

# NVMe-IP Demo Instruction

Rev3.2 20-Apr-20

This document describes the instruction to run NVMe-IP demo on FPGA development board by using the PCIe adapter board (AB18-PCleX16 board or AB16-PCleXOVR board). The PCIe adapter does not need for some boards which have PCIe female connector. The demo is designed to send NVMe command such as Write, Read, SMART, and Shutdown to NVMe SSD. User controls the test operation through NiosII command shell.

## 1 Environment Requirement

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

- 1) IntelFPGA board:
  - 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)
- 2) PC installing QuartusII programmer and NiosII command shell software
- 3) The PCIe adapter board (AB18-PCleX16 or AB16-PCleXOVR), provided by Design Gateway  
[https://dgway.com/ABseries\\_E.html](https://dgway.com/ABseries_E.html)
- 4) Power adapter of FPGA board
- 5) ATX power supply for PCIe adapter board
- 6) NVMe SSD connecting to PCIe female connector on AB18/AB16 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, and Alaric board: micro USB cable

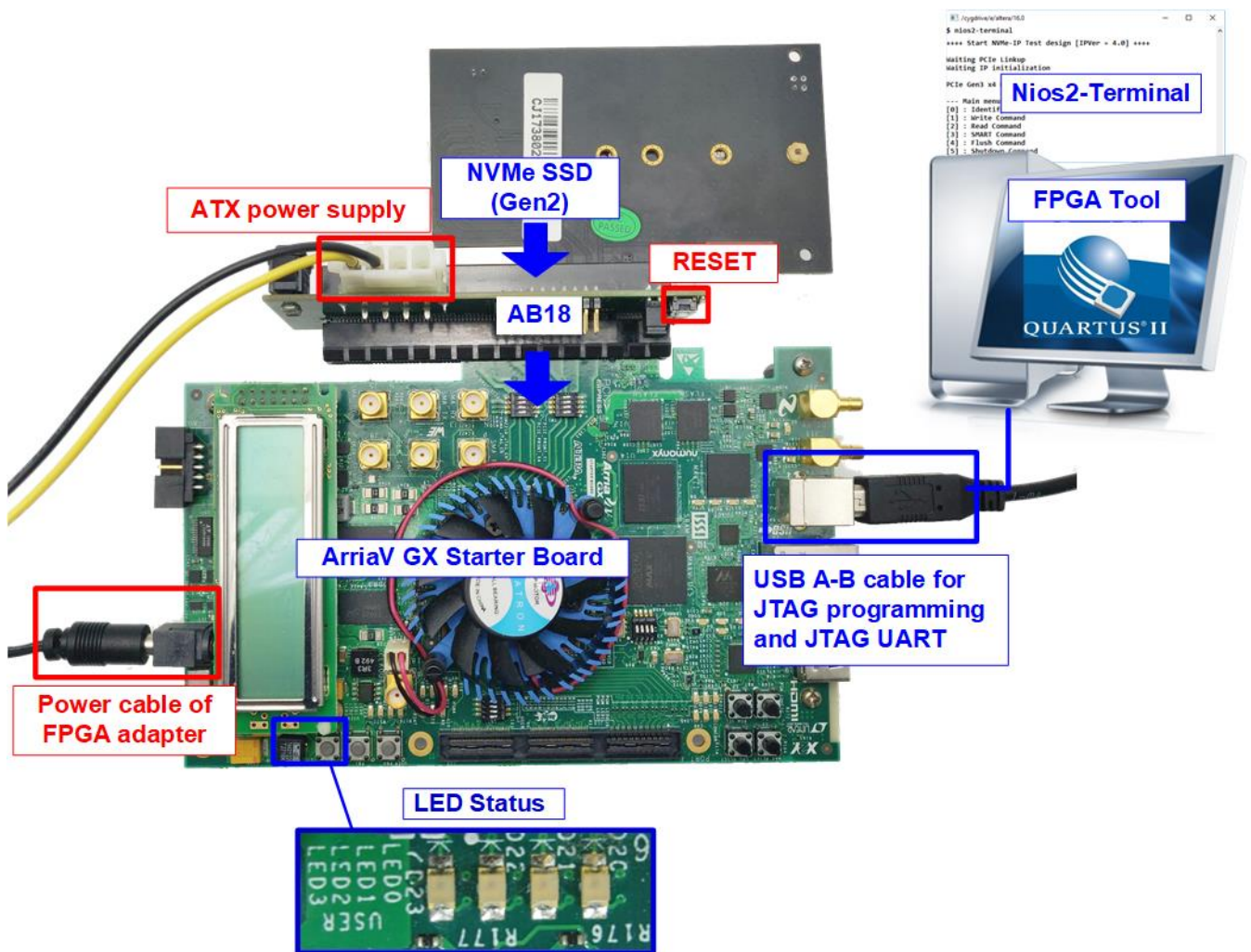


Figure 1-1 NVMe-IP Demo Environment Setup on ArriaV GX Starter Board

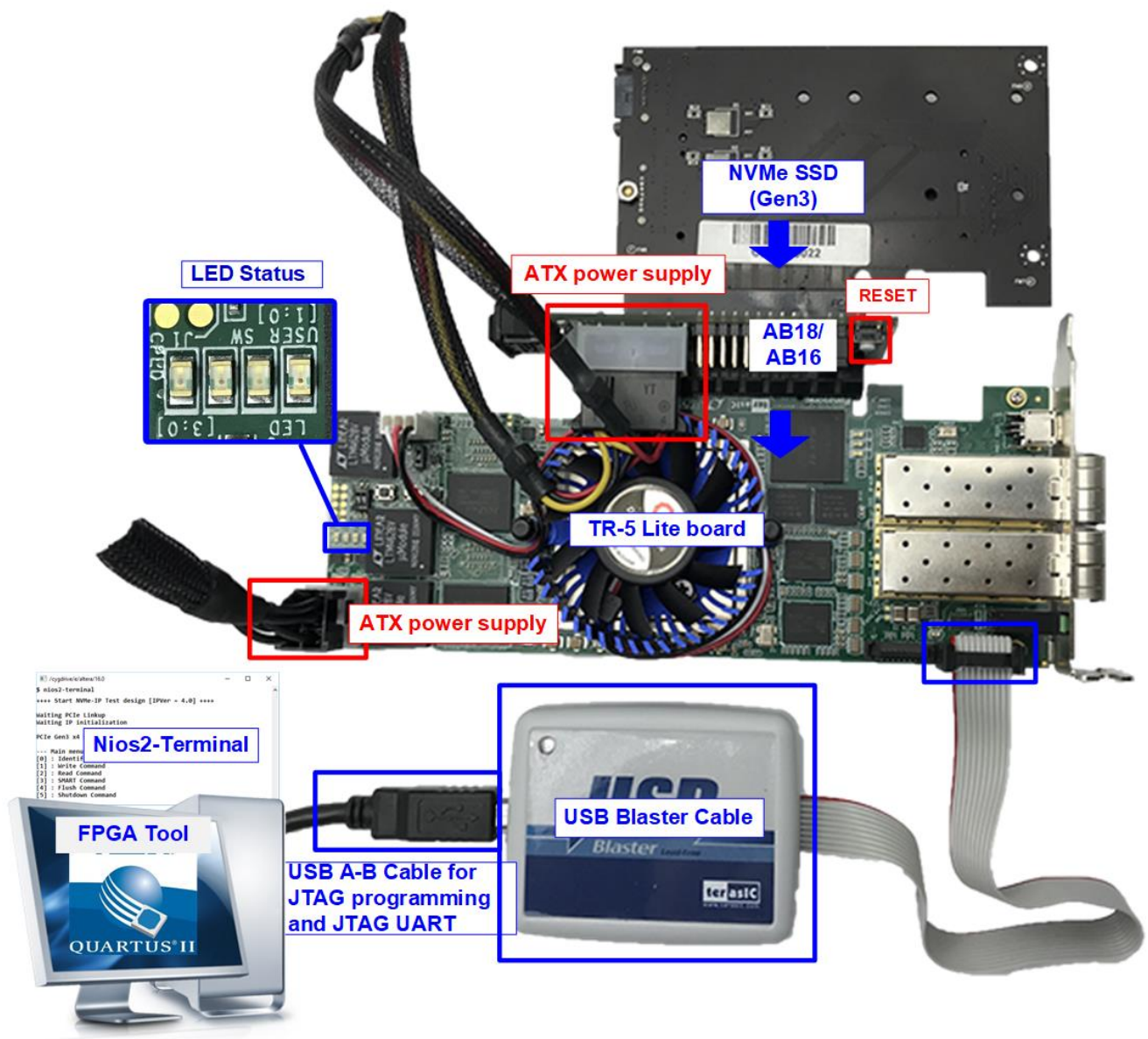


Figure 1-2 NVMe-IP Demo Environment Setup on TR-5 Lite Development Board



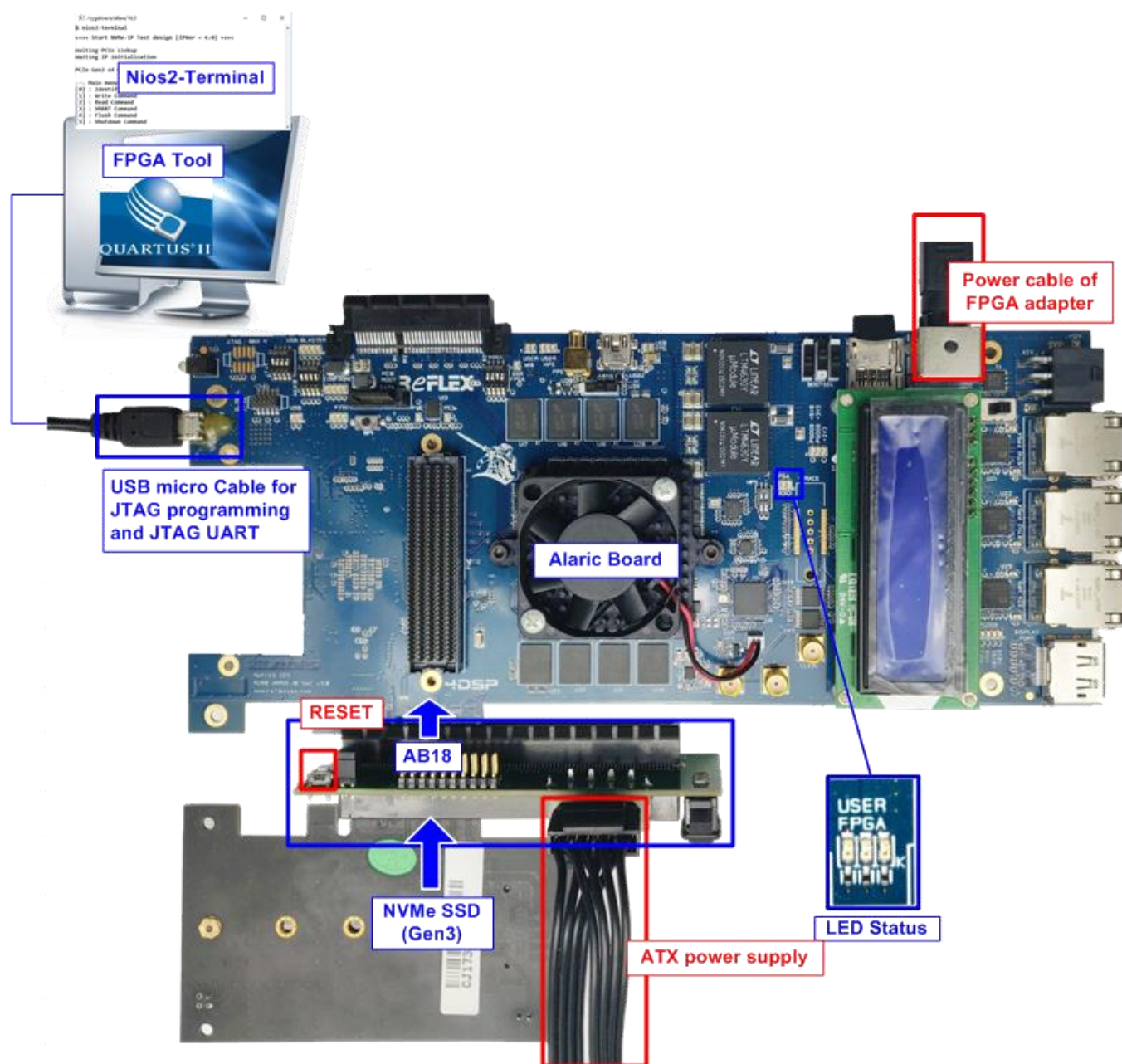


Figure 1-3 NVMe-IP Demo Environment Setup on Alaric Board

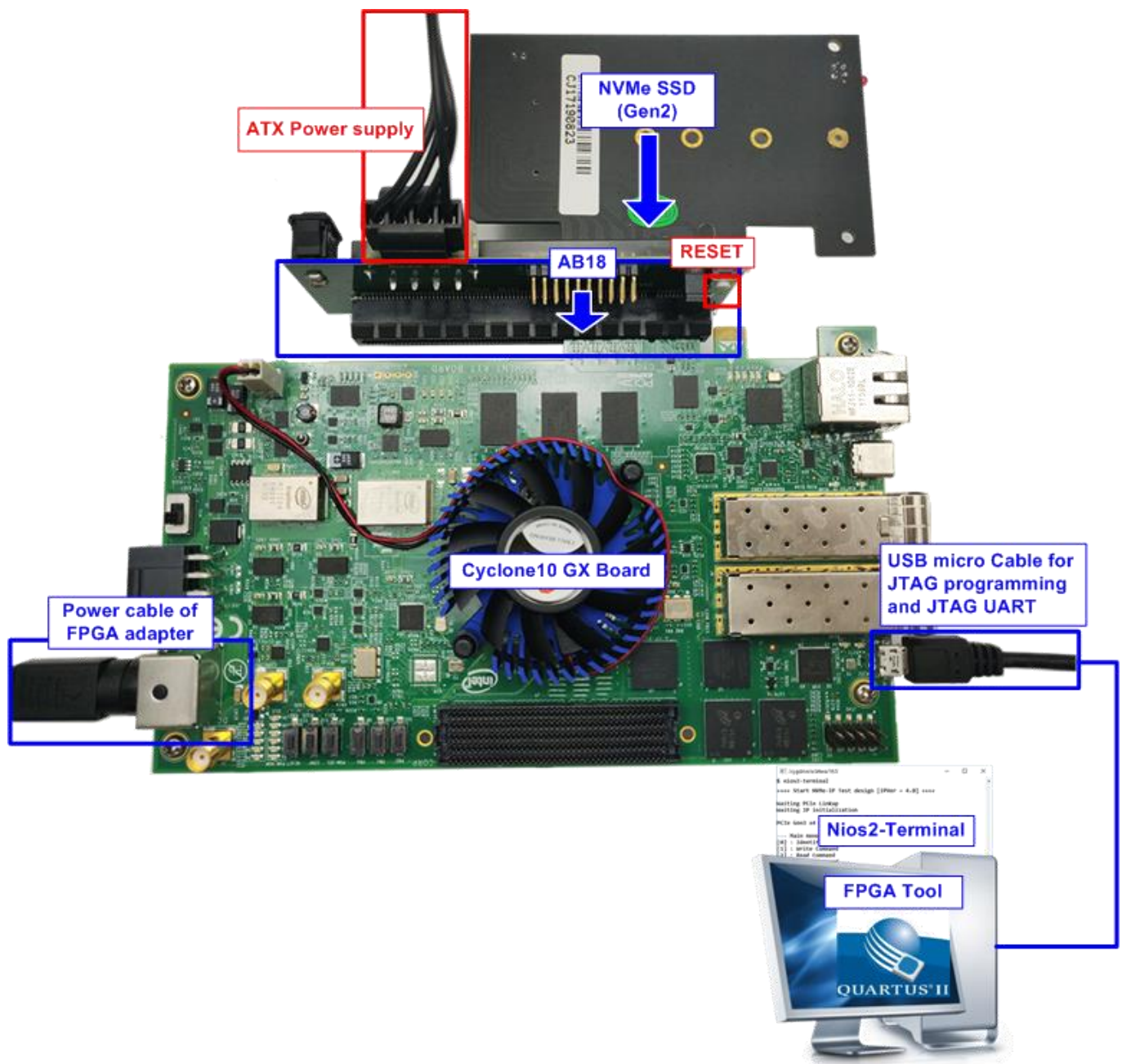


Figure 1-4 NVMe-IP Demo Environment Setup on Cyclone10 GX Development Board

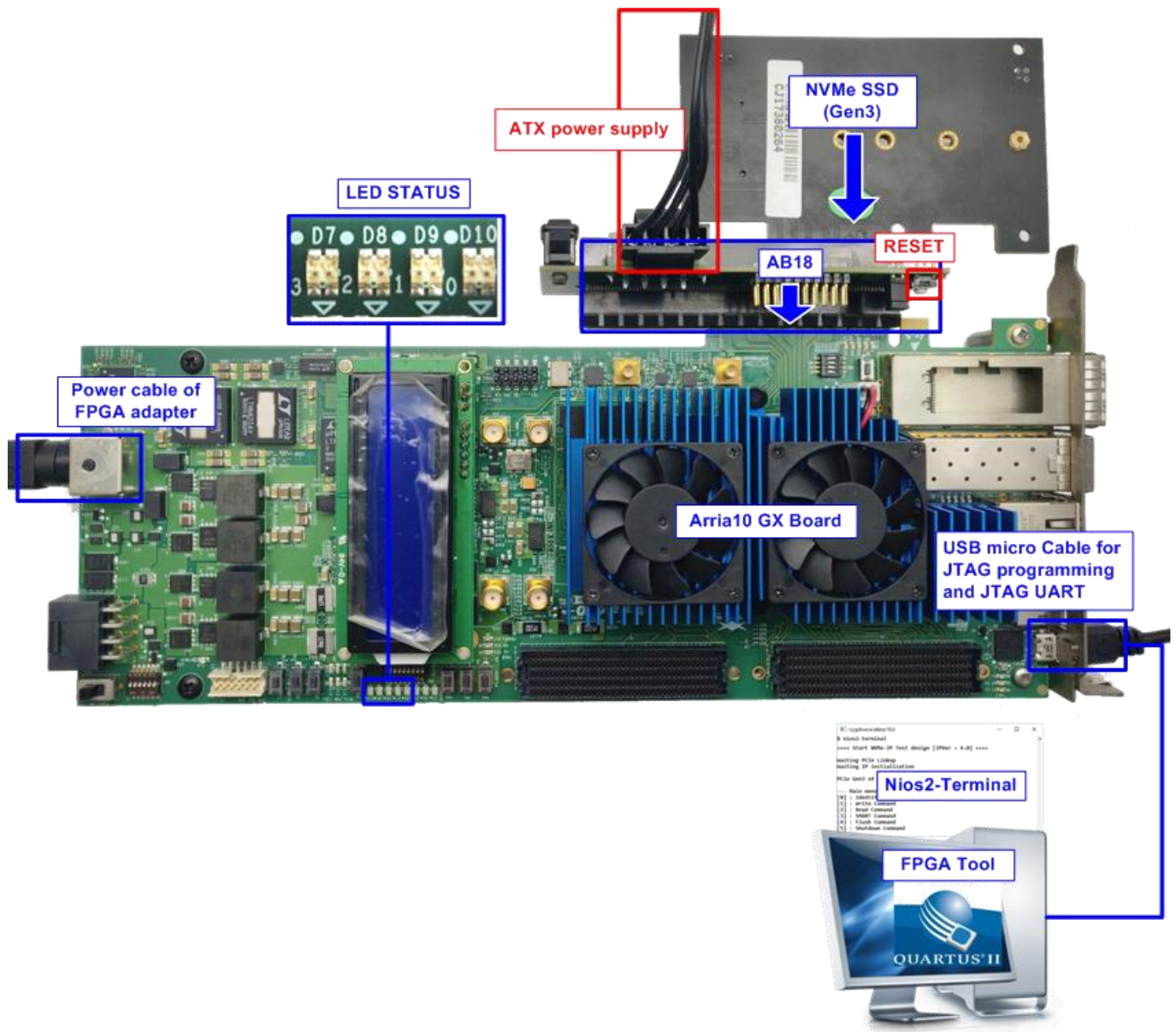


Figure 1-5 NVMe-IP Demo Environment Setup on Arria10 GX Development Board



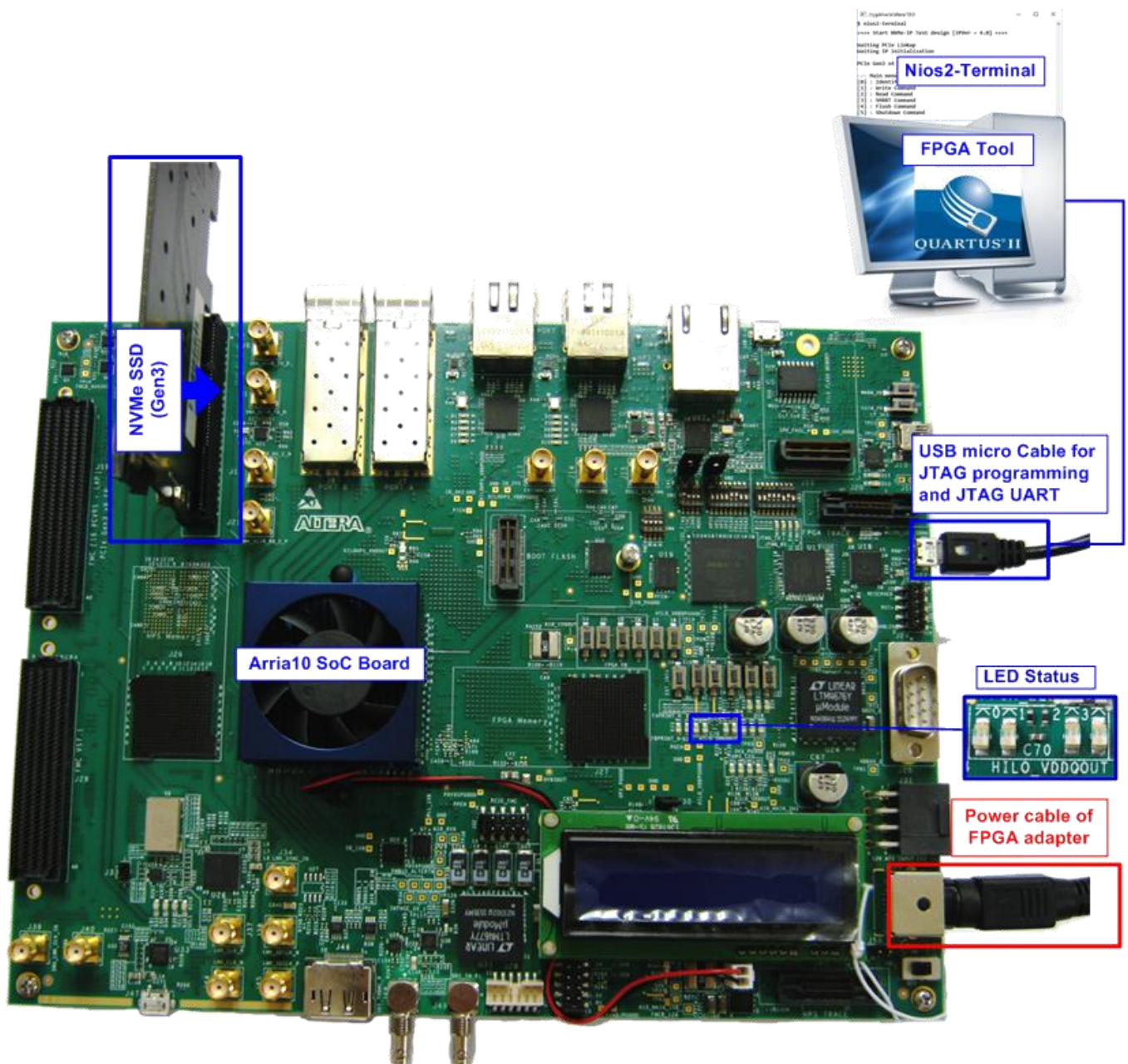


Figure 1-6 NVMe-IP Demo Environment Setup on Arria10 SoC Development Board

## 2 Demo setup

### 2.1 Board setup

#### 2.1.1 TR-5 Lite Development board by AB18/AB16 and ATX power supply

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

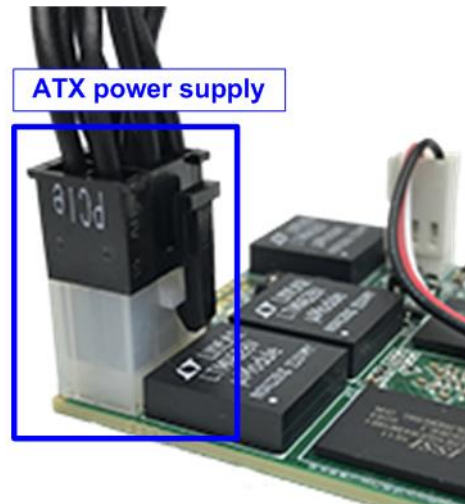


Figure 2-1 ATX power supply connected to FPGA

- 3)
  - a. Connect A Side of PCIe connector on AB18/AB16-PCleXOVR board to PCIe connector on FPGA board.
  - b. Check that two mini jumpers are inserted at J5 connector on AB16.
  - c. Connect NVMe SSD to B Side of PCIe connector on AB16-PCleXOVR board
  - d. Connect ATX power supply to AB18/AB16-PCleXOVR and FPGA board as shown in Figure 2-2

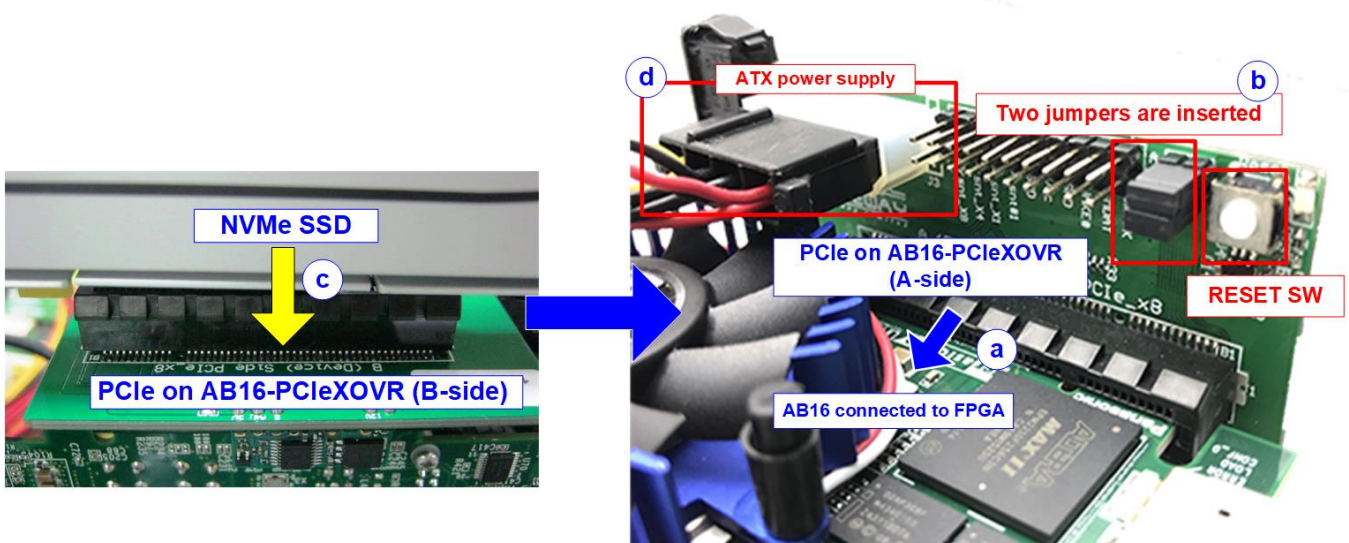


Figure 2-2 Connect PCIe connector between AB16 and FPGA board



- 4) a. Connect USB Blaster cable to FPGA board for JTAG programming/NiosII command shell.  
b. Connect USB A-B cable to USB Blaster, as shown in Figure 2-3.

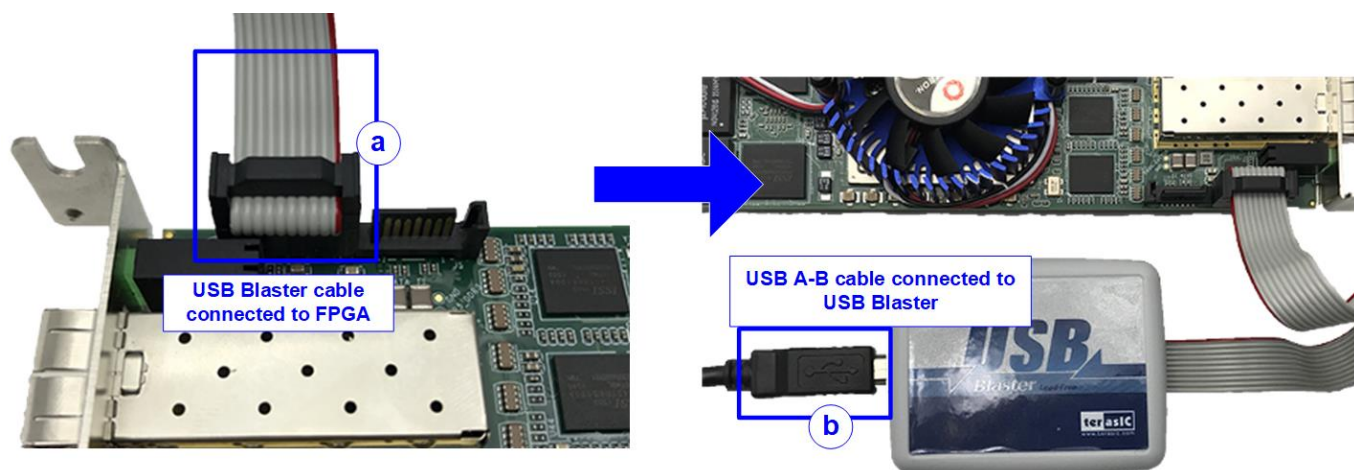


Figure 2-3 USB cable connection

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

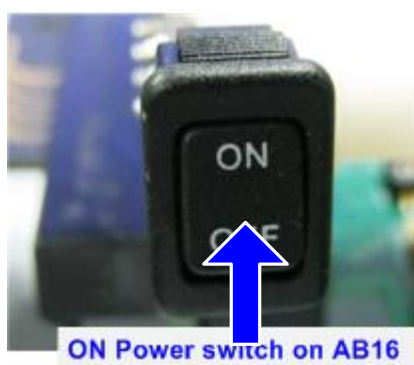


Figure 2-4 Power on AB16 board

### 2.1.2 Arria10 GX/Cyclone10GX/Alaric board or ArriaV GX by AB18 and ATX power supply

- 1) Power off system.
- 2) a. Connect ATX power to ATX power connector on AB18-PCleX16 board.  
 b. Connect A Side of PCIe connector on AB18-PCleX16 board to PCIe connector on FPGA board  
 c. Check that two mini jumpers are inserted at J5 connector on AB18  
 d. Connect NVMe SSD to B Side of PCIe connector on AB18-PCleX16 board

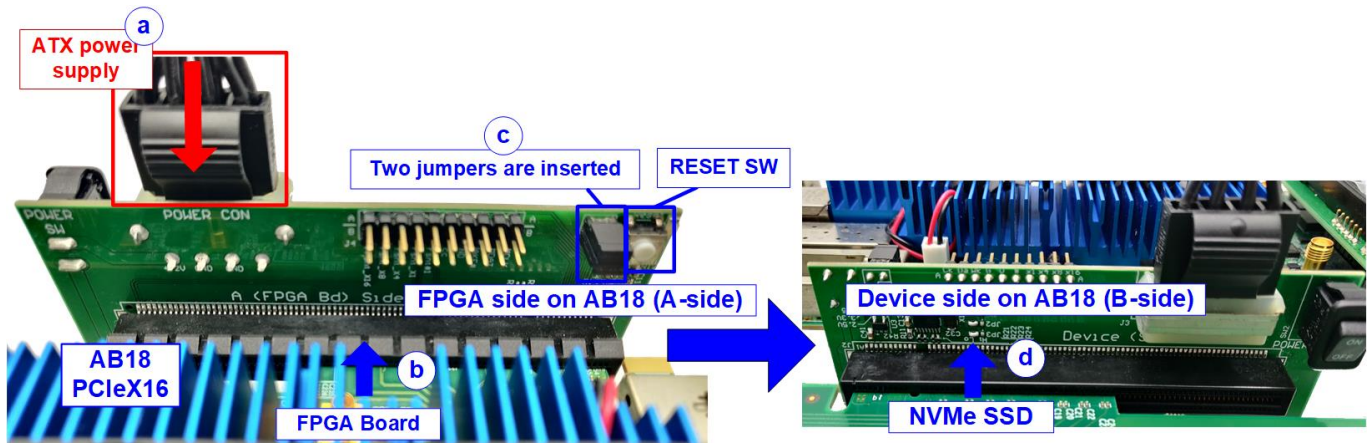


Figure 2-5 Connect PCIe connector between AB16 and FPGA board

- 3) For JTAG programming and NiosII command shell;
  - For Arria10 GX, Cyclone10GX and Alaric board, connect micro USB cable from FPGA board to PC
  - For ArriaV GX, connect USB A-B cable from FPGA board to PC
- 4) Connect FPGA power adapter to FPGA board.
- 5) Turn on power switch of FPGA development board, AB18-PCleX16 board, and ATX power supply.

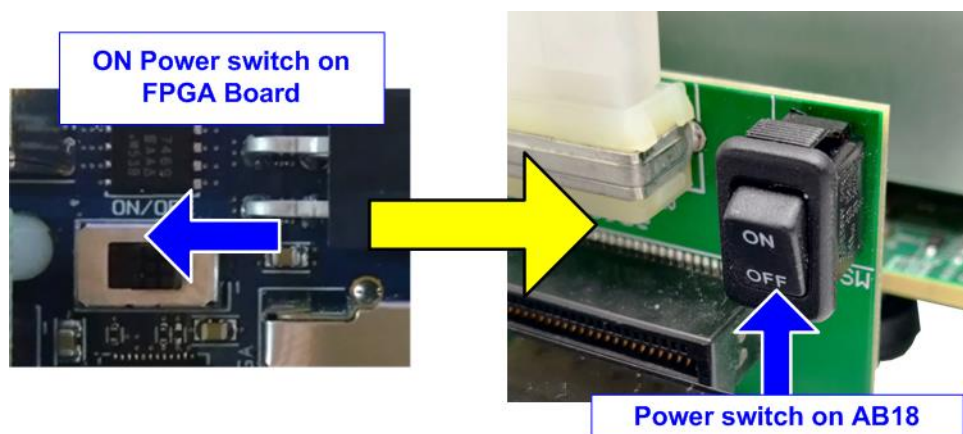


Figure 2-6 Power on FPGA board and AB16 board

### 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 2-7.
- 3) Connect micro USB cable from FPGA board to PC for JTAG programming/NiosII command shell.

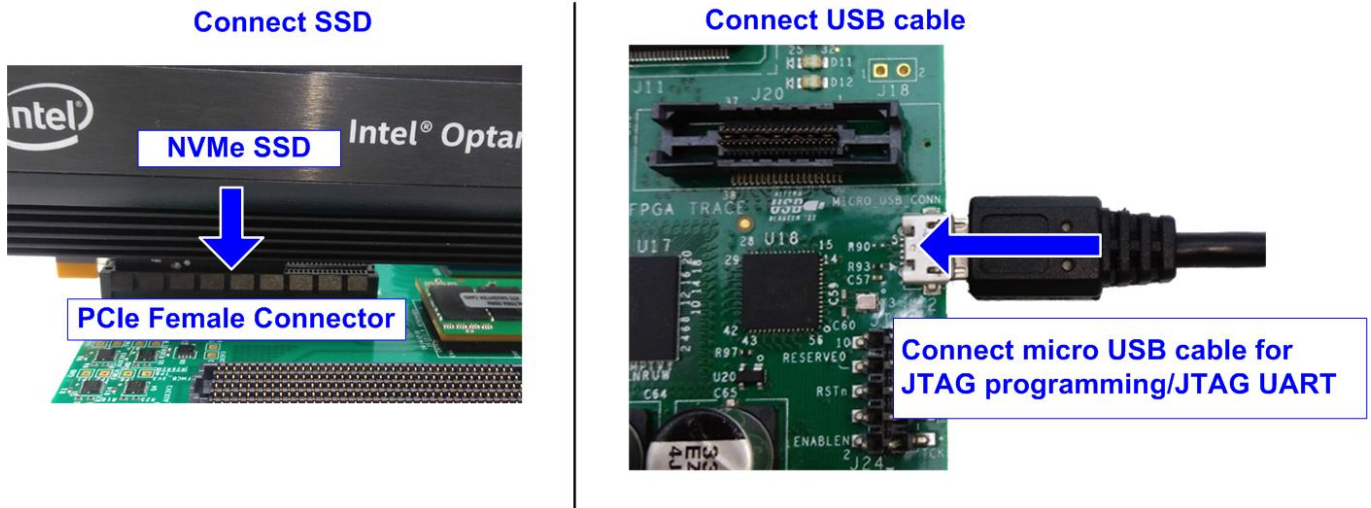


Figure 2-7 NVMe PCIe SSD connection on FPGA board

- 4) Set SW1[2] = OFF position to source power to the PCIe, as shown in Figure 2-8.

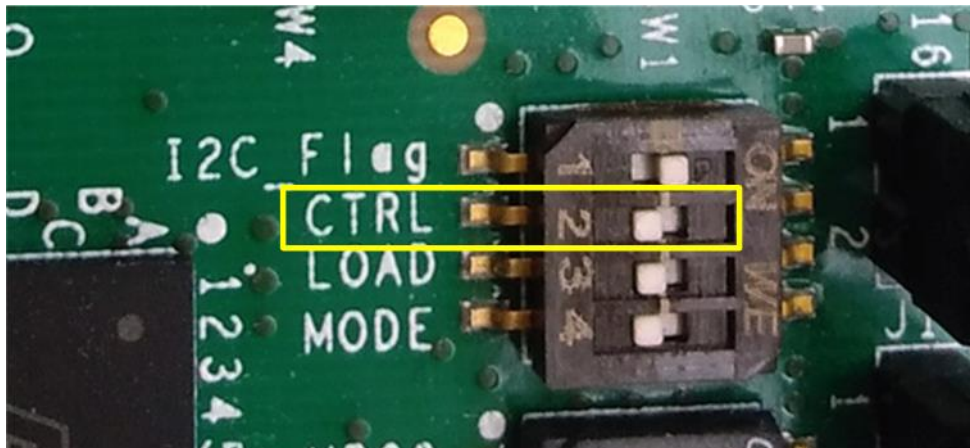


Figure 2-8 Source power to the PCIe for Arria10 SoC board

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



## 2.2 Program setup

- 1) Use QuartusII Programmer to program “NVMeIPTest.sof” file, as shown in Figure 2-9.

