User's Guide

EXP4

Expansion system with four slots

for PCI Express add-in cards

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EXP4: Expansion System with Four Slots for PCI Express Add-in Cards

Overview

The EDT EXP4 is a 1U rack-mountable expansion system that provides four internal slots for PCIe Gen1 / Gen2 add-in cards, and two external host ports for PCIe Gen1 / Gen2 computers. The system can be used simply to add slots, or to run high-power interfaces not supported by typical host servers. The add-in cards can be from EDT or a third party.

The four slots connect, through two riser cards (each supporting two slots), to a switchboard which connects to the two host ports. The switchboard provides one routing switch and four slide switches, used for assigning each slot to a host.

Each of the four slots provides a 16-lane connector that can accept a lane-width of 1, 4, 8, or 16 lanes; however, the maximum number of lanes implemented is eight per slot.

Each of the four slots can be logically connected to either of the two host ports in any configuration: two on each port; three on one port and one on the other; or all four on one port.

If the add-in cards are from EDT, they can be ordered separately and configured by the customer, or ordered with the EXP4 and preconfigured at EDT before shipping.

Included Parts

As shown in Figure 1, the EXP4 expansion case comes with one power cable and one external PCIe8 EXP host adapter with cabling, which links to a host computer. A second host adapter with cabling may be purchased for a second host.

Figure 1. Expansion case (rear view) with included power cable, PCIe host adapter, and PCIe cable

Up to four add-in cards (for internal slots) can be ordered separately or with the EXP4.

One PCIe8 EXP host adapter with cabling is included.

A second host adapter with cabling may be purchased as an option.
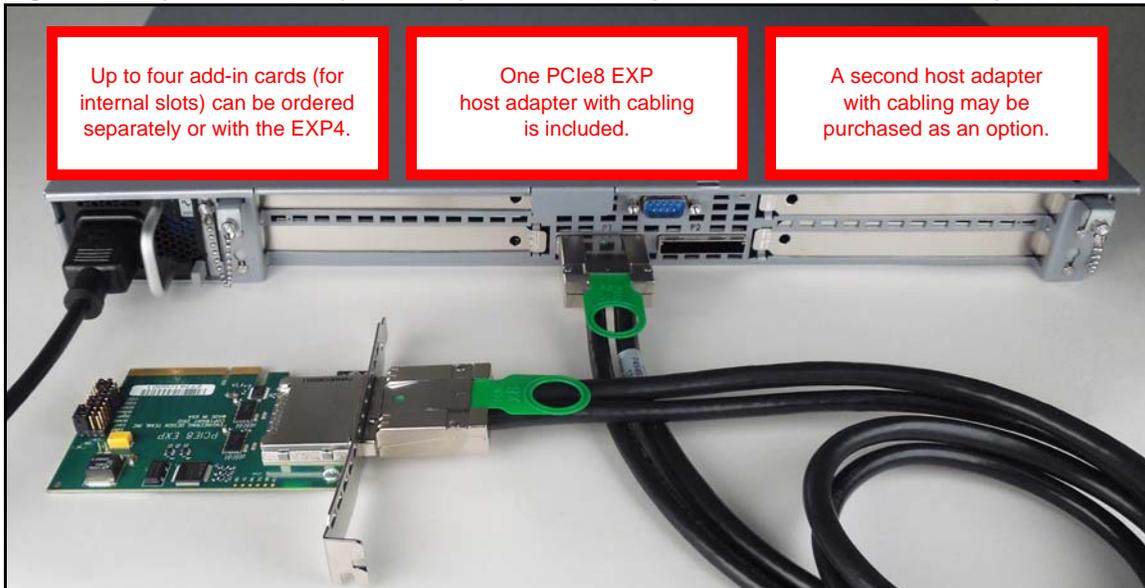
Companion Products

EDT provides multiple PCIe interfaces that can be used as add-in cards in the EXP4. See Related Resources on page 7.

Related Resources

The resources below may be helpful or necessary for your applications.

- To find complete details on any EDT product, go to www.edt.com and find the appropriate product page. That page will provide links to the product's datasheet specifications, user's guide, and other documentation.

