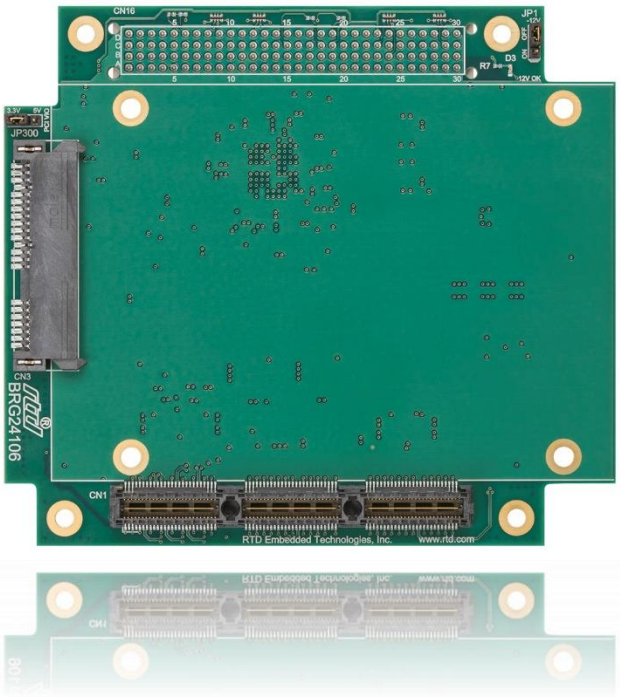
BRG24106xHR

PCI Express to PCI Bridge with 2.5" SATA Drive Carrier

User's Manual

BDM-610020146 Rev. A



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Rev A	Initial Release

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Table of Contents

1 Introduction 7

1.1 Product Overview 7

1.2 Board Features 7

1.3 Ordering Information 8

1.4 Contact Information 8
- 1.4.1 Sales Support 8
- 1.4.2 Technical Support 8

2 Specifications 9

2.1 Operating Conditions 9

2.2 Electrical Characteristics 9

3 Board Connection 11

3.1 Board Handling Precautions 11

3.2 Physical Characteristics 11

3.3 Stacking Requirements 12

3.4 Connectors and Jumpers 12
- 3.4.1 Bus Connectors 13
  - CN1(Top) & CN2(Bottom): PCIe Connector 13
  - CN16: PCI Connector 13
- 3.4.2 I/O Connectors 13
  - CN3: 2.5" SATA Drive Connector 13
- 3.4.3 Jumpers 14
  - B1: Factory Use Only 14
  - JP1: -12V Control 14
  - JP300: PCI Vio Select 14

3.5 Steps for Installing 15

4 IDAN Connections 16

4.1 Module Handling Precautions 16

4.2 Physical Characteristics 16

4.3 Connectors 17
- 4.3.1 External I/O Connectors 17
- 4.3.2 Bus Connectors 17
  - CN1(Top) & CN2(Bottom): PCIe Connector 17
  - CN16: PCI Connector 17

4.4 Steps for Installing 18

5 Functional Description 19

5.1 Block Diagram 19
- 5.1.1 PCIe to PCI Bridge 19
- 5.1.2 SATA Drive Connector 20

5.2 PCIe to PCI Bridge 21
- 5.2.1 PCI Bus Masters 21
- 5.2.2 Wake from PCI Devices 21
- 5.2.3 Compatibility with PCI-to-ISA Bridges (BRG17088) 21

5.3 SATA Link Shifting 21

5.4 Power 21
- 5.4.1 -12V Power Supply 21

6 Troubleshooting 22

7 Additional Information 23

7.1 PC/104 Specifications 23
7.2 PCI and PCI Express Specification 23
7.3 Serial ATA Specification 23
8 Limited Warranty **24**

Table of Figures

Figure 1: BRG24106AHR (Above CPU) 8
Figure 2: BRG24106BHR (Below CPU) 8
Figure 3: Board Dimensions 11
Figure 4: Board Connections 12
Figure 5: Example 104™Stack 15
Figure 6: IDAN Dimensions 16
Figure 7: Example IDAN System 18
Figure 8: Functional Diagram for PCIe to PCI Bridge 19
Figure 9: Functional Diagram for SATA 2.5" Drive Connector 20

Table of Tables

Table 1: Ordering Options 8
Table 2: Operating Conditions 9
Table 3: Supply Voltage Requirements 9
Table 4: Electrical Characteristics 9
Table 5: BRG24106xHR Bus Connectors 13
Table 6: JP1 Settings 14
Table 7: JP300 Settings 14
Table 8: SATA Link, Upstream vs. Shifted 20

1 Introduction

1.1 Product Overview

The BRG24106xHR is designed to add a PCI Express (PCIe) to PCI Bridge to a PCIe/104 system, while also providing the system with a 2.5" SATA disk drive interface.

The PCI Express to PCI Bridge functionality utilizes a PCIe x1 link which interfaces to the host CPU module, providing a full PCI interface to PC/104-Plus and PCI-104 peripheral cards. This allows the addition of a PCI bus segment to the 104™ system which can support four more peripheral cards. It is compatible with all PCI Express cpuModules.

The 2.5" drive connector on the BRG24106xHR utilizes the first available SATA link on the PCIe/104 Type 2 connector. Power to the drive connector is sourced from the PCIe/104 connector, eliminating the need for external out-of-stack cabling.

