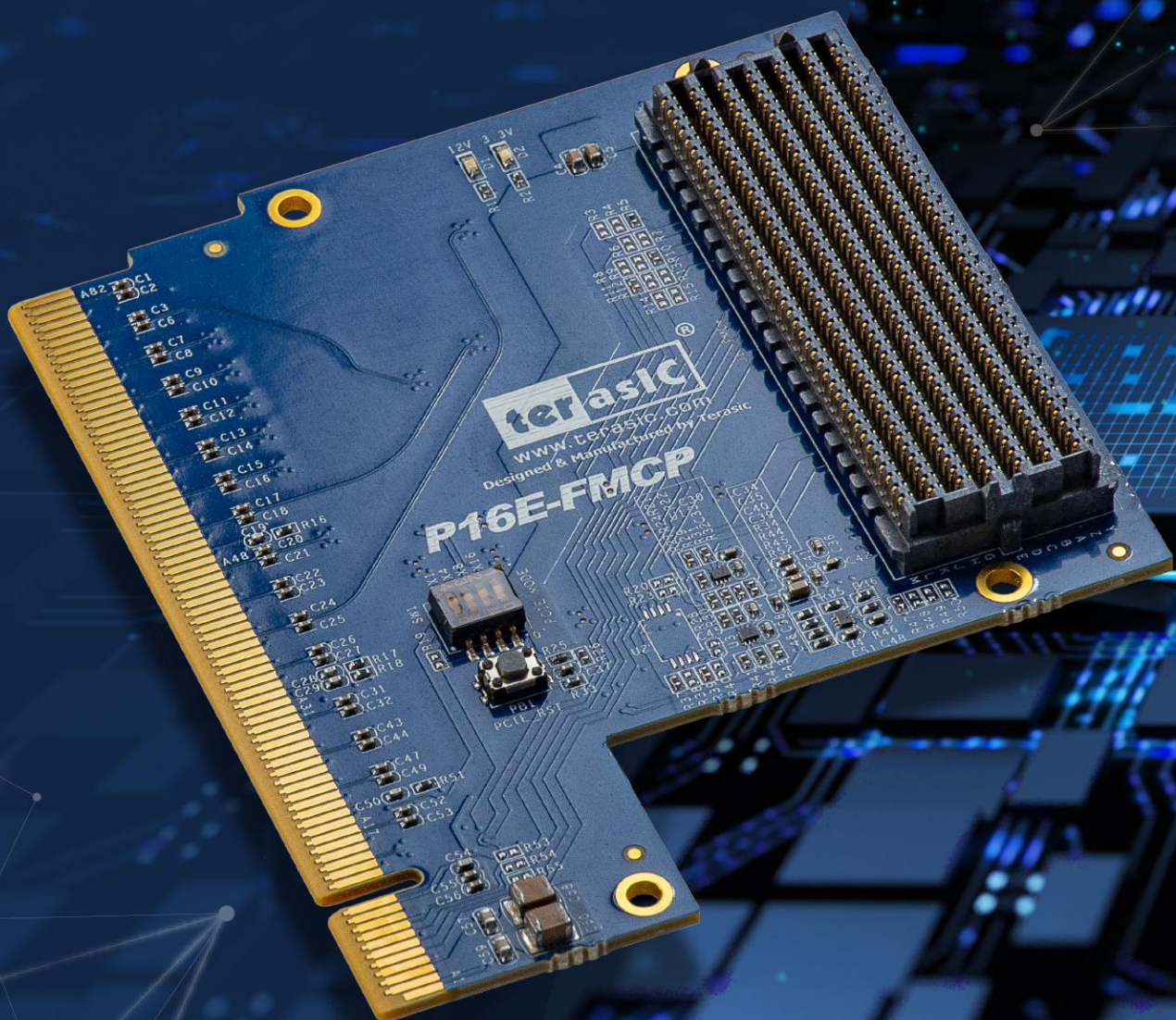


# P16E-FMCP

## User Manual ▲



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# Chapter 1

## *P16E-FMCP Development Kit*

The P16E-FMCP FMC+ daughter card allows the FPGA boards equipped with the FMC+ connector and support the PCIe interface to connect with the PC.