- To find EDT information that is not related to a specific EDT product (such as installation packages, or cable pinouts that apply to multiple products), go to www.edt.com and look in Product Documentation.

| *EDT resources*	*Detail*	*Web link*
• Available mezzanine boards (I/O interfaces): optical, electrical, radio, etc.	Webpages, datasheets, user's guides and documentation	www.edt.com (search for your I/O signal)
• Available main board (DMA interface): PCIe8 L*X*/F*X*/SX	Webpages, datasheets, user's guides and documentation	www.edt.com/main_boards.html
• Installation packages: Windows, Linux, Mac OS X	Software & firmware downloads	www.edt.com/software.html
• Application programming interface (API)	HTML & PDF versions	www.edt.com/manuals.html

Other resources	*Detail*	*Web link*
• PCI Express Card Electromechanical Specification, Rev. 2.0, dated 2007 April 11	Available to PCISIG members	www.pcisig.com
• PCI Express External Cabling Specification, Rev. 1.0, dated 2007 January 04	Available to PCISIG members	www.pcisig.com

Getting Started

To set up the EXP4, first you will need to remove its cover. To do so, position your hands as in Figure 2.

1. Place your left index finger on the release button (front center on cover) and hold it down.

2. Place your right fingers under the release tab (rear center of cover).

3. Still holding down the release button with your left hand, press your right thumb against the "DIAG" port (not against the system frame) for leverage and pull the release tab toward yourself with your right hand.

Figure 2. Removing the cover (rear view)
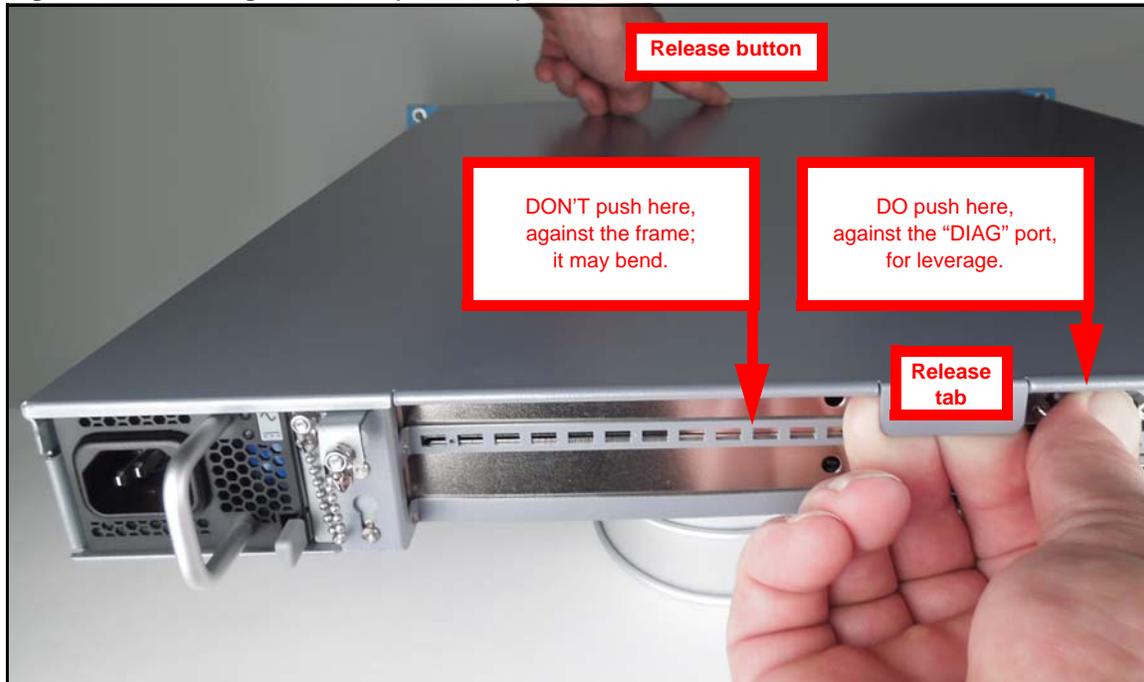
After removing the cover, you will need to configure certain internal components, as explained under Hardware.

Hardware

In the center of the EXP4 is a switchboard with an IDT router switch. The switchboard is connected to two internal riser cards (one on each side), each supporting two PCIe Gen1 / Gen2 slots; and two external PCIe Gen1 / Gen2 host ports.

As stated in the Overview section:

• Each of the four slots can be logically connected to either of the two host ports in any configuration: two on each port; three on one port and one on the other; or all four on one port.

• Each slot provides one 16-lane connector that accepts a lane-width of 1, 4, 8, or 16 lanes; however, the maximum number of lanes implemented is eight per slot.

The four slots are labeled as slot 3, slot 2, slot 1, slot 0, while the two host ports are labeled as P1 (for host computer 0) and P2 (for host computer 1).

On the switchboard are four slide switches, labeled like the slots, which are used to assign a host to each slot – e.g., if the "Slot 0" switch is set to 0, then slot 0 is logically connected to host 0. Routing is performed according to the position of the slide switches at power-on.

Seven fuses and five fan units (each with two fans) perform the respective functions of circuit protection and cooling. For details, see Fuses and Fans on page 12.