1.2 Board Features

- Stackable PCIe/104 Type 2 Expansion Bus
  - PCI Express (PCIe) x1 Upstream Interface to CPU
  - SATA interface to CPU
- PCI Downstream Interface to Peripheral Cards
- Power rails (+5V, +3.3V, +12V) connected between the PCIe and PCI bus
- PCI Express Bus:
  - Provides 2.5 Gbps in each direction
    - Complies with PCI Express Base Specification, Revision 1.0a
  - Single lane and single Virtual Channel operation
    - Compatible with multi-Virtual Channel chipsets
  - Packetized serial traffic with PCI Express Split Completion protocol
  - Data Link Layer Cyclic Redundancy Check (CRC) generator and checker
  - Automatic Retry of bad packets
  - In-band interrupts and messages
  - Message Signaled Interrupt (MSI) support
- PCI Bus:
  - 32-bit, 33 MHz PCI Bus
  - PCI Master Controller allows PCI Express access to PCI Target Devices
  - PCI Target Controller allows full transparent access to PCI Express resources
  - Message Signaled Interrupt (MSI) support
  - Legacy Interrupt support
  - Four Bus Masters
  - Jumper selectable VIO
    - 5V or 3.3V signal level
  - Jumper selectable -12V @ 500 mA power supply to PCI bus
- Adds one 2.5" SATA (Serial ATA) drive to a system using the PCIe/104 Type 2 bus interface on select RTD cpuModules
  - Useful for RAID configurations
  - Stack up to 2x SATA drive carrier modules per PCIe/104 Type 2 bus interface on the host cpuModule (permitting a maximum of up to 4x SATA drive carriers in one system)
- Benefits of SATA over PATA (Parallel ATA)
  - Transfer rates up to 3.0 Gbits per second is faster and more efficient than PATA
  - Dedicated SATA links for each drive in the system eliminate master/slave addressing jumper
  - Backwards compatibility with PATA permits use of Legacy Mode
- Physical and environmental characteristics
  - Supports 2.5" SATA rotating or flash drives
  - -40 to +85ºC operating temperature[1]
  - RTD IDAN™ compatible

[1] Operating temperature range may be limited by the rating of the SATA drive installed in the SATA drive carrier module

1.3 Ordering Information

The BRG24106xHR is available with the following options:

Table 1: Ordering Options

Part Number	Description
BRG24106AHR	PCIe to PCI Bridge for **Above** the CPU
BRG24106BHR	PCIe to PCI Bridge for **Below** the CPU
IDAN-BRG24106AHRS	PCIe to PCI Bridge for **Above** the CPU in IDAN enclosure
IDAN-BRG24106BHRS	PCIe to PCI Bridge for **Below** the CPU in IDAN enclosure
BRG24106AHR/FSxx	BRG24106AHR with Apacer Flash Drive Installed
BRG24106BHR/FSxx	BRG24106BHR with Apacer Flash Drive Installed
IDAN-BRG24106AHRS/FSxx	IDAN-BRG24106AHRS with Apacer Flash Drive Installed
IDAN-BRG24106BHRS/FSxx	IDAN-BRG24106BHRS with Apacer Flash Drive Installed

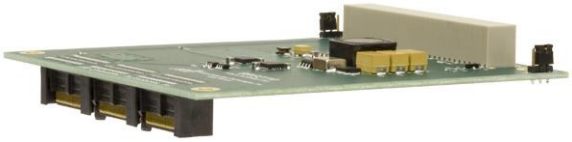

Figure 1: BRG24106AHR (Above CPU)

Figure 2: BRG24106BHR (Below CPU)

The Intelligent Data Acquisition Node (IDAN™) building block can be used in just about any combination with other IDAN building blocks to create a simple but rugged 104™ stack. This module can also be incorporated in a custom-built RTD HiDAN™ or HiDANplus® High Reliability Intelligent Data Acquisition Node. Contact RTD sales for more information on our high reliability systems.

For more information on the Apacer Flash Drives available for the BRG24106xHR/FSxx and IDAN-BRG24106xHR/FSxx, contact RTD sales.

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 your 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

2 Specifications

2.1 Operating Conditions

Table 2: Operating Conditions

Symbol	Parameter	Test Condition	Min	Max	Unit
V_{cc5}	5V Supply Voltage		4.75	5.25	V
V_{cc3}	3.3V Supply Voltage		n/a	n/a	V
V_{cc12}	12V Supply Voltage		n/a	n/a	V
V_{cc-12}	-12V Supply Voltage		n/a	n/a	V
T_a	Operating Temperature		-40	+85	C
T_s	Storage Temperature		-55	+125	C
RH	Relative Humidity	Non-Condensing	0	90%	%
MTBF	Mean Time Before Failure	23C, Ground Benign		TBD	Hours

NOTE: The Operating Environment and Storage Conditions apply to the BRG24106xHR board only. For recommended operating conditions of third party 2.5" SATA drives, refer to documentation from the manufacturer.

2.2 Electrical Characteristics

The SATA drive connector (CN3) on the BRG24106xHR requires +5 V, +3.3 V, and +12 V for operation, all of which are supplied by the PCIe/104 Type 2 connectors (CN1 and CN2). The +5 V power rail is used to generate all other onboard voltage requirements. All other bus connector supply voltages are pass-through and are unused by the BRG24106xHR.

Table 3: Supply Voltage Requirements

Symbol	Parameter	Test Condition	Min	Max	Unit
V_{cc5}	5 V Supply Voltage		4.750	5.250	V
$V_{cc5\text{-}STBY}$	5 V Stand-by Supply Voltage		n/a	n/a	V
V_{cc3}	3.3 V Supply Voltage		3.135	3.465	V
V_{cc12}	12 V Supply Voltage		11.400	12.600	V
V_{cc-12}	-12 V Supply Voltage		n/a	n/a	V

Supply current and power consumption for the BRG24106xHR are listed in the table below.

Table 4: Electrical Characteristics

Symbol	Parameter	Test Condition	Min	Max	Unit
P	Power Consumption	V_{cc5} = 5.0V; no disk drive installed		0.5	W
I_{cc5}	5V Input Supply Current	Active		100	mA
V_{OUT12}	-12V Output Supply Voltage	JP1 = 1-2 (ON)	-13.2	-10.8	V
I_{OUT12}	-12V Output Supply Current	JP1 = 1-2 (ON)		500	mA
I_{BUS5}	5V Current between buses			8.0	A
$I_{BUS3.3}$	3.3V Current between buses			3.0	A
I_{BUS12}	12V Current between buses			1.0	A
PCI Bus					
$V_{IH3.3}$	PCI 3.3V Input High Voltage	JP300 = 1-2 (3.3V)	1.65	3.3	V
$V_{IL3.3}$	PCI 3.3V Input Low Voltage	JP300 = 1-2 (3.3V)	0	0.7	V
V_{IH5}	PCI 5V Input High Voltage	JP300 = 2-3 (5V)	2.0	5.5	V
V_{IL5}	PCI 5V Input Low Voltage	JP300 = 2-3 (5V)	0	0.8	V
I_{IL}	PCI Input Leakage	0<V_I<VIO	-10	10	uA
I_{OZ}	PCI Hi-Z Leakage	0<V_I<VIO		10	uA