The P16E-FMCP daughter card is purposely designed to convert transceiver channels of FMC+ connector to PCIe Edge. It can support up to PCIe Gen 4 x16. Developers can connect the PCIe Edge of P16E-FMCP to a PC slot through a PCIe 4.0 X16 Riser Cable.

The kit also provides complete demo source codes for the P16E-FMCP working with different FPGA development kits with FMC+ connectors.

### 1.1 Package Contents



The P16E-FMCP package includes:

- One P16E-FMCP module
- Screw & Copper Pillar Package
- System CD Download Guide

**Figure 1-1 The P16E-FMCP package contents**

### 1.2 P16E-FMCP System CD

The P16E-FMCP System CD contains all the documents and supporting materials associated with P16E-FMCP, including the user manual, reference designs, and device datasheets. Users can download this system CD from the link: <http://p16e-fmcp.terasic.com/cd>.

## 1.3 Getting Help

Here are the addresses where you can get help if you encounter any problems:

Terasic Technologies

No.80, Fenggong Rd., Hukou Township, Hsinchu County 303035. Taiwan

Email: [support@terasic.com](mailto:support@terasic.com)

Tel.: +886-3-575-0880

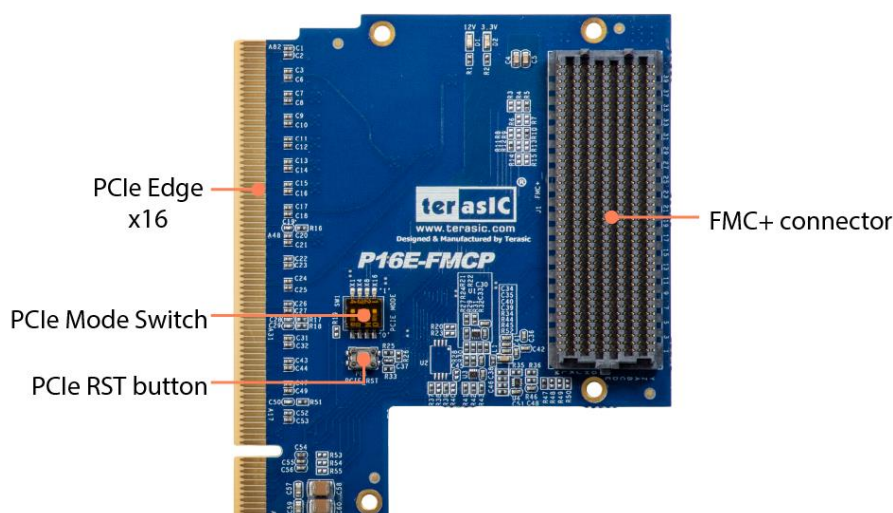
Website: <http://www.terasic.com>



## Chapter 2

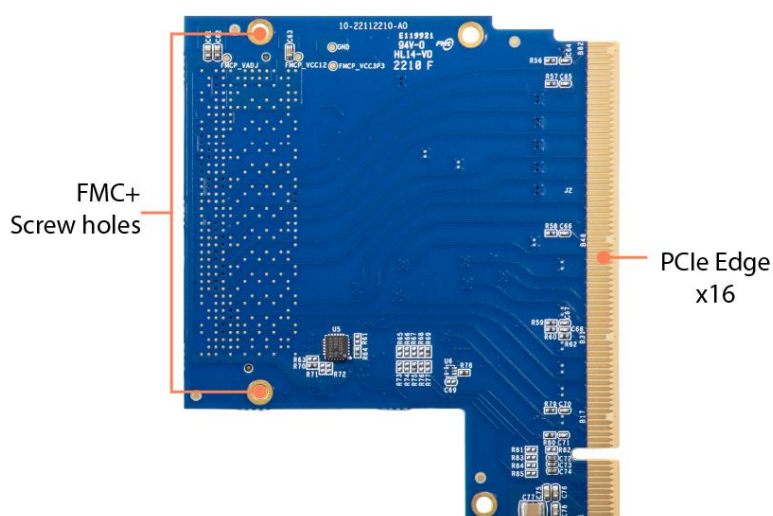
### *Introduction of the P16E-FMCP Board*