The front panel has one LED indicator that shows green for normal operation, yellow for standby power, or red for faults. The rear panel provides the two host ports (P1 and P2), one diagnostic port (DIAG), and one power port with a removable 600-watt power supply, upgradable to 850 or 1100 watts.

Figure 3 and Figure 4 show the locations of the various features on the EXP4.

Figure 3. Key features (top view without cover)

LED status indicator

Front panel

Five fan units (two fans each)

Seven fuses:

• Fuses 0, 1, 2 respectively correlate to the cables for "right" riser card, switchboard, and "left" riser card.

• Fuses 3, 4, 5, 6 respectivey correlate to the cables for the PCIe cards (cables can be connected to the cards in any configuration).

Switchboard features:

a) JTAG pins

b) Left riser card (slots 1, 0)

c) Right riser card (slots 3, 2)

d) Four slide switches accessed via the round cutout), one per slot

Power supply (removable)

Rear panel

Ports: power, P1, DIAG, P2

"right" fans:
0   1
5   6

"center" fans:
4
9

"left" fans:
3   2
8   7

fuse 3   fuse 4   fuse 0   fuse 1   fuse 2   fuse 5   fuse 6

"right" riser card   slot 3   slot 2
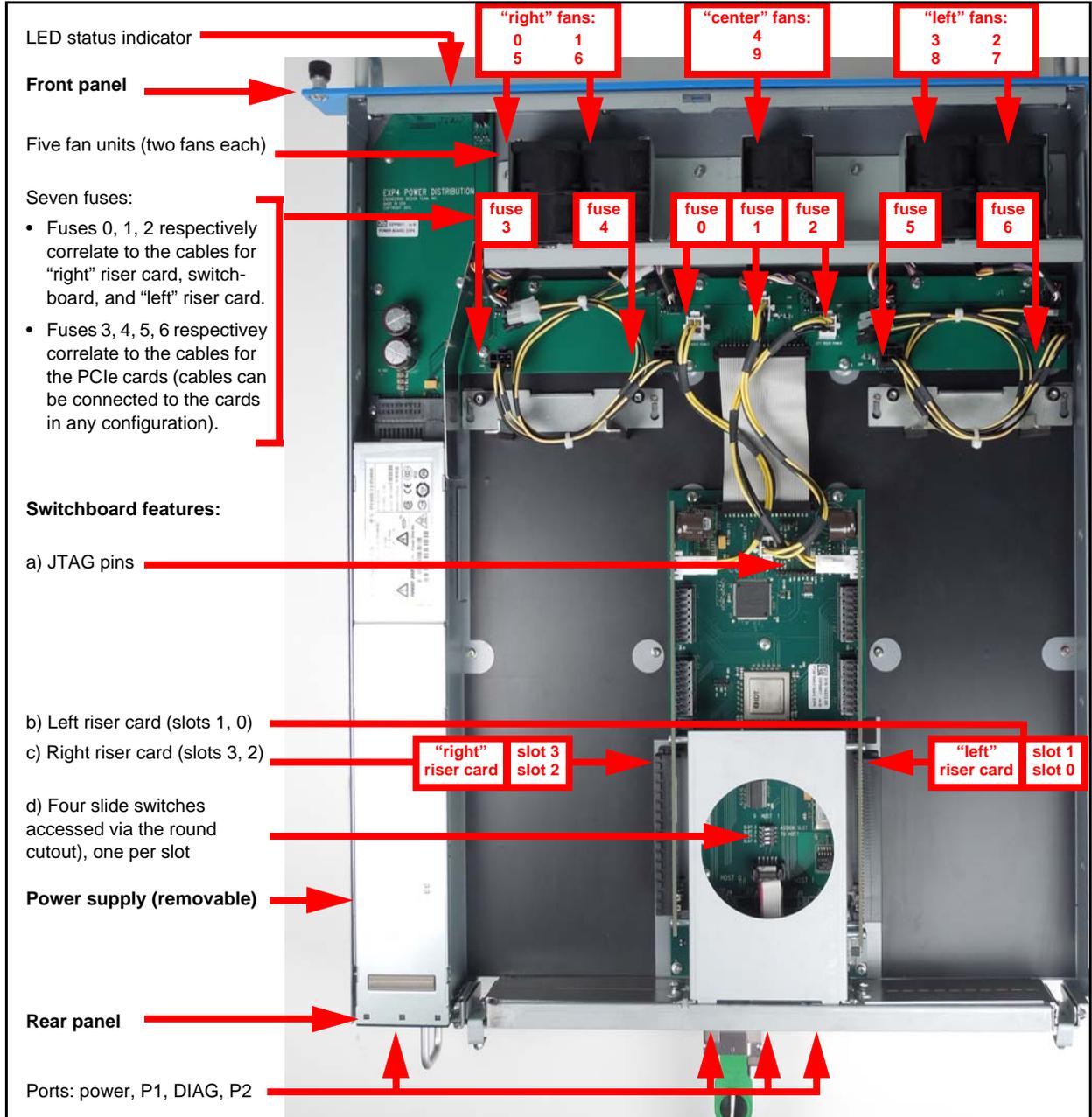
"left" riser card   slot 1   slot 0

