NVMeG3-IP Demo Instruction

Rev2.0 16-Dec-20

1 Overview

This document describes the instruction to run NVMeG3-IP demo on FPGA development board for accessing one NVMe SSD. The demo is designed to run Identify, Write, Read, SMART, Flush and Shutdown command. User controls test operation via FPGA console.

After user finishes FPGA board setup following “dg_nvmeip_fpgasetup” document, main menu is displayed and the user sets the input to the console for selecting test operation.

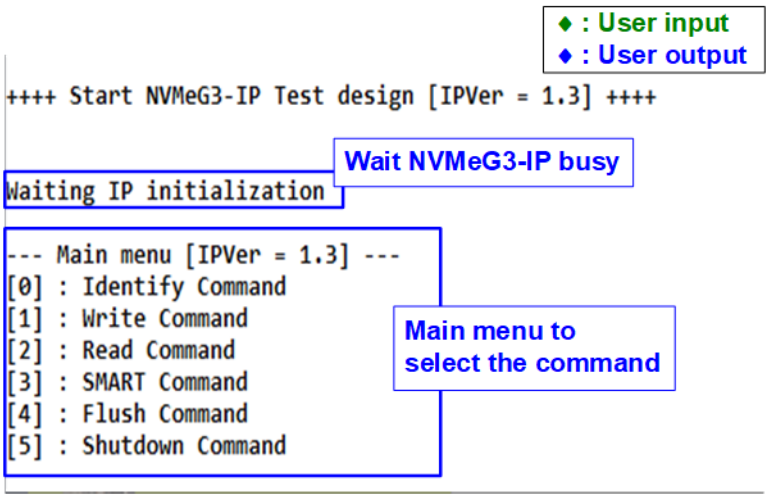

Figure 1-1 NVMeG3-IP main menu

2 Test Menu

2.1 Identify Command

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

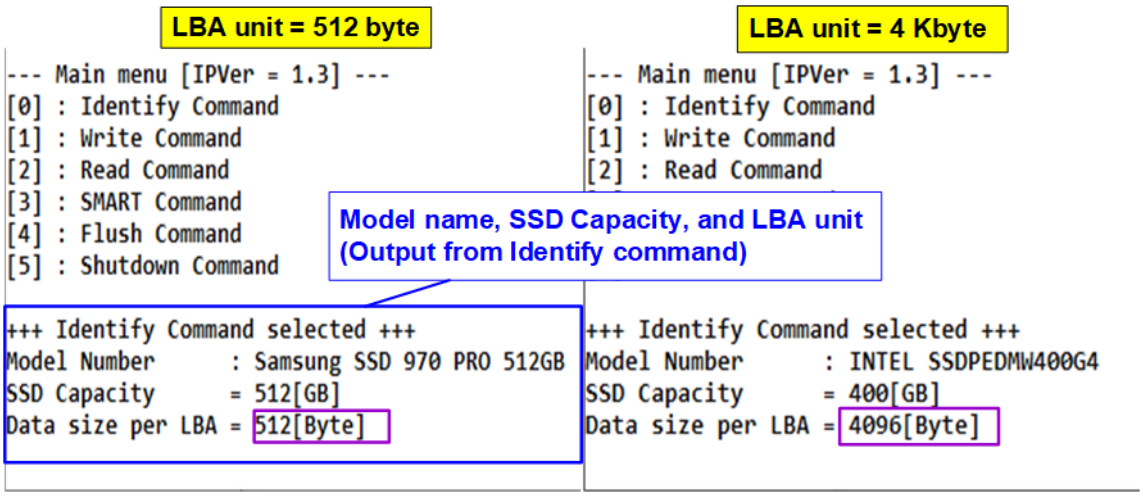

Figure 2-1 Test result when running Identify command

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

2.2 Write Command

Select ‘1’ to send Write command to NVMe SSD.