This chapter describes the architecture and configuration of the P16E-FMCP Board including block diagram and components related.



**Figure 2-1 The P16E-FMCP Board PCB and Component Diagram of top side**

The Photographs of the P16E-FMCP are shown in **Figure 2-1** and **Figure 2-2**. They depict the layout of the board and indicates the location of the connectors and the key components on the top and bottom side.



## Figure 2-2 The P16E-FMCP Board PCB and Component Diagram of bottom side

The following hardware is provided on the board:

- PCIe Clock Buffer Si53152
- A Push Button for PCIe Reset
- FMC+ Connector (HPC)

## 2.1 Features

The P16E-FMCP daughter card is purposely designed to convert transceiver channels of FMC+ connector to PCIe Edge. It can support up to PCIe Gen 4 x16. Developers can connect the PCIe Edge of P16E-FMCP to a PC slot through a PCIe 4.0 X16 Riser Cable.

A FPGA board to compatible with P16E-FMCP, it must be:

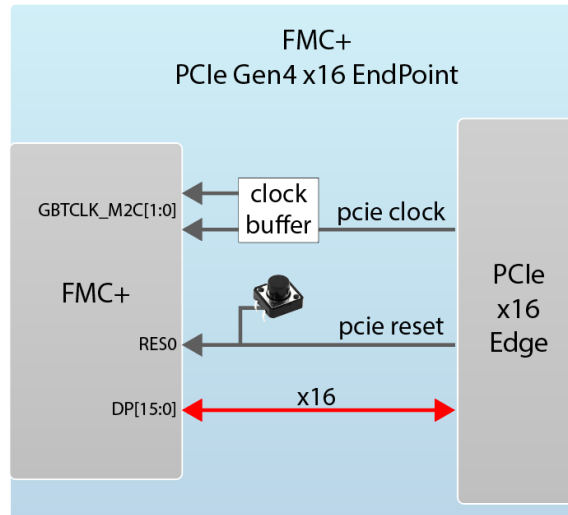
- Provide FMC+ connector. Note, FMCP\_VAJD is not required if SMB bus is not used.
- GBTCLK\_M2C in FMC+ connector must connect to the reference clock pins of FPGA PCIe End-point IP.
- RES0 in FMC+ connector must connect to the reset pin of FPGA PCIe End-point IP.
- DP[15:0] in FMC+ connector must connect to the transceiver pins of FPGA PCIe End-point IP.

## 2.2 Block Diagram of the P16E-FMCP Board

Below [Figure 2-3](#) shows the P16E-FMCP Block Diagram. The PCIe clock is coming from PCIe Edge and connect to PCIe clock buffer Si53125 as a input clock. The Si53125 output two PCIe clocks to the GBTCLK\_M2C pins of FMC+ connector. In the FPGA board, the PCIe clock signal must connect to the reference clock pins of the FPGA PCIe IP.

The PCIe reset signal is coming from PCIe edge, and directly connect to the RES0 side-band pin of FMC+ connector. In the FPGA board, the RES0 must connect to the reset pin of FPGA PCIe IP. On board push button PB1 can be used to trigger a PCIe reset signal to FMC+ RES0. It is designed for debug prupuse.

