NVMeG3-IP Demo Instruction

Rev1.0 1-May-20

This document describes the instruction to run NVMeG3-IP demo on FPGA development board by using the PCIe adapter board (AB18-PCIeX16 board or AB16-PCIeXOVR board). The PCIe adapter does not need for the board which has PCIe female connector. The demo is designed to send NVMe commands 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) Intel FPGA board: Arria10 GX Development board
2) PC installing QuartusII programmer and NiosII command shell software
3) The PCIe adapter board: AB18-PCIeX16 or AB16-PCIeXOVR board by Design Gateway https://dgway.com/ABseries_E.html
4) Power adapter of FPGA board
5) ATX power supply for PCIe adapter board
6) NVMe PCIe Gen3 SSD
7) A micro USB cable for FPGA programming/NiosII command shell, connecting between FPGA board and PC.

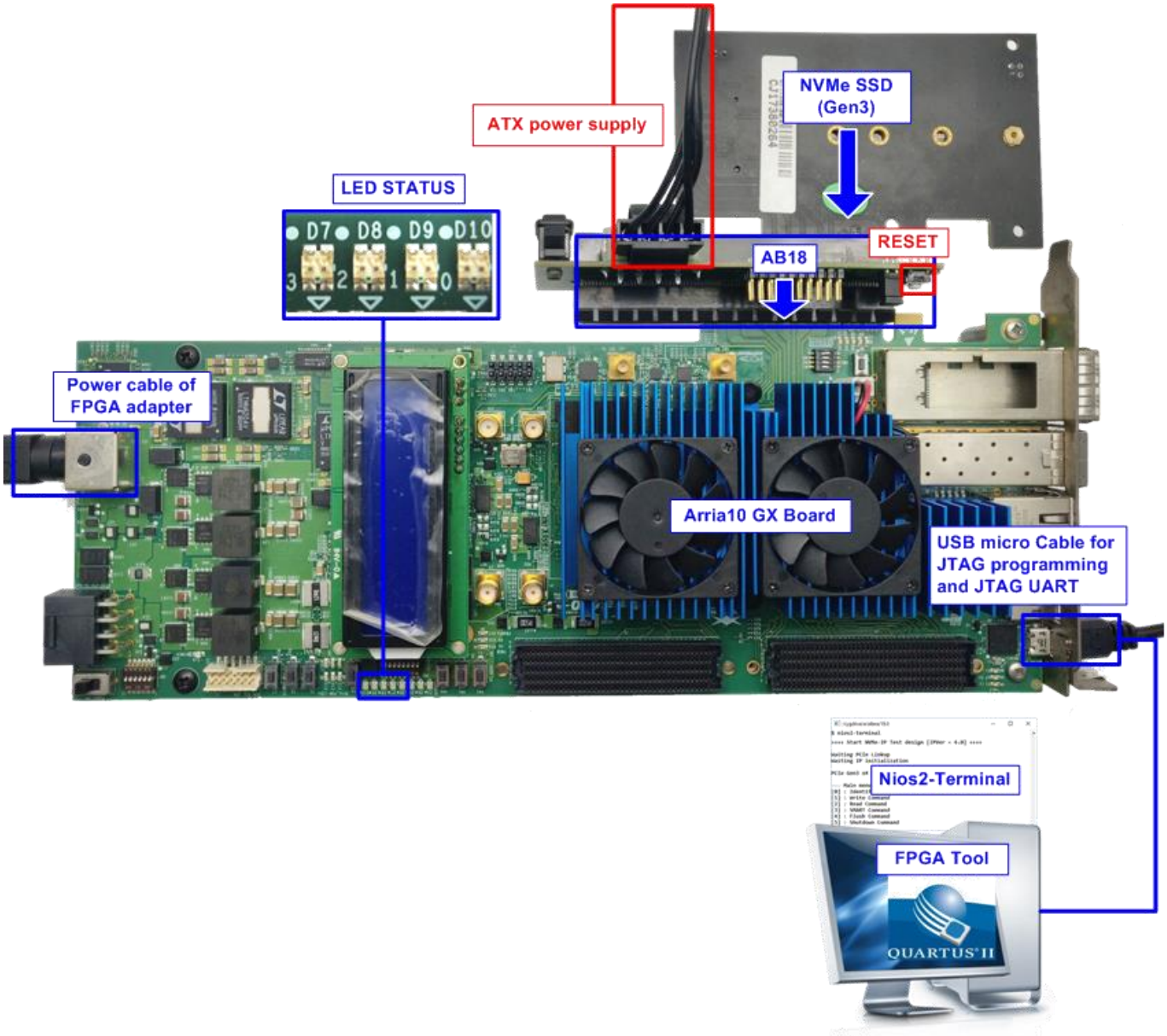

Figure 1-1 NVMeG3-IP Demo Environment Setup on Arria10 GX Development Board

2 Demo setup

2.1 Board setup

1) Power off system.
2) Connect AB18-PCIeX16 board to the FPGA by follow the steps below.
    a) Connect ATX power to ATX power connector on AB18-PCIeX16 board.
    b) Connect A Side of PCIe connector on AB18-PCIeX16 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-PCIeX16 board

    Warning: Please confirm that the SSD is inserted in the correct side of AB18 (B side, not A side) before power on system.