Table 4: Electrical Characteristics

Symbol	Parameter	Test Condition	Min	Max	Unit
$V_{OH3.3}$	PCI 3.3V Output High Voltage	JP300 = 1-2 (3.3V), I_{OUT} = -0.5mA	2.97		V
$V_{OL3.3}$	PCI 3.3V Output Low Voltage	JP300 = 1-2 (3.3V) , I_{OUT} = 1.5mA		0.33	V
V_{OH5}	PCI 5V Output High Voltage	JP300 = 2-3 (5V) , I_{OUT} = -12mA	2.4		V
V_{OL5}	PCI 5V Output Low Voltage	JP300 = 2-3 (5V) , I_{OUT} = 12mA		0.4	V
PCIe Bus					
	Differential Output Voltage		0.8	1.2	V
	DC Differential TX Impedance		95.2	116.9	Ω
	Differential Input Voltage		0.175	3.3	V
	DC Differential RX Impedance		92.7	115.8	Ω
	Electrical Idle Detect Threshold		61	173	mV

NOTE: Power measurements were recorded with no device installed in the 2.5" SATA drive connector.

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 73 g (0.16 lbs.)
- Dimensions: 90.17 mm L x 109.51 mm W (3.550 in L x 4.272 in W)

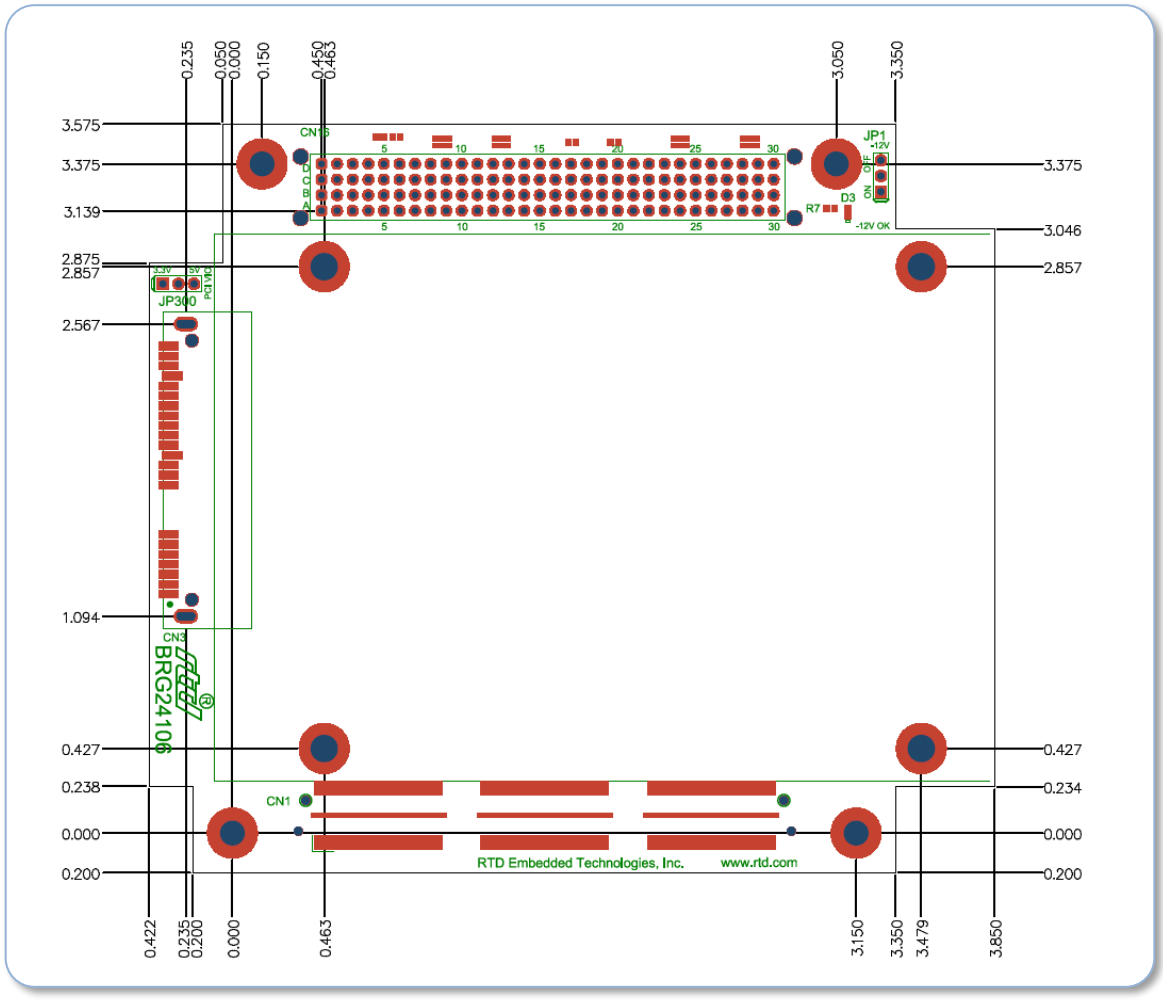

Figure 3: Board Dimensions

3.3 Stacking Requirements

It is common for the host cpuModule to require high speed peripherals (SATA, USB 3.0, PCI Express, etc.) to be installed within six boards of the CPU. However, the stacking nature of the BRG24106xHR requires that it is one of the last PCIe/104 devices in the stack to host PCI-104 peripherals.

Stacking too many peripherals between the CPU and the BRG24106xHR may result in SATA signal deterioration. To avoid stacking more than five peripherals between the CPU and BRG24106xHR, stack additional peripherals on the other side of the CPU.