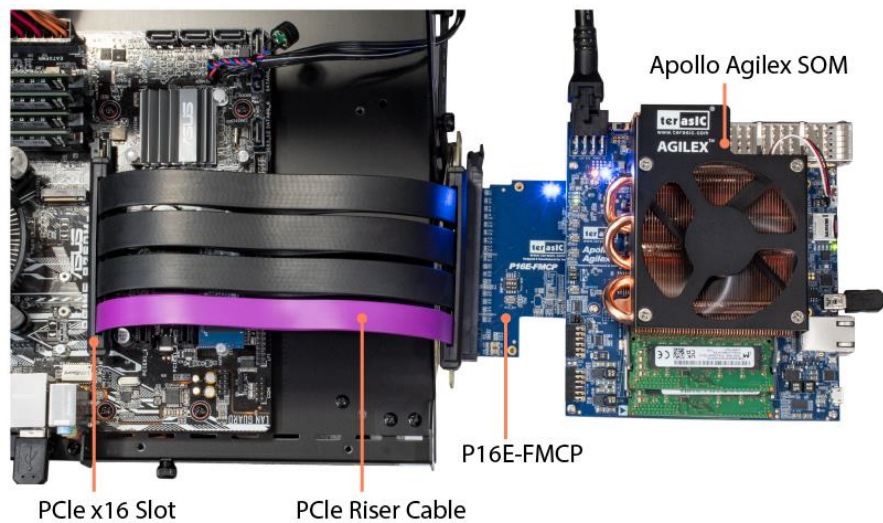
PCIe x16 pair high speed lanes are directly connected between PCIe Edge and FMC+ Gigabit Transceiver data pairs. Each lane provides speeds up to 16GT/s for supporting PCIe Gen4.



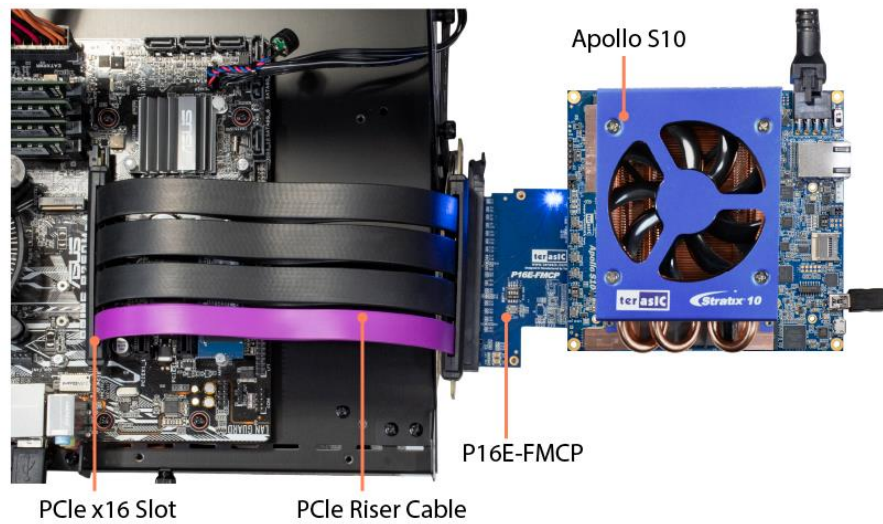
**Figure 2-3 Block diagram of P16E-FMCP Board**

## 2.3 Connectivity

Terasic P16E-FMCP is able to connect on to FPGA board equipped with FMC+ connector. The Below pictures [Figure 2-4](#) and [Figure 2-5](#) show the connections with two different Terasic FPGA Boards:



**Figure 2-4 Connect the P16E-FMCP to Apoll-Agilex FMC+ port**



**Figure 2-5 Connect the P16E-FMCP to Apollo-S10 FMC+ port**



# Chapter 3

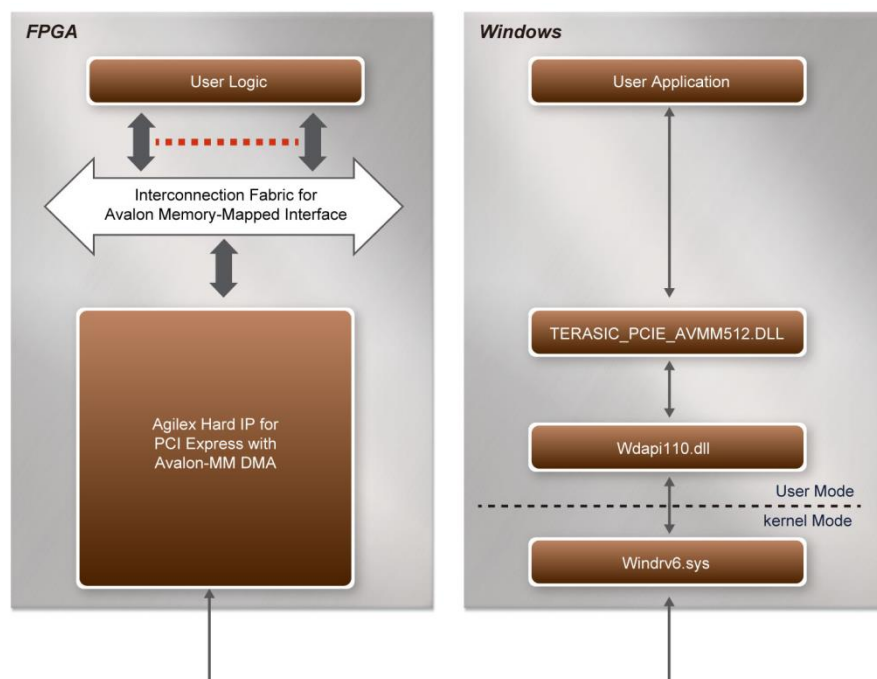
## PCIe Endpoint Example Codes

This chapter provides PCIe examples for users to get started using the P16E-FMCP board. Terasic Apollo-Agilex SOM or Apollo-S10 FPGA board is required to perform the demonstration. Also, a PCIe Riser Cable is required to P16E-FMCP to connect to your PC easily.

### 3.1 Demo Setup with Apollo Agilex SOM on Windows

**Agilex Hard IP for PCI Express with Avalon-MM DMA** is used to implement a PCIe Endpoint Gen4 x16 demonstration. For the design details, please the **PCI Express Reference Design** chapter in Terasic **DE10-Agilex User Manual**.

**Figure 3-1** shows the architecture of the PCIe end-point demo.



**Figure 3-1 Architecture of PCIe End-point Gen4 x16 Demonstration**

#### ■ Project Information

The project is located on the folder <CD>\Demonstration\Agilex\_SOM. Below tables describe the

project detail information.

Items	Sub folder
Quartus Project Source (Quartus Pro 21.4)	PCle_Fundamental
FPGA Configure File	PCle_Fundamental\demo_batch
Windows Application Execution file	PCle_Fundamental\demo_batch\windows_ap p
Windows PCIe Driver	PCle_SW_KIT\Windows\PCle_Driver
Windows Library	PCle_SW_KIT\Windows\PCle_Library
Windows Application Source (VC 2019)	PCle_SW_KIT\Windows\PCIE_FUNDAMENT AL

## ■ System Requirements

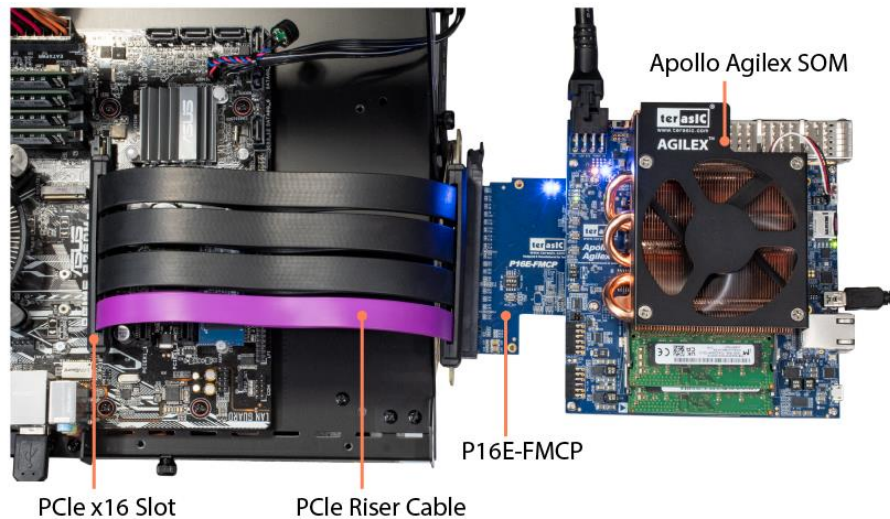
The following items are required to setup PCIe End-point demonstration:

- P16E-FMCP board x1
- Apollo-Agilex Board x1
- PCIe Riser Cable x1
- PC with PCIe x16 Port x1

## ■ Hardware Setup

Please follow the steps below to set up the hardware as shown in [Figure 3-2](#)

1. Install P16E-FMCP on the FMC+ connector of Apollo-Agilex.
2. Connect the PCIe edge of P16E-FMCP to the PCIe Slot of PC by a PCIe riser cable.



**Figure 3-2 Hardware Setup for Apollo-Agilex Demo**

## ■ Demo Setup Operation

Please follow the steps below to perform the demonstration. For details, please see the **PCI Express Reference Design** chapter in Terasic **DE10-Agilex User Manual**. The manual can be downloaded from the [Resource](#) website of the DE10-Agilex board.

1. Power on Apollo-Agilex.
2. Configure FPGA by executing test.bat on the system CD folder:  
     Demonstration\Apollo\_SOM\PCIe\_Fundamental\demo\_batch
3. Power on PC.
4. Make sure Windows detected the PCIe FPGA board.
5. Install the PCIe Driver located in the system CD:

Linux: Demonstration\Apollo\_SOM\PCIe\_SW\_KIT\Linux\PCIe\_Driver

Windows: Demonstration\Apollo\_SOM\PCIe\_SW\_KIT\Windows\PCIe\_Driver

6. Execute the Windows application PCIE\_FUNDAMENTAL.exe located on the CD folder:

Linux: Demonstration\Apollo\_SOM\PCIe\_Fundamental\demo\_batch\linux\_app

Windows: Demonstration\Apollo\_SOM\PCIe\_Fundamental\demo\_batch\windows\_app

7. A console mode manual will appear. Select DMA Memory Test to perform DMA test.

## 3.2 Demo Setup with Apollo S10

**Stratix 10 Hard IP for PCI Express with Avalon-MM DMA** IP is used to implement the PCIe End-point Gen3x16 demonstration. The demo can be executed on both Linux and Windows. For details, please refer to the **PCI Express Reference Design** Section in Terasic DE10-Pro User Manual. The manual can be download from <http://de10-pro.terasic.com/cd>.

### ■ Project Information

The project is located on the folder <CD>\Demonstration\Agilex\_S10. Below tables describe the project detail information.