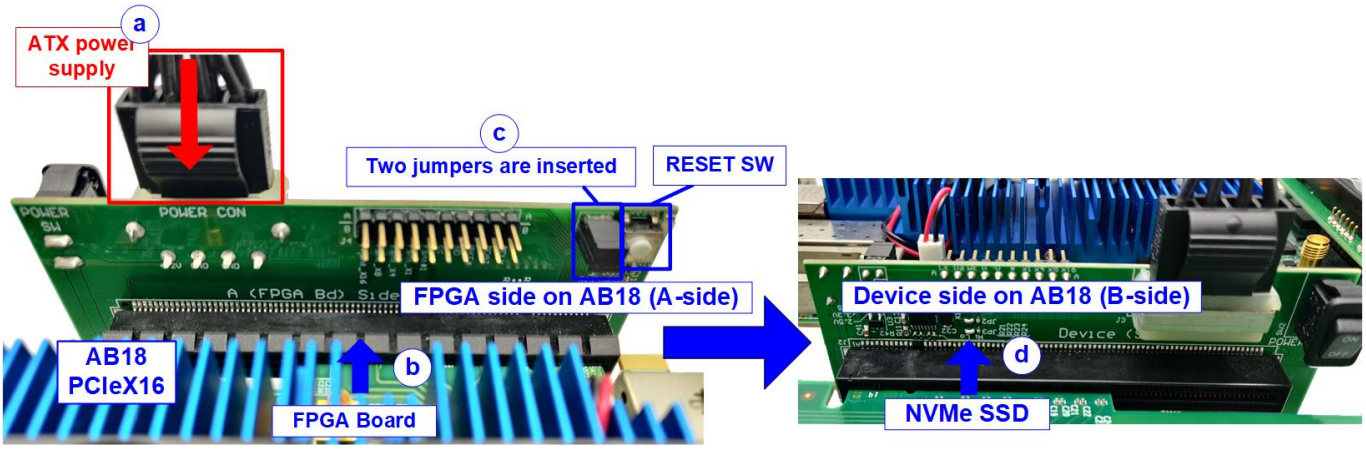

Figure 2-1 Connect PCIe connector between AB18 and FPGA board

3) Connect micro USB cable from FPGA board to PC for JTAG programming and for NiosII command shell.
4) Connect FPGA power adapter to FPGA board.
5) Turn on power switch of FPGA development board, AB18-PCIeX16 board, and ATX power supply.

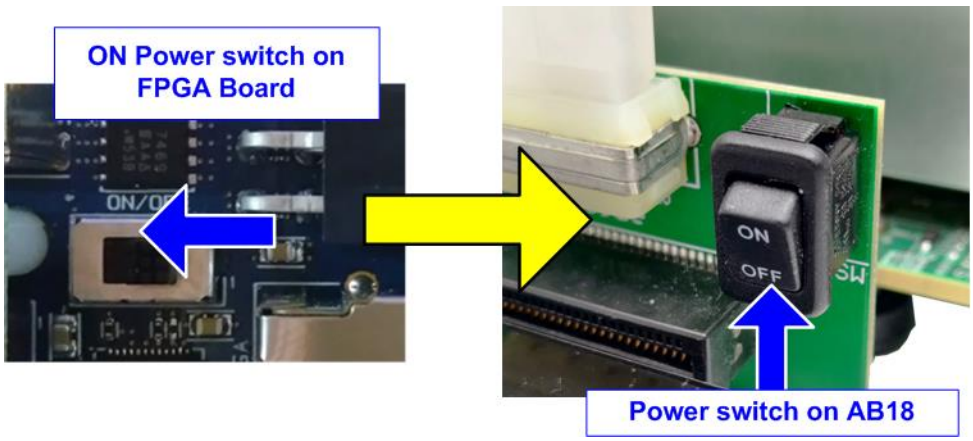

Figure 2-2 Power on FPGA board and AB18 board

2.2 Program setup

1) Use QuartusII Programmer to program “NVMeG3IPTest.sof” file, as shown in Figure 2-3.

