SMDAT	JTAG3
7	GND	JTAG4
8	+3.3 V	JTAG5
9	JTAG1	+3.3 V
10	3.3Vaux	+3.3 V
11	WAKE#	PERST#
Mechanical Key		
12	RSVD	GND
13	GND	REFCLK+
14	HSOp(0)	REFCLK-
15	HSOn(0)	GND
16	GND	HSIp(0)
17	PRSNT#2	HSIn(0)
18	GND	GND
19	HSOp(1)	RSVD
20	HSOn(1)	GND
21	GND	HSIp(1)
22	GND	HSIn(1)
23	HSOp(2)	GND
24	HSOn(2)	GND
25	GND	HSIp(2)
26	GND	HSIn(2)
27	HSOp(3)	GND
28	HSOn(3)	GND
29	GND	HSIp(3)
30	RSVD	HSIn(3)
31	PRSNT#2	GND
32	GND	RSVD
33	HSOp(4)	RSVD
34	HSOn(4)	GND
35	GND	HSIp(4)
36	GND	HSIn(4)
37	HSOp(5)	GND
38	HSOn(5)	GND
39	GND	HSIp(5)
40	GND	HSIn(5)
41	HSOp(6)	GND
42	HSOn(6)	GND

Pin	Side B	Side A
43	GND	HSIp(6)
44	GND	HSIn(6)
45	HSOp(7)	GND
46	HSOn(7)	GND
47	GND	HSIp(7)
48	PRSNT#2	HSIn(7)
49	GND	GND
50	HSOp(8)	RSVD
51	HSOn(8)	GND
52	GND	HSIp(8)
53	GND	HSIn(8)
54	HSOp(9)	GND
55	HSOn(9)	GND
56	GND	HSIp(9)
57	GND	HSIn(9)
58	HSOp(10)	GND
59	HSOn(10)	GND
60	GND	HSIp(10)
61	GND	HSIn(10)
62	HSOp(11)	GND
63	HSOn(11)	GND
64	GND	HSIp(11)
65	GND	HSIn(11)
66	HSOp(12)	GND
67	HSOn(12)	GND
68	GND	HSIp(12)
69	GND	HSIn(12)
70	HSOp(13)	GND
71	HSOn(13)	GND
72	GND	HSIp(13)
73	GND	HSIn(13)
74	HSOp(14)	GND
75	HSOn(14)	GND
76	GND	HSIp(14)
77	GND	HSIn(14)
78	HSOp(15)	GND
79	HSOn(15)	GND
80	GND	HSIp(15)
81	PRSNT#2	HSIn(15)
82	RSVD#2	GND

3.3.3 EXTERNAL CONNECTORS

Auxiliary Power Input Connector (CN100)

As an alternative to powering the PCIe/104 bus connectors (CN1 & CN5) and PCIe x1 and x16 slots (CN4 & CN3) with a traditional PCIe/104 power supply, power may be applied through the Auxiliary Power Input Connector (CN100). This connector consists of three terminal blocks which permit connecting input and ground connections from an external DC supply to the +3.3V, +5V, and +12V rails used on the ADP041.

The input terminal blocks at CN100 may be especially useful if the PCIe/104 power supply connected to the PCIe/104 bus (CN1 & CN5) supplies +5V but does not provide +3.3V or +12V. For such PCIe/104 power supplies, +3.3V and +12V may be supplied to the terminal blocks of CN100 to ensure these rails are present on the PCIe x1 slot (CN4) and PCIe x16 slot (CN3). Supplying +3.3V and +12V to the Auxiliary Power Input Connector will also source power to these rails on the PCIe/104 connectors (CN1 & CN5).

For a detailed diagram showing the power map of the ADP041, refer to Figure 4 on 15.

3.4 Selecting the Stack Order for the ADP041

There are two stacking rules when connecting the ADP041 to a PC/104 system:

1. The PCIe x1 and x16 slot connectors both connect to the top-side PCIe/104 connector (CN1). Therefore, to utilize the PCIe x1 and x16 slot connectors, the ADP041 must stack somewhere below the host CPU.