3.4 Connectors and Jumpers

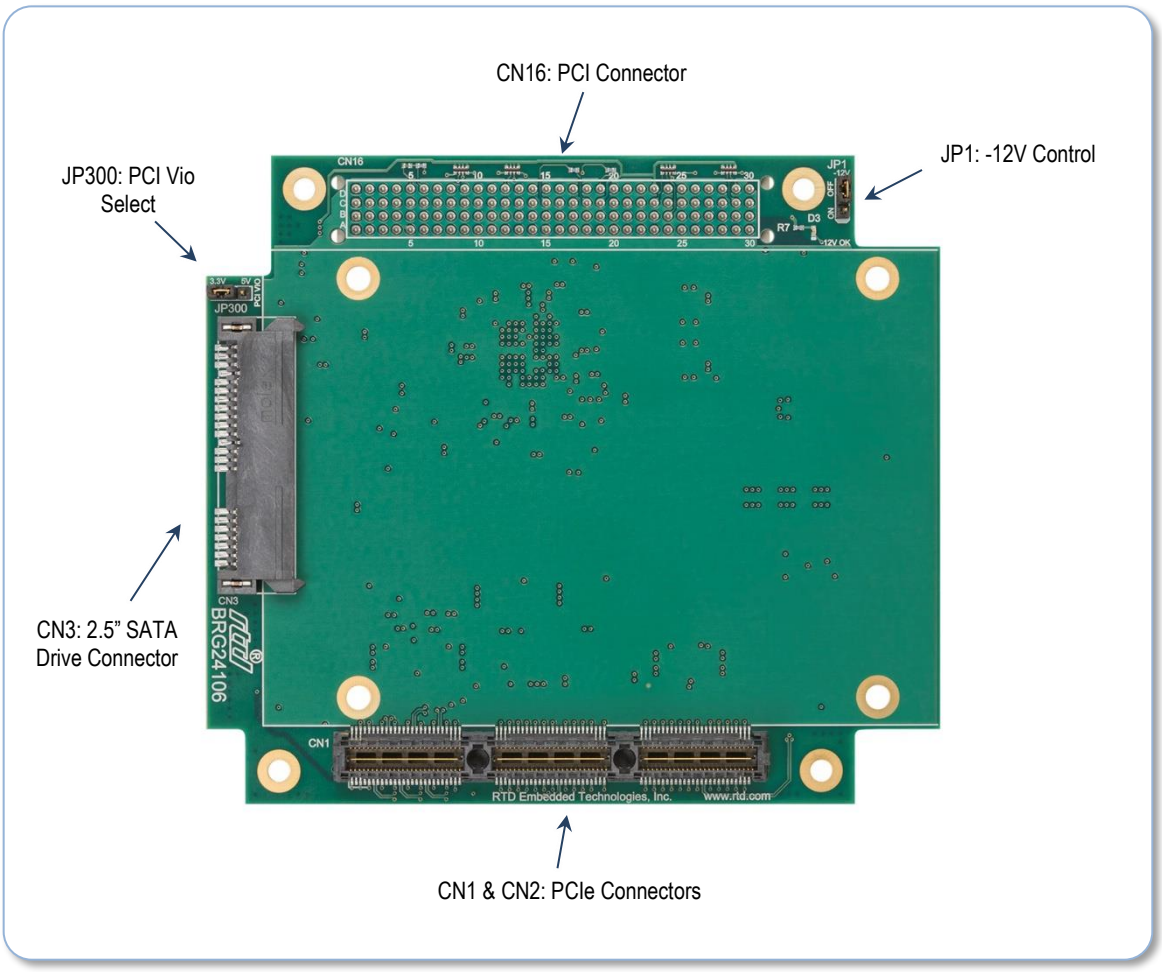

Figure 4: Board Connections

3.4.1 BUS CONNECTORS

Table 5: BRG24106xHR Bus Connectors

Connector	Function	Size and Pitch	Mating Connector
CN1	PCIe/104 Type 2 Bus (Top)	156-pin, 0.635mm	Samtec ASP-129646-03
CN2	PCIe/104 Type 2 Bus (Bottom)	156-pin, 0.635mm	Samtec ASP-129637-03
CN16	PCI-104 (PCI) Bus	120-pin, 2mm	Samtec ESQT-130-02-G-Q-368

CN1(Top) & CN2(Bottom): PCIe Connector

The PCIe connector is the connection to the system CPU. The position and pin assignments are compliant with the *PCI/104-Express Specification*. (See PC/104 Specifications on page 23)

The BRG24106xHR must connect to a Type 2 PCIe/104 connector. It uses one SATA link and one PCIe x1 link from the PCIe connector.

NOTE: The BRG24106xHR is not a "Universal" PCIe peripheral card. The PCIe connectors are only compatible with Type 2 PCIe/104 connectors.

CN16: PCI Connector

The PCI connector is the connection to PCI peripheral modules. The position and pin assignments are compliant with the *PCI/104-Express Specification*. (See PC/104 Specifications on page 23)

3.4.2 I/O CONNECTORS

CN3: 2.5" SATA Drive Connector

The 2.5" SATA drive connector on the BRG24106xHR provides a convenient interface to the SATA links on the PCIe/104 Type 2 bus on select RTD PCIe/104 and PCI/104-Express cpuModules.

The data segment of the 2.5" SATA drive connector is connected to the first available SATA link on the host cpuModule's PCIe/104 Type 2 connector. A full SATA power segment is provided on the 2.5" SATA drive connector. Voltage rails on the power segment include +5 V, +3.3 V, and +12 V, all of which are supplied by the PCIe/104 Type 2 connectors (CN1 and CN2) as well as the PCI connector (CN16).

NOTE: When installing a 2.5" drive, be certain to install all four mounting screws in the underside of the board. Failure to do so may introduce intermittent SATA connection issues, which can lead to drive errors and data corruption!

NOTE: Screw threading for 2.5" drives may vary from vendor to vendor.

3.4.3 JUMPERS

On all jumpers, pin 1 is designated by a thick white silkscreen line, and a square pad on the PCB.

B1: Factory Use Only

The configuration of solder jumper B1 is defined by the factory and should not be changed.