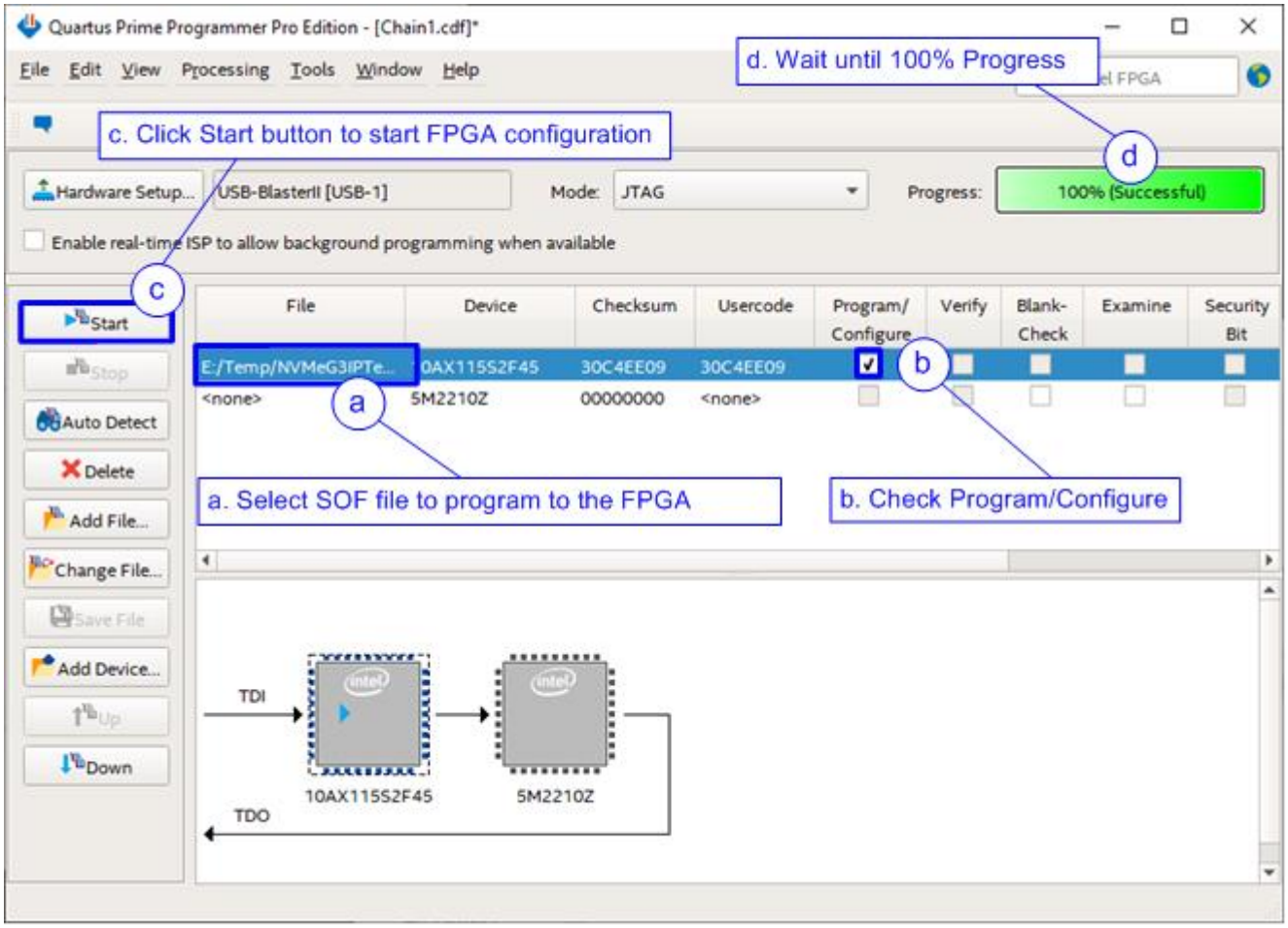

Figure 2-3 Programmed by QuartusII Programmer

2) Open NiosII Command Shell and run nios2-terminal command. Boot message is displayed.
   - "Waiting IP initialization" is displayed when NVMeG3-IP initialization process begins.
   - After initialization process is done, Main menu is displayed. Now the test system is ready to receive command from user.