2. Unlike most PCIe/104 peripherals, the ADP041 does not shift lanes of unused PCIe x1 links on the PCIe/104 connector. The top-side PCIe/104 connector (CN1) does not pass any PCIe links to the bottom side connector (CN2). Power connections, however, are passed through. Therefore, with the exception of power supplies, devices installed below the ADP041 which would normally utilize the x1 or x16 links on the PCIe/104 connector will effectively have no connection to devices stacked to the top-side PCIe/104 connector (CN1). For this reason, if other peripherals are required in the system, they must be stacked somewhere above the ADP041.

For systems with PCI devices, the PCI-104 connector (CN2) will permit the system to meet these requirements while allowing the PCI bus to pass through to other boards within the system.

3.5 Steps for Installing

1. Always work at an ESD protected workstation, and wear a grounded wrist-strap.
2. Turn off power to the PC/104 system or stack.
3. Select and install stand-offs to properly position the module on the stack.
4. Remove the module from its anti-static bag.
5. Check that pins of the bus connector are properly positioned.
6. Check the stacking order; make sure all of the busses used by the peripheral cards are connected to the cpuModule.
7. Hold the module by its edges and orient it so the bus connector pins line up with the matching connector on the stack.
8. Gently and evenly press the module onto the PC/104 stack.
9. If any boards are to be stacked above this module, install them.
10. Attach any necessary cables to the PC/104 stack.
11. Re-connect the power cord and apply power to the stack.
12. Boot the system and verify that all of the hardware is working properly.

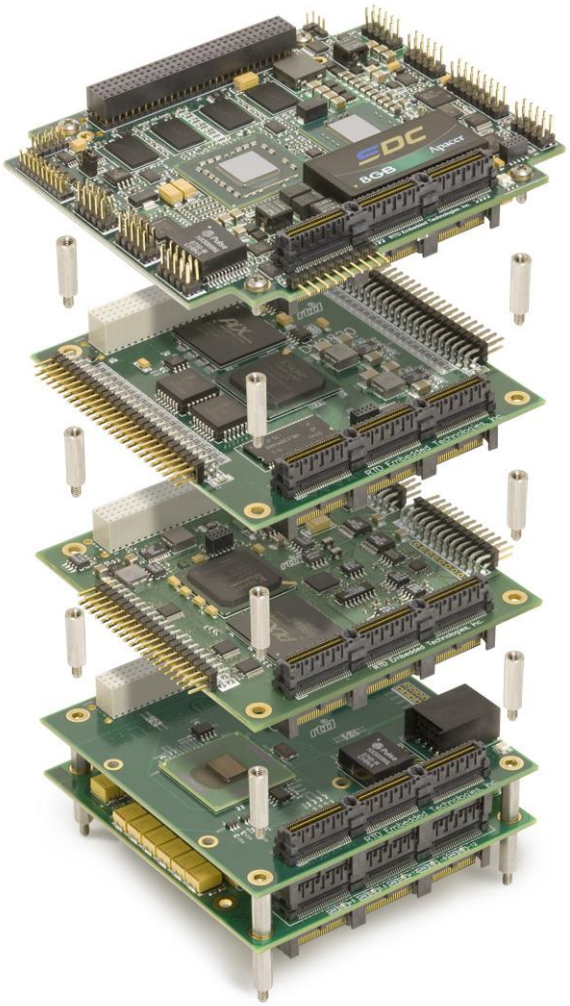

Figure 3: Example 104™ Stack

4 Functional Description

4.1 Functional Diagram and Power Map

The Figure below shows the functional diagram of the ADP041. The various parts of the block diagram are discussed in the following sections.