Figure 4. Front panel LED and rear panel ports

Configuring the Slots

On the switchboard, the four slide switches (accessed through the round cutout) tell the system, at power-on, which host computer is logically connected to each slot. The slots and slide switches are shown in Figure 3 above.

NOTE   Some computers (such as the Dell R610) will not load the operating system successfully if connected to a host port with no slots assigned to it.

By default, the EXP4 is shipped with all four slots assigned to host 0 (port P1), and no slots assigned to host 1 (port P2).

To change these default host assignments...

1. Turn off all host computers.

2. If you have only one host computer (host 0), connect it to port P1 with the included PCIe host adapter and cable. If you have a second host (host 1), connect it to port P2 with a second (optional) host adapter and cable, which can be purchased as an option from EDT.

3. If your PCIe add-in cards were ordered separately and are not yet inserted, insert each one into the desired slot.

4. Decide which host to assign to slot 0 and set the "Slot 0" slide switch accordingly (left for host 0, or right for host 1, as shown in Figure 5); do the same for all four slots. Each slot can be assigned to either host.

NOTE   The system recognizes the slide switch positions only during power-on, so the required sequence is: turn off the power, set the slide switches, turn on the power again.

5. Connect the EXP4 to a power source with the EDT-provided power cable.

6. Turn on all host computers.

Figure 5. Slide switches for assigning hosts to slots

These slide switches (on the switchboard) are accessed through the round cutout area to assign slots to hosts. For example, if the "Slot 0" switch is set to the left ("0"), then slot 0 is assigned to host 0. The settings are recognized only at power-on, so the required sequence is: power off, set slide switches, power on.

"Host 0" and "Host 1" (for host computers 0 and 1) correlate respectively to rear panel ports P1 and P2.

Adjusting the Signal Characteristics

The PCIe host adapter has two repeaters, each supporting four lanes for transmitting and receiving PCIe signals, which correlate to two repeaters on the switchboard. The repeaters' transmit and receive characteristics can be adjusted to match the signal characteristics of the cable to the EXP4 and the signal traces on the host computer.

The signal characteristics (equalization and deemphasis) are adjusted via jumpers on the adapter. Each jumper has three possible settings: 2.5 volt; ground; or not connected.

Figure 6 shows the adapter and a closeup of the jumpers, set for typical use with the EDT-supplied PCIe 1m cable.

NOTE   EXP4 settings are optimized for a cable of 1m or less. For longer cables, contact EDT to discuss custom firmware.

Figure 6. PCIe host adapter – full view and closeup view
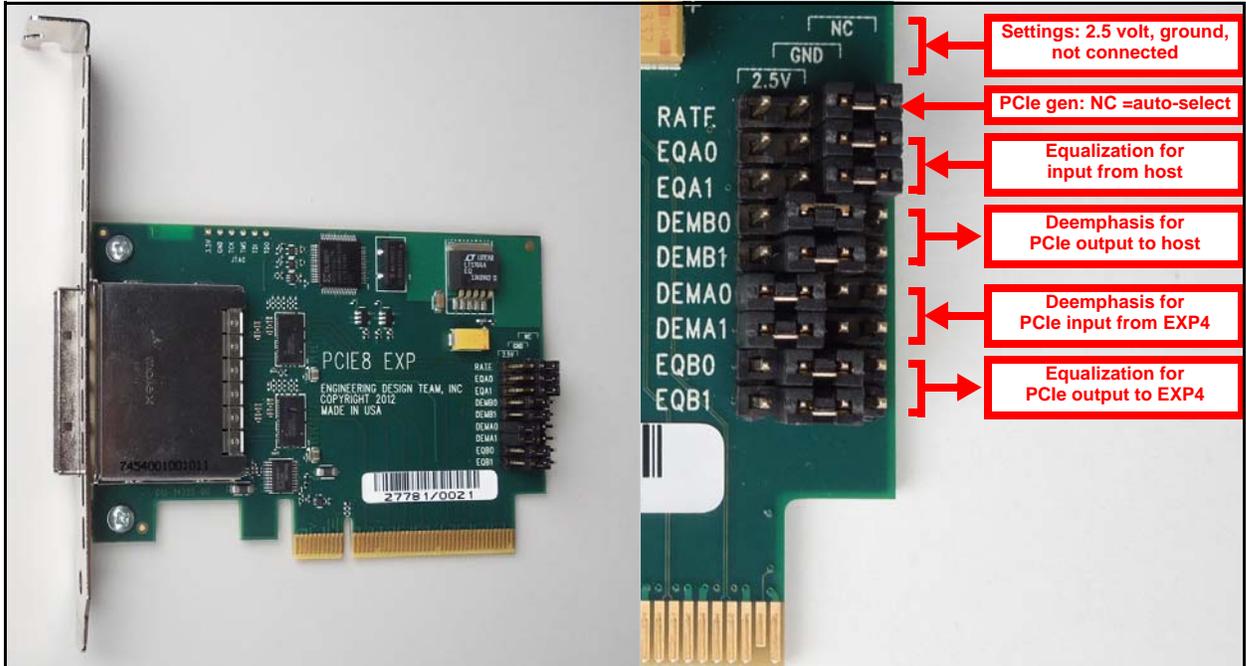

