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PCA

User Manual

Terasic PCIe Cable Adapter Daughter Card

terasic
www.terasic.com

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CONTENTS

Chapter 1

Introduction of the PCA Card

PCA(PCIe Cable Adapter)，which is used to connect PCIe upstream slot with downstream target board by a PCIe X4 cable , supports the PCIe X4 & X1 mode. PCA card can provide programmable equalization, amplification, and de-emphasis for PCIe transceiver signal by using 8 select bits. It is also available to optimize performance over a variety of physical mediums by reducing Inter-symbol interference.

1.1 Features

Figure 1-1 shows a photograph of the PCA Card.
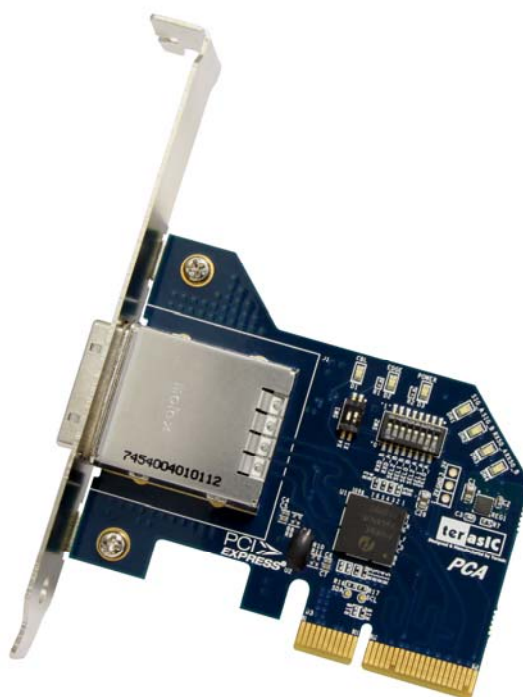

Figure 1-1   Layout of the PCA card

The key features of the card are listed below:

- Up to 5.0Gbps PCIe 2.0 Serial Re-Driver
- PCIe X4 Gen 2
- Adjustable receiver equalization
- Adjustable transmitter amplitude and de-emphasis

1.2 About the KIT

The PCA kit will come with the following contents:

- PCA card

Please visit *PCIe_Cable.terasic.com* download the PCA user manual.

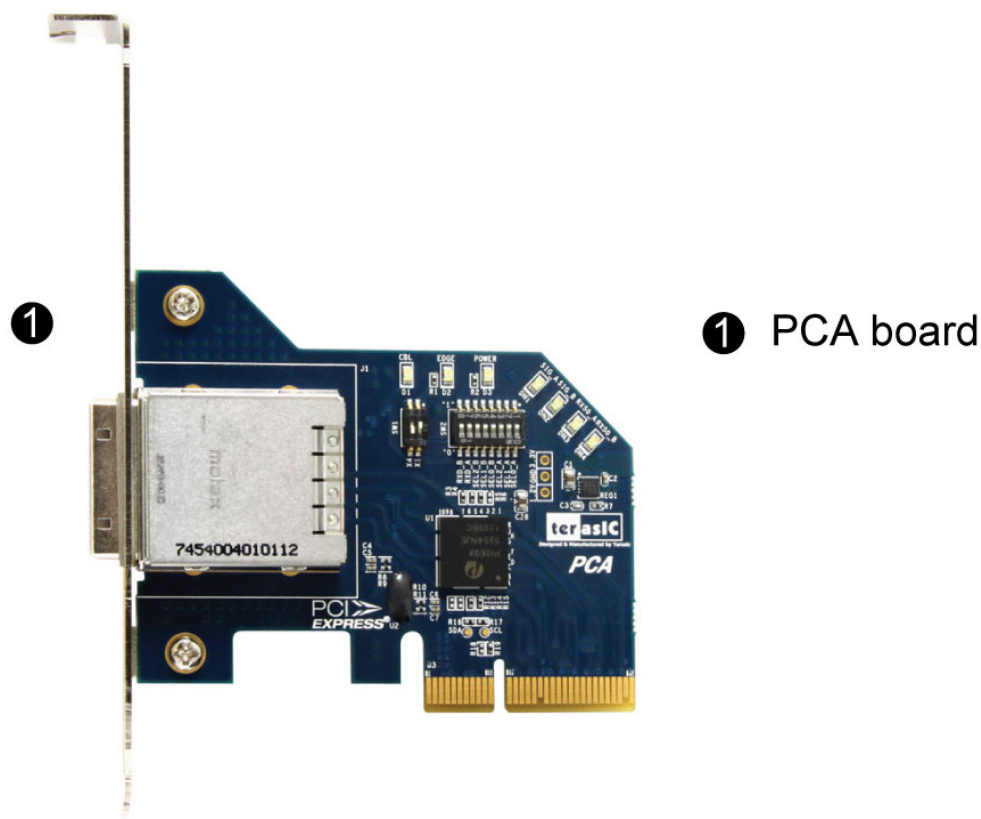Figure 1-2 shows the photograph of the PCA kit content.

Figure 1-2   PCA kit package contents

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1.3 Getting Help

Here is information of how to get help if you encounter any problem:

Terasic Technologies

- Tel: +886-3-550-8800
- Email: support@terasic.com

PCA Card Architecture

This chapter provides information about architecture and block diagram of the PCA board.