JP1: -12V Control

JP1 is used to enable and disable the -12V power supply to the PCI bus. See the "-12V Power Supply" section on page 21 for more details.

Table 6: JP1 Settings

Setting	Description
1-2	BRG24106xHR supplies -12V to the PCI bus.
2-3	BRG24106xHR does not supply -12V to the PCI bus. (factory default)

NOTE: When the BRG24106xHR is supplying -12V to the PCI bus (i.e. JP1 = 1-2), there must not be any other -12V power supplies on that PCI bus segment.

JP300: PCI Vio Select

JP300 is used to set the voltage of the VIO pins on the PCI bus. It does not change the actual signal level that the BRG24106xHR uses. When selecting a VIO voltage, be sure that all of the PCI peripheral cards on the PCI bus of the BRG24106xHR are compatible with the selected voltage.

Table 7: JP300 Settings

Setting	Description
1-2	PCI bus VIO pins set to 3.3V (factory default)
2-3	PCI bus VIO pins set to 5V

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.

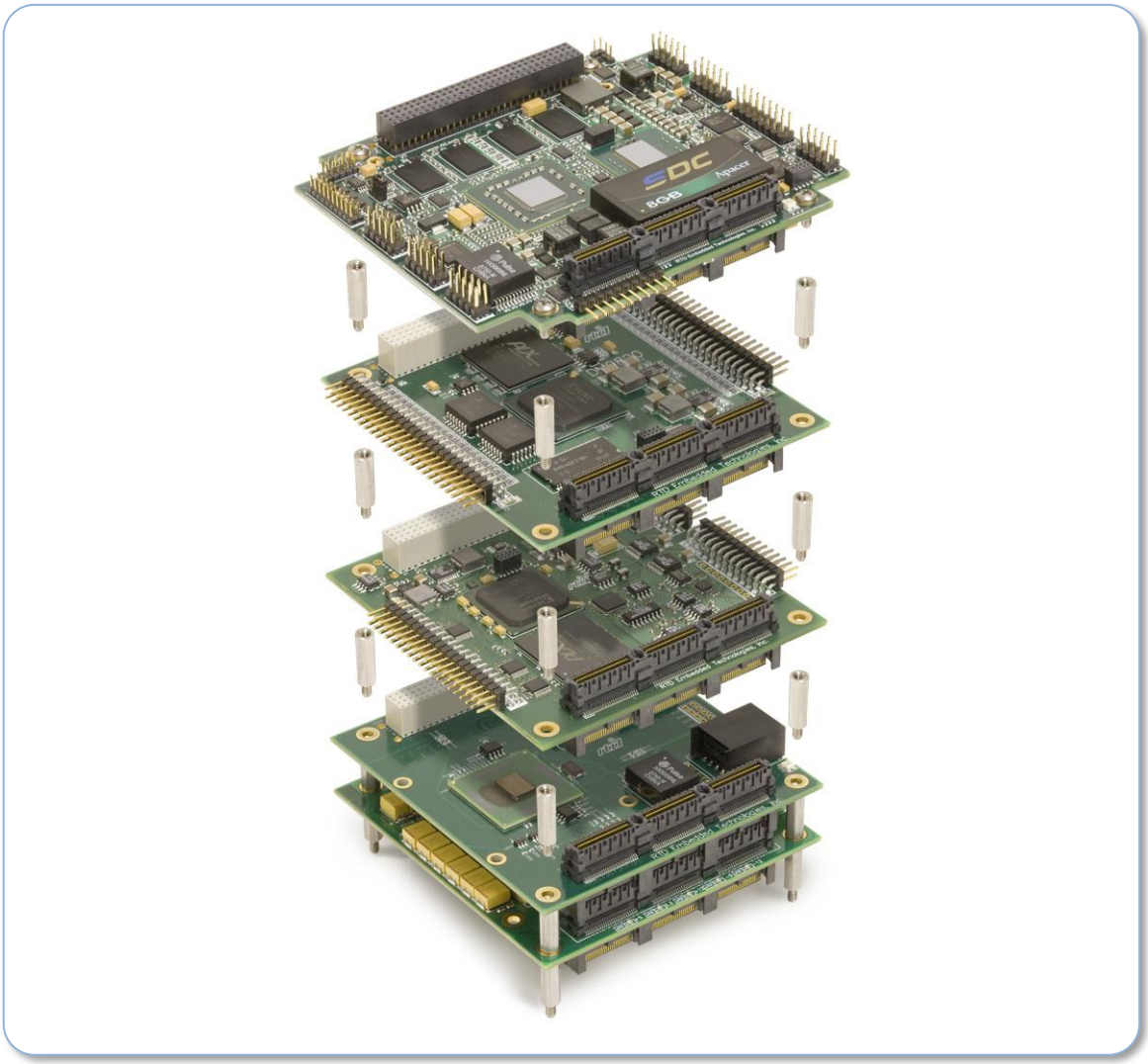

Figure 5: Example 104™ Stack

4 IDAN Connections

4.1 Module Handling Precautions

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

4.2 Physical Characteristics

- Weight: Approximately 0.23 kg (0.50 lbs.)
    - Does not include SATA disk drive
- Dimensions: 151.972 mm L x 129.978 mm W x 16.993 mm H (5.983 in L x 5.117 in W x 0.669 in H)

