



# FPGA Setup for NVMe-IP/NVMeG3-IP demo

Rev4.2 29-Jun-23

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# FPGA Setup for NVMe-IP/NVMeG3-IP demo

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This document describes the FPGA and environment setup for running NVMe-IP or NVMeG3-IP demo on FPGA development board by using the PCIe adapter board (AB18-PCIeX16 or AB16-PCIeXOVR adapter board) with NVMe SSD. User controls the test operation via NiosII command shell.

## 1 Environment Requirement

To run the demo on FPGA development board, please prepare following environment.

1) Supported FPGA Development board:

NVMe-IP:

- ArriaV GX Starter board (PCIe Gen2)
- Cyclone10 GX Development board (PCIe Gen2)
- TR5-Lite Development board (PCIe Gen3)
- Arria10 SoC Development board (PCIe Gen3)
- Arria10 GX Development board (PCIe Gen3)
- Alaric board (PCIe Gen3)
- Stratix10 GX Development board (PCIe Gen3)
- Agilex F-series Development board (PCIe Gen4)

NVMeG3-IP:

- Arria10 GX Development board (PCIe Gen3)

- 2) PC installing QuartusII programmer and NiosII command shell software
- 3) The PCIe adapter board (AB18-PCIeX16 or AB16-PCIeXOVR), provided by Design Gateway  
[https://dgway.com/ABseries\\_E.html](https://dgway.com/ABseries_E.html)
- 4) Intel power adapter for FPGA board
- 5) ATX power supply for AB18-PCIeX16 adapter board
- 6) NVMe SSD connecting with PCIe adapter board
- 7) A cable for FPGA programming/NiosII command shell, connecting between FPGA board and PC.
  - a) ArriaV GX Starter board: USB A-B cable
  - b) TR5-Lite board: USB A-B cable and USB Blaster
  - c) Cyclone10GX, Arria10 SoC, Arria10 GX, Alaric board, Stratix10 GX board, and Agilex F-series: micro USB cable

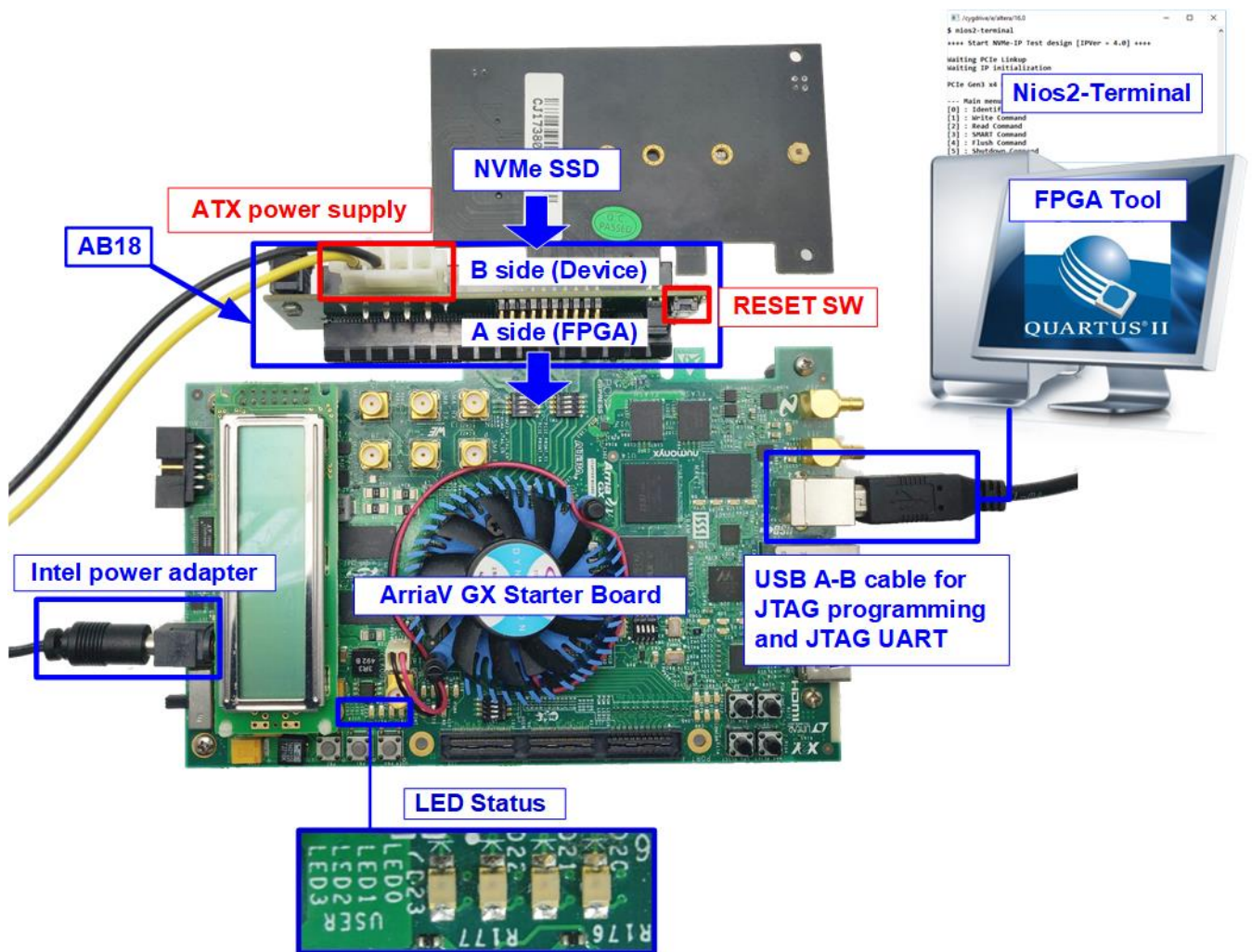


Figure 1-1 NVMe-IP demo setup on ArriaV GX Starter board (PCIe Gen2)