2.1 Layout and Components

The picture of the PCA card is shown in Figure 2-1 and Figure 2-2. It depicts the layout of the board and indicates the locations of the connectors and key components.
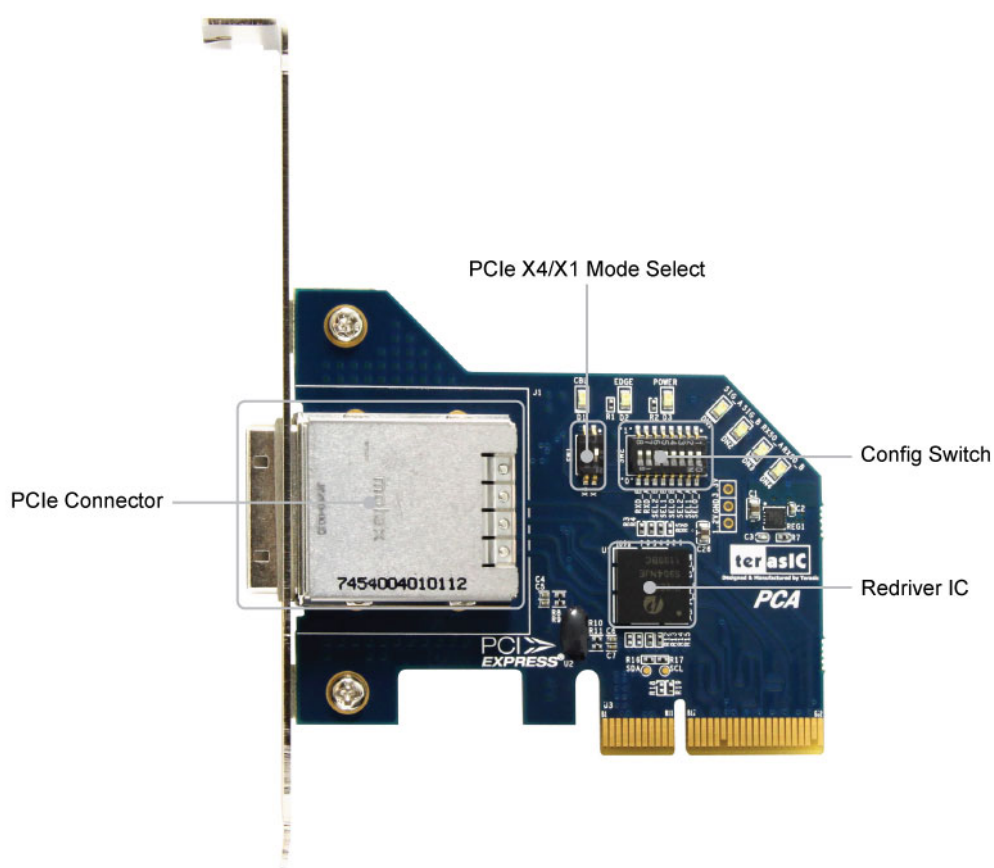

Figure 2-1 The PCA Card PCB and component diagram (top view)

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Figure 2-2 The PCA Card PCB and component diagram (bottom view)

2.2 Block Diagram of the PCA Board

Figure 2-3 shows the block diagram of the PCA card.
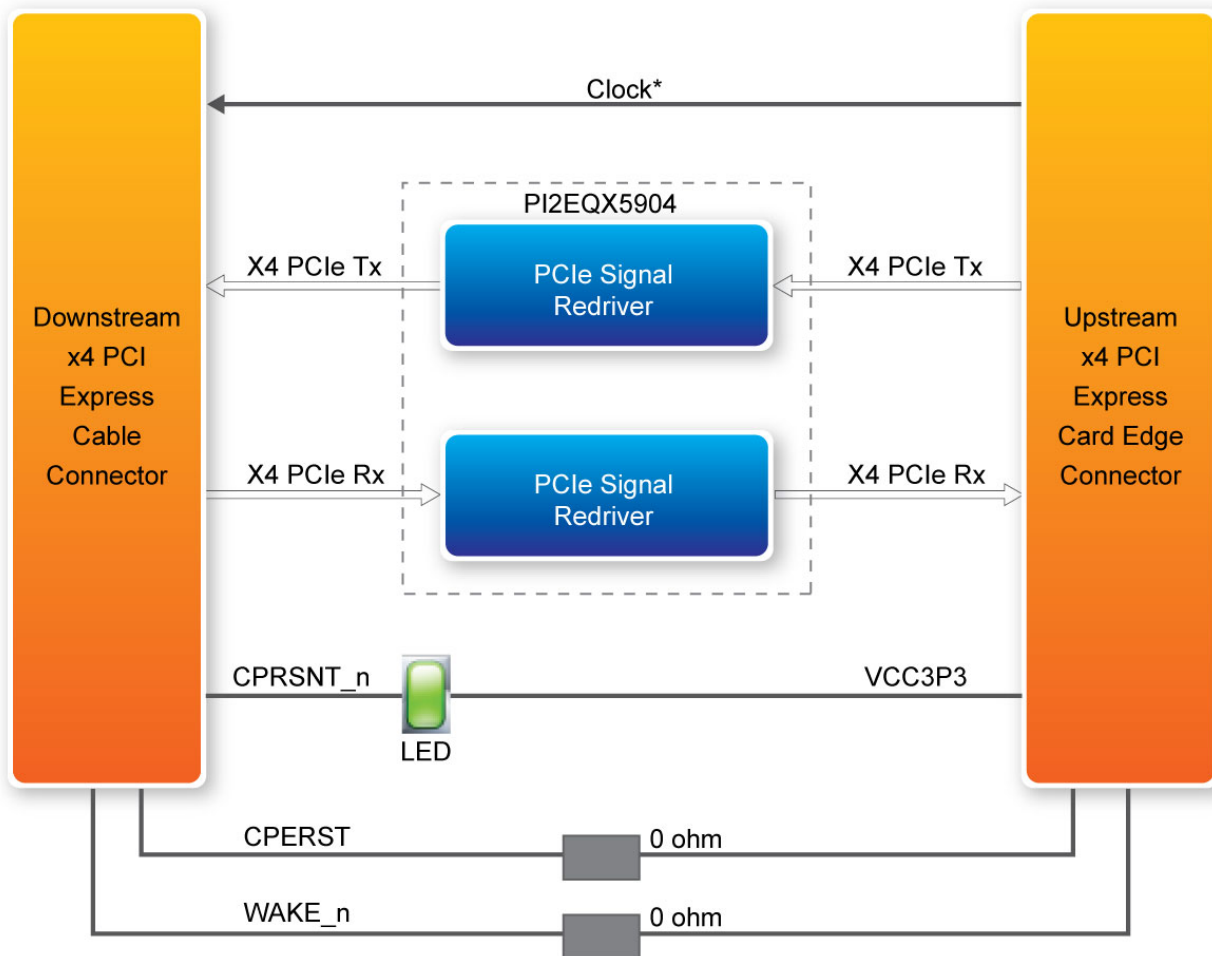
Figure 2-3 Block Diagram of PCA card

Chapter 3

Board Component

This chapter describes the specifications of the on board components.