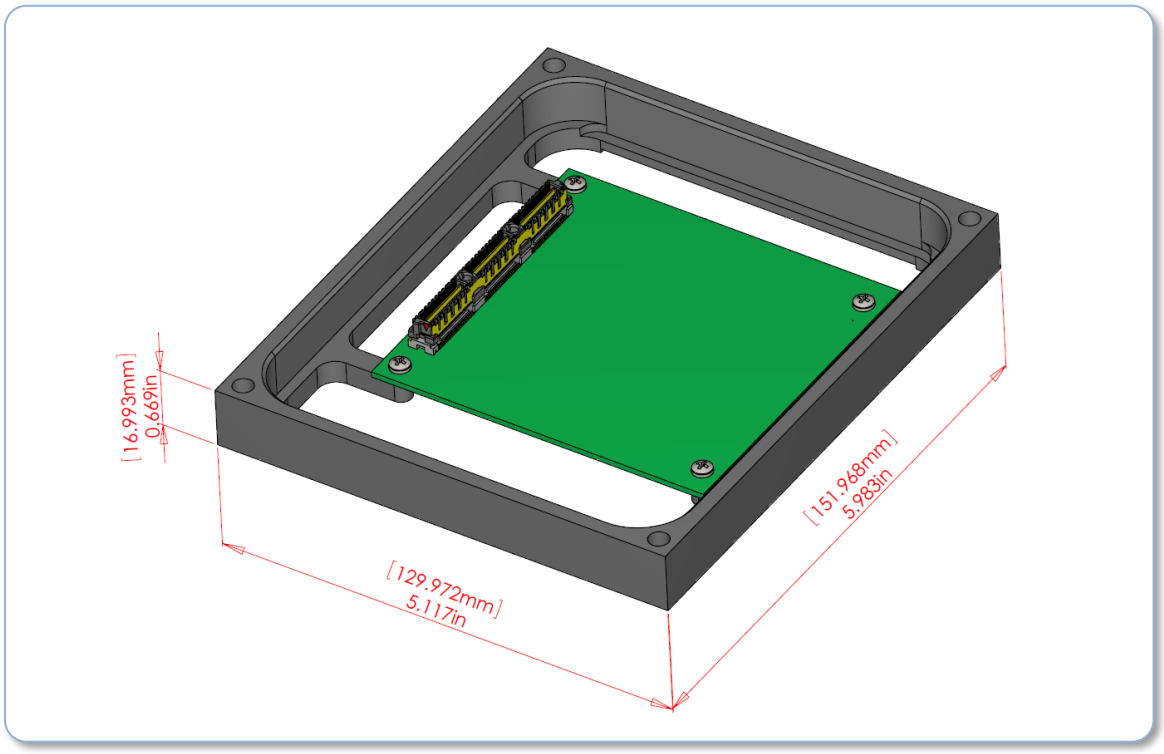

Figure 6: IDAN Dimensions

4.3 Connectors

4.3.1 External I/O Connectors

There are no external I/O connectors on the IDAN-BRG24106xHR

4.3.2 Bus Connectors

CN1(Top) & CN2(Bottom): PCIe Connector

The PCIe connector is the connection to the system CPU. The position and pin assignments are compliant with the *PCI/104-Express Specification*. (See PC/104 Specifications on page 23)

The BRG24106xHR must connect to a Type 2 PCIe/104 connector.

CN16: PCI Connector

The PCI connector is the connection to PCI peripheral modules. The position and pin assignments are compliant with the *PCI/104-Express Specification*. (See PC/104 Specifications on page 23)

4.4 Steps for Installing

1. Always work at an ESD protected workstation, and wear a grounded wrist-strap.
2. Turn off power to the IDAN system.
3. Remove the module from its anti-static bag.
4. Check that pins of the bus connector are properly positioned.
5. Check the stacking order; make sure all of the busses used by the peripheral cards are connected to the cpuModule.
6. Hold the module by its edges and orient it so the bus connector pins line up with the matching connector on the stack.
7. Gently and evenly press the module onto the IDAN system.
8. If any boards are to be stacked above this module, install them.
9. Finish assembling the IDAN stack by installing screws of an appropriate length.
10. Attach any necessary cables to the IDAN system.
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.

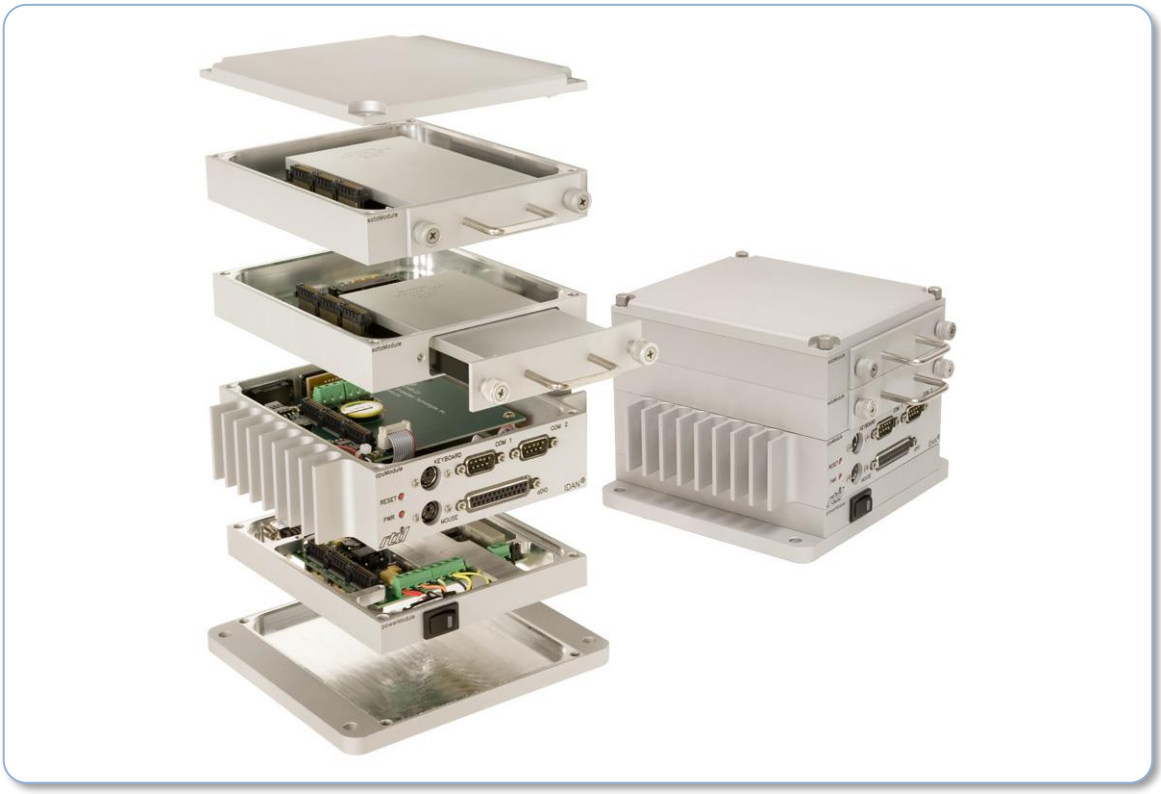

Figure 7: Example IDAN System

5 Functional Description

5.1 Block Diagram

The figure below shows the functional block diagram of the BRG24106xHR. The various parts of the block diagram are discussed in the following sections.