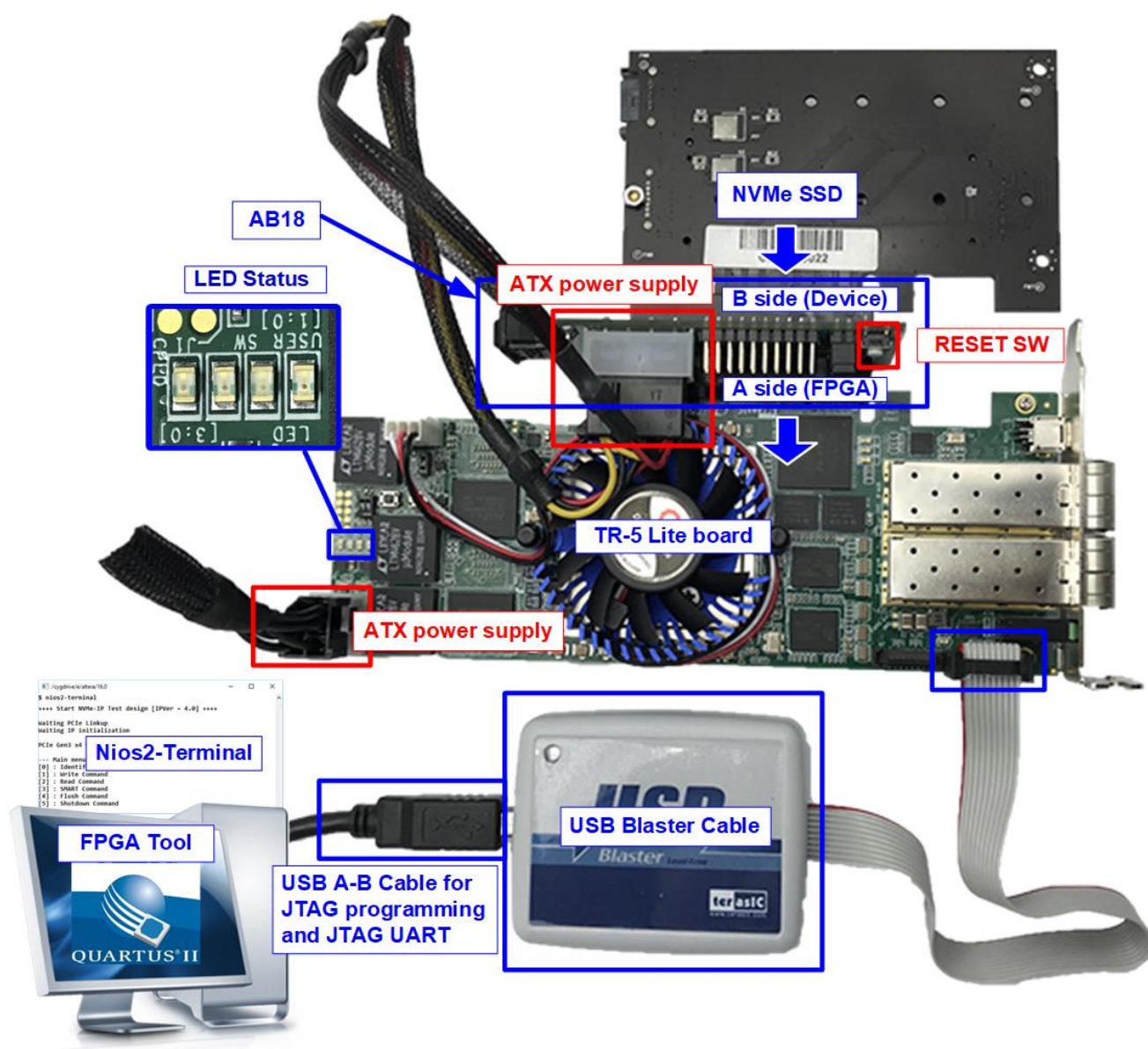


Figure 1-2 NVMe-IP demo setup on TR-5 Lite Development board (PCIe Gen3)

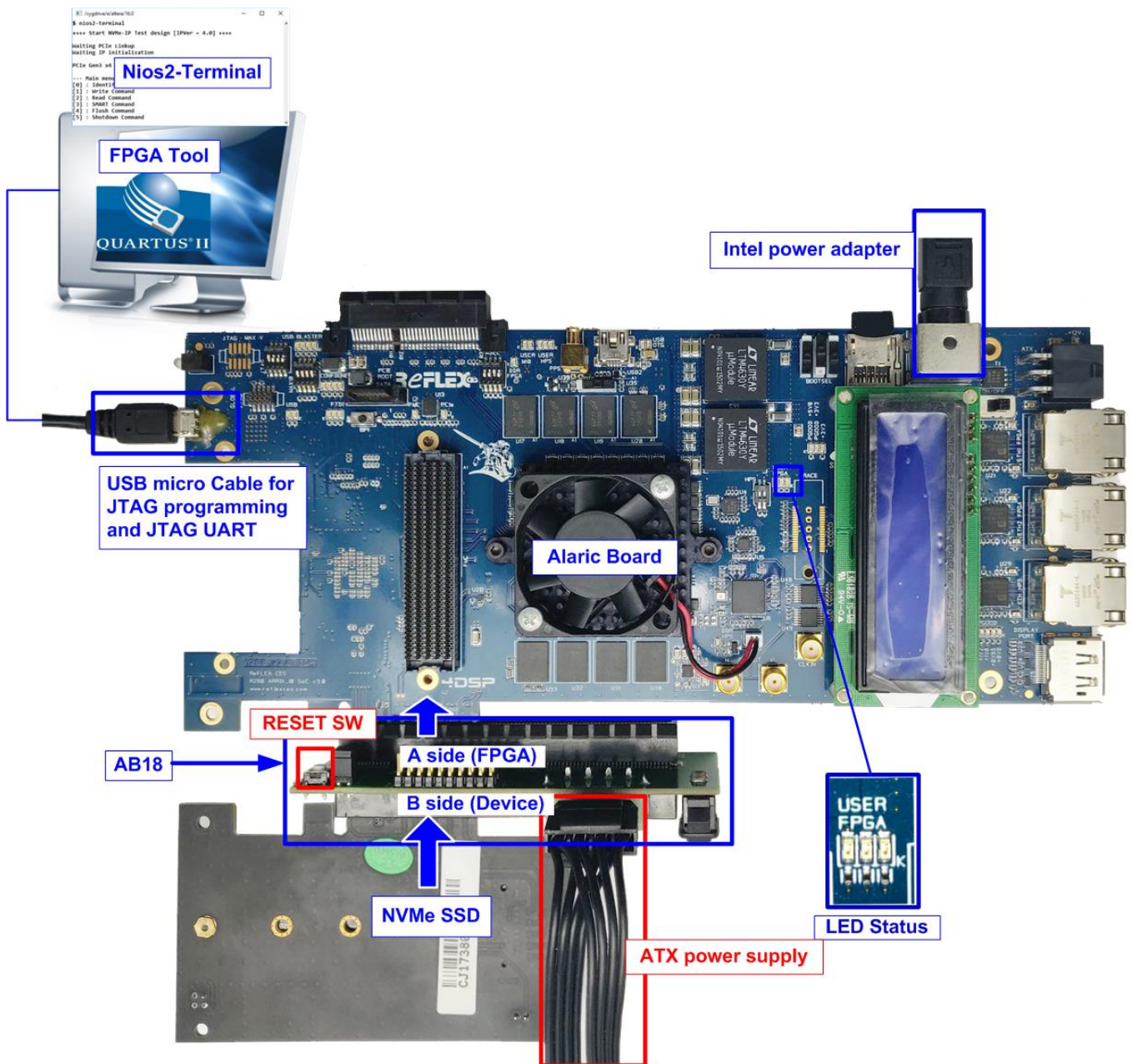


Figure 1-3 NVMe-IP demo setup on Alaric board (PCIe Gen3)