3.1 PCIe Edge Connector

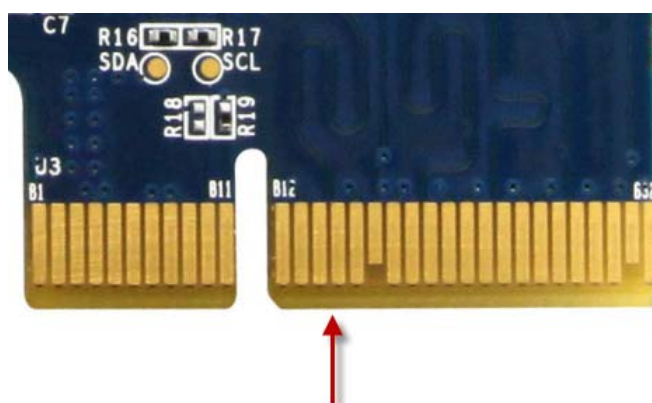This Edge connector is used to connect the PCA with PC motherboard PCIe slot, as show Figure 3-1 and Figure 3-2.
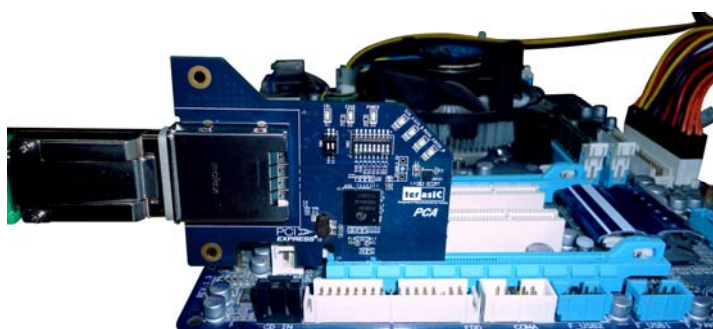

Figure 3-1 PCA Edge Connector

Figure 3-2 plug the PCA into motherboard PCIe slot

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The pins are numbered as shown with side A on the top of the centerline on the solder side of the board and side B on the bottom of the centerline on the component side of the board.

The PCIe interface pins PETpx, PETnx, PERpx, and PERnx are named with the following convention: "PE" stands for PCIe high speed, "T" for Transmitter, "R" for Receiver, "p" for positive (+), and "n" for negative (-).

Note that adjacent differential pairs are separated by two ground pins to manage the connector crosstalk.

Table 3-1 gives the wiring information of the PCIe Edge connector.

Table 3-1 Pin assignments and descriptions on PCIe Edge connector

Pin Numbers	Side B		Side A	
	Name	Description	Name	Description
1	NC	NC	PRSNT1n	Hot-Plug presence detect
2	NC	NC	NC	NC
3	NC	NC	NC	NC
4	GND	Ground	GND	Ground
5	NC	NC	NC	NC
6	NC	NC	NC	NC
7	GND	Ground	NC	NC
8	VCC3P3	3.3V Power	NC	NC
9	NC	NC	VCC3P3	3.3V Power
10	3.3VAUX	3.3 V Auxiliary Power	VCC3P3	3.3V Power
11	WAKE	NC	PERSTn	Fundamental Reset
Mechanical Key				
12	RSVD	Reserved	GND	Ground
13	GND	Ground	REFCLK+	Reference clock (differential pair)
14	PETp0	Transmitter differential pair, Lane 0	REFCLK-	
15	PETn0		GND	Ground
16	GND	Ground	PERp0	Receiver differential pair, Lane 0
17	PRSNT2n	Hot-Plug presence detect	PERn0	
18	GND	Ground	GND	Ground
19	PETp1	Transmitter differential pair, Lane 1		
20	PETn1		GND	Ground
21	GND	Ground	PERp1	Receiver differential pair,
22	GND	Ground	PERn1	

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				Lane 1
23	PETp2	Transmitter differential pair, Lane 2	GND	Ground
24	PETn2		GND	Ground
25	GND	Ground	PERp2	Receiver differential pair, Lane 2
26	GND	Ground	PERn2	
27	PETp3	Transmitter differential pair, Lane 3	GND	Ground
28	PETn3		GND	Ground
29	GND	Ground	PERp3	Receiver differential pair, Lane 3
30	RSVD	Reserved	PERn3	
31	PRSNT2n	Hot-Plug presence detect	GND	Ground
32	GND	Ground	RSVD	Reserved

3.2 PCIe Cable Connector

PCIe cable connector is used to connect the PCIe X4 Cable and PCA cable connector, Connect the PCA by using a PCIe X4 Cable, as show **Figure 3-3.**