Items	Sub folder
Quartus Project Source (Quartus Pro 19.1)	PCIe_Fundamental
FPGA Configure File	PCIe_Fundamental\demo_batch
Linux Application Execution file	PCIe_Fundamental\demo_batch\linux_app
Windows Application Execution file	PCIe_Fundamental\demo_batch\windows_app
Linux PCIe Driver	PCIe_SW_KIT\Linux\PCIe_Driver
Linux Library	PCIe_SW_KIT\Linux \ PCIe_Library
Linux Application Source	PCIe_SW_KIT\Linux \PCIE_FUNDAMENTAL
Windows PCIe Driver	PCIe_SW_KIT\Windows\PCIe_Driver
Windows Library	PCIe_SW_KIT\Windows\ PCIe_Library
Windows Application Source (VC 2019)	PCIe_SW_KIT\Windows\PCIE_FUNDAMENTAL

### ■ System Requirements

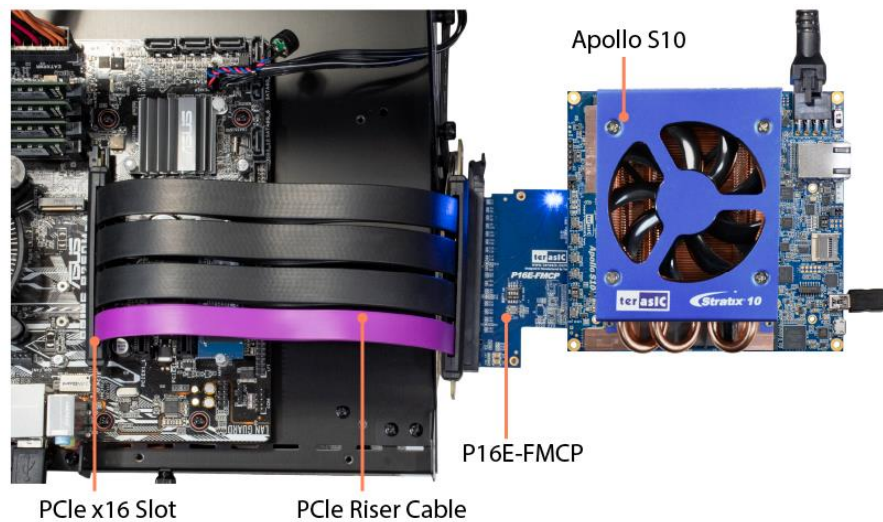
The following items are required to setup PCIe End-point demonstration:

- P16E-FMCP board x1
- Apollo-S10 Board x1
- PCIe Riser Cable x1
- PC with PCIe x16 Port x1

### ■ Hardware Setup

Please follow the steps below to set up the hardware as shown in [Figure 3-3](#)

- 1.Install P16E-FMCP on the FMC+ connector of Apollo-S10.
- 2.Connect the PCIe edge of P16E-FMCP to the PCIe Slot of PC by a PCIe riser cable.



**Figure 3-3 Hardware for Apollo S10**

## ■ Demo Setup Operation

Please follow the steps below to perform the demonstration. For details, please see the **PCI Express Reference Design** chapter in **Terasic DE10-Pro User Manual**. The manual can be downloaded from <http://de10-pro.terasic.com/cd>.

1. Power on Apollo-S10.
2. Configure FPGA by executing test.bat on the system CD folder:  
Demonstration\Apollo\_S10\PCIe\_Fundamental\demo\_batch
3. Power on PC.
4. Make sure Windows detected the PCIe FPGA board.
5. Install the PCIe Driver located in the system CD:

Linux: Demonstration\Apollo\_S10\PCIe\_SW\_KIT\Linux\PCIe\_Driver

Windows: Demonstration\Apollo\_S10\PCIe\_SW\_KIT\Windows\PCIe\_Driver

6. Execute the Windows application PCIE\_FUNDAMENTAL.exe located on the CD folder:

Linux: Demonstration\Apollo\_S10\PCIe\_Fundamental\demo\_batch\linux\_app

Windows: Demonstration\Apollo\_S10\PCIe\_Fundamental\demo\_batch\windows\_app

7. A console mode manual will appear. Select DMA Memory Test to perform DMA test.



# Chapter 4

## *Appendix*

### 4.1 Revision History

Version	Change Log
V1.0	Initial Version

### 4.2 Copyright Statement

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