Table 1, Table 2, and Table 3 (below) explain the jumper setttings.

Table 1. Rate select jumpers for host

Notes: GND = ground; NC = not connected.

If jumpering is set to...	...then the system will...
2.5V	Assume PCIe Gen2.
GND	Assume PCIe Gen1.
NC	Automatically detect and select the PCIe generation of the host computer (this is the factory default

Table 2. Equalization select jumpers for host (EQA) and EXP4 (EQB)

Notes: GND = ground; NC = not connected. If your PCIe cable exceeds 1m, contact EDT to discuss custom firmware.

EQ[A/B]1	EQ[A/B]0	Suggested use – host interface	Suggested use – EXP4 interface
NC	NC	Bypass – default setting	Bypass – default setting
2.5V	2.5V	8" FR4 (6-mil trace)	< 1m (28 AWG) PCIe cable
GND	GND	14" FR4 (6-mil trace)	1m (28 AWG) PCIe cable
NC	GND	20" FR4 (6-mil trace)	5m (26 AWG) PCIe cable
NC	2.5V	40" FR4 (6-mil trace)	9m (24 AWG) PCIe cable
GND	2.5V	50" FR4 (6-mil trace)	10m (24 AWG) PCIe cable
2.5V	GND	30" FR4 (6-mil trace)	7m (24 AWG) PCIe cable
GND	NC	–	15m (24 AWG) PCIe cable
2.5V	NC	–	> 15m (24 AWG) PCIe cable

Table 3. Deemphasis select jumpers for host (DEMB) and EXP4 (DEMA)

Notes: GND = ground; NC = not connected. If your PCIe cable exceeds 1m, contact EDT to discuss custom firmware.

DEM[A/B]1	DEM[A/B]0	Suggested use – host interface	Suggested use – EXP4 interface
GND	GND	–	–
GND	2.5V	8" FR4 (6-mil trace)	< 1m (28 AWG) PCIe cable
2.5V	GND	–	–
2.5V	2.5V	15" FR4 (6-mil trace)	–
GND	NC	–	–
2.5V	NC	–	–
NC	GND	30" FR4 (6-mil trace)	–
NC	2.5V	40" FR4 (6-mil trace)	–
NC	NC	–	–

Fuses and Fans

The EXP4 has seven internal fuses (each 15-amp), and five fan units with two fans per unit. For the location and identification number of each fuse and each fan, see Figure 3.

A red LED status indicator signifies an open internal fuse, caused by an overcurrent condition.

NOTE   The EXP4 fuses are installed by EDT; they must be replaced by EDT or a skilled technician.

For cooling, each fan is designed to cool a specific area. The fan speed is determined by power consumption, not by internal temperature. As power consumption rises or falls in a given area, the fans for that area will adjust accordingly.

For details on diagnostics related to the fuses and fans, see Diagnostics.

LED Status Indicator

On the front panel, the LED status indicator will display green (as in Figure 7) for normal operation; yellow for standby power; or red if an internal fuse is open. For details, see Fuses and Fans and Diagnostics.

Figure 7. Front panel: LED status indicator
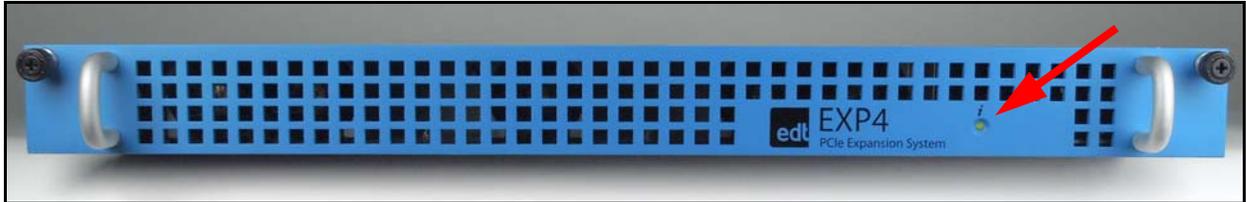
Firmware and Software

The EXP4 is shipped preloaded to operate automatically on a Linux operating system; simply plug it in to a Linux host computer, and the unit will run. However, EDT does provide additional software for specific purposes, as outlined below.

Software for Firmware Updates

If a firmware update is needed, you can perform the update through the host by using the EDT software program called EdtLoader. This program, provided with the firmware update, is installed by default in the directory `/opt/EDTexp4`.

The EdtLoader application updates the EXP4 by updating the firmware on the FPGA and the software on the microcomputer. The application communicates with the microcomputer through the PCI configuration space via the `pciutils` program, which is included and should load automatically with the firmware update.

To run EdtLoader:

1. Log in with full administrative permissions to enable access to the PCI configuration space.

2. Enter...

    ```
    cd /opt/EDTexp4
    ./EdtLoader [-c | -b | -l] [path to updated file]
    ```
    ...where the expressions `[-c | -b | -l]` will perform the following functions...
    `-c` will load updated software to the microcomputer itself.
    `-b` will load an updated FPGA configuration file.
    `-l` will update the bootloader software.

The path argument is optional. The default behavior is to look in the current directory for an update file. If you pass in a path when updating the microcomputer code, you will be prompted to verify that you are loading the correct file.

Software for Monitoring and Control (in Development)

In addition to the current software for updating the firmware, EDT is developing software to monitor the EXP4 internal system parameters (voltage, temperature, and power) and control the fan speed through the host computer.

Restoring Corrupted Firmware

In rare cases, such as if there is a power shutdown during a firmware update, the EXP4 firmware may become corrupted. In such cases, you can move the JTAG jumpers and perform a firmware update to restore the firmware.

NOTE   Firmware updates and EdtLoader, the software required to perform them, are provided as needed by EDT.

To restore corrupted firmware:

1.   Power off the host system and unplug the EXP4 unit.

2.   Find the JTAG pins on the switchboard inside the EXP4 system (Figure 3).

3.   Move the JTAG jumper from its original position on pins 3 and 4 (Figure 8) to its alternate position on pins 2 and 3.

Figure 8. JTAG jumper in original position (pins 3 and 4)
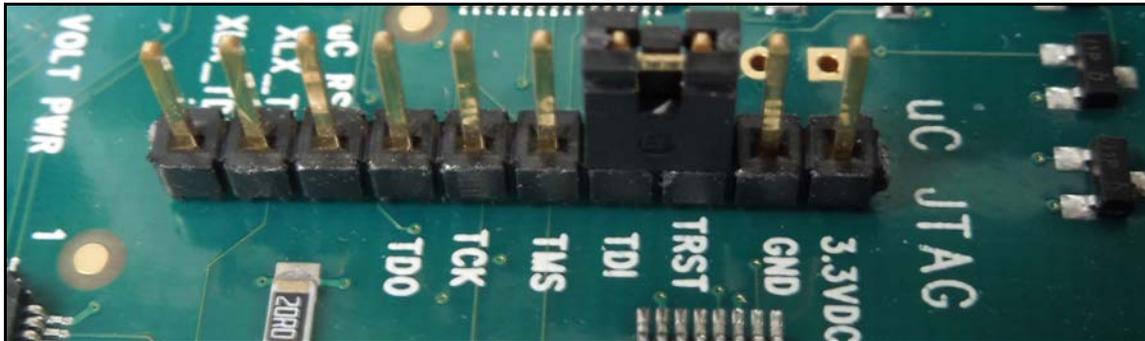
4.   Plug in the EXP4 unit and power on the system; doing so will load the backup firmware.

5.   Run EdtLoader, the software application provided by EDT with the firmware update, as instructed under Software for Firmware Updates.

6.   After the firmware update is complete, power off the host computer and unplug the EXP4 again.

7.   Move the JTAG jumper back to its original position on pins 3 and 4.

8.   Plug in the EXP4 and power on the host computer to resume normal operation.

Diagnostics

For diagnostics, the EXP4 provides a variety of commands and screens, supported through the rear-panel DIAG port.

DIAG Port and Cabling

The DIAG port links to a serial RS232 port at 115.2k baud (8 bits, no parity, 1 stop bit). The two ports must be connected by a cable with two female PC DE9-pin subminiature connectors – one at each end.