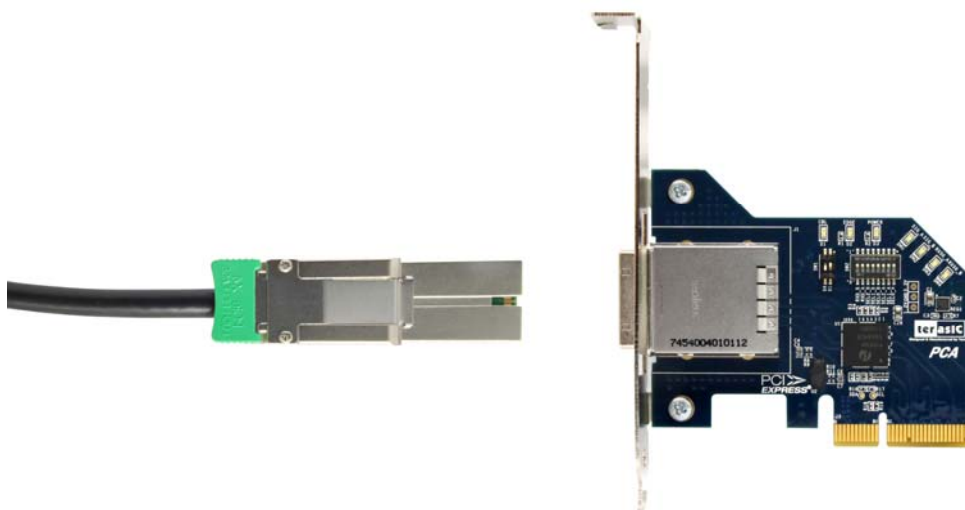

Figure 3-3 PCIe X4 Cable and PCA

To purchase the PCIe X4 Cable, please refer Terasic website *PCIe_Cable.terasic.com*.

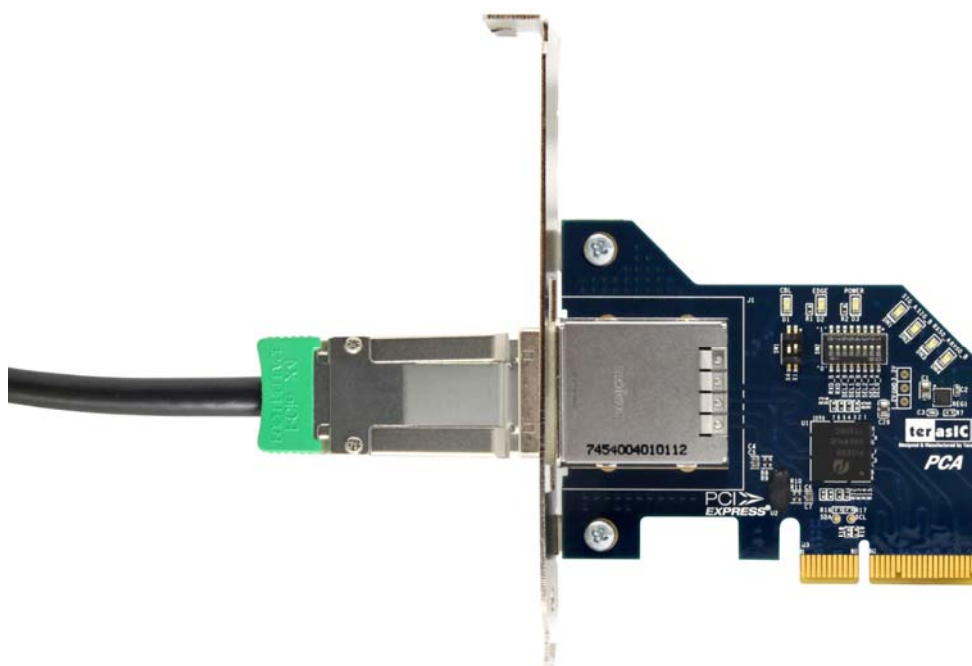**Figure 3-4** as show the PCIe Cable connects PCA connector

Figure 3-4 PCIe Cable connects PCA connector

Table **3-2** gives the wiring information of the PCIe Cable connector.

Pin Numbers	Name	Description
A1	GND	Ground reference for PCI Express transmitter Lanes
A2	PETp0	Differential PCI Express transmitter Lane 0
A3	PETn0	Differential PCI Express transmitter Lane 0
A4	GND	Ground reference for PCI Express transmitter Lanes
A5	PETp1	Differential PCI Express transmitter Lane 1
A6	PETn1	Differential PCI Express transmitter Lane 1
A7	GND	Ground reference for PCI Express transmitter Lanes
A8	PETp2	Differential PCI Express transmitter Lane 2
A9	PETn2	Differential PCI Express transmitter Lane 2
A10	GND	Ground reference for PCI Express transmitter Lanes

A11	PETp3	Differential PCI Express transmitter Lane 3
A12	PETn3	Differential PCI Express transmitter Lane 3
A13	GND	Ground reference for PCI Express transmitter Lanes
A14	CREFCLK+	Differential 100MHz cable reference clock
A15	CREFCLK-	Differential 100MHz cable reference clock
A16	GND	Ground reference for PCI Express transmitter Lanes
A17	SB_RTN	Signal return for single ended sideband signals
A18	CPRSNTn	Used for detection of whether a cable is installed and the downstream subsystem is powered
A19	CPWRON	Turns power on / off to slavetype downstream subsystems
B1	GND	Ground reference for PCI Express transmitter Lanes
B2	PERp0	Differential PCI Express receiver Lane 0
B3	PERn0	Differential PCI Express receiver Lane 0
B4	GND	Ground reference for PCI Express transmitter Lanes
B5	PERp1	Differential PCI Express receiver Lane 1
B6	PERn1	Differential PCI Express receiver Lane 1
B7	GND	Ground reference for PCI Express transmitter Lanes
B8	PERp2	Differential PCI Express receiver Lane 2
B9	PERn2	Differential PCI Express receiver Lane 2
B10	GND	Ground reference for PCI Express transmitter Lanes
B11	PERp3	Differential PCI Express receiver Lane 3
B12	PERn3	Differential PCI Express receiver Lane 3
B13	GND	Ground reference for PCI Express transmitter Lanes

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B14	PWR	+3.3VCable power
B15	PWR	+3.3VCable power
B16	PWR RTN	Cable power return
B17	PWR RTN	Cable power return
B18	CWAKEn	Power management signal for wakeup events (optional)
B19	CPERSTn	Cable PERSTn