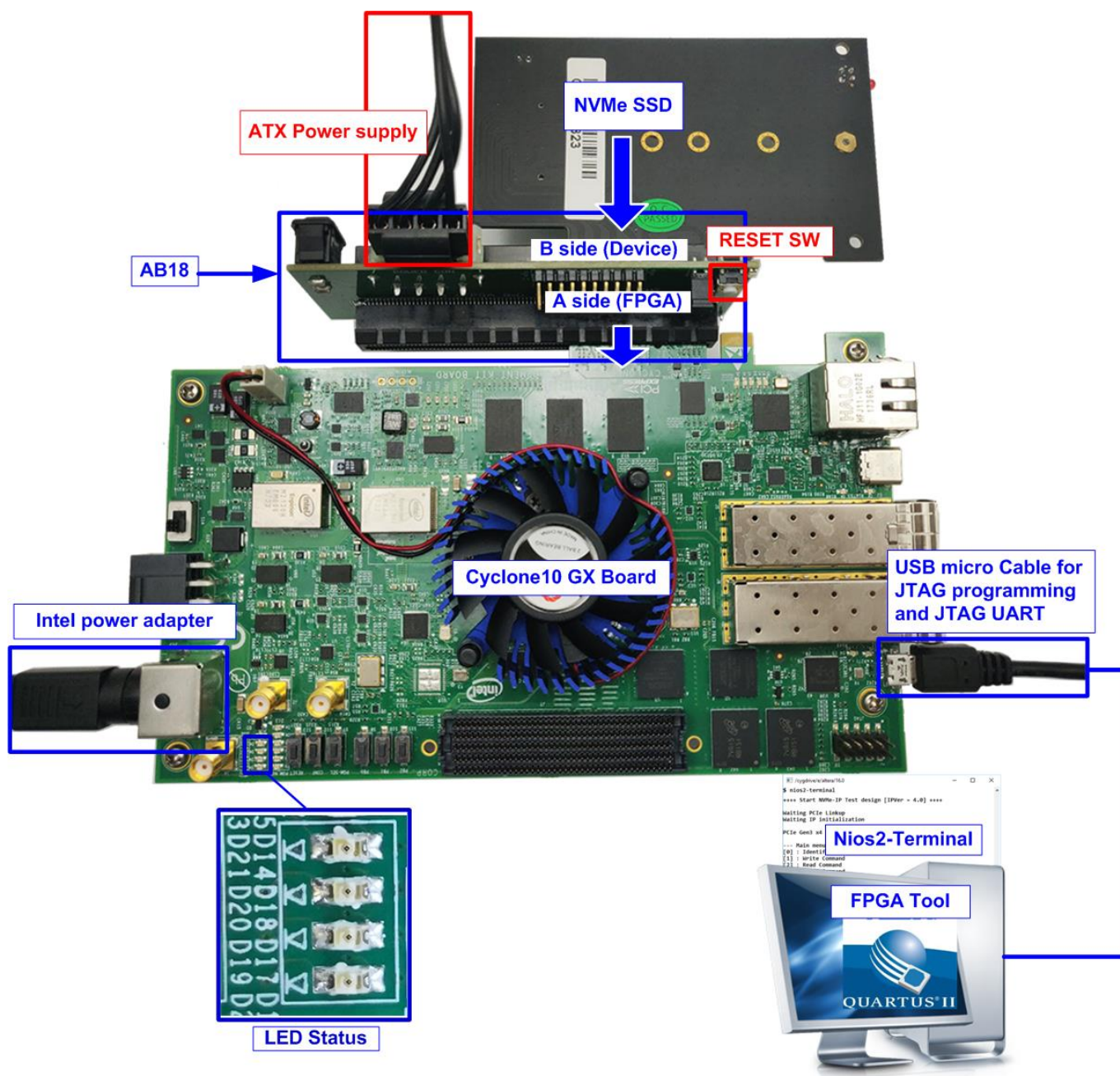


Figure 1-4 NVMe-IP demo setup on Cyclone10 GX board (PCIe Gen2)

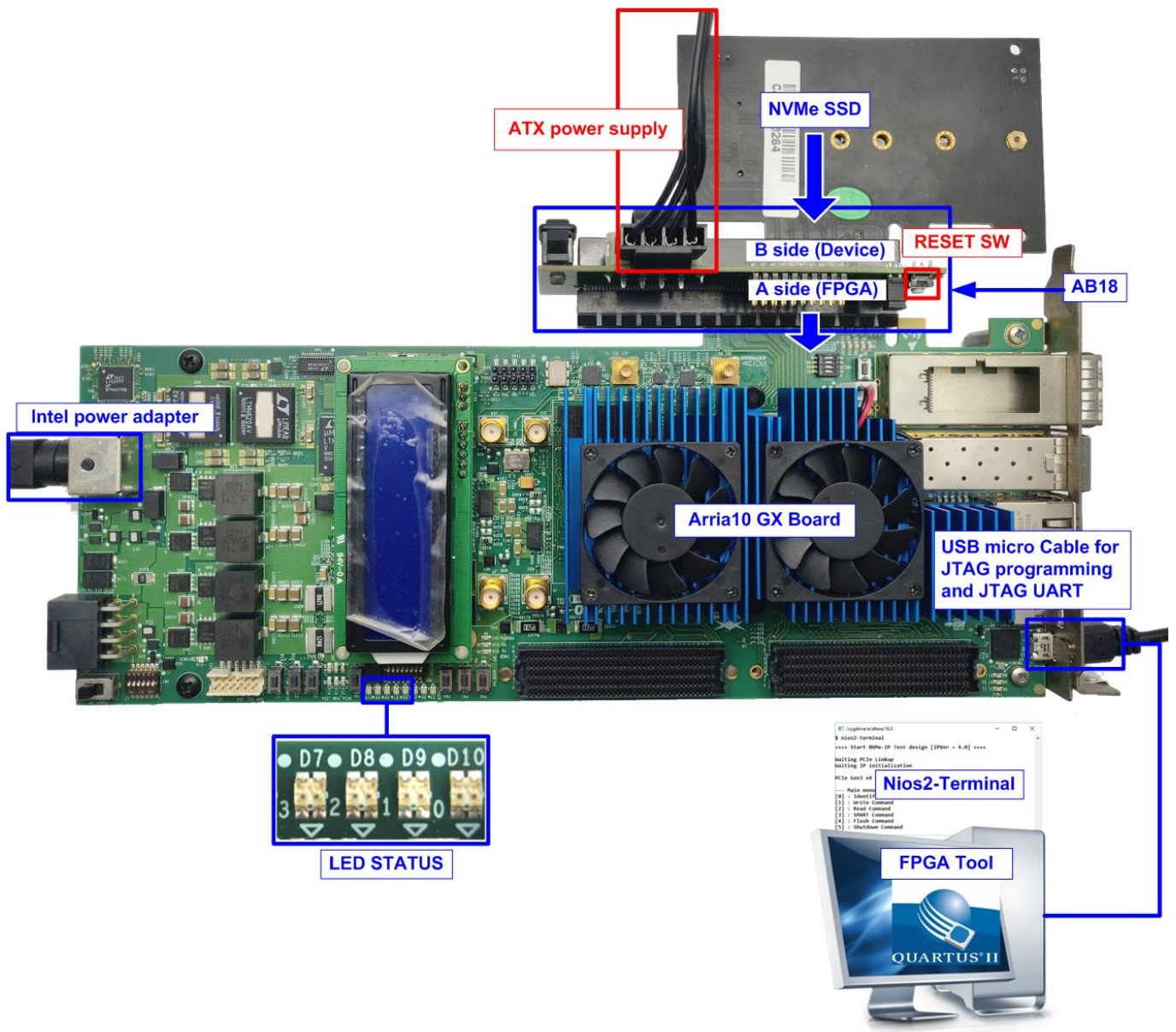


Figure 1-5 NVMe-IP/NVMeG3-IP demo setup on Arria10 GX Development board (PCIe Gen3)

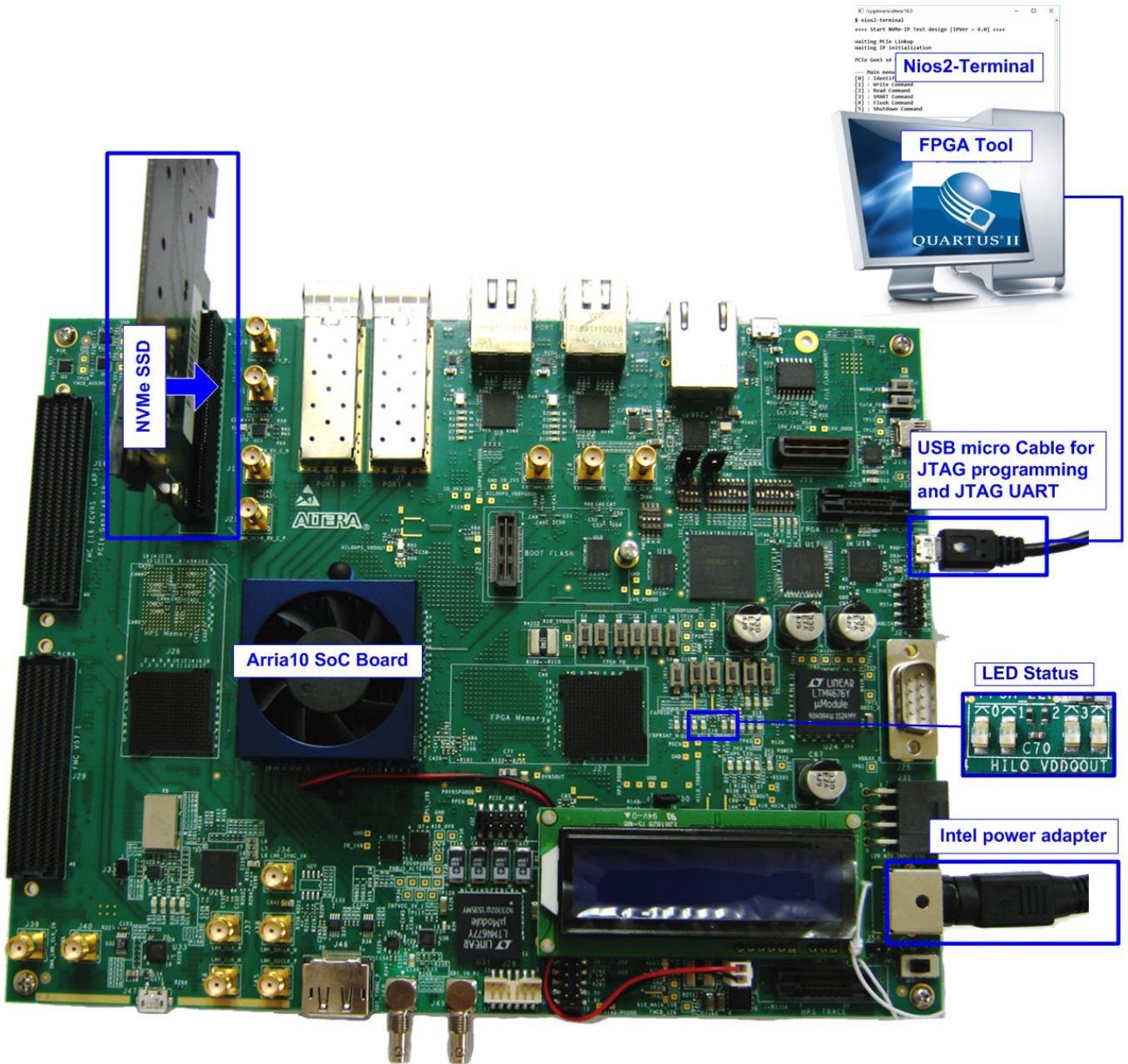


Figure 1-6 NVMe-IP demo setup on Arria10 SoC Development board (PCIe Gen3)



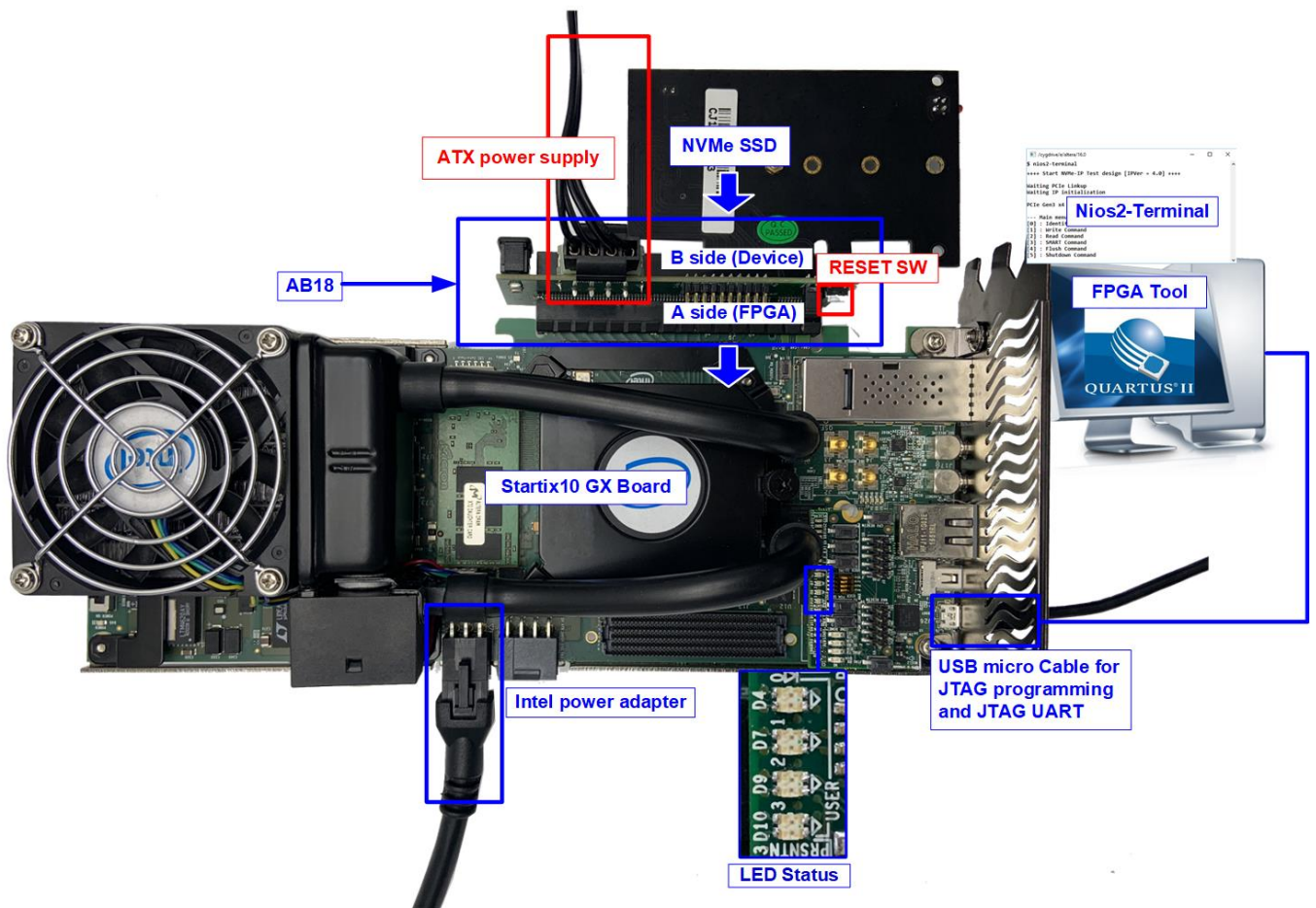


Figure 1-7 NVMe-IP demo setup on Stratix10 GX Development board (PCIe Gen3)

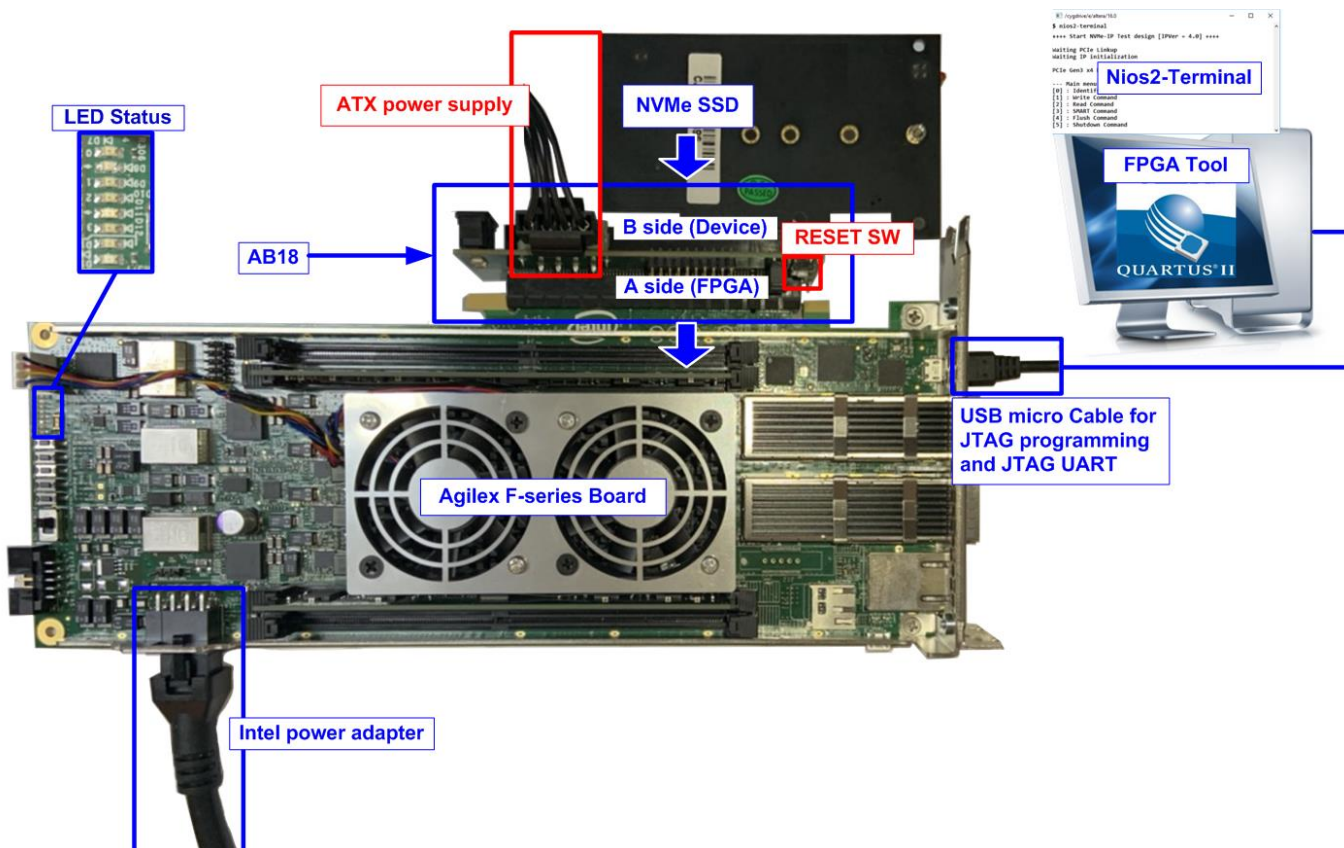


Figure 1-7 NVMe-IP demo setup on Agilex F-series Development board (PCIe Gen4)

## 2 Demo setup

### 2.1 Board setup

#### 2.1.1 TR-5 Lite Development board by AB18 and ATX power supply

- 1) Power off system.
- 2) Connect ATX power supply to FPGA board.



Figure 2-1 ATX power supply connected to FPGA

- 3) Connect AB18/AB16, SSD, and FPGA board by following steps.
  - i. Connect A Side of PCIe connector on AB18/AB16 board to PCIe connector on FPGA board.
  - ii. Check that two mini jumpers are inserted at J5 connector on AB18/AB16 board.
  - iii. Connect NVMe SSD to B Side of PCIe connector on AB18/AB16 board.
  - iv. Connect ATX power supply to AB18/AB16 board as shown in Figure 2-2.

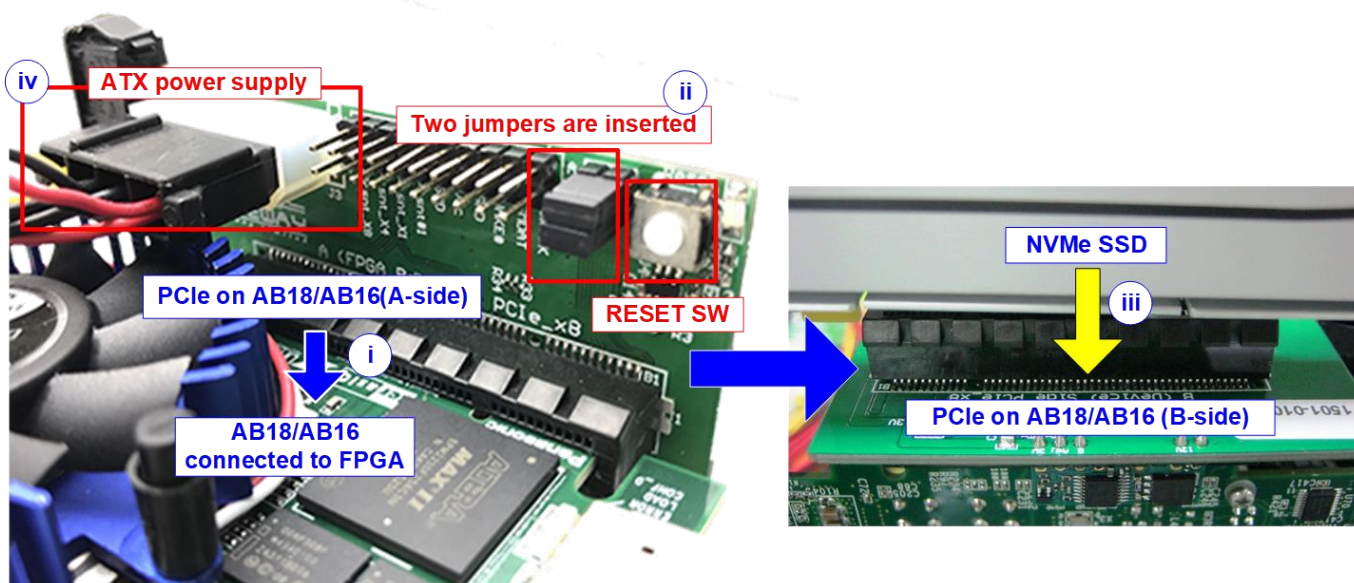


Figure 2-2 Connect PCIe connector between AB18/AB16 and FPGA board

- 4) Connect USB cable to FPGA board by following steps.
  - i. Connect USB Blaster cable to FPGA board for JTAG programming/NiosII command shell.
  - ii. Connect USB A-B cable to USB Blaster, as shown in Figure 2-3.

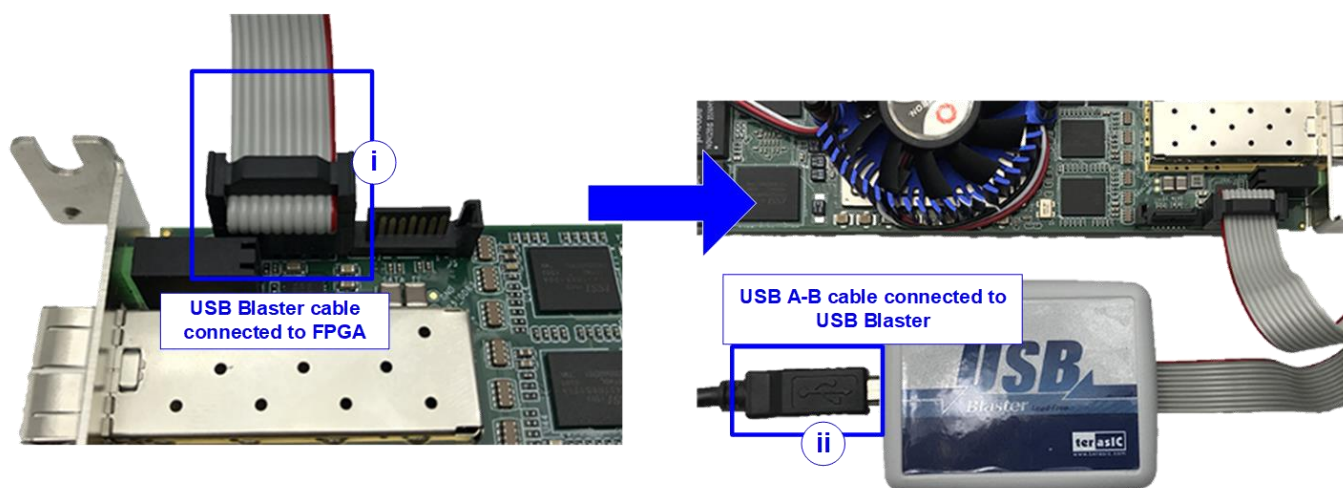


Figure 2-3 USB cable connection

- 5) Turn on power switch of ATX power supply and AB18/AB16 board.