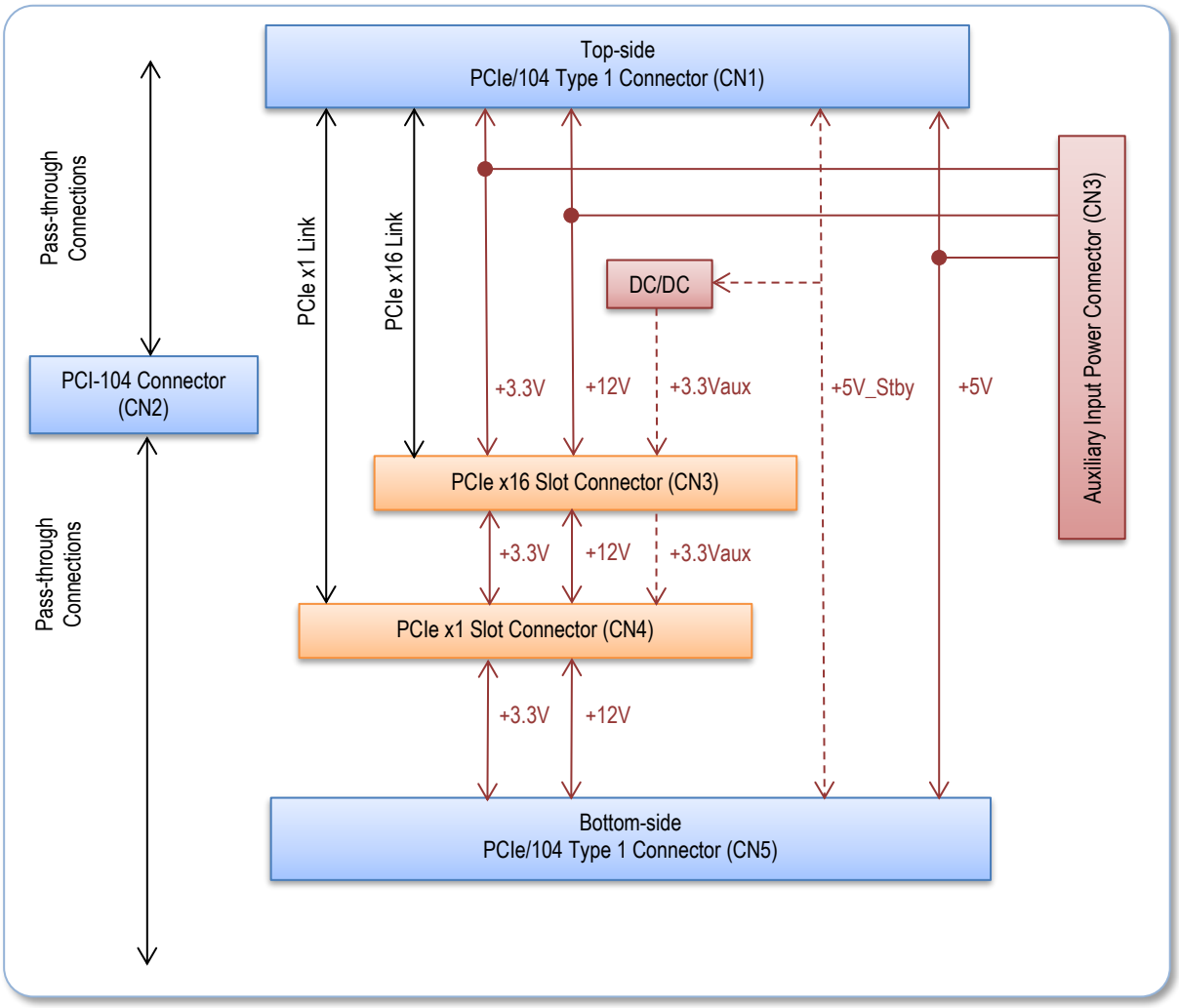

Figure 4: ADP041 Functional Diagram and Power Map

The ADP041 only requires +5V (V_{cc5}) to operate and may be supplied on either the PCIe or PCI side of the ADP041. Although not required, +5V Standby ($V_{cc5\text{-}STBY}$) may be provided on the PCIe connector to permit waking the system if supported by the host.

Acceptable voltage ranges for +5V (V_{cc5}) and +5V Standby ($V_{cc5\text{-}STBY}$) are listed in Table 2: Operating Conditions.

4.2 PCIe/104 Type 2 Compatibility

The ADP041 adheres to the peripheral stacking rules of the PCIe/104 specification, which ensure that systems are not damaged when different types of peripheral boards and host modules are stacked together.

Because the ADP041 permits integration of PCIe x16 peripherals into PCIe/104 systems, it is only compatible with PCIe/104 Type 1 hosts. The ADP041 may configured for PCIe/104 Type 2 compatibility, with the following restrictions:

1. Bus stack error detection on the CPU must be disabled.

2. When connected to a PCIe/104 Type 2 host, the PCIe x16 slot connector will only support x4 devices.

For more information on the system stacking requirements for PCIe/104 Type 1 and Type 2, refer to the *PCI/104-Express & PCIe/104 Specification*. (See PC/104 Specifications on page 18.)

5 Troubleshooting

If you are having problems with your system, please try the following initial steps:

- **Simplify the System** – Remove modules one at a time from your system to see if there is a specific module that is causing a problem. Perform you troubleshooting with the least number of modules in the system possible.

- **Swap Components** – Try replacing parts in the system one at a time with similar parts to determine if a part is faulty or if a type of part is configured incorrectly.

If problems persist, or you have questions about configuring this product, contact RTD Embedded Technologies via the following methods:

Phone: +1-814-234-8087
E-Mail: techsupport@rtd.com

Be sure to check the RTD web site (http://www.rtd.com) frequently for product updates, including newer versions of the board manual and application software.

6 Additional Information

6.1 PC/104 Specifications

A copy of the latest PC/104 specifications can be found on the webpage for the PC/104 Embedded Consortium:

www.pc104.org

6.2 PCI and PCI Express Specification

A copy of the latest PCI and PCI Express specifications can be found on the webpage for the PCI Special Interest Group:

www.pcisig.com

7 Limited Warranty

RTD Embedded Technologies, Inc. warrants the hardware and software products it manufactures and produces to be free from defects in materials and workmanship for one year following the date of shipment from RTD Embedded Technologies, Inc. This warranty is limited to the original purchaser of product and is not transferable.

During the one year warranty period, RTD Embedded Technologies will repair or replace, at its option, any defective products or parts at no additional charge, provided that the product is returned, shipping prepaid, to RTD Embedded Technologies. All replaced parts and products become the property of RTD Embedded Technologies. Before returning any product for repair, customers are required to contact the factory for a Return Material Authorization (RMA) number.

This limited warranty does not extend to any products which have been damaged as a result of accident, misuse, abuse (such as: use of incorrect input voltages, improper or insufficient ventilation, failure to follow the operating instructions that are provided by RTD Embedded Technologies, “acts of God” or other contingencies beyond the control of RTD Embedded Technologies), or as a result of service or modification by anyone other than RTD Embedded Technologies. Except as expressly set forth above, no other warranties are expressed or implied, including, but not limited to, any implied warranties of merchantability and fitness for a particular purpose, and RTD Embedded Technologies expressly disclaims all warranties not stated herein. All implied warranties, including implied warranties for merchantability and fitness for a particular purpose, are limited to the duration of this warranty. In the event the product is not free from defects as warranted above, the purchaser's sole remedy shall be repair or replacement as provided above. Under no circumstances will RTD Embedded Technologies be liable to the purchaser or any user for any damages, including any incidental or consequential damages, expenses, lost profits, lost savings, or other damages arising out of the use or inability to use the product.

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This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

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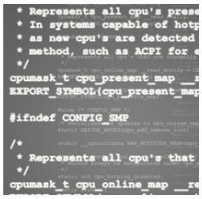

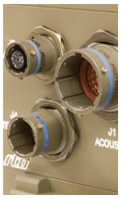
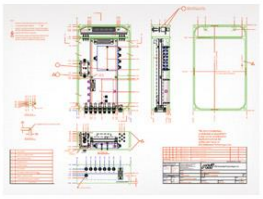

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