3.3 Switches

The PCA contains x2 and x8 switches that allow configuration of the PCA PCIe mode (SW1), equalization and de-emphasis (SW2). The two switches, SW1 and SW2, are located on top of the front side of the PCA card. **Figure 3-5** show the location of the board.
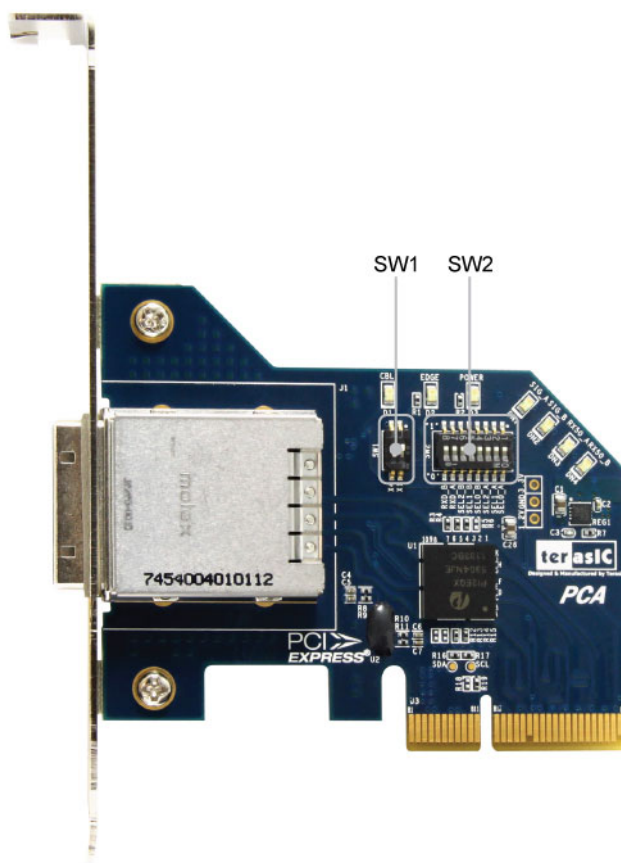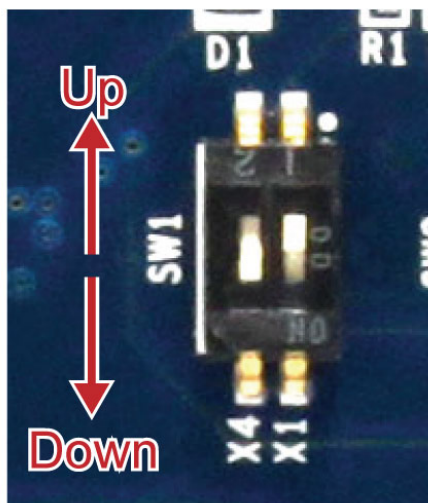

Figure 3-5 Switches

Figure 3-6 show the SW1 settings

Table 3-3 SW1 Settings

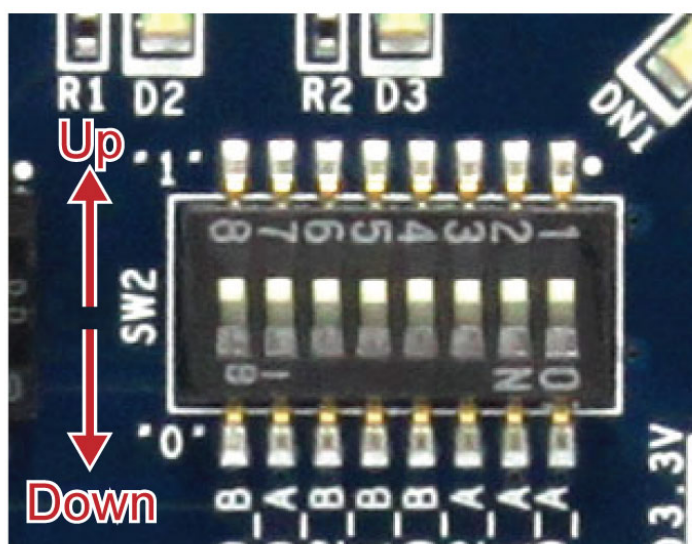| Pin 2	Pin 1	PCIe Mode(X1/X4)
UP	UP	NULL
UP	Down	X1
Down	UP	X4(Default mode)
Down	Down	NULL

Figure 3-7 Show the SW2 Settings

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The PI2EQX5904 has two channels, A and B, has separate equalization control. **Figure 3-8** show the channel A and B inside on the block diagram.
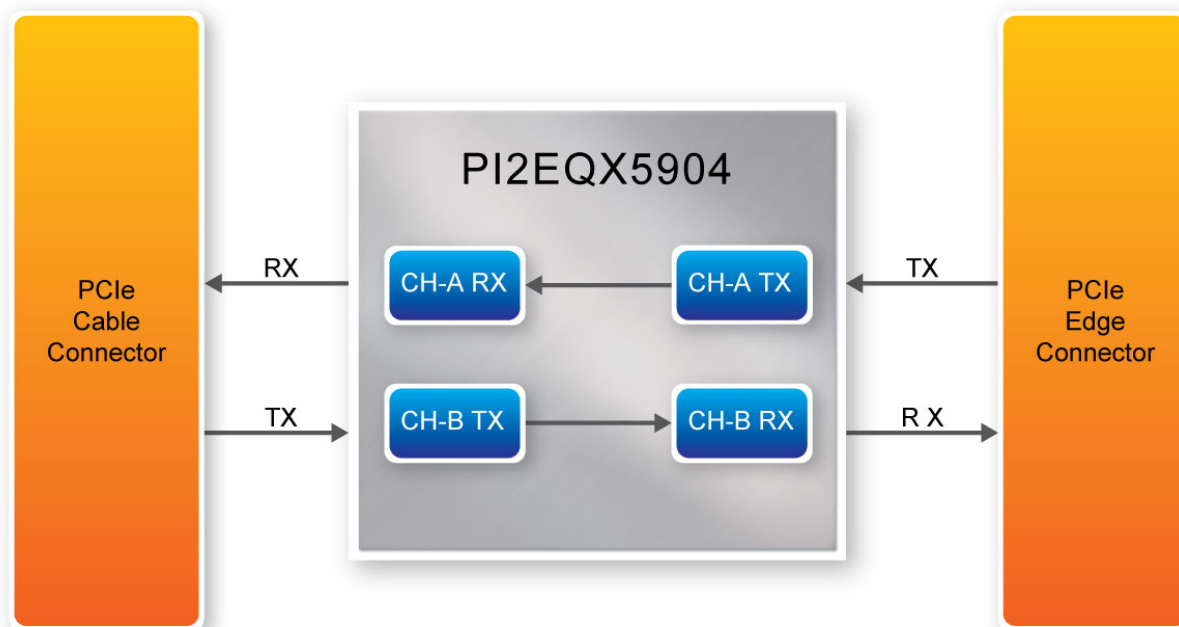