5.1.1 PCIe to PCI Bridge

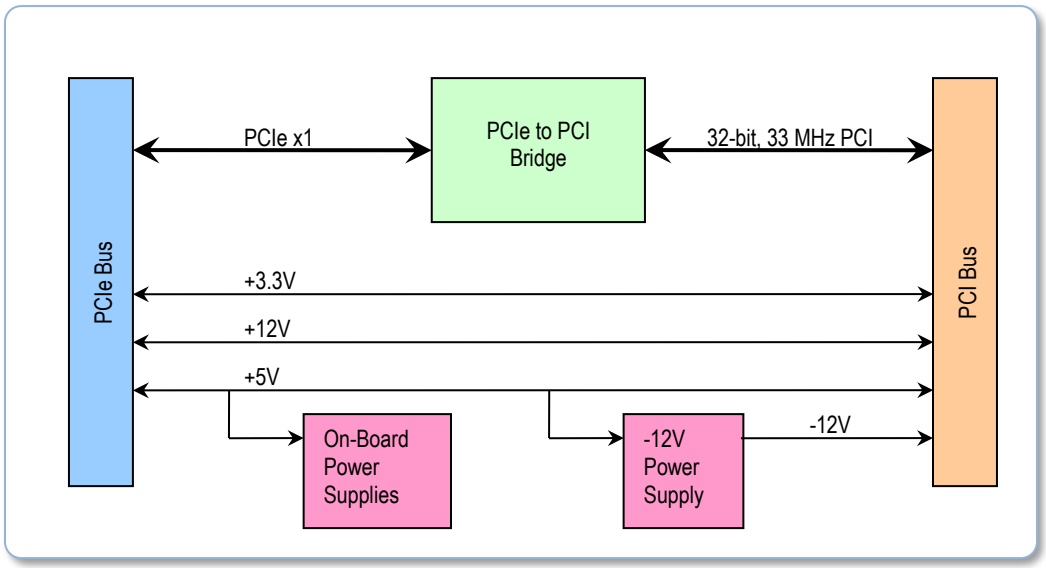

Figure 8: Functional Diagram for PCIe to PCI Bridge

5.1.2 SATA DRIVE CONNECTOR

The figure below shows a functional diagram which demonstrates how the upstream SATA link of the 2.5" SATA Drive Connector (CN3) maps to the host cpuModule of the system. It also shows how the unused SATA link on the upstream bus connector is lane-shifted, making the link available to the next SATA device in the system.