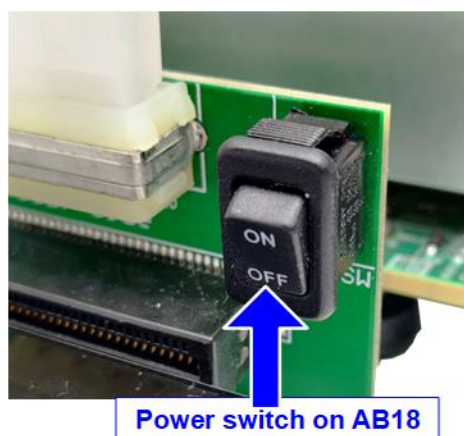


Figure 2-4 Power on AB18/AB16 board

## 2.1.2 Arria10 GX/Cyclone10GX/Alaric board/ArriaV GX/Stratix10 GX/Agilex F-series by AB18 and ATX power supply

- 1) Power off system.
- 2) Connect AB18/AB16, SSD, and FPGA board by following steps.
  - i. Connect ATX power to ATX power connector on AB18-PCIeX16 board.
  - ii. Connect A Side of PCIe connector on AB18-PCIeX16 board to PCIe connector on FPGA board
  - iii. Check that two mini jumpers are inserted at J5 connector on AB18
  - iv. Connect NVMe SSD to B Side of PCIe connector on AB18-PCIeX16 board

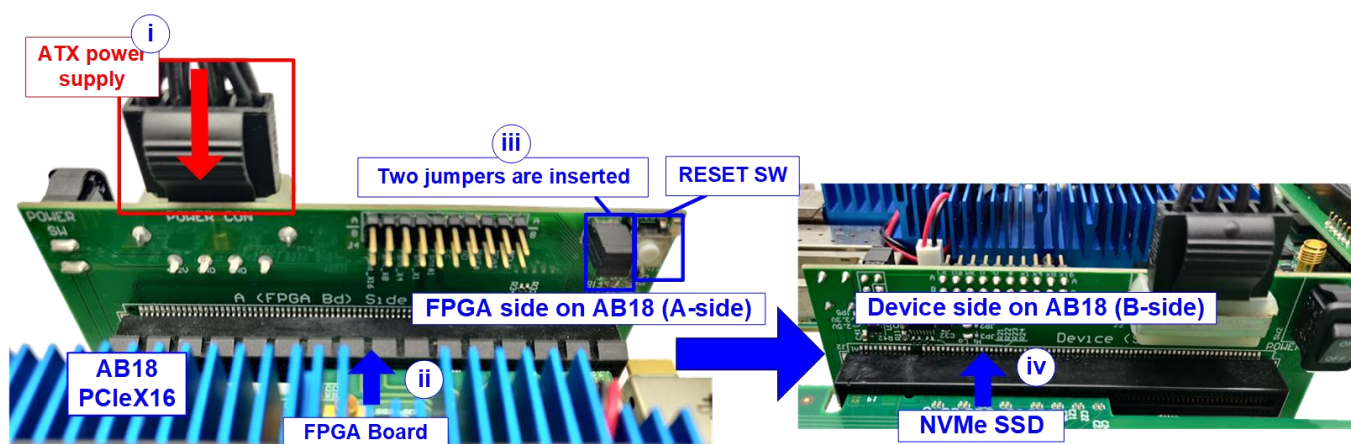


Figure 2-5 Connect PCIe connector between AB18 and FPGA board

- 3) For JTAG programming and NiosII command shell,
  - a. Arria10 GX, Cyclone10GX, Alaric board, Stratix10GX, and Agilex F-series: Connect micro USB cable from FPGA board to PC
  - b. ArriaV GX: Connect USB A-B cable from FPGA board to PC

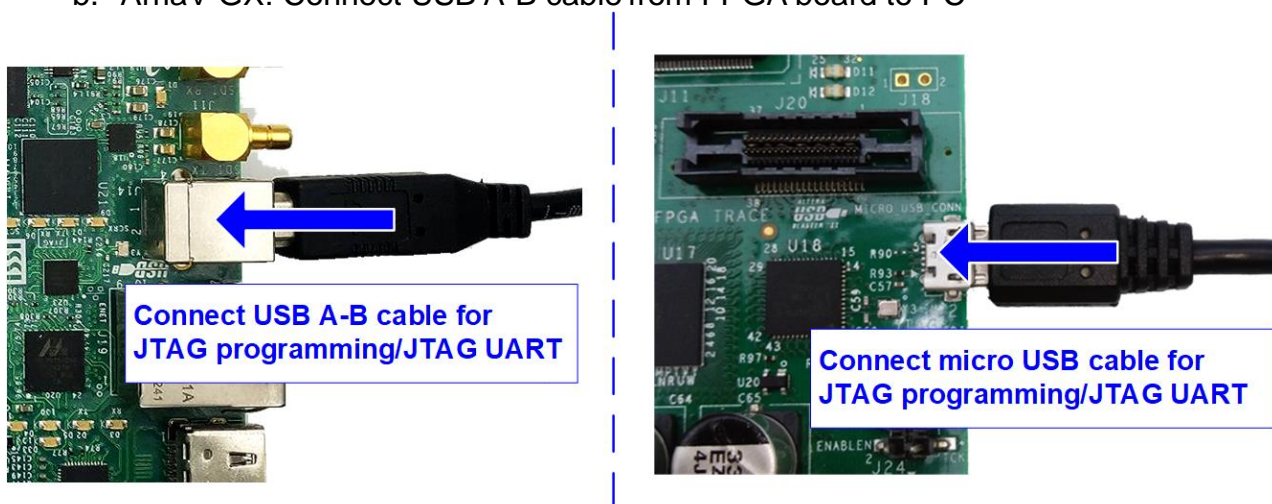


Figure 2-6 Connect USB cable to FPGA board

4) Connect FPGA power adapter to FPGA board.

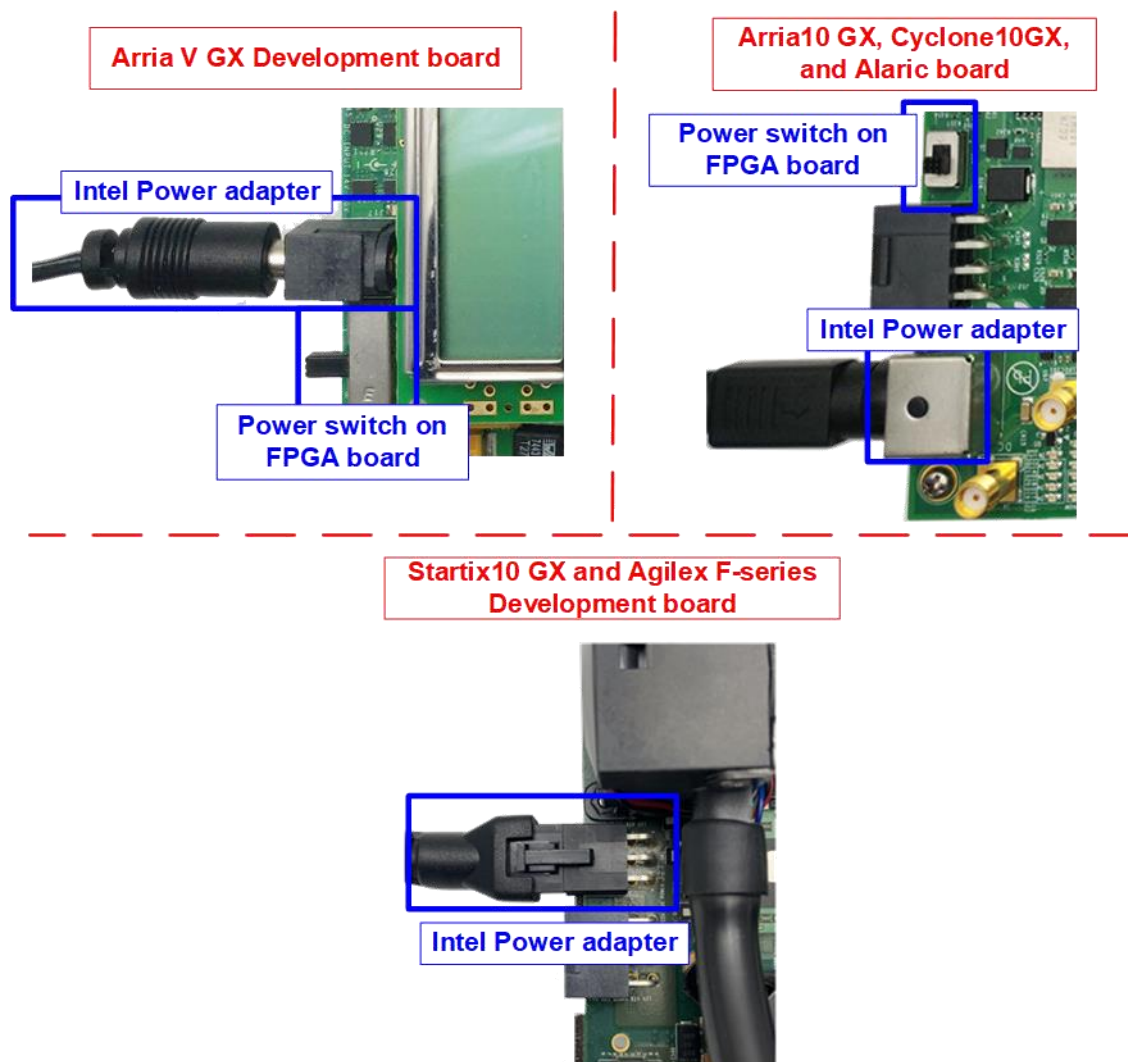


Figure 2-7 Connect Intel power adapter to FPGA board

5) Turn on power switch of FPGA development board, AB18-PCIeX16 board and ATX power supply.