Figure 3-8 CH_A and CH_B within PI2EQX5904

Table 3-4 SW2 Settings (Input Equalizer Configuration for Channel A)

Pin 1 SEL0_A	Pin 2 SEL1_A	Pin 3 SEL2_A	@1.25GHz	@2.5GHz
0	0	0	0.5dB	1.2 dB
0	0	1	0.6dB	1.5 dB
0	1	0	1.0 dB	2.6 dB
0	1	1	1.9 dB	4.3 dB
1	0	0	2.8 dB	5.8 dB
1	0	1	3.6 dB	7.1 dB
1	1	0	5.0 dB	9.0 dB
1	1	1	7.7 dB(Default Setting)	12.3 dB(Default Setting)

Table 3-5   SW2 Settings(Input Equalizer Configuration for Channel B)

Pin 4 SEL0_B	Pin 5 SEL1_B	Pin 6 SEL2_B	@1.25GHz	@2.5GHz
0	0	0	0.5dB	1.2 dB
0	0	1	0.6dB	1.5 dB
0	1	0	1.0 dB	2.6 dB
0	1	1	1.9 dB	4.3 dB
1	0	0	2.8 dB	5.8 dB
1	0	1	3.6 dB	7.1 dB
1	1	0	5.0 dB	9.0 dB
1	1	1	7.7 dB(Default Setting)	12.3 dB(Default Setting)

Receiver Detect Enable input for CH_A(Pin 7)&B(Pin 8) with 100kohm pull up resistors. RXD_A&B High indicates that the Receiver Detect Function Enable

Table 3-6   SW2 Settings(Receiver Detect Function Enable for CH_A & CH_B)

Pin 7 RXD_A	Pin 8 RXD_B	Receiver Detect Function Enable
1	1	CH_A & CH_B Receiver Detect Enable(Default Setting)
1	0	CH_A Receiver Detect Enable CH_B Receiver Detect Disable
0	1	CH_A Receiver Detect Disable CH_B Receiver Detect Enable
0	0	CH_A & CH_B Receiver Detect Disable

Please refer the datasheet of PI2EQX5904 to more settings.

3.4 LEDs

The PCA includes status LEDs, Please refer **Table 3-7** for the status of the LED indicator.

Board Reference	LED name	Description
D1	CBL	Cable PRSNT1n
D2	EDGE	Edge PRSNT1n

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D3	POWER	Power LED
DN1	SIG_A	Signal detect output for CH_A
DN2	SIG_B	Signal detect output for CH_B
DN3	RX50_A	Receiver Detect Output for CH_A0
DN4	RX50_B	Receiver Detect Output for CH_B0

Set up on PCA

This chapter illustrates the set up for the PCA card (base on the TR4 Board). To purchase the TR4 board, please visit www.tr4.terasic.com.

4.1 Introduction

The application reference design shows how to implement fundamental control and data transfer by using **PCIE0** port on the TR4. In the design, basic I/O is used to read or write the buttons and LEDs on the TR4. High-speed data transfer is performed by DMA. Both Memory-Mapped and FIFO memory types are demonstrated in the reference design. The demonstration also makes use of the associated PCIe cable adapter card (PCA).

4.2 System Requirements

The following items are required for the PCA demonstration

- TR4 board   x1
- PCA card   x1
- PCIe X4 Cable   x1
- PC   x2

■ **Demonstration Files Location**

The demo file is located in the folder (on the TR4 CD): *TR4_PCIe0_Fundamental\demo_batch*

The folder includes following files:

- PC Application Software: PCIe_Fundamental_Demo.exe
- FPGA Configuration File: *tr4_pcie0_fundamental.sof*
- PCIe Library : TERASIC_PCIE.DLL
- Demo Batch File : *tr4_pcie0_fundamental*.bat

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■ PCA Setup

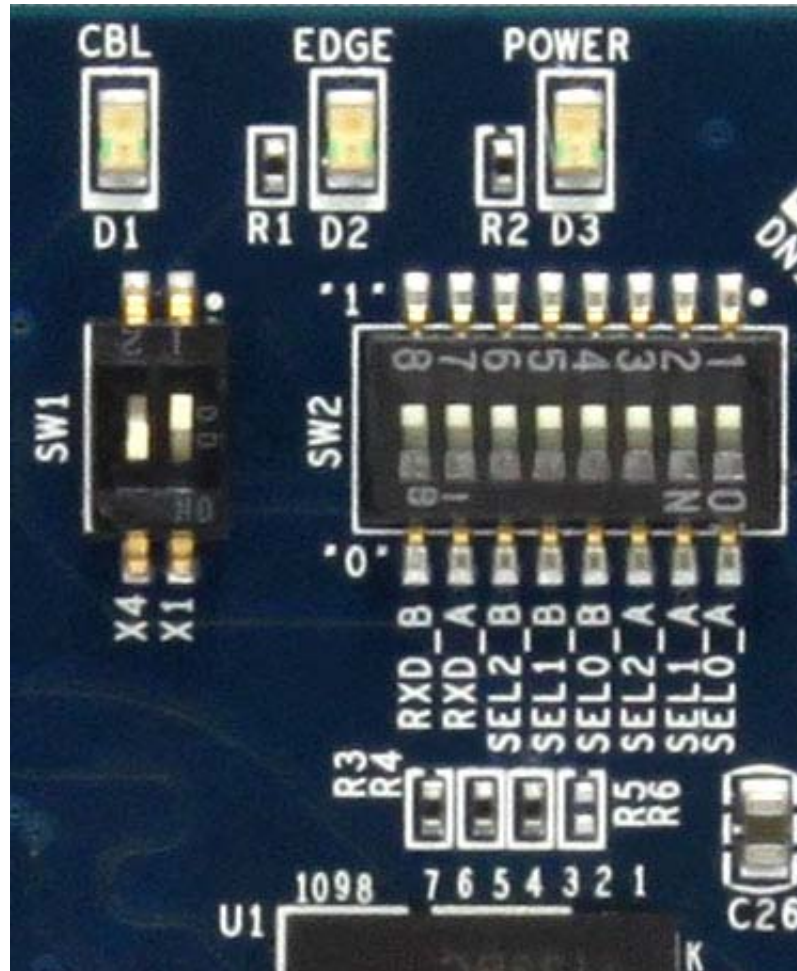- SW1 :set to X4 mode, SW2: all pin set to "1". as shown in **Figure 4-1**