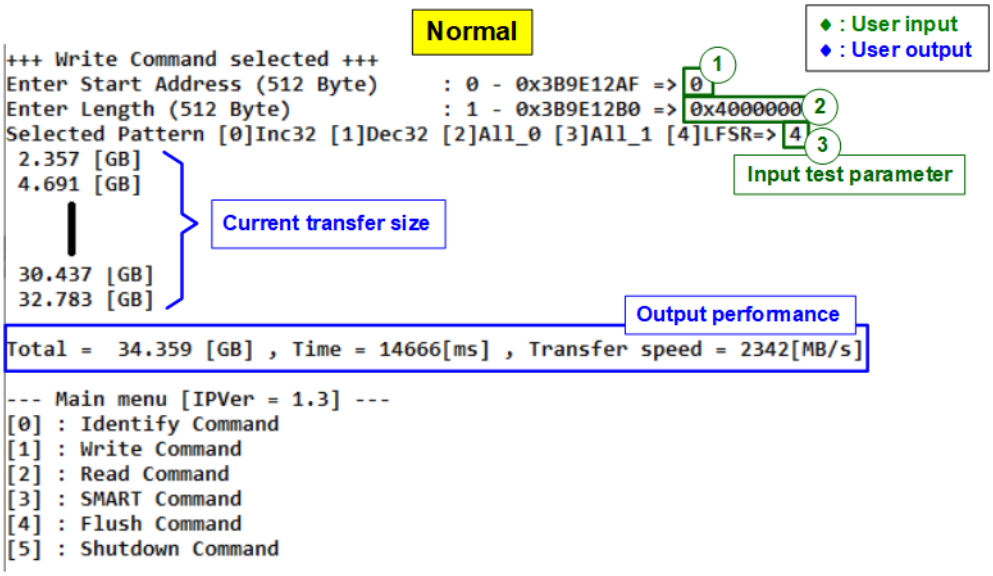

Figure 2-2 Test result when running Write command

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.

Test data of 32-bit increment pattern

64-bit header of each 512-byte

48-bit address (512 byte unit) | 0x0000 | Test data (32-bit increment)

The 1st 512-byte data

The 2nd 512-byte data

64-bit header

Offset	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
00000010	04	00	00	00	05	00	00	00	06	00	00	00	07	00	00	00
00000020	08	00	00	00	09	00	00	00	0A	00	00	00	0B	00	00	00
00000030	0C	00	00	00	0D	00	00	00	0E	00	00	00	0F	00	00	00
00000040	10	00	00	00	11	00	00	00	12	00	00	00	13	00	00	00
00000050	14	00	00	00	15	00	00	00	16	00	00	00	17	00	00	00
00000060	18	00	00	00	19	00	00	00	1A	00	00	00	1B	00	00	00
[illegible]	[illegible]	[illegible]	[illegible]	00	1D	00	00	00	1E	00	00	00	1F	00	00	00
[illegible]	[illegible]	[illegible]	[illegible]	00	21	00	00	00	22	00	00	00	23	00	00	00
00000090	24	00	00	00	25	00	00	00	26	00	00	00	27	00	00	00
000000A0	28	00	00	00	29	00	00	00	2A	00	00	00	2B	00	00	00
000000B0	2C	00	00	00	2D	00	00	00	2E	00	00	00	2F	00	00	00
000000C0	30	00	00	00	31	00	00	00	32	00	00	00	33	00	00	00
000000D0	34	00	00	00	35	00	00	00	36	00	00	00	37	00	00	00
000000E0	38	00	00	00	39	00	00	00	3A	00	00	00	3B	00	00	00
000000F0	3C	00	00	00	3D	00	00	00	3E	00	00	00	3F	00	00	00
00000100	40	00	00	00	41	00	00	00	42	00	00	00	43	00	00	00
00000110	44	00	00	00	45	00	00	00	46	00	00	00	47	00	00	00
00000120	48	00	00	00	49	00	00	00	4A	00	00	00	4B	00	00	00
00000130	4C	00	00	00	4D	00	00	00	4E	00	00	00	4F	00	00	00
00000140	50	00	00	00	51	00	00	00	52	00	00	00	53	00	00	00
00000150	54	00	00	00	55	00	00	00	56	00	00	00	57	00	00	00
00000160	58	00	00	00	59	00	00	00	5A	00	00	00	5B	00	00	00
00000170	5C	00	00	00	5D	00	00	00	5E	00	00	00	5F	00	00	00
00000180	60	00	00	00	61	00	00	00	62	00	00	00	63	00	00	00
00000190	64	00	00	00	65	00	00	00	66	00	00	00	67	00	00	00
000001A0	68	00	00	00	69	00	00	00	6A	00	00	00	6B	00	00	00
000001B0	6C	00	00	00	6D	00	00	00	6E	00	00	00	6F	00	00	00
000001C0	70	00	00	00	71	00	00	00	72	00	00	00	73	00	00	00
000001D0	74	00	00	00	75	00	00	00	76	00	00	00	77	00	00	00
000001E0	78	00	00	00	79	00	00	00	7A	00	00	00	7B	00	00	00
000001F0	7C	00	00	00	7D	00	00	00	7E	00	00	00	7F	00	00	00
00000200	01	00	00	00	00	00	00	00	82	00	00	00	83	00	00	00
[illegible]	[illegible]	[illegible]	[illegible]	00	85	00	00	00	86	00	00	00	87	00	00	00
[illegible]	[illegible]	[illegible]	[illegible]	00	89	00	00	00	8A	00	00	00	8B	00	00	00

Test data of 32-bit LFSR pattern

64-bit header of each 512-byte

48 bit address | 0x0000 | Test data (32-bit LFSR)

64-bit header

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	00	00	00	00	00	00	00	01	00	00	00	02	00	00	00
04	00	00	00	09	00	00	00	12	00	00	00	24	00	00	00
49	00	00	00	92	00	00	00	24	01	00	00	49	02	00	00
92	04	00	00	24	09	00	00	49	12	00	00	92	24	00	00
24	49	00	00	49	92	00	00	92	24	01	00	24	49	02	00
49	92	04	00	92	24	09	00	24	49	12	00	49	92	24	00
93	24	49	00	27	49	92	00	4F	92	24	01	9E	24	49	02
3C	49	92	04	79	92	24	09	F3	24	49	12	E7	49	92	24
CF	93	24	49	9E	27	49	92	3D	4F	92	24	7A	9E	24	49
F5	3C	49	92	EB	79	92	24	D7	F3	24	49	AE	E7	49	92
5D	CF	93	24	BA	9E	27	49	75	3D	4F	92	EB	7A	9E	24
D7	F5	3C	49	AE	EB	79	92	5C	D7	F3	24	B8	AE	E7	49
70	5D	CF	93	E0	BA	9E	27	C1	75	3D	4F	83	EB	7A	9E
07	D7	F5	3C	0E	AE	EB	79	1D	5C	D7	F3	3B	B8	AE	E7
77	70	5D	CF	EE	E0	BA	9E	DC	C1	75	3D	B8	83	EB	7A
70	07	D7	F5	E0	0E	AE	EB	C1	1D	5C	D7	83	3B	B8	AE
07	77	70	5D	0E	EE	E0	BA	1C	DC	C1	75	39	B8	83	EB
73	70	07	D7	E6	E0	0E	AE	CD	C1	1D	5C	9A	83	3B	B8
34	07	77	70	68	0E	EE	E0	D1	1C	DC	C1	A3	39	B8	83
47	73	70	07	8E	E6	E0	0E	1D	CD	C1	1D	3A	9A	83	3B
74	34	07	77	E9	68	0E	EE	D3	D1	1C	DC	A6	A3	39	B8
4C	47	73	70	98	8E	E6	E0	31	1D	CD	C1	63	3A	9A	83
C6	74	34	07	8D	E9	68	0E	1B	D3	D1	1C	37	A6	A3	39
6E	4C	47	73	DC	98	8E	E6	B8	31	1D	CD	70	63	3A	9A
E1	C6	74	34	C3	8D	E9	68	86	1B	D3	D1	0D	37	A6	A3
1A	6E	4C	47	34	DC	98	8E	68	B8	31	1D	D0	70	63	3A
A0	E1	C6	74	41	C3	8D	E9	83	86	1B	D3	06	0D	37	A6
0C	1A	6E	4C	18	34	DC	98	30	68	B8	31	60	D0	70	63
C0	A0	E1	C6	81	41	C3	8D	03	83	86	1B	07	06	0D	37
0F	0C	1A	6E	1F	18	34	DC	3F	30	68	B8	7F	60	D0	70
FF	C0	A0	E1	FF	81	41	C3	FE	03	83	86	FD	07	06	0D
FA	0F	0C	1A	F4	1F	18	34	E9	3F	30	68	D3	7F	60	D0
01	00	00	00	00	00	00	00	02	00	00	00	04	00	00	00
09	00	00	00	12	00	00	00	24	00	00	00	49	00	00	00
92	00	00	00	24	01	00	00	49	02	00	00	92	04	00	00

Figure 2-3 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 2-3 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 2-4. When the input does not align to 8, “Invalid input” is displayed and the operation is cancelled.