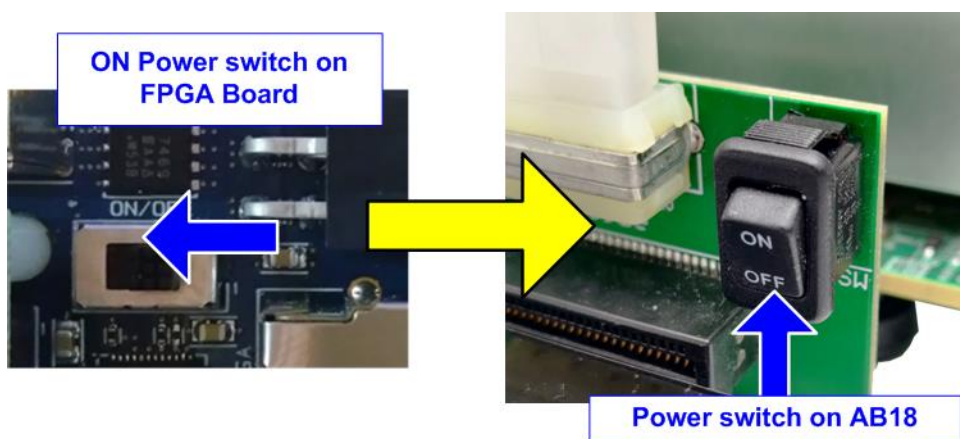


Figure 2-8 Power on FPGA board and AB18 board

### 2.1.3 Arria10 SoC Development board

- 1) Power off system.
- 2) Connect NVMe SSD to PCIe connector on FPGA board, as shown in Figure 2-9.
- 3) Connect micro USB cable from FPGA board to PC for JTAG programming/NiosII command shell.

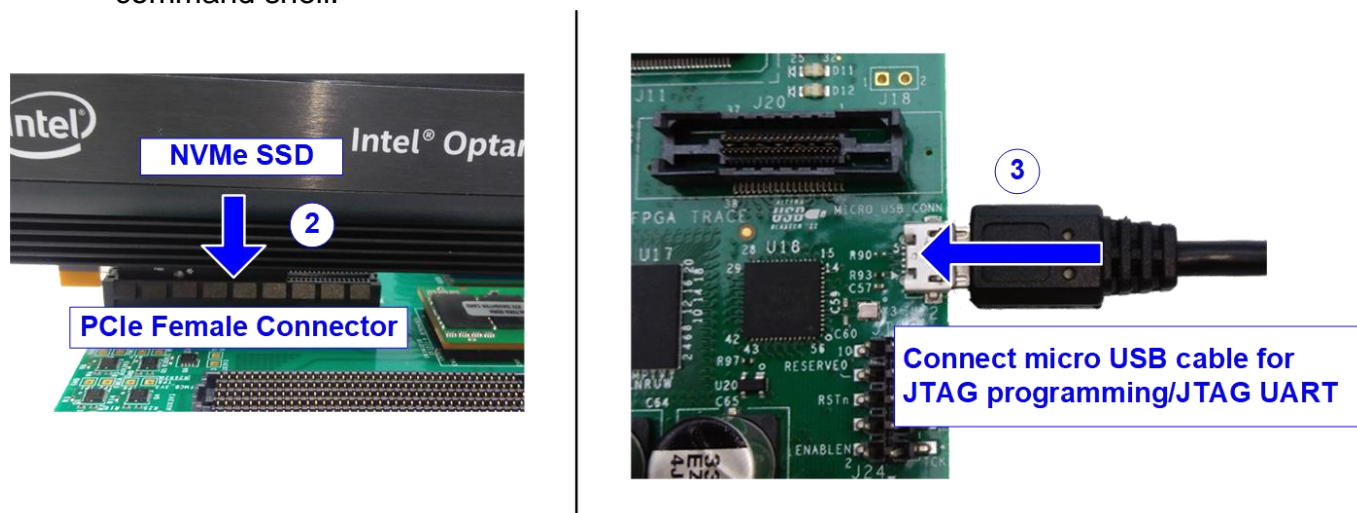


Figure 2-9 NVMe PCIe SSD connection on FPGA board

- 4) Set SW1[2] = OFF position to source power to the PCIe, as shown in Figure 2-10.

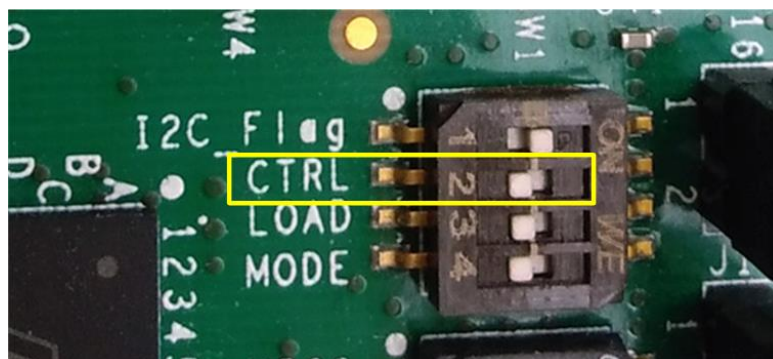


Figure 2-10 Source power to the PCIe for Arria10 SoC board

- 5) Connect FPGA power adapter to FPGA board and power on FPGA development board.

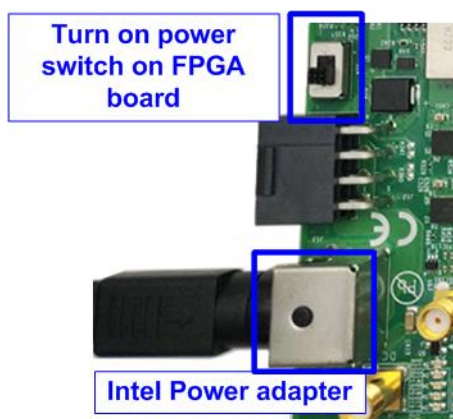


Figure 2-11 Connect Intel power adapter on Arria10 SoC board

## 2.2 Program setup

- 1) Use QuartusII Programmer to program “NVMeIPTest\_xxx.sof” file, as shown in Figure 2-12.

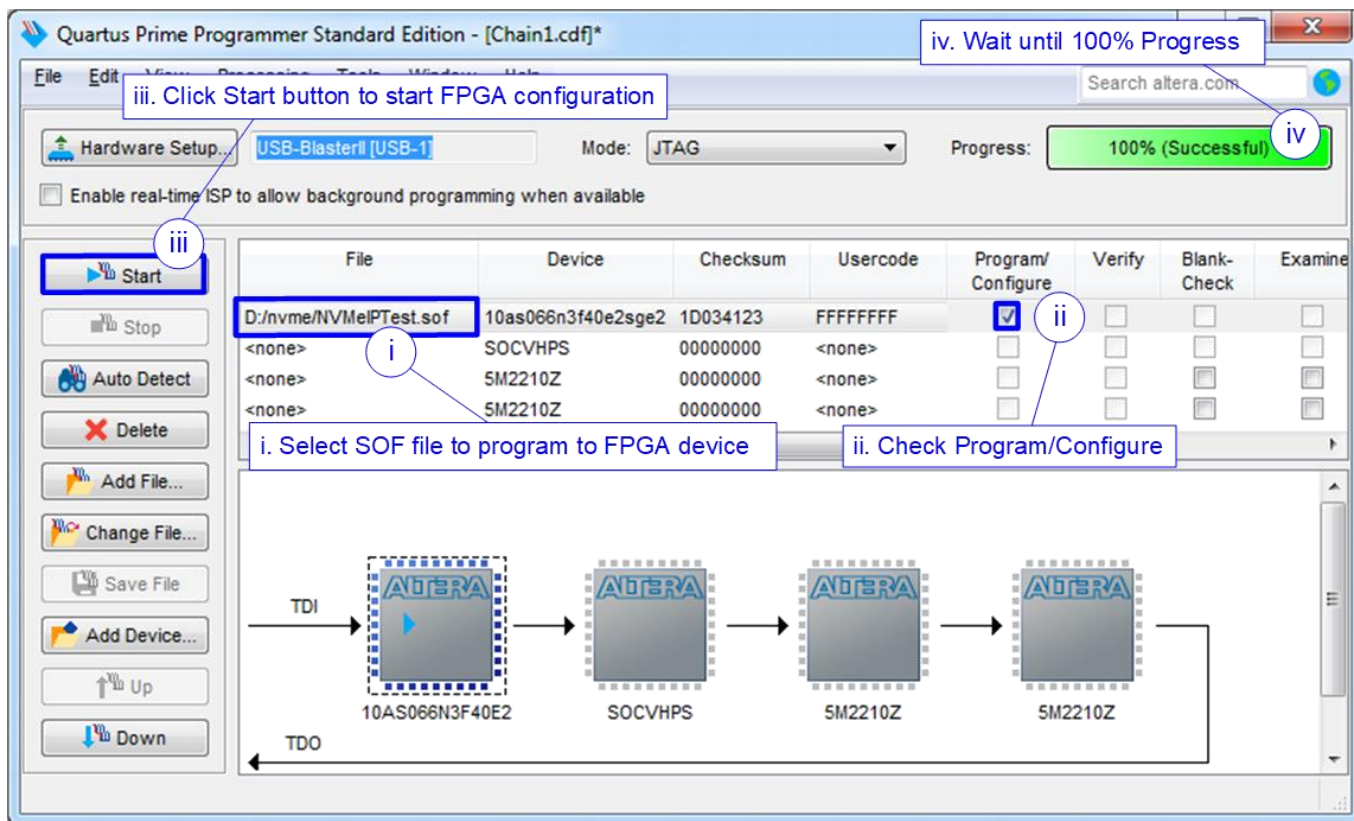


Figure 2-12 Programmed by QuartusII Programmer



- 2) Open NiosII Command Shell and run “nios2-terminal” command. After that, boot message is displayed.
  - i. “Waiting PCIe Linkup” is displayed when CPU monitors linkup signal of PCIe-IP.
  - ii. “Waiting IP initialization” is displayed after PCIe-IP linkup. Next, CPU waits until NVMe-IP initialization finished.
  - iii. “PCIe Gen3 (or 4/2/1) x4 (or x2/x1) Device Detect” shows PCIe speed and PCIe lane after finishing IP initialization process.
  - iv. Finally, Main menu is displayed to receive command from user.

```

/cydrive/e/altera/16.0
$ nios2-terminal
nios2-terminal: connected to hardware target using JTAG UART on cable
nios2-terminal: "USB-BlasterII [USB-1]", device 1, instance 0
nios2-terminal: (Use the IDE stop button or Ctrl-C to terminate)

++++ Start NVMe-IP Test design [IPVer = 4.0] ++++

Waiting PCIe Linkup
Waiting IP initialization
PCIe Gen3 x4 Device Detect
--- Main menu [IPVer = 4.0] ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command
  
```

Figure 2-13 NiosII Terminal

- 3) Check LED status on FPGA board. The description of LED is shown as follows. *Note: There are three LEDs on Alaric board. Therefore, LED3 is not available.*

Table 2-1 LED Definition

GPIO LED	ON	OFF
0	Normal operation	Clock is not locked
1	System is busy	Idle status
2	PCIe Error detect	Normal operation
3	Data verification fail	Normal operation

- 4) After programming completely, LED[0] and LED[1] are ON when PCIe initialization is processing. LED[1] is OFF after PCIe completes initialization process. Finally, the system is ready to receive command from user.

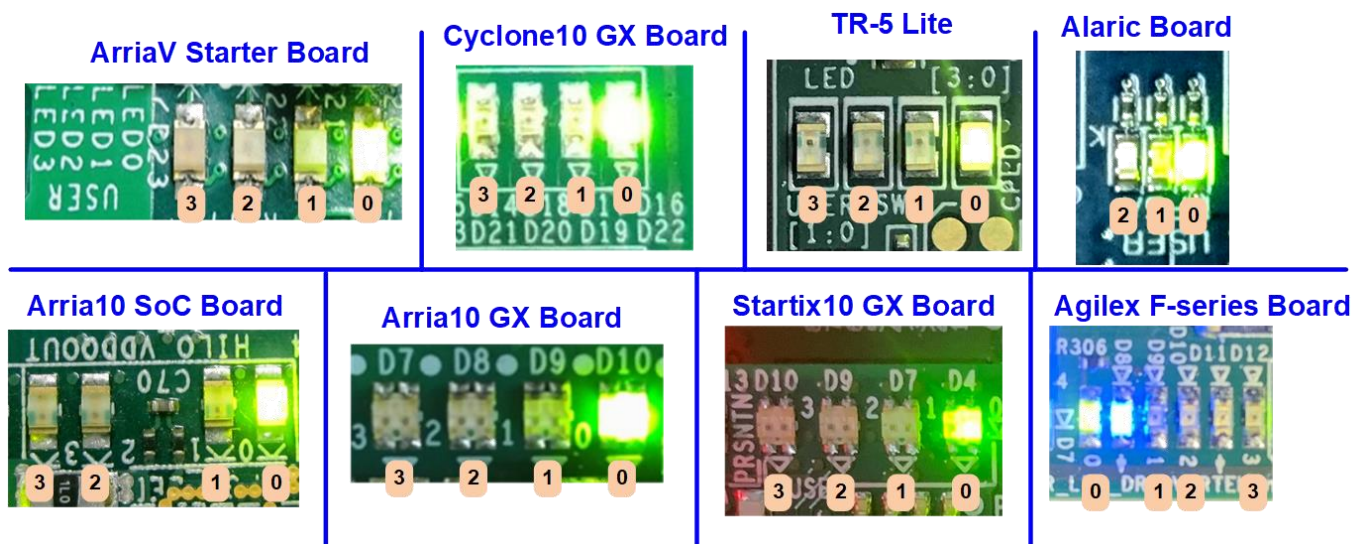


Figure 2-14 LED Status for user output

### 3 Revision History

Revision	Date	Description
1.0	9-Aug-16	Initial version release
1.1	17-Aug-16	Update message during write/read command
1.2	19-Dec-16	Update performance result of new buffer system
1.3	20-Mar-17	Support Arria10 GX Development board
1.4	9-May-17	Update SSD model and test result for new IP version
2.0	8-Jun-17	Support only 256 Kbyte buffer
2.1	31-Jul-17	Add LFSR pattern
2.2	25-Sep-17	Support Alaric board
2.3	27-Oct-17	Change PCIe connector on Alaric board
3.0	20-Jul-18	Support Shutdown, SMART, and Flush command
3.1	12-Feb-20	Support Cyclone10GX and AB18-PCIeX16 board
3.2	20-Apr-20	Remove PCIeSub board support of AB18
4.0	13-Jul-20	Remove instruction from the document and include NVMeG3-IP
4.1	24-Sep-20	Support Stratix10GX board
4.2	1-Jun-21	Support Agilex F-series board (PCIe Gen4)