Figure 4-1 PCA switches setting

■ Demonstration Setup

- Make sure TR4 and PC are both powered off.
- Plug the PCA card into PCIe slot on the PC motherboard.
- Use the PCIe cable to connect to the TR4 PCIE0 connector and PCIe adapter card as shown in **Figure 4-2**
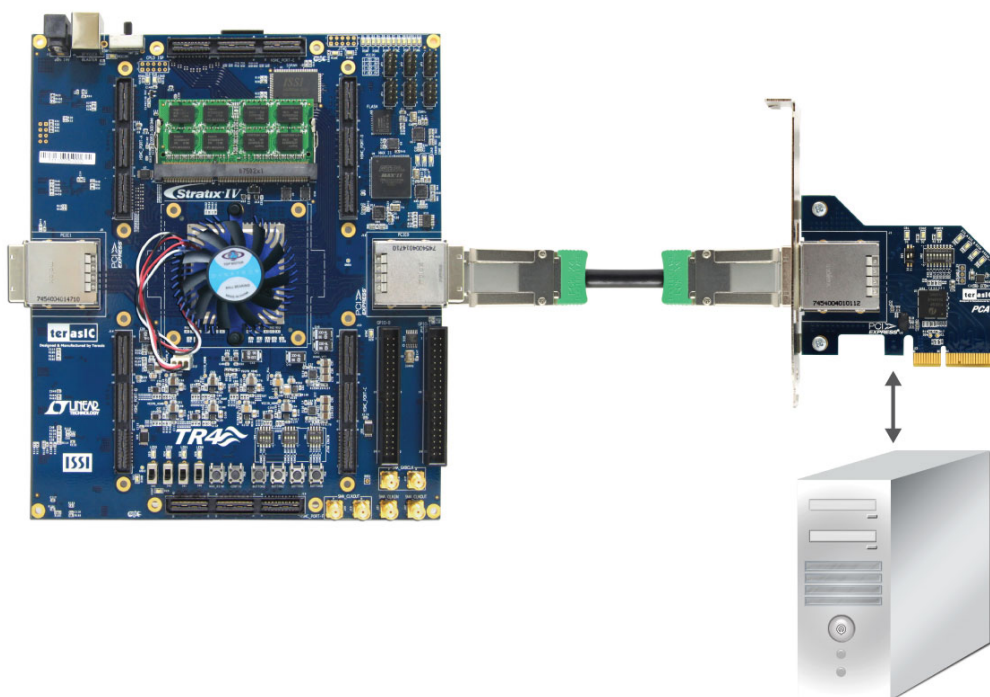
Figure 4-2 PCIe Fundamental Communication Demonstration Setup

- Power on your PC.
- Download the tr4_pcie0_fundamental.sof into the TR4 using the Quartus II Programmer. And all seven LEDs on PCA card will be lighted on if work rightly while the PC automatic start
- Install PCIe driver if necessary. The driver is located in the folder PCIe_SDK\Driver.
- Launch the demo program PCIe_Fundamental_Demo.exe shown in **Figure 4-3**.
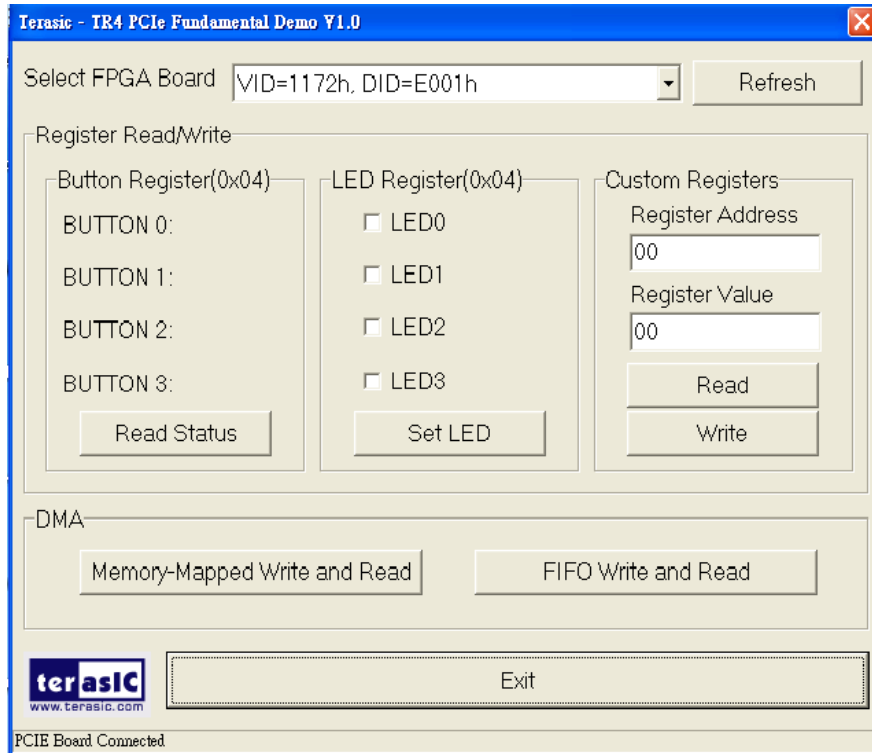
Figure 4-3 PCIe Fundamental Demo GUI