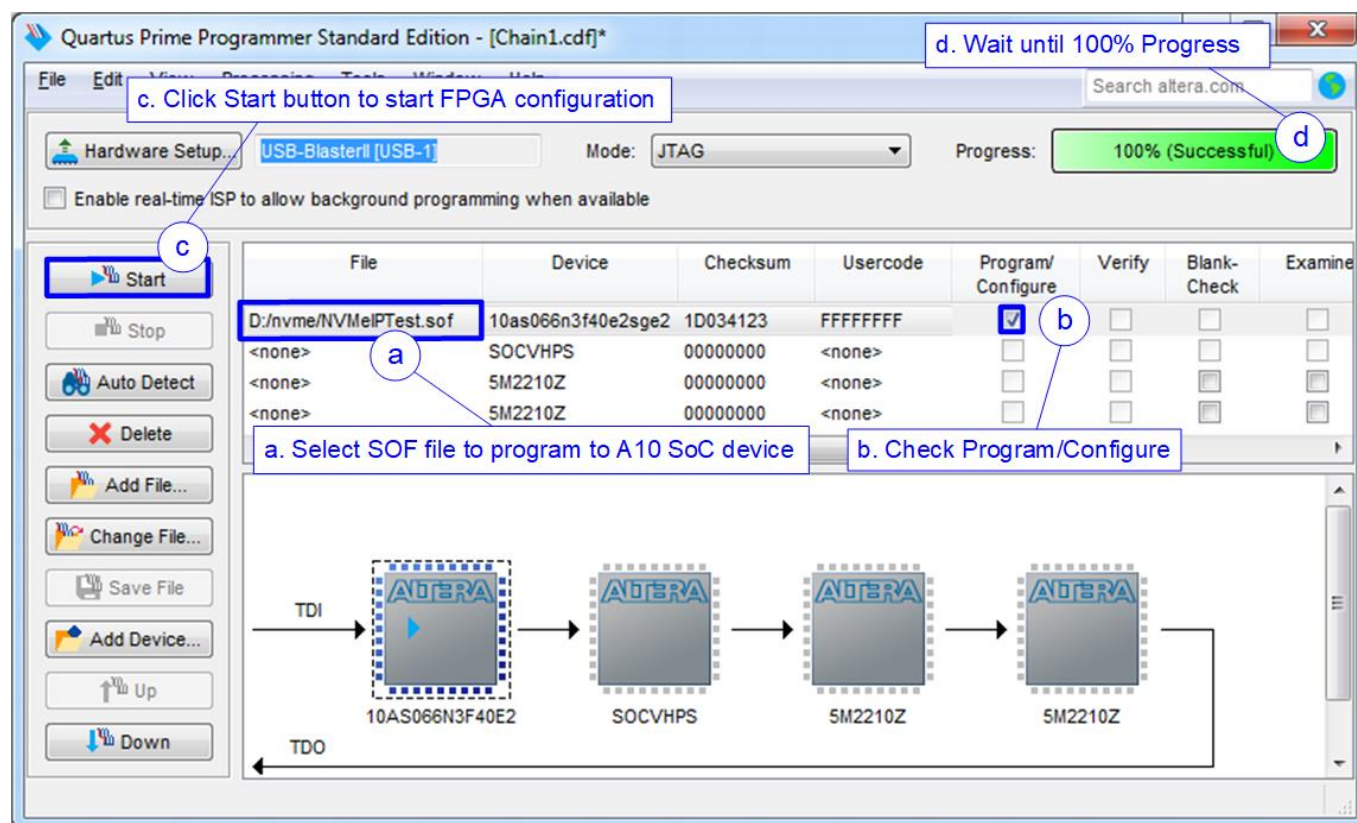


Figure 2-9 Programmed by QuartusII Programmer

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

```

/cygdrive/e/altera/16.0
$ nios2-terminal Command script
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 Wait PCIe Linkup
Waiting IP initialization Wait NVMe-IP busy

PCIe Gen3 x4 Device Detect PCIe speed = Gen3 and PCIe land = 4 lane

--- Main menu [IPVer = 4.0] ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command
  
```

Main menu to select operating command

Figure 2-10 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.

- 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. After that, the system is ready to receive command from user.

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

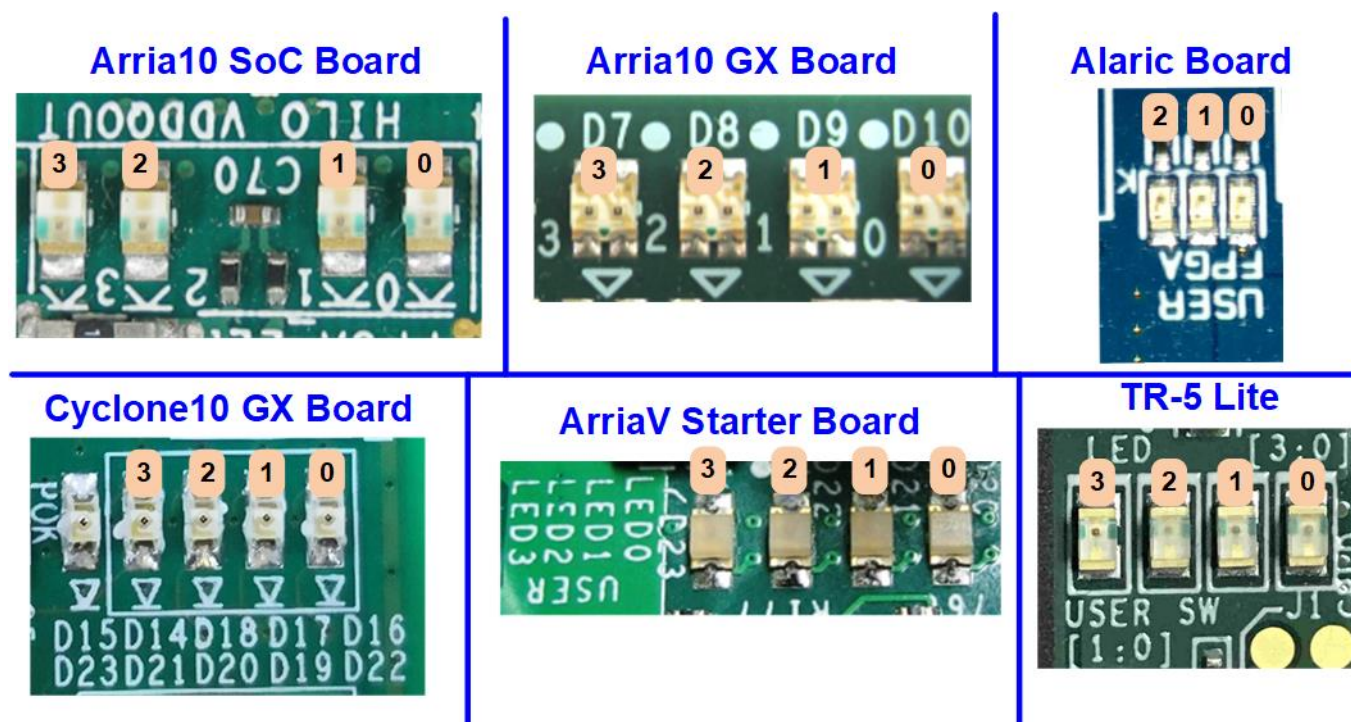


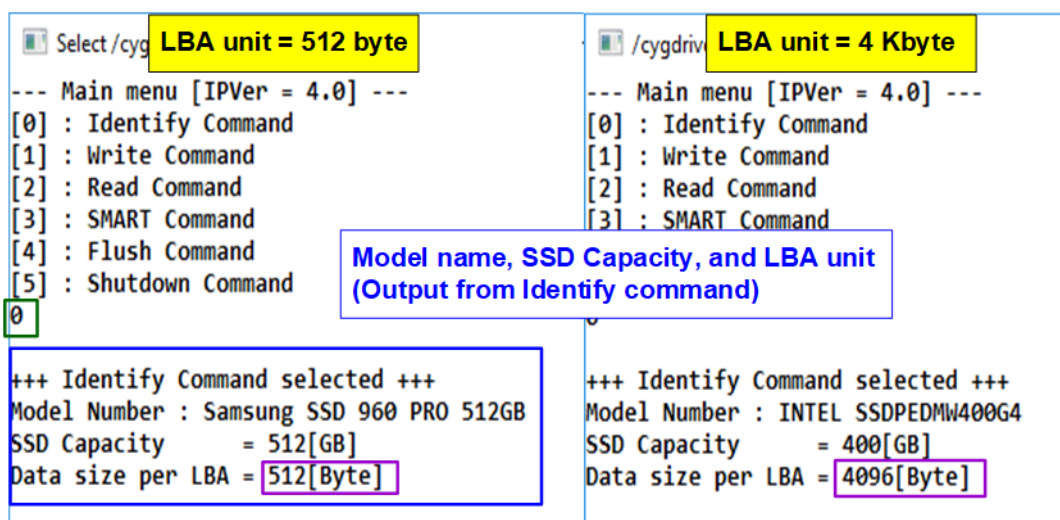
Figure 2-11 LED Status for user output



### 3 Test Menu

#### 3.1 Identify Command

Select '0' to send Identify command to NVMe SSD.



Terminal Window	LBA unit	Model Number	SSD Capacity	Data size per LBA
Select /cyg	512 byte	Samsung SSD 960 PRO 512GB	512[GB]	512[Byte]
/cygdrive	4 Kbyte	INTEL SSDPEDMW400G4	400[GB]	4096[Byte]

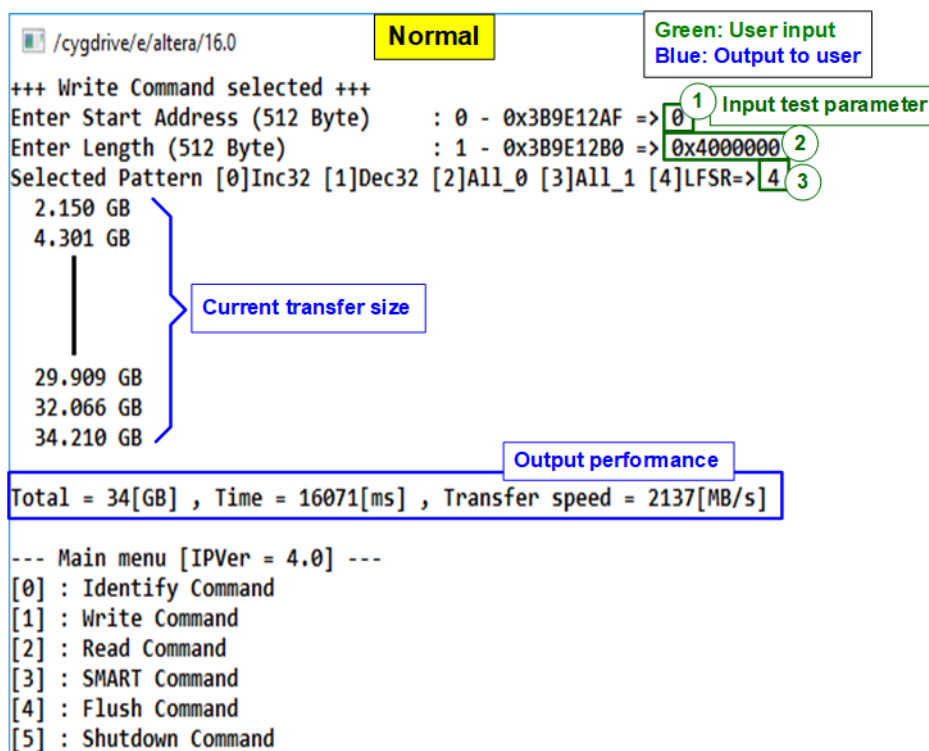
Figure 3-1 Test result when running Identify command

After finishing the operation, the SSD information output from Identify command is displayed. The console shows three values.

- 1) SSD model number: This value is decoded from Identify controller data.
- 2) SSD capacity: This value is signal output from NVMe-IP.
- 3) Data size per LBA: This value is signal output from NVMe-IP. Two values are supported, i.e. 512 byte and 4 Kbyte.

## 3.2 Write Command

Select '1' to send Write command to NVMe SSD.



```

/cygdrive/e/altera/16.0
Normal
+++ Write Command selected +++
Enter Start Address (512 Byte) : 0 - 0x3B9E12AF => 0
Enter Length (512 Byte) : 1 - 0x3B9E12B0 => 0x4000000
Selected Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR=> 4
2.150 GB
4.301 GB
29.909 GB
32.066 GB
34.210 GB
Total = 34[GB] , Time = 16071[ms] , Transfer speed = 2137[MB/s]
--- Main menu [IPVer = 4.0] ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command

```

Figure 3-2 Test result when running Write command

User inputs three parameters as follows.

- 1) Start Address: Input start address to write SSD as 512-byte unit. The input is decimal unit when user enters only digit number. User can add "0x" to be a prefix for hexadecimal unit. When LBA unit of SSD is 4 Kbyte, this input must be aligned to 8.
- 2) Transfer Length: Input total transfer size as 512-byte unit. The input is decimal unit when user enters only digit number. User can add "0x" to be a prefix for hexadecimal unit. When LBA unit of SSD is 4 Kbyte, this input must be aligned to 8.
- 3) Test pattern: Select test data pattern for writing to SSD. There are five patterns, i.e. 32-bit incremental, 32-bit decremental, all-0, all-1, and 32-bit LFSR counter.

When all inputs are valid, the operation begins. During writing data, current transfer size is displayed on the console every second to show that system is still alive. Finally, total size, total time usage, and test speed are displayed on the console to be a test result.

Test data of 32-bit increment pattern																Test data of 32-bit LFSR pattern																	
←64-bit header of each 512-byte→																←64-bit header of each 512-byte→																	
Offset	48-bit address (512 byte unit)								Test data (32-bit increment)								Offset	48 bit address								Test data (32-bit LFSR)							
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00000000	00	00	00	00	00	00	00	00	02	00	00	00	03	00	00	00	00	00	00	00	00	00	00	00	01	00	00	00	02	00	00	00	
00000010	04	00	00	00	05	00	00	00	06	00	00	00	07	00	00	00	04	00	00	00	09	00	00	00	12	00	00	00	24	00	00	00	
00000020	08	00	00	00	09	00	00	00	0A	00	00	00	0B	00	00	00	49	00	00	00	92	00	00	00	24	01	00	00	49	02	00	00	
00000030	0C	00	00	00	0D	00	00	00	0E	00	00	00	0F	00	00	00	92	04	00	00	24	09	00	00	49	12	00	00	92	24	00	00	
00000040	10	00	00	00	11	00	00	00	12	00	00	00	13	00	00	00	24	49	00	00	49	92	00	00	92	24	01	00	24	49	02	00	
00000050	14	00	00	00	15	00	00	00	16	00	00	00	17	00	00	00	49	92	04	00	92	24	09	00	24	49	12	00	49	92	24	00	
00000060	18	00	00	00	19	00	00	00	1A	00	00	00	1B	00	00	00	93	24	49	00	27	49	92	00	4F	92	24	01	9E	24	49	02	
The 1 <sup>st</sup> 512-byte data																3C	49	92	04	79	92	24	09	F3	24	49	12	E7	49	92	24		
00000090	24	00	00	00	25	00	00	00	26	00	00	00	27	00	00	00	CF	93	24	49	9E	27	49	92	3D	4F	92	24	7A	9E	24	49	
000000A0	28	00	00	00	29	00	00	00	2A	00	00	00	2B	00	00	00	5D	CF	93	24	BA	9E	27	49	75	3D	4F	92	EB	7A	9E	24	
000000B0	2C	00	00	00	2D	00	00	00	2E	00	00	00	2F	00	00	00	D7	F5	3C	49	AE	EB	79	92	5C	D7	F3	24	B8	AE	E7	49	
000000C0	30	00	00	00	31	00	00	00	32	00	00	00	33	00	00	00	70	5D	CF	93	E0	BA	9E	27	C1	75	3D	4F	83	EB	7A	9E	
000000D0	34	00	00	00	35	00	00	00	36	00	00	00	37	00	00	00	07	D7	F5	3C	0E	AE	EB	79	1D	5C	D7	F3	3B	B8	AE	E7	
000000E0	38	00	00	00	39	00	00	00	3A	00	00	00	3B	00	00	00	77	70	5D	CF	EE	E0	BA	9E	DC	C1	75	3D	B8	83	EB	7A	
000000F0	3C	00	00	00	3D	00	00	00	3E	00	00	00	3F	00	00	00	70	07	D7	F5	E0	0E	AE	EB	C1	1D	5C	D7	83	3B	B8	AE	
00000100	40	00	00	00	41	00	00	00	42	00	00	00	43	00	00	00	07	77	70	5D	0E	EE	E0	BA	1C	DC	C1	75	39	B8	83	EB	
00000110	44	00	00	00	45	00	00	00	46	00	00	00	47	00	00	00	73	70	07	D7	E6	E0	0E	AE	CD	C1	1D	5C	9A	83	3B	B8	
00000120	48	00	00	00	49	00	00	00	4A	00	00	00	4B	00	00	00	34	07	77	70	68	0E	EE	E0	D1	1C	DC	C1	A3	39	B8	83	
00000130	4C	00	00	00	4D	00	00	00	4E	00	00	00	4F	00	00	00	47	73	70	07	8E	E6	E0	0E	1D	CD	C1	1D	3A	9A	83	3B	
00000140	50	00	00	00	51	00	00	00	52	00	00	00	53	00	00	00	74	34	07	77	E9	68	0E	EE	D3	D1	1C	DC	A6	A3	39	B8	
00000150	54	00	00	00	55	00	00	00	56	00	00	00	57	00	00	00	4C	47	73	70	98	8E	E6	E0	31	1D	CD	C1	63	3A	9A	83	
00000160	58	00	00	00	59	00	00	00	5A	00	00	00	5B	00	00	00	C6	74	34	07	8D	E9	68	0E	1B	D3	D1	1C	37	A6	A3	39	
00000170	5C	00	00	00	5D	00	00	00	5E	00	00	00	5F	00	00	00	6E	4C	47	73	DC	98	8E	E6	B8	31	1D	CD	70	63	3A	9A	
00000180	60	00	00	00	61	00	00	00	62	00	00	00	63	00	00	00	E1	C6	74	34	C3	8D	E9	68	86	1B	D3	D1	0D	37	A6	A3	
00000190	64	00	00	00	65	00	00	00	66	00	00	00	67	00	00	00	1A	6E	4C	47	34	DC	98	8E	68	B8	31	1D	D0	70	63	3A	
000001A0	68	00	00	00	69	00	00	00	6A	00	00	00	6B	00	00	00	A0	E1	C6	74	41	C3	8D	E9	83	86	1B	D3	06	0D	37	A6	
000001B0	6C	00	00	00	6D	00	00	00	6E	00	00	00	6F	00	00	00	0C	1A	6E	4C	18	34	DC	98	30	68	B8	31	60	D0	70	63	
000001C0	70	00	00	00	71	00	00	00	72	00	00	00	73	00	00	00	C0	A0	E1	C6	81	41	C3	8D	03	83	86	1B	07	06	0D	37	
000001D0	74	00	00	00	75	00	00	00	76	00	00	00	77	00	00	00	0F	0C	1A	6E	1F	18	34	DC	3F	30	68	B8	7F	60	D0	70	
000001E0	78	00	00	00	79	00	00	00	7A	00	00	00	7B	00	00	00	FF	C0	A0	E1	FF	81	41	C3	FE	03	83	86	FD	07	06	0D	
000001F0	7C	00	00	00	7D	00	00	00	7E	00	00	00	7F	00	00	00	FA	0F	0C	1A	F4	1F	18	34	E9	3F	30	68	D3	7F	60	D0	
00000200	01	00	00	00	00	00	00	00	82	00	00	00	83	00	00	00	01	00	00	00	00	00	00	00	02	00	00	00	04	00	00	00	
The 2 <sup>nd</sup> 512-byte data																09	00	00	00	12	00	00	00	24	00	00	00	49	00	00	00		
64-bit header																92	00	00	00	24	01	00	00	49	02	00	00	92	04	00	00		
																64-bit header																	

Figure 3-3 Example Test data of the 1<sup>st</sup> and 2<sup>nd</sup> 512-byte by using increment/LFSR pattern

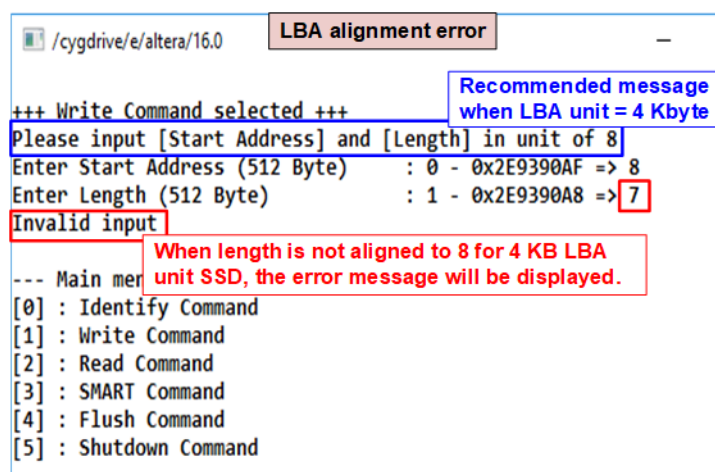
Test data in SSD is split into 512-byte unit. For incremental, decremental, or LFSR pattern, each 512-byte data has unique 64-bit header consisting of 48-bit address (in 512-byte unit) and 16-bit zero value. The data after 64-bit header is the test pattern which is selected by user.

The left window of Figure 3-3 shows the example when using 32-bit incremental pattern while the right window shows the example when using 32 bit LFSR pattern. The unique header is not included when running all-0 or all-1 pattern.



When user runs Write or Read command with 4-Kbyte LBA SSD, there is the message displaying on the console to show the input limitation which must be aligned to 8, as shown in Figure 3-4. When the input does not align to 8, “Invalid input” is displayed and the operation is cancelled.

Also, Figure 3-5 shows the example when the input is out of the recommended range for each parameter. The console displays “Invalid input” and then the operation is cancelled.

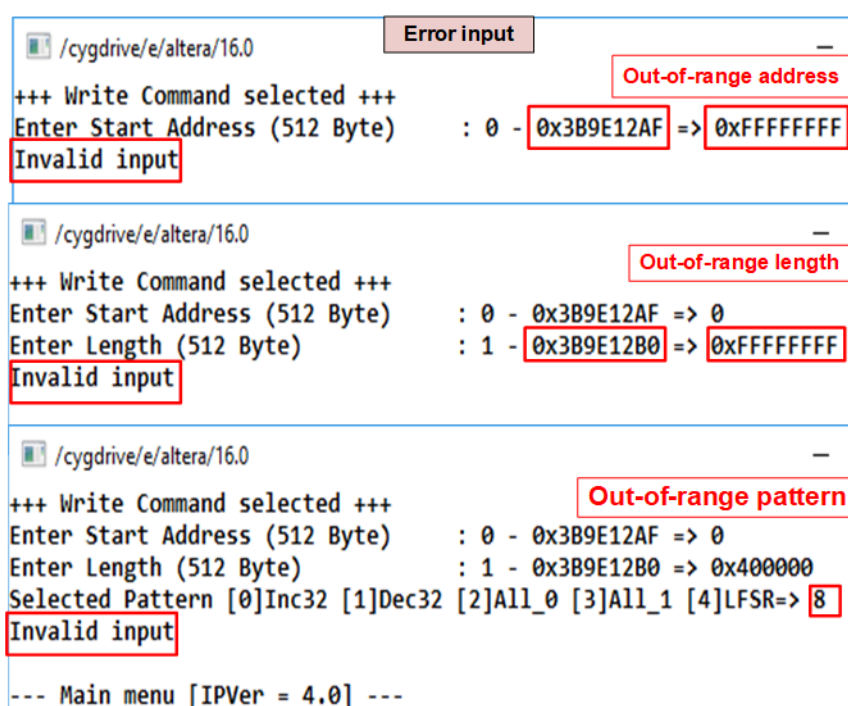


```

/cygdrive/e/altera/16.0
+++ Write Command selected +++
Please input [Start Address] and [Length] in unit of 8
Enter Start Address (512 Byte) : 0 - 0x2E9390AF => 8
Enter Length (512 Byte) : 1 - 0x2E9390A8 => 7
Invalid input
--- Main menu ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command

```

Figure 3-4 Error message when the input is unaligned for SSD with 4KB LBA unit



```

/cygdrive/e/altera/16.0
+++ Write Command selected +++
Enter Start Address (512 Byte) : 0 - 0x3B9E12AF => 0xFFFFFFFF
Invalid input

/cygdrive/e/altera/16.0
+++ Write Command selected +++
Enter Start Address (512 Byte) : 0 - 0x3B9E12AF => 0
Enter Length (512 Byte) : 1 - 0x3B9E12B0 => 0xFFFFFFFF
Invalid input

/cygdrive/e/altera/16.0
+++ Write Command selected +++
Enter Start Address (512 Byte) : 0 - 0x3B9E12AF => 0
Enter Length (512 Byte) : 1 - 0x3B9E12B0 => 0x400000
Selected Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR=> 8
Invalid input

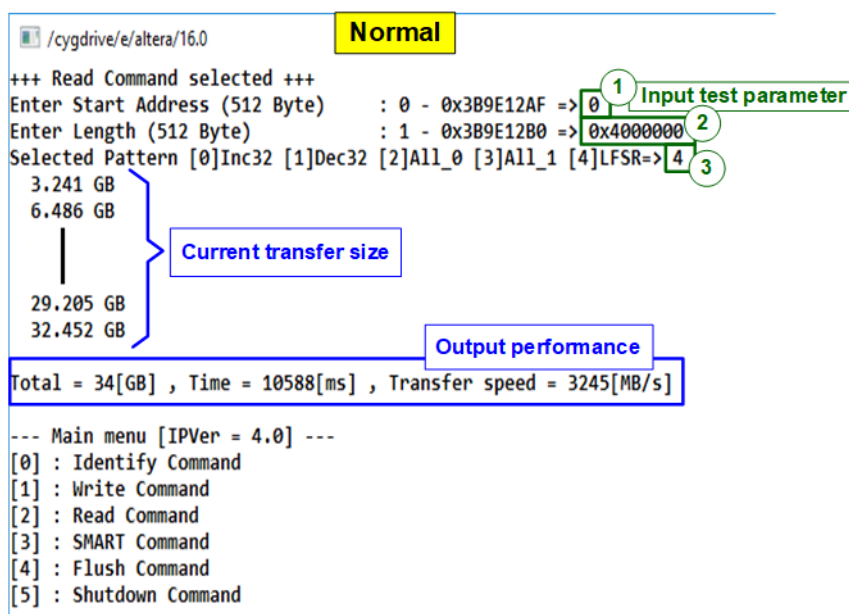
--- Main menu [IPVer = 4.0] ---

```

Figure 3-5 Error message from the invalid input

### 3.3 Read Command

Select '2' to send Read command to NVMe SSD.



```

/cygdrive/e/altera/16.0
Normal
+++ Read Command selected +++
Enter Start Address (512 Byte) : 0 - 0x3B9E12AF => 0
Enter Length (512 Byte) : 1 - 0x3B9E12B0 => 0x4000000
Selected Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR=> 4
3.241 GB
6.486 GB
|
29.205 GB
32.452 GB
Total = 34[GB] , Time = 10588[ms] , Transfer speed = 3245[MB/s]
--- Main menu [IPVer = 4.0] ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command
  
```

Annotations in the screenshot:

- Input test parameter:** Points to the input '0' for Start Address.
- Current transfer size:** Points to the list of transfer sizes (3.241 GB, 6.486 GB, 29.205 GB, 32.452 GB).
- Output performance:** Points to the summary line: Total = 34[GB] , Time = 10588[ms] , Transfer speed = 3245[MB/s].

Figure 3-6 Input and result of Read Command menu

User inputs three parameters as follows.

- 1) Start Address: Input start address to read SSD as 512-byte unit. The input is decimal unit when user enters only digit number. User can add "0x" to be a prefix for hexadecimal unit. When LBA unit of SSD is 4 Kbyte, this input must be aligned to 8.
- 2) Transfer Length: Input total transfer size as 512-byte unit. The input is decimal unit when user enters only digit number. User can add "0x" to be a prefix for hexadecimal unit. If LBA unit of SSD is 4 Kbyte, this input must be aligned to 8.
- 3) Test pattern: Select test data pattern to verify data from SSD. Test pattern must be matched with the pattern using in Write Command menu. There are five patterns, i.e. 32-bit incremental, 32-bit decremental, all-0, all-1, and 32-bit LFSR counter

Similar to Write command menu, test system reads data from SSD when all inputs are valid. During reading data, current transfer size is displayed on the console every second to show that system is still alive. Total size, total time usage, and test speed are displayed after finishing the operation.

"Invalid input" is displayed when some inputs are invalid or unaligned to 8 (when connecting to 4-KB LBA SSD).

Figure 3-7 shows error message when data verification is failed. “Verify fail” is displayed with the information of the 1<sup>st</sup> failure data, i.e. the error byte address, the expected value, and the read value.

User can press any key(s) to cancel read operation or wait until finishing Read command. Similar to the normal condition, the output performance is displayed on the console when the user does not enter any key(s) to stop the operation.

When cancelling the operation, the read command still runs as the background process. It is recommended to power-off/on AB18/AB16, and then press “RESET” button to restart system.



```

Select /cygdrive/e/ Verification error without cancellation
+++ Read Command selected +++
Enter Start Address (512 Byte) : 0 - 0x3B9E12AF => 0
Enter Length (512 Byte) : 1 - 0x3B9E12B0 => 0x40000000
Selected Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR=> 0
Verify fail
1st Error at Byte Addr = 0x00000000
Expect Data = 0x00000002_00000002_00000000_00000000
Read Data = 0x00000001_00000001_00000000_00000000
Press any key to cancel operation
3.242 GB
6.485 GB
|
29.193 GB
32.440 GB
Total = 34[GB] , Time = 10591[ms] , Transfer speed = 3244[MB/s]

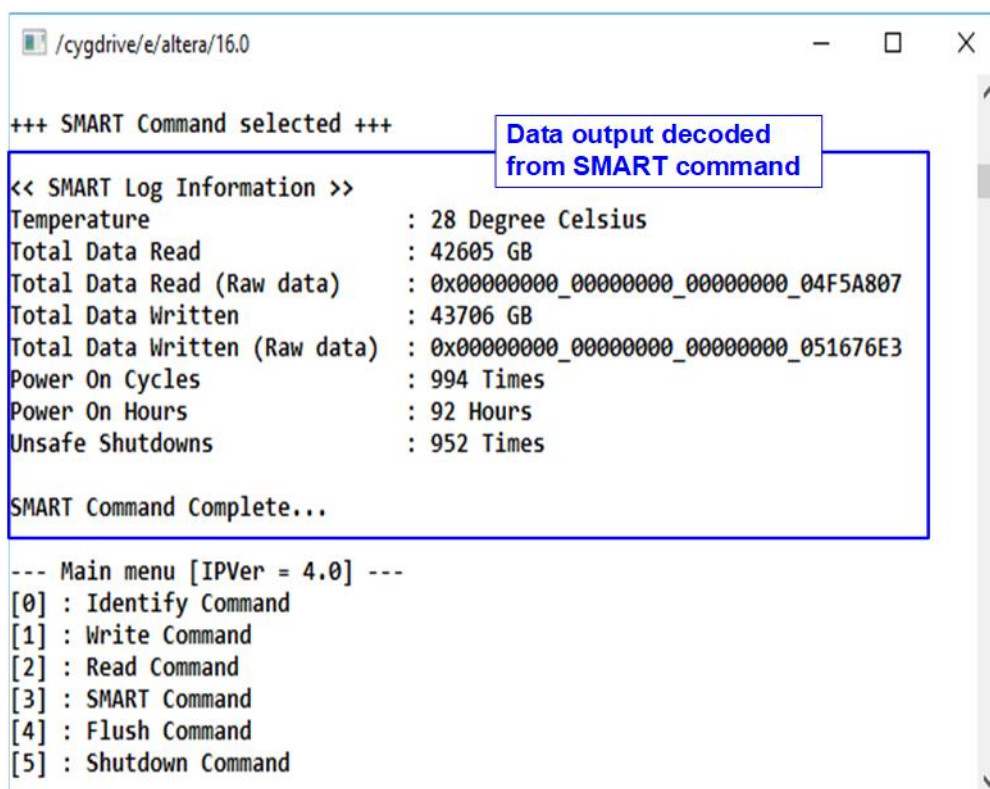
Select /cygdrive/e/alte Verification error with cancellation
+++ Read Command selected +++
Enter Start Address (512 Byte) : 0 - 0x3B9E12AF => 0
Enter Length (512 Byte) : 1 - 0x3B9E12B0 => 0x40000000
Selected Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR=> 0
Verify fail
1st Error at Byte Addr = 0x00000000
Expect Data = 0x00000002_00000002_00000000_00000000
Read Data = 0x00000001_00000001_00000000_00000000
Press any key to cancel operation
3.244 GB
6.492 GB
Operation is cancelled
Please reset system before starting a new test
--- Main menu [IPVer = 4.0] ---
[0] : Identify Command
[1] : Write Command
  
```

Figure 3-7 Data verification is failed



### 3.4 SMART Command

Select '3' to send SMART command to NVMe SSD.



```

/cygdrive/e/altera/16.0

+++ SMART Command selected +++

<< SMART Log Information >>
Temperature                : 28 Degree Celsius
Total Data Read             : 42605 GB
Total Data Read (Raw data)  : 0x00000000_00000000_00000000_04F5A807
Total Data Written          : 43706 GB
Total Data Written (Raw data) : 0x00000000_00000000_00000000_051676E3
Power On Cycles             : 994 Times
Power On Hours              : 92 Hours
Unsafe Shutdowns            : 952 Times

SMART Command Complete...

--- Main menu [IPVer = 4.0] ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command

```

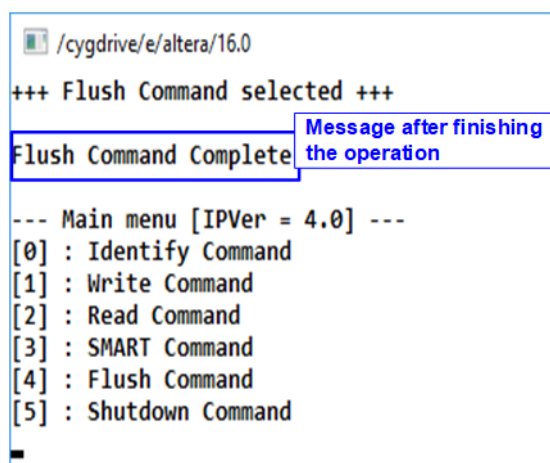
Figure 3-8 Test result when running SMART Command

When finishing the operation, SMART/Health Information (output from SMART command) is displayed as shown in Figure 3-8. The console shows six parameters, described as follows.

- 1) Temperature in °C unit.
- 2) Total Data Read decoded as GB/TB unit. Additionally, raw data without decoding is displayed in 128-bit hexadecimal unit. The unit size of raw data is 512,000 byte.
- 3) Total Data Written decoded as GB/TB unit. Additionally, raw data without decoding is displayed in 128-bit hexadecimal unit. The unit size of raw data is 512,000 byte.
- 4) Power On Cycles: Display the number of power cycles.
- 5) Power On Hours: Display period of time in hours to show how long the SSD has been powered on.
- 6) Unsafe Shutdowns: Display the number of unsafe shutdowns of SSD

### 3.5 Flush Command

Select '4' to send Flush command to NVMe SSD.



```

/cygdrive/e/altera/16.0
+++ Flush Command selected +++
Flush Command Complete
--- Main menu [IPVer = 4.0] ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command

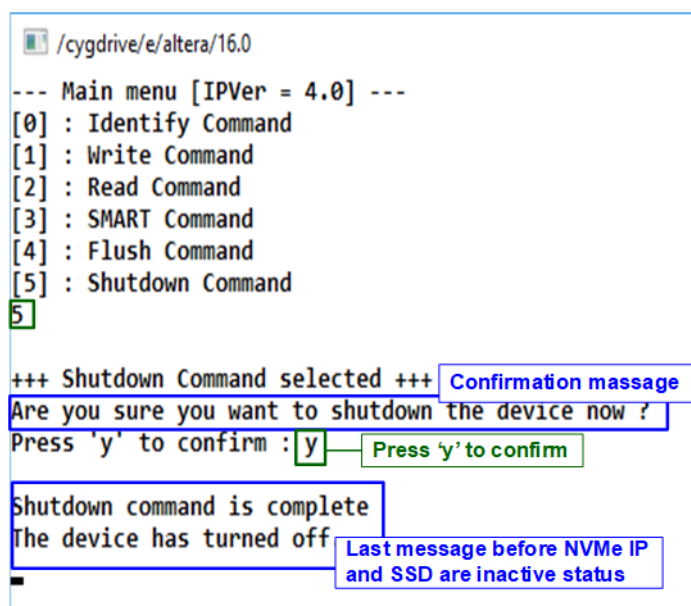
```

Figure 3-9 Test result when running Flush command

“Flush Command Complete” is displayed after the operation is completed.

### 3.6 Shutdown Command

Select '5' to send Shutdown command to NVMe SSD.



```

/cygdrive/e/altera/16.0
--- Main menu [IPVer = 4.0] ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command
5
+++ Shutdown Command selected +++
Are you sure you want to shutdown the device now ?
Press 'y' to confirm : y
Shutdown command is complete
The device has turned off

```

Figure 3-10 Shutdown Command with confirmation

The confirmation message is displayed on the console. User inputs 'y' or 'Y' to confirm the operation or inputs other keys to cancel the operation.

After finishing Shutdown operation, “Shutdown command is complete” is displayed on the console as the last message. Main menu is not displayed anymore. User needs to power off/on test system to start new test operation.

## 4 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-PCleX16 board
3.2	20-Apr-20	Remove PCIeSub board support of AB18