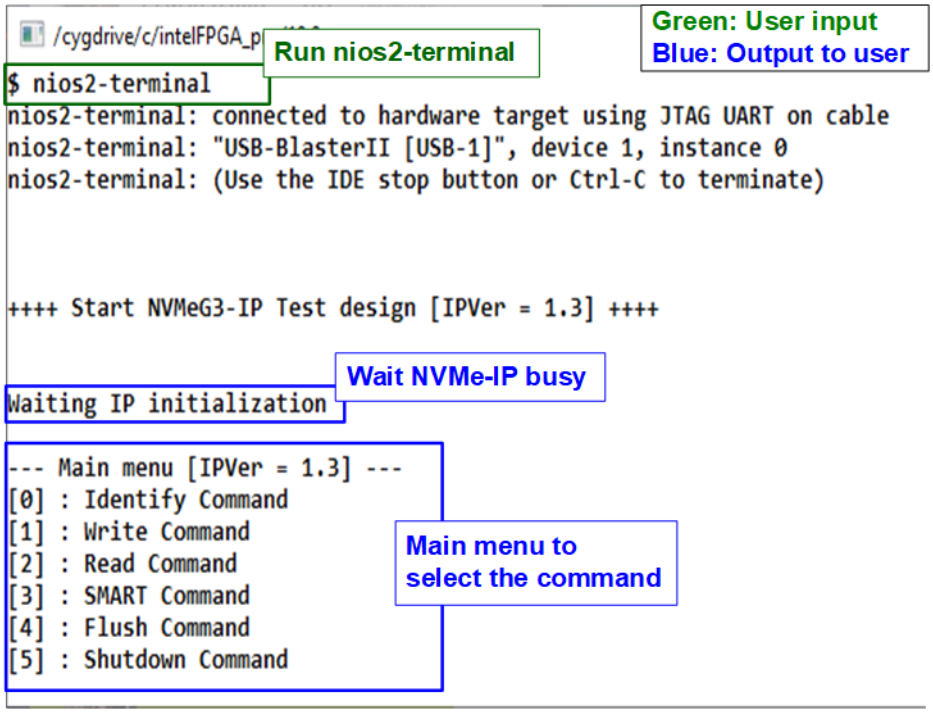

Figure 2-4 NiosII Terminal

3) Check LED status on FPGA board. The description of LED is shown as follows.

Table 2-1 LED Definition

GPIO LED	ON	OFF
0	Normal operation	Clock is not locked
1	System is busy	Idle status
2	Error detected	Normal operation

After programming completely, LED[0] and LED[1] are ON for processing PCIe initialization. Then, LED[1] is OFF when finishing PCIe initialization process. Finally, the system is ready to receive command from user.

Figure 2-5 LED Status after initialization process is completed

3 Test Menu

3.1 Identify Command

Select ‘0’ to send Identify command to NVMe SSD.

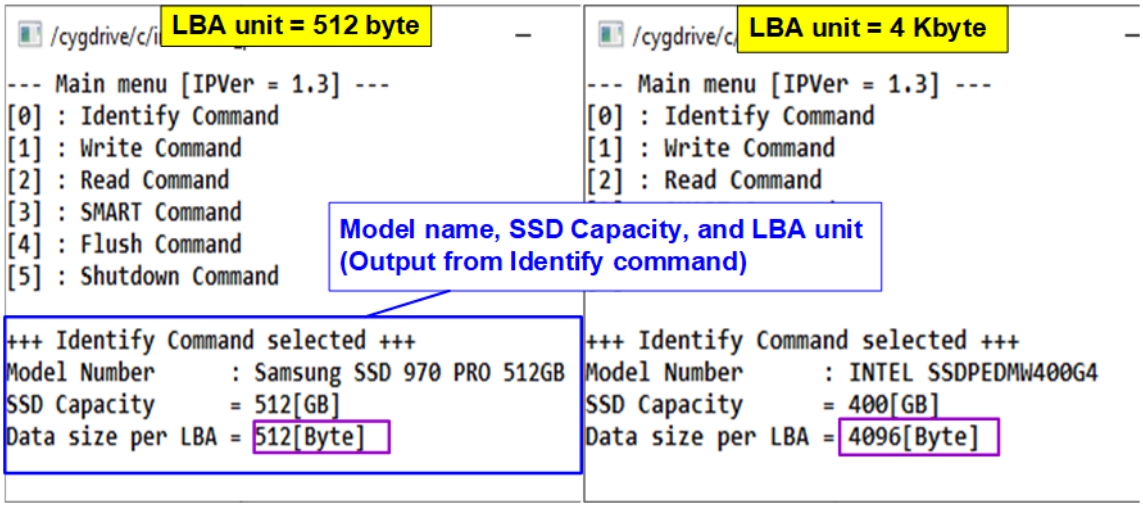

Figure 3-1 Test result when running Identify command

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 NVMeG3-IP.
3) Data size per LBA: This value is signal output from NVMeG3-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.

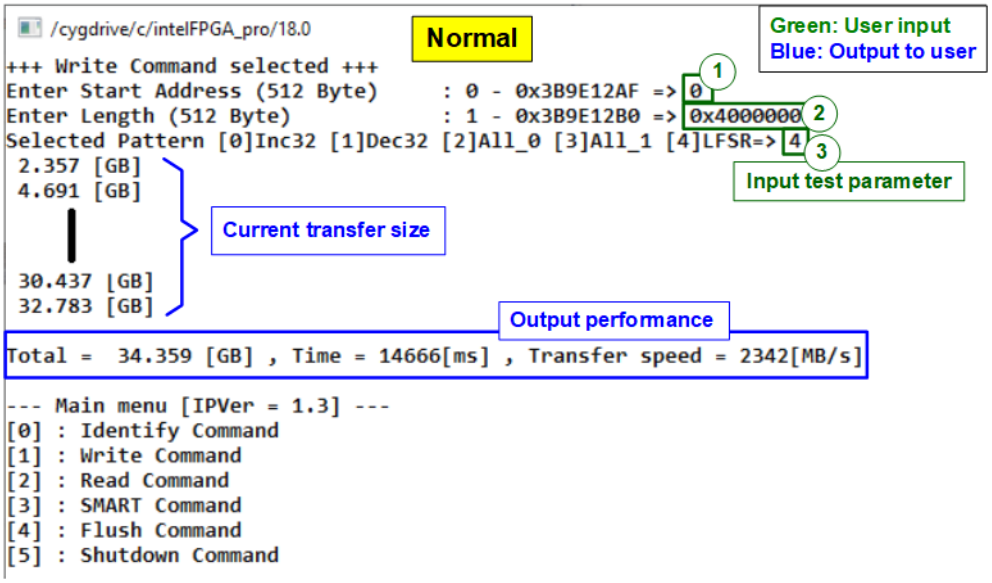

Figure 3-2 Test result when running Write command

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 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 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.