- Make sure 'Select FPGA Board' appears as "VID=1172, DID=E001".
- Press **BUTTON0~BUTTON3** on the TR4 and click 'Read Status' in the application software.
- Check/Uncheck the LED0-3 in this application software and click 'Set LED'. The LEDs on the TR4 should light and unlight accordingly.
- Click 'Memory-Mapped Write and Read' to test the memory –mapped DMA. A report dialog will appear when the DMA process is completed.
- Click 'FIFO Write and Read' to test the FIFO DMA. A report dialog box will appear when the DMA process is completed.
- The 'Custom Registers Group' is used to test custom design registers on the FPGA side. Users can use this function to verify custom register design.

■ Demonstration Setup

- Quartus II 11.1

■ **Demonstration Source Code Location**

- Quartus Project: TR4_PCIe0_Fundamental
- Borland C++ Project: TR4_PCIe0_Fundamental \pc

■ **FPGA Application Design**

The PCI Express demonstration uses the basic I/O interface and DMA channel on the Terasic PCIe IP to control I/O (Button/LED) and access two internal memories (RAM/FIFO) through the MUX block.
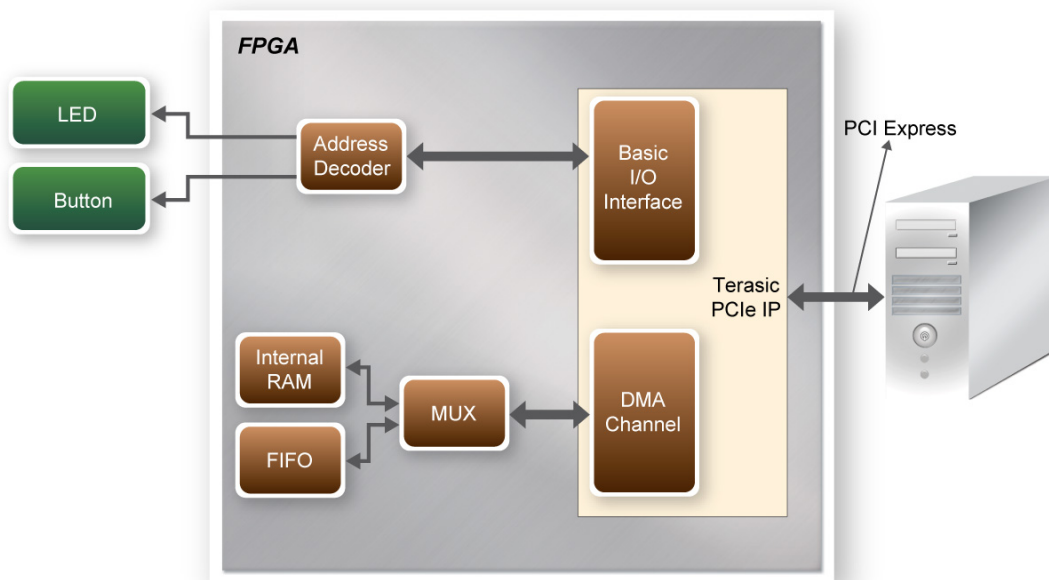

Figure 4-4 Hardware Block Diagram of the PCIe Reference Design

■ **PC Application Design**

The application shows how to call the TERASIC_PCIE.DLL exported to API. To enumerate all PCIe cards in system call, the software design defines some constants based on FPGA design shown below:

```
#define PCIE_VID                    0x1172
#define PCIE_DID                    0xE001

#define DEMO_PCIE_USER_BAR          PCIE_BAR1
#define DEMO_PCIE_IO_ADDR           0x04
#define DEMO_PCIE_FIFO_ID           0x00
```

The vendor ID is defined as 0x1172 and the device ID is defined as 0xE001. The BUTTON/LED register address is 0x04 based on PCIE_BAR1.

A C++ class **PCIE** is designed to encapsulate the DLL dynamic loading for TERASIC_PCIE.DLL. A PCIE instance is created with the name **m_hPCIE**. To enumerate all PCIe cards in system, call the function

```
m_hPCIE.ScanCard(wVendorID, wDeviceID, &dwDeviceNum, m_szPcieInfo);
```

where wVendorID and wDeviceID are zeros. The return value dwDeviceNum represents the number of PCIe cards found in the system. The m_szPcieInfo array contains detailed information for each PCIe card.

To connect the selected PCIe card, the functions are called:

```
int nSel = ComboBoxBoard->ItemIndex;
WORD VID = m_szPcieInfo[nSel].VendorID;
WORD DID = m_szPcieInfo[nSel].DeviceID;
bSuccess = m_hPCIE.Open(VID,DID,0); //0: first matched board
```

where nSel is selected index in the 'Selected FPGA Board' poll-down menu. Based on the return m_szPcieInfo, we can find the associated PID and DID which can br used to specifiy the target PCIe card.

To read the BUTTON status, the function is called:

```
m_hPCIE.Read32(DEMO_PCIE_USER_BAR, DEMO_PCIE_IO_ADDR, &dwData);
```

To set LED status, the function is called:

```
m_hPCIE.Write32(DEMO_PCIE_USER_BAR, DEMO_PCIE_IO_ADDR, dwData);
```

To write and read memory-mapped memory, call the functions:

```
// write
bSuccess = m_hPCIE.DmaWrite(LocalAddr, pWrite, nTestSize);
if (bSuccess){
    // read
    bSuccess = m_hPCIE.DmaRead(LocalAddr, pRead, nTestSize);
}
```

To write and read FIFO memory, call the functions: