

# raNVMe-IP Data Stream Demo Instruction

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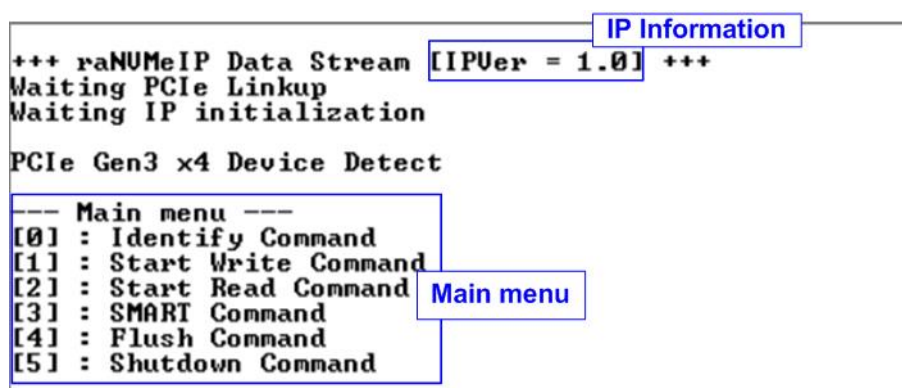
## 1 Overview

This document describes the instruction to run raNVMe-IP for transferring data stream, controlled by start/stop instead of transfer size. Similar to the standard raNVMe-IP demo, it can access one SSD for operating six commands, i.e., Identify, Write, Read, SMART, Flush or Shutdown command. But total transfer size is not set when running Write or Read command. User controls test operation via FPGA console.

To setup FPGA test environment, user can follow the instruction in “dg\_nvmeip\_fpgasetup” document which is the setup document of the standard NVMe-IP.

[https://dgway.com/products/IP/NVMe-IP/dg\\_nvmeip\\_fpgasetup\\_xilinx\\_en.pdf](https://dgway.com/products/IP/NVMe-IP/dg_nvmeip_fpgasetup_xilinx_en.pdf)

After finishing the board setup, the main menu is displayed and the user inputs to the console for selecting test operation.



```
+++ raNVMeIP Data Stream [IPVer = 1.0] +++
Waiting PCIe Linkup
Waiting IP initialization
PCIe Gen3 x4 Device Detect
--- Main menu ---
[0] : Identify Command
[1] : Start Write Command
[2] : Start Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command
```

The screenshot shows the main menu of the raNVMe-IP data stream demo. The text is displayed in a monospaced font. There are two callout boxes: one labeled "IP Information" pointing to the "[IPVer = 1.0]" text, and another labeled "Main menu" pointing to the menu list. The menu list is enclosed in a box.

Figure 1-1 Main menu of raNVMe-IP data stream demo

## 2 Test Menu

### 2.1 Identify Command

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

```

+++ Identify Command selected +++
Model Number      : INTEL SSDPED1D280GA
SSD Capacity      = 280[GB]

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

```

Model name and SSD capacity  
(Output from Identify command)

Figure 2-1 Test result when running Identify command

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

- 1) SSD model number: This value is decoded from Identify controller data.
- 2) SSD capacity: This value is signal output from raNVMe-IP.

```

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

+++ Identify Command selected +++
Error Detect
ErrorType = 0x00010000
ErrorType[16]: LBA does not support
PCIe Status = 0x104D

```

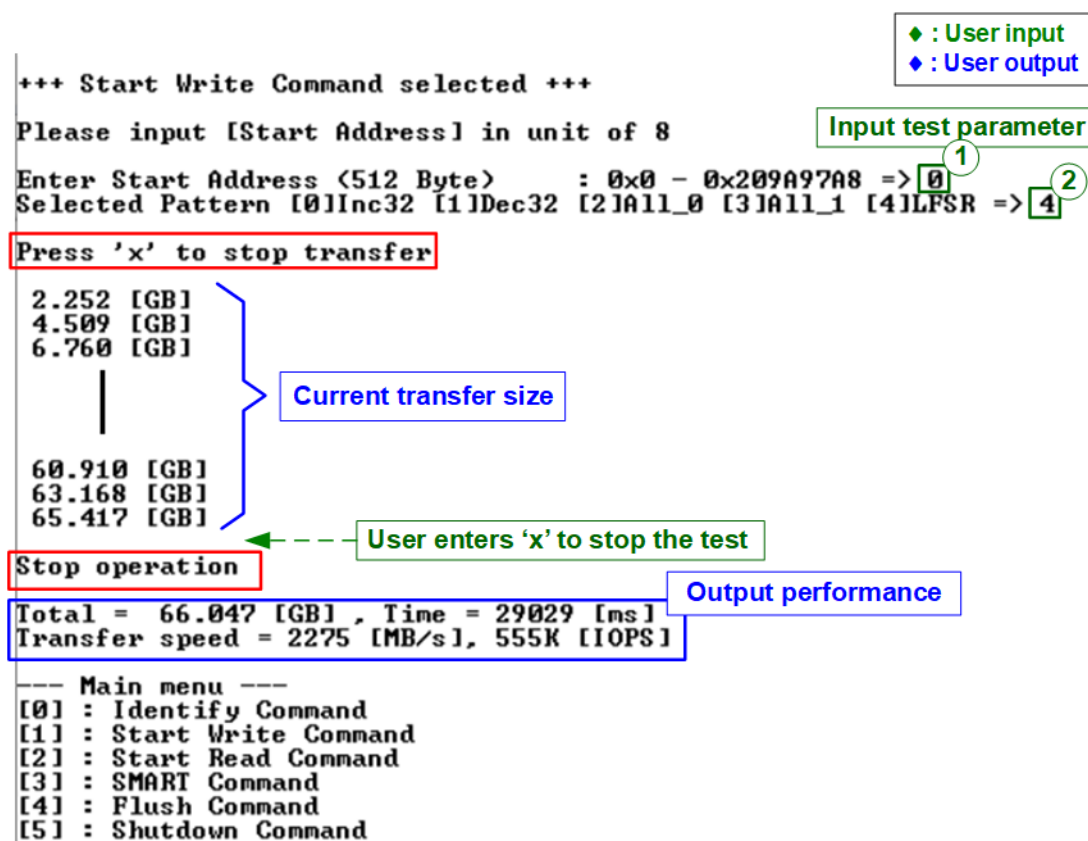
Error message when LBA  
unit of SSD is not supported

Figure 2-2 Error when LBA unit of SSD is not supported

When the SSD operates in LBA unit which is not equal to 512 bytes, the error message is shown on the console, as shown in Figure 2-2. After that, the system stays inactive status. User needs to reset the system to restart the demo.

## 2.2 Start Write Command

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



```

+++ Start Write Command selected +++
Please input [Start Address] in unit of 8
Enter Start Address <512 Byte>      : 0x0 - 0x209A97A8 => 0
Selected Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR => 4
Press 'x' to stop transfer

2.252 [GB]
4.509 [GB]
6.760 [GB]
|
60.910 [GB]
63.168 [GB]
65.417 [GB]

Total = 66.047 [GB] , Time = 29029 [ms]
Transfer speed = 2275 [MB/s], 555K [IOPS]

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

Annotations in the image:

- User input/output legend:** Green diamond for user input, blue diamond for user output.
- Input test parameter:** Points to the start address input '0' (labeled 1) and the pattern selection '4' (labeled 2).
- Current transfer size:** Points to the progress bar showing transfer size from 2.252 GB to 65.417 GB.
- User enters 'x' to stop the test:** Points to the 'Stop operation' message.
- Output performance:** Points to the final statistics: Total = 66.047 [GB], Time = 29029 [ms], Transfer speed = 2275 [MB/s], 555K [IOPS].

Figure 2-3 Test result when running Start write test

Before running Start write test, user sets two parameters: Start address and Test pattern.

- 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. According to raNVMe-IP specification, this input must be aligned to 8 for 4-Kbyte alignment.
- 2) 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.

After that, the IP starts writing the data to SSD if all inputs are valid. Otherwise, the operation is cancelled. During writing data, total transmit size is displayed on the console every second to be the test progress. The test can be stopped when the user enters 'x' or 'X'.

After the system completely stops the operation, test result, i.e., total size, total time usage and test speed are displayed on the console.

*Note: If the user does not stop the operation and the last address of SSD is written, the test system reset the next address for storing the next data will be equal to 0.*

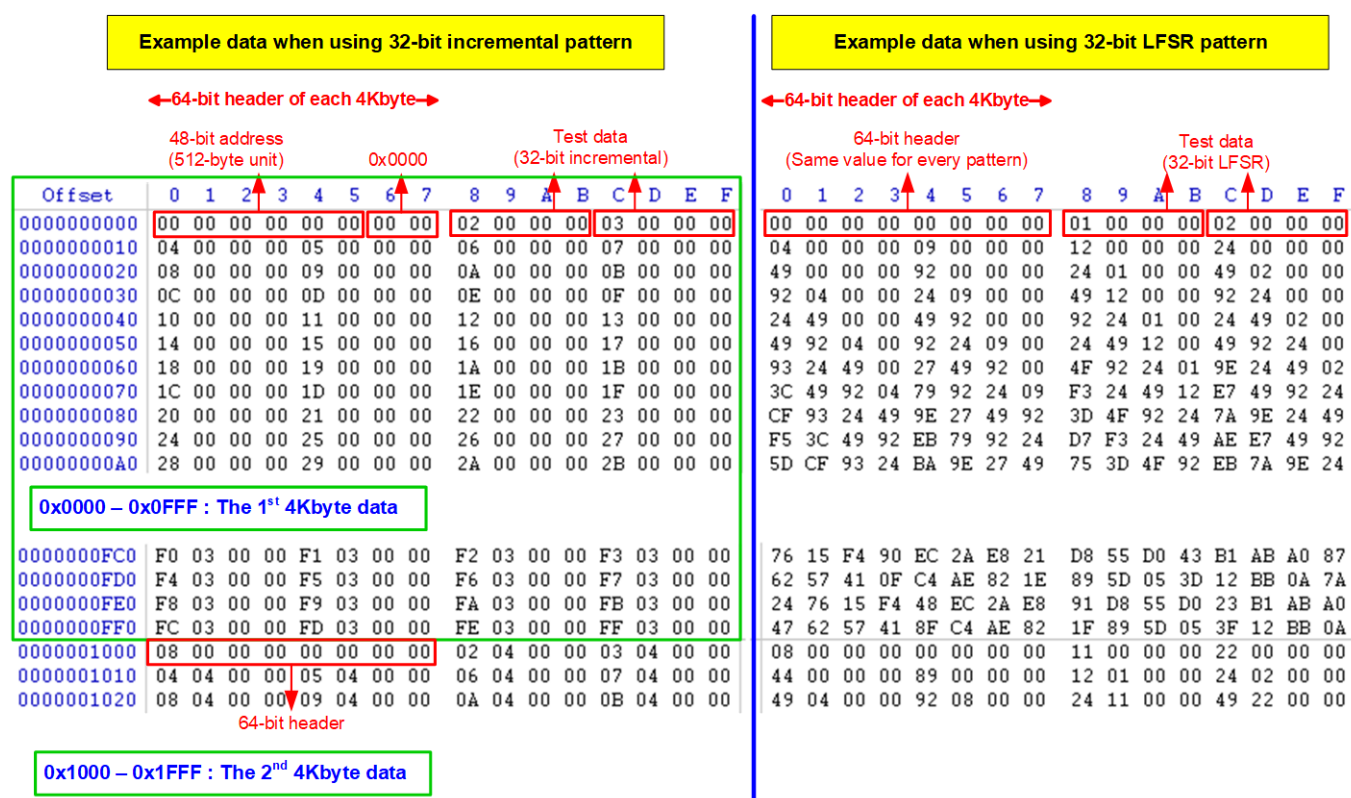


Figure 2-4 Example Test data of the 1<sup>st</sup> and 2<sup>nd</sup> 4Kbyte data by using incremental/LFSR pattern

Test data in SSD is split into 4096-byte (4K) unit. For incremental, decremental and LFSR pattern, each 4K-byte data has a unique 64-bit header consisting of 48-bit address in 512-byte unit and 16-bit zero value. The header is the same value for every test pattern. The data after 64-bit header is the test pattern which is selected by user. The unique header is not included when running all-0 or all-1 pattern.

The left window of Figure 2-4 shows the example when using 32-bit incremental pattern while the right window shows the example when using 32-bit LFSR pattern.

During running the test, if user enters other keys (not 'x' or 'X') to stop the operation, the warning message ("Press 'x' to stop") is displayed on the console. After that, the test is still run, as shown in Figure 2-5.

```

Press 'x' to stop transfer
2.370 [GB]
4.720 [GB]
Invalid input, Press 'x' to stop
7.075 [GB]
9.421 [GB]
11.764 [GB]
14.121 [GB]

```

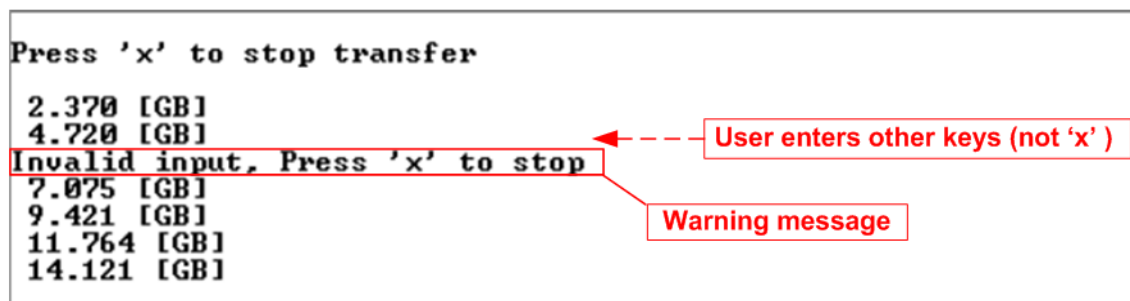


Figure 2-5 Other keys are received during running the write test

Figure 2-6 shows the example error message when the input from the user is invalid. It may be caused from out-of-range input or the address is not aligned to 8. "Invalid input" is displayed as the error message and the operation is cancelled before returning to the main menu.

```

Error input
+++ Start Write Command selected +++
Please input [Start Address] in unit of 8
Enter Start Address <512 Byte>      : 0x0 - 0x3B9E12A8 => 0xFFFFFFFF
Invalid input
Out of range address

+++ Start Write Command selected +++
Please input [Start Address] in unit of 8
Enter Start Address <512 Byte>      : 0x0 - 0x3B9E12A8 => 0x3
Invalid input
Address alignment error

+++ Start Write Command selected +++
Please input [Start Address] in unit of 8
Enter Start Address <512 Byte>      : 0x0 - 0x3B9E12A8 => 0x4000000
Selected Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR => 5
Invalid input
Invalid input

```

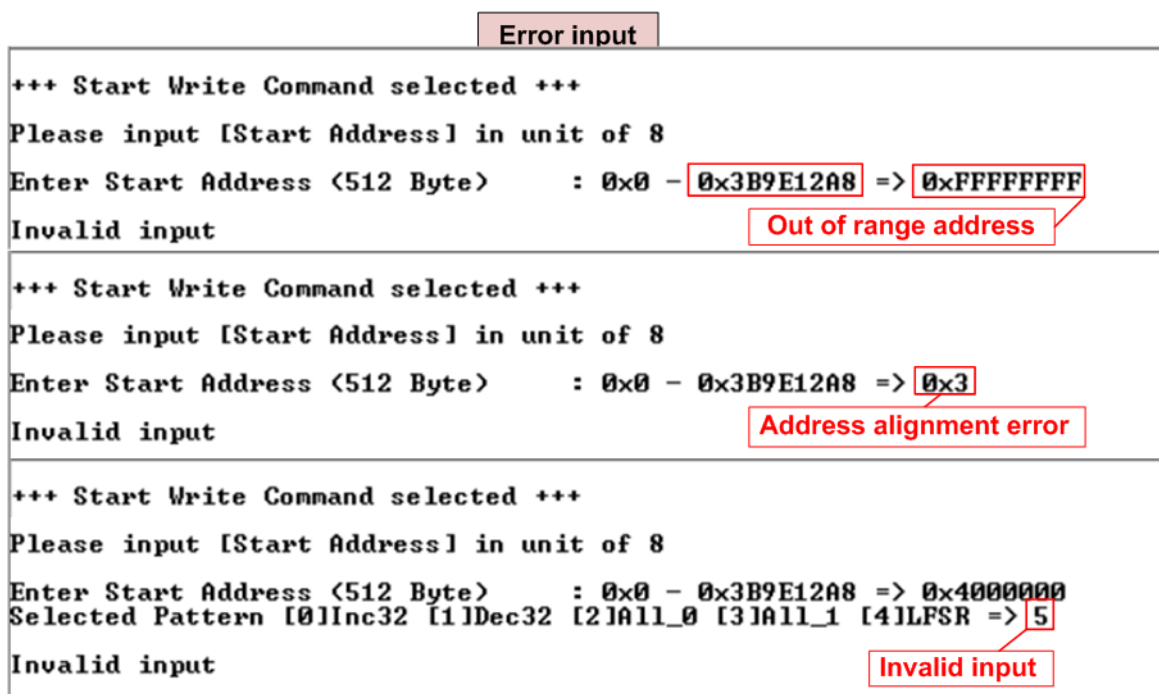
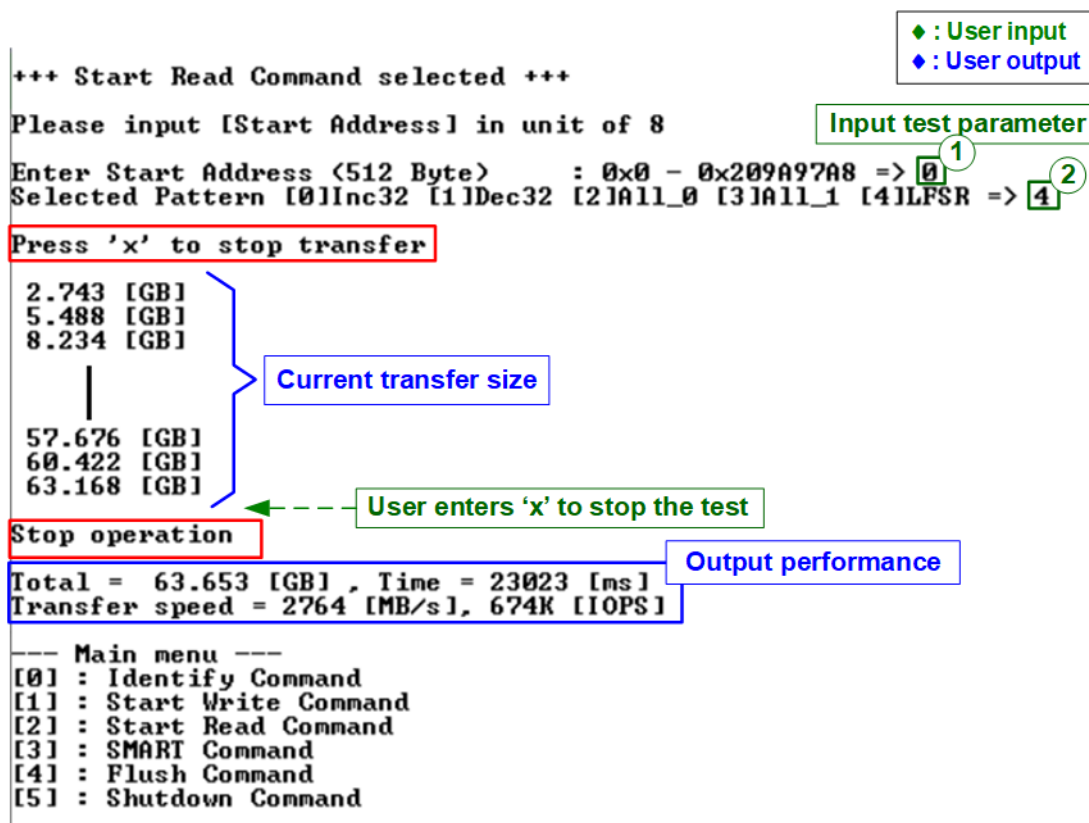


Figure 2-6 Error message from the invalid input

## 2.3 Start Read Command

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



The screenshot shows the command-line interface for the Start Read Command test. It includes the following elements:

- Legend:**
  - ◆ : User input
  - ◆ : User output
- Input test parameter:** A green box highlighting the input fields for the start address and test pattern.
- Annotations:**
  - 1: Points to the start address input field.
  - 2: Points to the test pattern selection field.
- Current transfer size:** A blue box highlighting the list of transfer sizes (2.743 GB, 5.488 GB, 8.234 GB, 57.676 GB, 60.422 GB, 63.168 GB).
- User enters 'x' to stop the test:** A green box with an arrow pointing to the 'Press 'x' to stop transfer' prompt.
- Output performance:** A blue box highlighting the performance results: Total = 63.653 [GB], Time = 23023 [ms], Transfer speed = 2764 [MB/s], 674K [IOPS].
- Main menu:** A list of commands: [0] : Identify Command, [1] : Start Write Command, [2] : Start Read Command, [3] : SMART Command, [4] : Flush Command, [5] : Shutdown Command.

Figure 2-7 Test result when running start read test

Similar to Start write test, user needs to set two parameters: Start address and Test pattern for running Start read test.

- 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. According to raNVMe-IP specification, this input must be aligned to 8 for 4-Kbyte alignment.
- 2) Test pattern: Select test data pattern for verifying the data. There are five patterns, i.e., 32-bit incremental, 32-bit decremental, all 0, all 1 and 32-bit LFSR counter.

After that, the IP starts reading the data from SSD if all inputs are valid. Otherwise, the operation is cancelled. During reading data, total receive size is displayed on the console every second to be the test progress. The test can be stopped when the user enters 'x' or 'X'.

After the system completely stops the operation, test result, i.e., total size, total time usage and test speed are displayed on the console.

*Note:* If the user does not stop the operation and the last address of SSD is read, the test system reset the next address for reading the next data will be equal to 0.

Figure 2-8 shows the 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. However, the operation does not stop until user enters ‘x’ or ‘X’.

```

+++ Start Read Command selected +++
Please input [Start Address] in unit of 8
Enter Start Address (512 Byte)      : 0x0 - 0x209A97A8 => 0
Selected Pattern [0]Inc32 [1]Dec32 [2]A11_0 [3]A11_1 [4]LFSR => 1
Press 'x' to stop transfer

Verify fail
1st Error at Byte Addr = 0x00000000
Expect Data           = 0xFFFFFFFFC_FFFFFFFD_00000000_00000000
Read Data             = 0x00000002_00000001_00000000_00000000
Press 'x' to stop transfer

2.742 [GB]
5.490 [GB]
8.236 [GB]
10.981 [GB]
13.728 [GB]

Stop operation

Total = 14.000 [GB] , Time = 5004 [ms]
Transfer speed = 2797 [MB/s], 682K [IOPS]

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

```

Wrong pattern (Written by 4)

Message when data verification is failed

Output performance

Figure 2-8 Data verification is failed



## 2.4 SMART Command

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

```

+++ SMART Command selected +++
<< SMART Log Information >>
Temperature                : 34 Degree Celsius
Total Data Read             : 52270 GB
Total Data Read <Raw data>  : 0x00000000_00000000_00000000_0615ADC6
Total Data Written          : 64736 GB
Total Data Written <Raw data> : 0x00000000_00000000_00000000_078929E6
Power On Cycles             : 1265 Times
Power On Hours              : 107 Hours
Unsafe Shutdowns           : 510 Times

SMART Command Complete

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

```

Data output decoded  
from SMART command

Figure 2-9 Test result when running SMART command

After finishing the operation, SMART/Health Information (output from SMART command) is displayed as shown in Figure 2-9. 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 as 128-bit hexadecimal unit. The unit size of raw data is 512,000 bytes.
- 3) Total Data Written decoded as GB/TB unit. Additionally, raw data without decoding is displayed as 128-bit hexadecimal unit. The unit size of raw data is 512,000 bytes.
- 4) Power On Cycles: Display the number of power cycles.
- 5) Power On Hours: Display the 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



## 2.5 Flush Command

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

```

+++ Flush Command selected +++
Flush Command Complete
--- Main menu ---
[0] : Identify Command
[1] : Start Write Command
[2] : Start Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command

```

Message after  
finishing the operation

Figure 2-10 Test result when running Flush command

"Flush Command Complete" is displayed after finishing Flush operation.

## 2.6 Shutdown Command

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

```

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

+++ 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...

```

Confirmation message

Press 'y' to confirm

Last message before NVMe-IP  
and SSD are inactive status

Figure 2-11 Test result when running Shutdown command

The confirmation message is displayed on the console. User enters 'y' or 'Y' to continue the operation or 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.

### 3 Revision History

Revision	Date	Description
1.0	27-Nov-20	Initial version release
1.1	12-Jan-21	Update test result by new SSD model