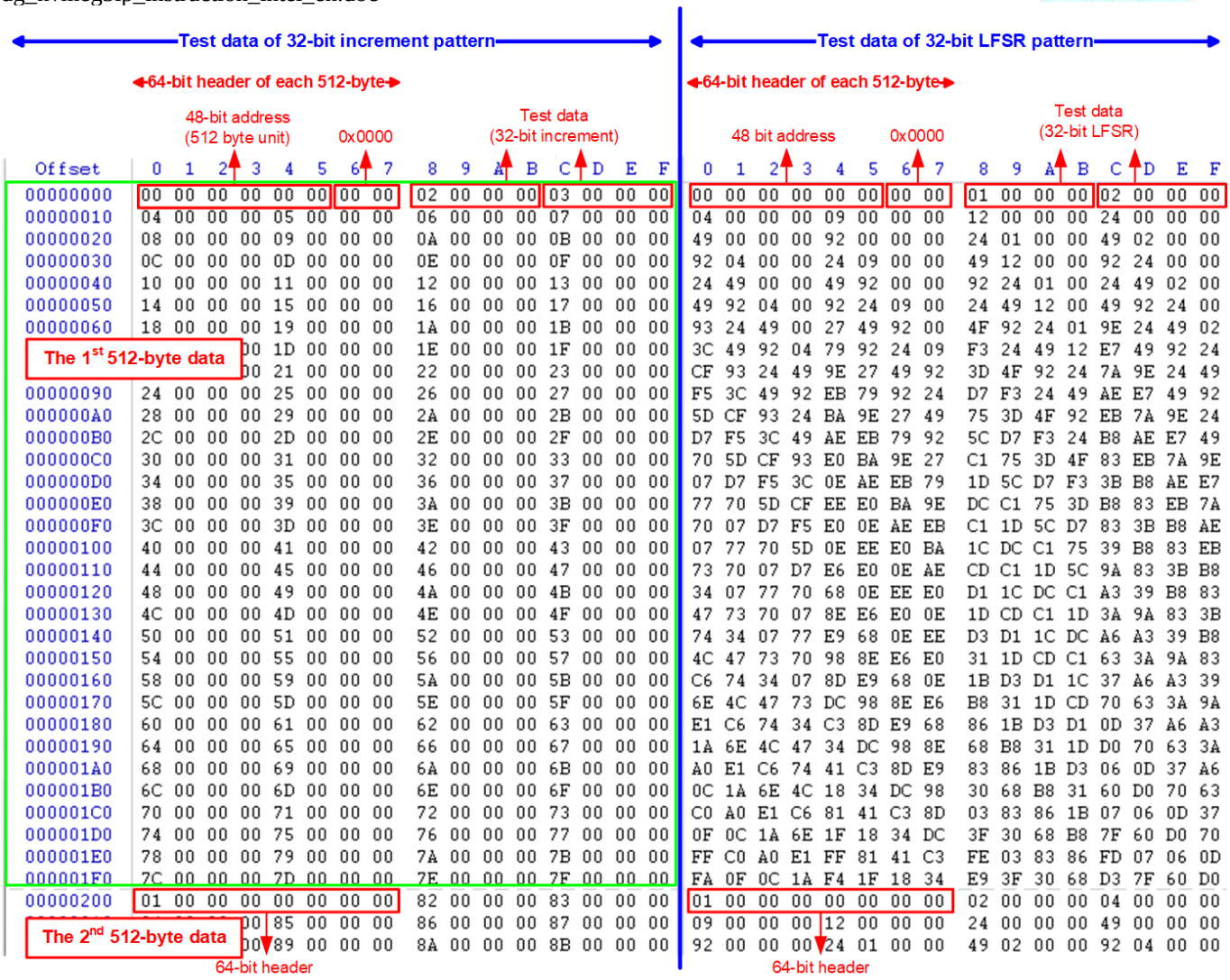

Figure 3-3 Example Test data of the 1st and 2nd 512-byte by using increment/LFSR pattern

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.

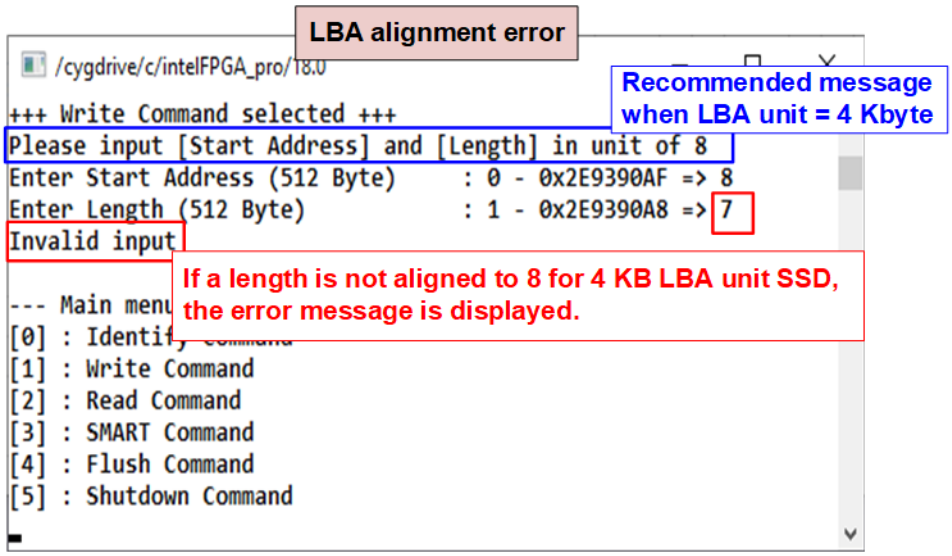

Figure 3-4 Error message when the input is unaligned for SSD with 4KB LBA unit

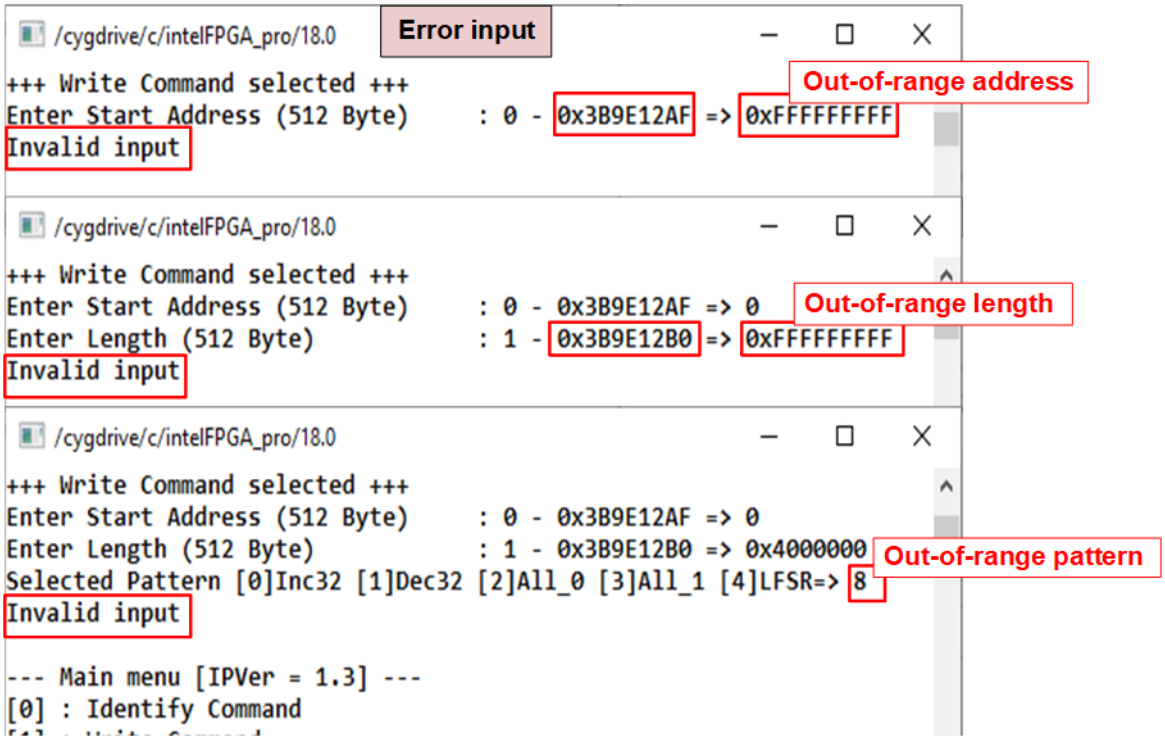

Figure 3-5 Error message from the invalid input

3.3 Read Command

Select ‘2’ to send Read command to NVMe SSD.