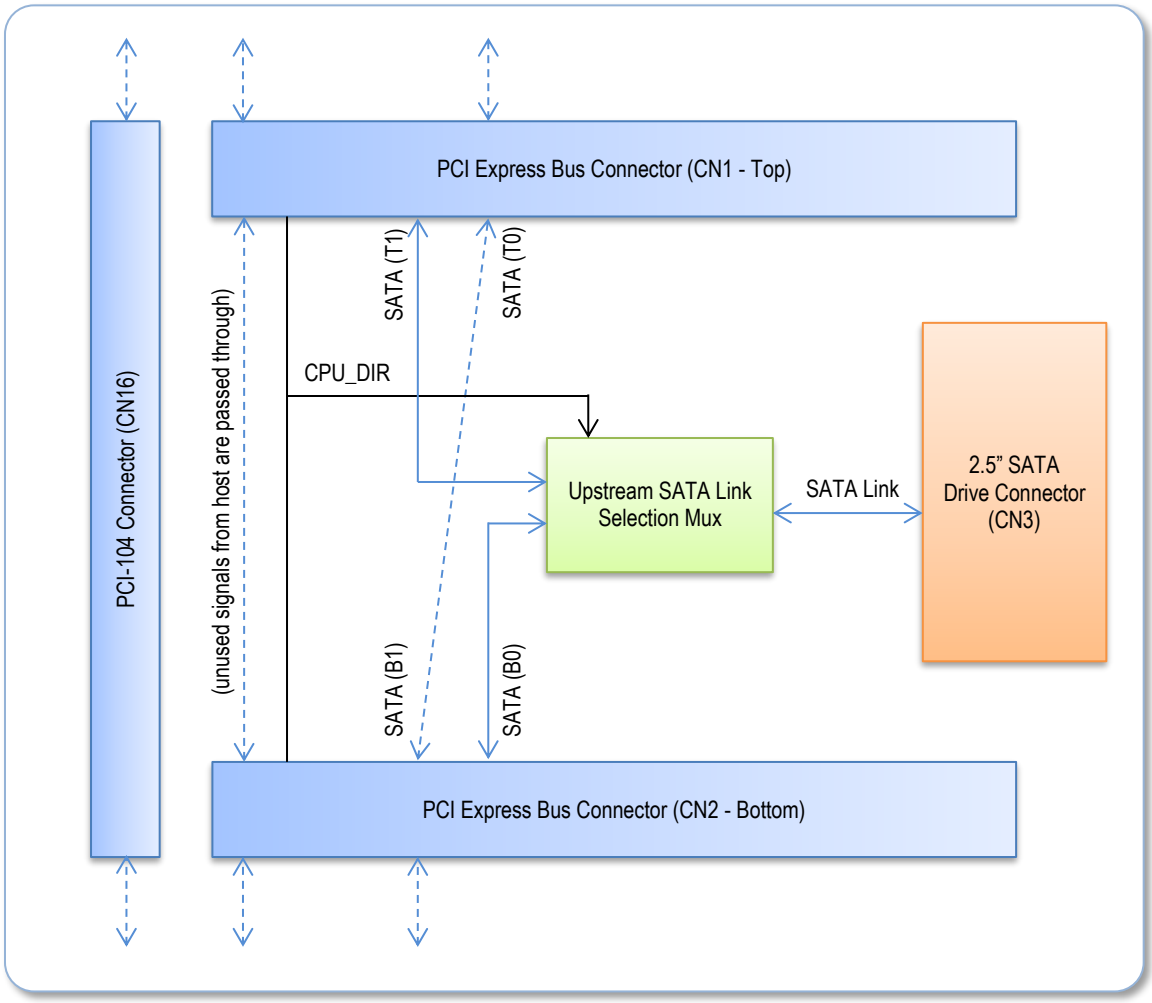

Figure 9: Functional Diagram for SATA 2.5" Drive Connector

The CPU_DIR signal from the host CPU on the PCI Express bus connectors indicates whether the BRG24106xHR is stacked above or below the CPU, and automatically determines if the upstream SATA link for the 2.5" SATA drive connector should connect to the top PCIe connector (CN1) or the bottom PCIe connector (CN2).

Dashed lines in the functional diagram indicate signals which are passed through from the host to the next card in the stack. If the host CPU offers two SATA connections on the PCIe bus connector, the next order SATA link is lane-shifted on the BRG24106xHR, making it available to the next SATA drive carrier in the stack.

Table 8: SATA Link, Upstream vs. Shifted

BRG24016xHR Position	2.5" SATA Drive Connector Upstream Link	Unused SATA Link Lane-Shifted
Above CPU	SATA (B0)	SATA (B1)
Below CPU	SATA (T1)	SATA (T0)

For more information on the CPU_DIR signal and lane shifting, refer to the *PCI/104-Express Specification*. (See PC/104 Specifications, page 23.)

5.2 PCIe to PCI Bridge

The PCI Express to PCI Bridge allows legacy PCI devices to be used with newer PCI Express chipsets. It utilizes a single PCIe x1 link to communicate with the host, and a 33 MHz, 32-bit PCI bus to attach to peripheral cards. It appears in the system as a standard PCI to PCI Bridge, and therefore requires no software changes to operate.

5.2.1 PCI Bus Masters

The BRG24106xHR supports four bus masters on the PCI bus segment. The bus masters can access targets on the PCI bus, as well as targets on PCIe side of the bridge. Note that most chipsets only support system memory as the target for accesses – peer-to-peer transactions between PCIe devices is not supported. Peer-to-peer transactions between two PCI devices that are on the same bus segment are always supported. Contact your CPU vendor or RTD technical support for more information.

5.2.2 Wake from PCI Devices

A device on the PCI bus of the BRG24106xHR is not capable of waking the system from standby.

5.2.3 Compatibility with PCI-to-ISA Bridges (BRG17088)

The BRG24106xHR does not support a PCI to ISA Bridge (i.e. BRG17088) on its PCI bus. A PCI-to-ISA bridge must be attached to the primary PCI bus of the CPU. Contact RTD technical support for more information.

5.3 SATA Link Shifting

The BRG24106xHR's 2.5" SATA Drive Connector (CN3) utilizes the first SATA link on the PCIe/104 Type 2 bus

As a result, when the BRG24106AHR is the first SATA device stacked above a CPU, the unused SATA link on the bus is shifted from the bottom-side PCIe/104 Type 2 connector (CN2) to the top-side (CN1). Shifting the remaining link allows additional SATA drive carriers such as RTD's SATA24106HR to be installed upwards in the stack.

Similarly, when the BRG24106BHR is the first SATA device stacked below a CPU, the unused SATA link on the bus is shifted from the top-side PCIe/104 Type 2 connector (CN1) to the bottom-side (CN1), permitting a second SATA drive carrier to be installed downwards in the stack. This bidirectional stacking is possible due to an onboard switch, which uses the CPU's CPU_DIR pin to determine whether the BRG24106xHR is stacked above or below the host cpuModule.

5.4 Power

The SATA drive connector (CN3) on the BRG24106xHR requires +5 V, +3.3 V, and +12 V for operation, all of which are supplied by the PCIe/104 Type 2 connectors (CN1 and CN2). The +5 V power rail is used to generate all other onboard voltage requirements. All other bus connector supply voltages are pass-through and are unused by the BRG24106xHR.

The main power rails (+5V, +3.3V, and +12V) are connected between the PCIe and PCI bus. The ATX control signals are also connected between the two busses. Therefore, the system power supply may be located on either the PCIe or PCI side of the BRG24106xHR. However, when the CPU is on the PCI side of the BRG24106xHR, the 2.5" SATA drive connector (CN3) will have no host connection, and will therefore not be usable. Regardless of where the power supply is located within the system, the amount of current that can be supplied across the bridge is shown in Table 4: Electrical Characteristics on page 9.

5.4.1 -12V Power Supply

Since there is a -12V pin on the PCI bus, but not on the PCIe bus, the BRG24106xHR provides a -12V supply to the PCI bus. This may be used when the system power supply is not on the BRG24106xHR's PCI bus, and a module on the PCI bus requires -12V. The -12V Supply may be enabled or disabled with JP1 as shown in Table 6 on page 14.

NOTE: When the BRG24106xHR is supplying -12V to the PCI bus (i.e. JP1 = 1-2), there must not be any other -12V power supplies on that PCI bus segment.

6 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.

7 Additional Information

7.1 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

7.2 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

7.3 Serial ATA Specification

A copy of the latest Serial ATA specification can be found on the webpage for the Serial ATA International Organization:

www.sata-io.org

8 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.

Some states do not allow the exclusion or limitation of incidental or consequential damages for consumer products, and some states do not allow limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you.

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

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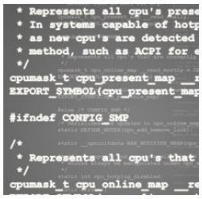

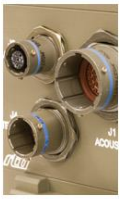
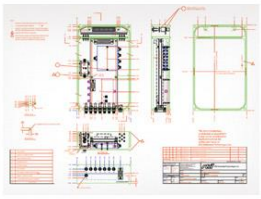

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