The standard pin assignments for a 9-pin serial port are used:

•   Pin 2 is used for receiving (i.e., the host computer is receiving from the expansion slots);

•   Pin 3 is used for transmitting (i.e., the host computer is transmitting to the expansion slots);

•   Pin 5 is used for ground.

•   All other pins (1, 4, 6, 7, 8, and 9) are ignored.

Screens

For a screen display of the diagnostic information, use a terminal emulation program (for example, Hyperterm for Windows, or Minicom for Linux) to enter the EDT-provided commands and see the resulting screens.

Figure 9 shows an example of the loading screen, while Figure 10 shows an example of a command screen. For a list of all commands and their results, see Commands.

Figure 9. Loading screen

```
EXP4 Controller:
Jul 13 2012, 07:22:49  ◄── This line tells the version date and time of the firmware that is loading.
High Code running      ◄── This line tells whether the firmware is loading from the high sector or the middle sector.
Decoding
Bitfile 1  ◄── This line tells which bitfile (FPGA configuration file) is loading.
Count: 49
Count: 12
Count: 11
Count: 9
Xilinx 2012/06/15, 15:55:21  ◄── This line tells the version date and time of the FPGA configuration file that is loading.
Count fb
Num data bytes 3f125
                    rd_init f0f0 rd_done 80 init_l 1000 done 2
    0  ◄── Each time the state of the power-on sequencer changes, a number like this appears at the end of the boot screen.
```

```
Connected 0:23:59     Auto detect     115200 8-N-1    SCROLL    CAPS    NUM    Capture    Print echo
```

Figure 10. Command screen (showing the "F" command for fan information)

```
input received – f
  0.000000Volts,   0.000000Watts(60sec average),  0.000000Watts
  0.134546Volts,  10.763671Watts(60sec average),  9.990234Watts
  0.106348Volts,   8.507813Watts(60sec average),  9.796875Watts
  0.000000Volts,   0.000000Watts(60sec average),  7.425781Watts
  0.000000Volts,   0.000000Watts(60sec average),  0.000000Watts
  0.000000Volts,   0.000000Watts(60sec average),  0.000000Watts
  0.100708Volts,   8.056641Watts(60sec average),  6.638672Watts
FPGA tach value 0 0000 rpm = 0
FPGA tach value 1 0000 rpm = 0
FPGA tach value 2 0eeb rpm = 7855
FPGA tach value 3 0ef5 rpm = 7834
FPGA tach value 4 1236 rpm = 6435
FPGA tach value 5 0000 rpm = 0
FPGA tach value 6 0000 rpm = 0
FPGA tach value 7 16bb rpm = 5155
FPGA tach value 8 1620 rpm = 5296
FPGA tach value 9 1a9f rpm = 4402
Fan Speed Right=0, Center=2, Left=3  ◄── These fan speeds go up or down to meet the cooling needs. Figure 4 (page 10) shows which fans are "right," "center," and "left."
Fuse 3 bad  ◄── Fault messages are displayed every minute.
–
```

```
Connected 1:00:25     Auto detect     115200 8-N-1    SCROLL    CAPS    NUM    Capture    Print echo
```

Commands

The EXP4 provides commands to perform a variety of functions. These commands and functions are shown in Table 4.

Table 4. EXP4 commands (not case-sensitive), part 1 of 2

Command	Functionality
I	Shows register contents for the IDT router switch.
	For example:

```
input received - i
0000 807a111d 00100007 06040002 00010010 00000000 00000000 000a0605 000001f1
0020 ddf0dc00 0001fff1 00000000 00000000 00000000 00000040 00000000 00070000
...
```

| N | Shows register contents for the repeaters from National Semiconductor (now Texas Instruments). |
| | For example: |

```
input received - n
00 00 00 00 00 00 00 00
07 33 14 00 00 22 00 00
0e 22 30 0f 01 00 00 00
...
```

| T | Shows temperature information. |
| | For example (`local` is the temperature of the input air, while `ext` is the temperature of the external output air): |

```
input received - t
temp: local 24 C ext 29 C timeouts 0, count to minute 18
```

| P | Shows current power-on state, followed by the last 50 power-on states before the current state. |
| | For example ("national" means the repeaters, and "PERST" means "PCI Express reset"): |

```
input received - p
power on state 8
state history current first - 8 13 8 7 12 6 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
last time to power good from power on = 18ms
last national programming time = 57ms
last time from national programmed to PERST high = 122ms
last reboot PERST low time = 5ms
```

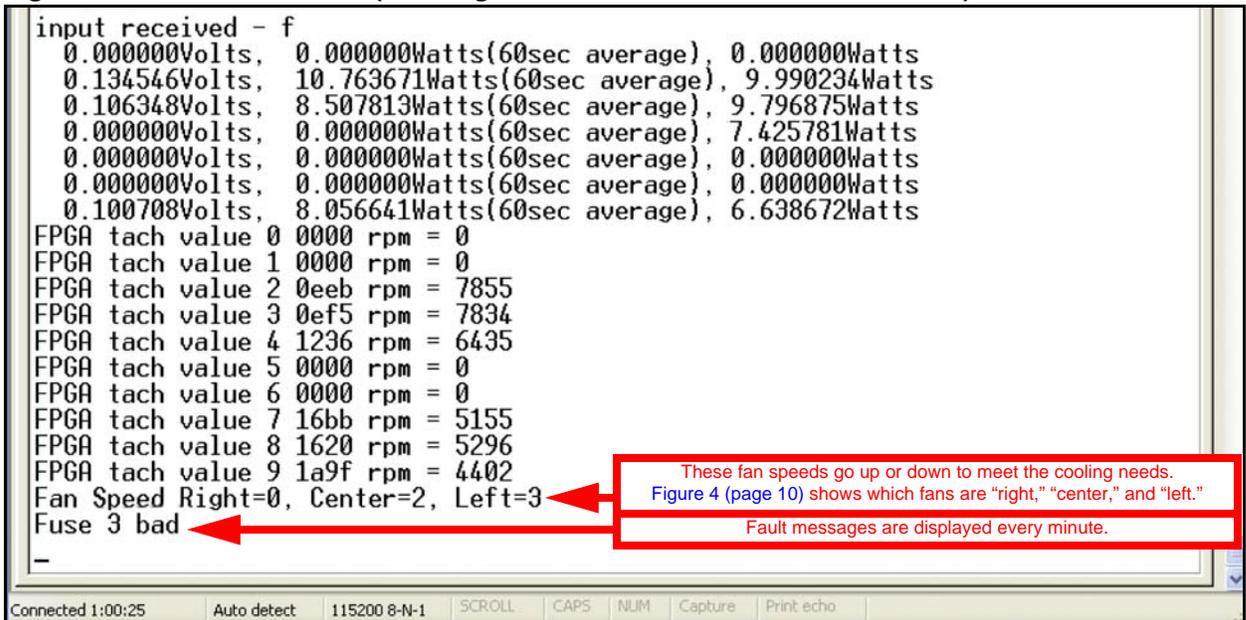| R | Reset for the IDT router switch. Do not use this command; it will corrupt the state of a running system. |

Table 4. EXP4 commands (not case-sensitive), part 2 of 2

A   Sets "early reset." Has no effect on the EXP4.

F   Fan speed for the five double fan units (to find the location and identification number of each fan, see Figure 4).

      For example:

```
input received - f

  0.000000Volts,  0.000000Watts(60sec average), 0.000000Watts

  0.135352Volts,  10.828125Watts(60sec average), 10.957031Watts

  0.105542Volts,  8.443359Watts(60sec average), 8.765625Watts

  0.000000Volts,  0.000000Watts(60sec average), 0.000000Watts

  0.000000Volts,  0.000000Watts(60sec average), 0.000000Watts

  0.000000Volts,  0.000000Watts(60sec average), 0.000000Watts

  0.100708Volts,  8.056641Watts(60sec average), 8.314453Watts

FPGA tach value 0 0ee6 rpm = 7865
FPGA tach value 1 0ef8 rpm = 7828
FPGA tach value 2 0ee6 rpm = 7865
FPGA tach value 3 0ef8 rpm = 7828
FPGA tach value 4 1201 rpm = 6509
FPGA tach value 5 1644 rpm = 5263
FPGA tach value 6 162d rpm = 5284
FPGA tach value 7 1644 rpm = 5263
FPGA tach value 8 162d rpm = 5284
FPGA tach value 9 19e4 rpm = 4526

Fan Speed Right=3, Center=2, Left=3
```

D   Version date.

      For example:

```
High Code Version is Jul 13 2012, 07:22:49
```

Revision Log

Below is a history of modifications to this guide.

Date	Rev	By	Pp	Detail
20121031	00a	PH	13	• Added a space after "cd" (Software for Firmware Updates > To run EdtLoader... > step "2")
			16	• Deleted cross-reference to Related Resources (Commands > Table 4 > command "N")
20121030	00	PH	All	• Created new guide.

Table 5. Rate select jumpers for host

Notes: GND = ground; NC = not connected.

If jumpers are set to...	...then the system will...
RATE 2.5V ● ● ● ●	Assume PCIe Gen2.
GND ● ● ● ●	Assume PCIe Gen1.
NC ● ● ● ●	Automatically detect and select the PCIe generation of the host computer (this is the factory default