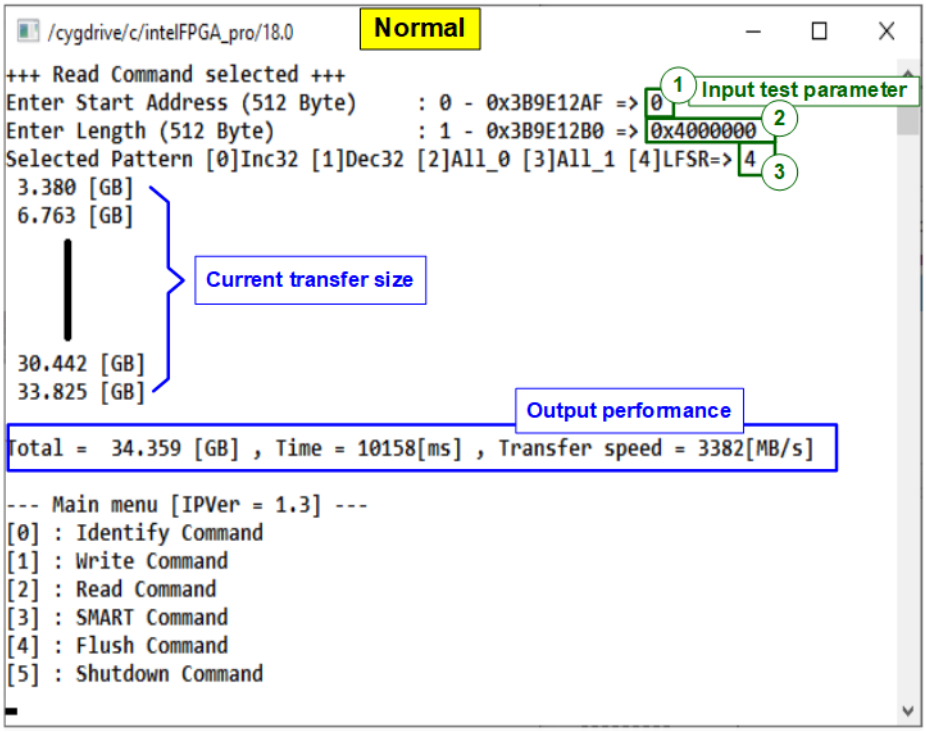

Figure 3-6 Input and result of Read Command menu

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 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 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, al- 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 1st 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 the system.

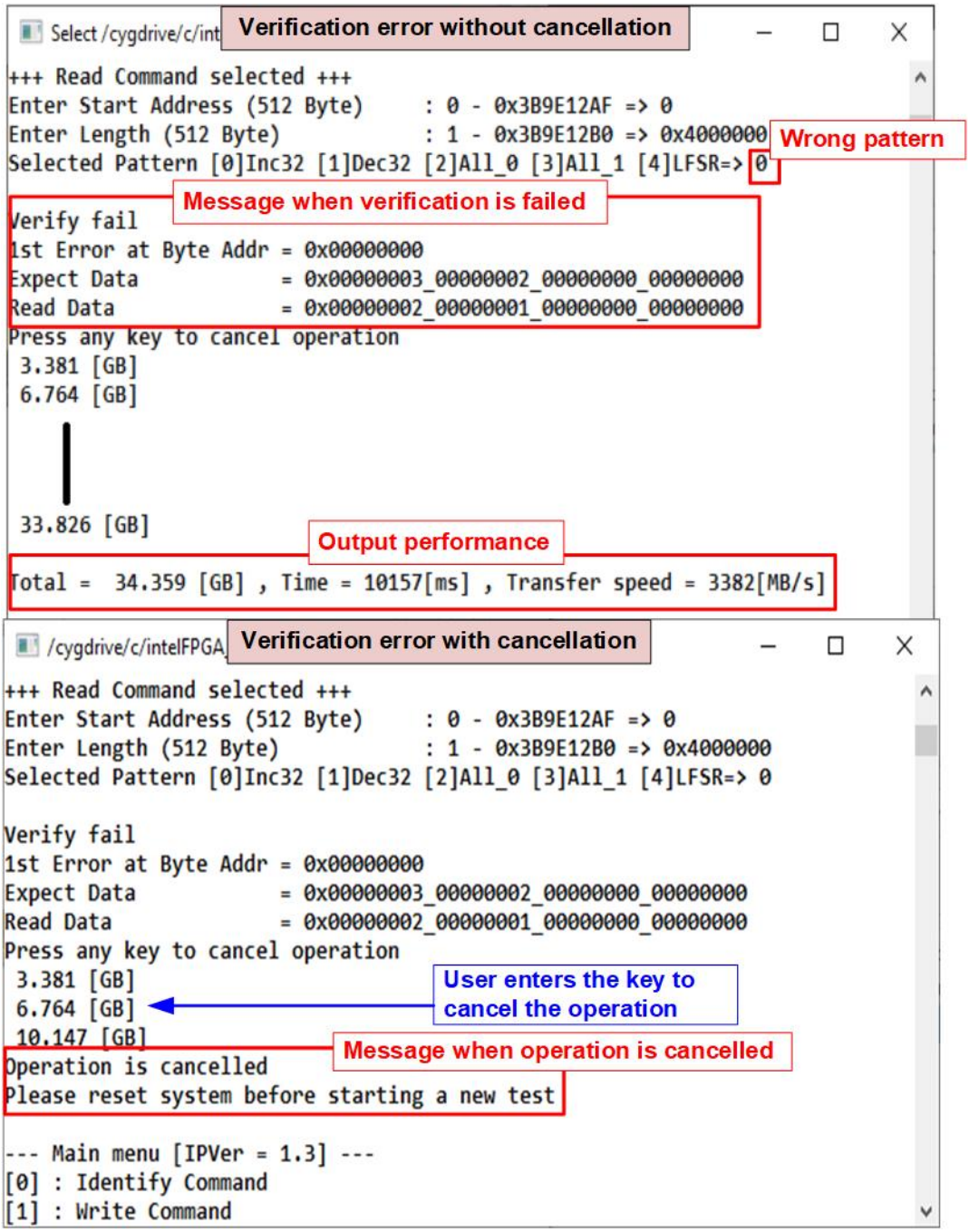

Figure 3-7 Data verification is failed

3.4 SMART Command

Select ‘3’ to send SMART command to NVMe SSD.

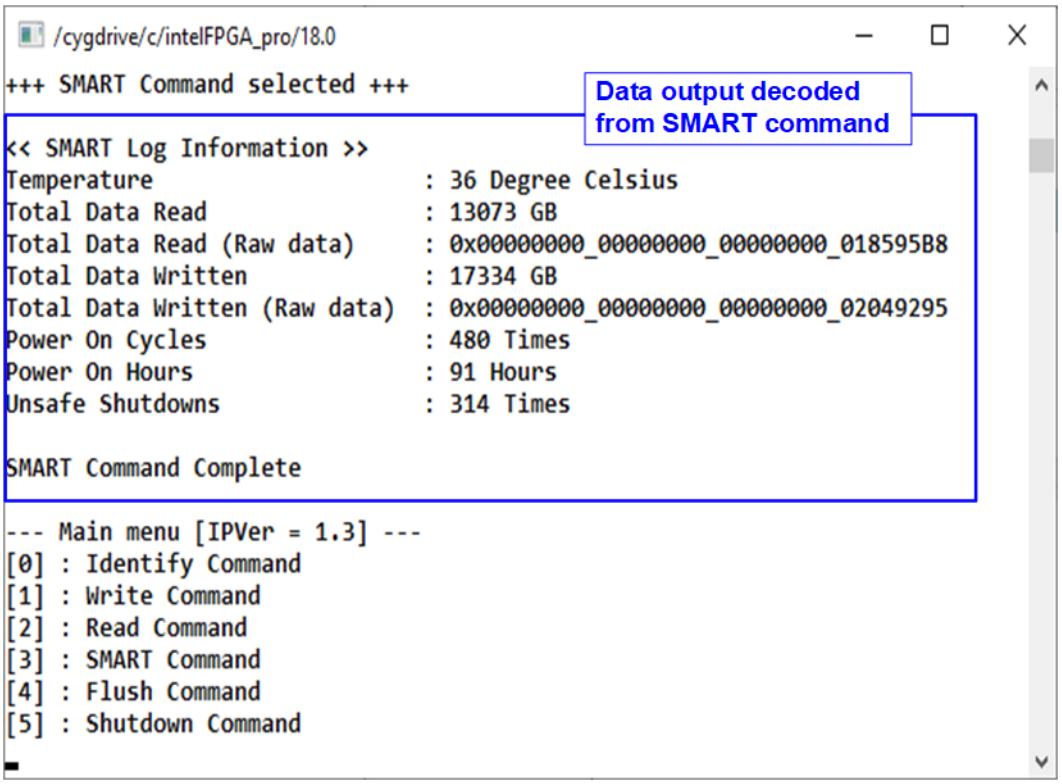

Figure 3-8 Test result when running SMART Command

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.

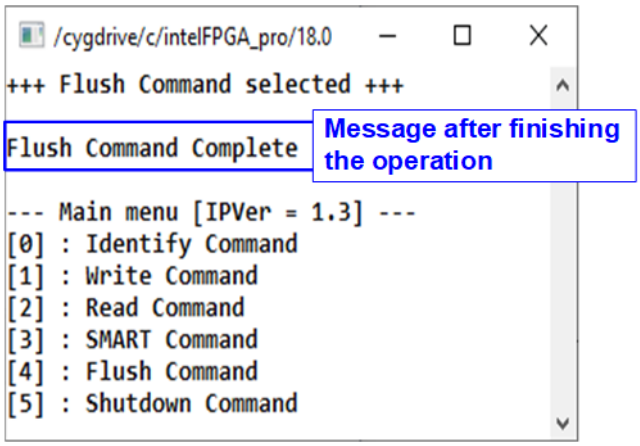

Figure 3-9 Test result when running Flush command

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

3.6 Shutdown Command

Select ‘5’ to send Shutdown command to NVMe SSD.

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 to be 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	1-May-20	Initial version release