Also, Figure 2-5 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.

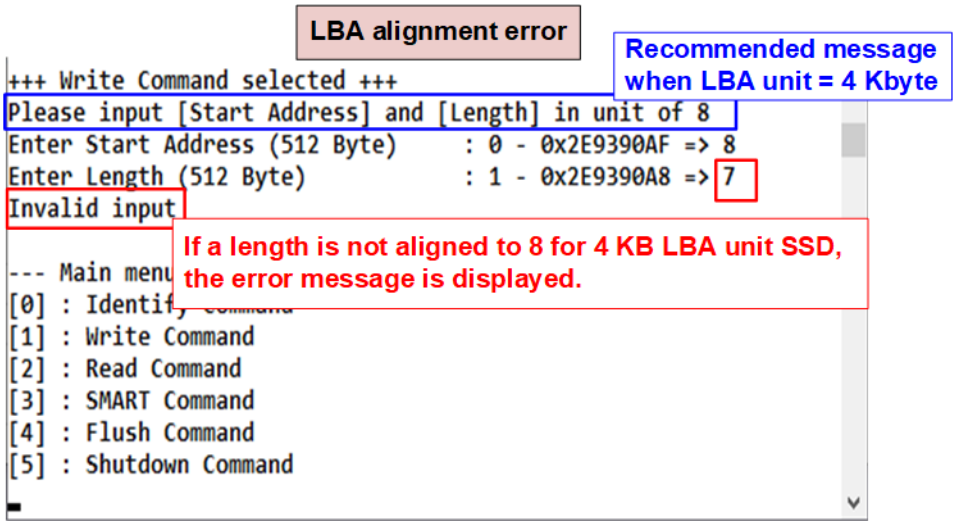

Figure 2-4 Error message when the input is unaligned for SSD with 4KB LBA unit

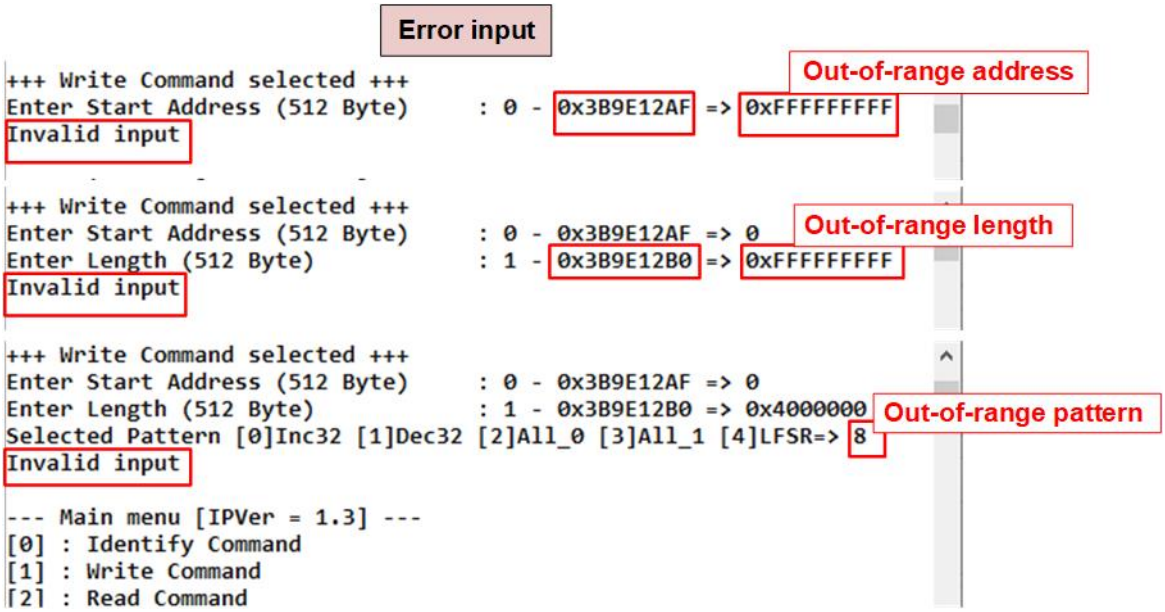

Figure 2-5 Error message from the invalid input

2.3 Read Command

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

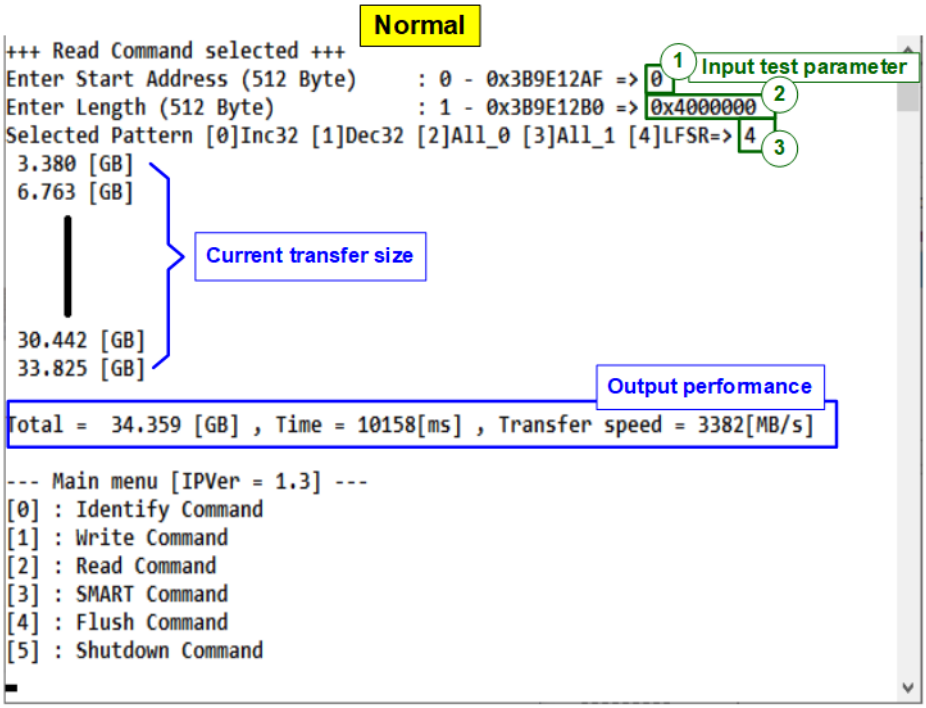

Figure 2-6 Input and result of Read Command menu

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 2-7 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.

Verification error without cancellation

```
+++ 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=> 0
Verify fail
1st Error at Byte Addr = 0x00000000
Expect Data            = 0x00000003_00000002_00000000_00000000
Read Data              = 0x00000002_00000001_00000000_00000000
Press any key to cancel operation
 3.381 [GB]
 6.764 [GB]
 33.826 [GB]
Total =  34.359 [GB] , Time = 10157[ms] , Transfer speed = 3382[MB/s]
```

Wrong pattern

Message when verification is failed

Output performance

Verification error with cancellation

```
+++ 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=> 0

Verify fail
1st Error at Byte Addr = 0x00000000
Expect Data            = 0x00000003_00000002_00000000_00000000
Read Data              = 0x00000002_00000001_00000000_00000000
Press any key to cancel operation
 3.381 [GB]
 6.764 [GB]
 10.147 [GB]
Operation is cancelled
Please reset system before starting a new test

--- Main menu [IPVer = 1.3] ---
[0] : Identify Command
[1] : Write Command
```

User enters the key to cancel the operation

Message when operation is cancelled

Figure 2-7 Data verification is failed

2.4 SMART Command

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

```
+++ SMART Command selected +++

<< SMART Log Information >>
Temperature                     : 36 Degree Celsius
Total Data Read                 : 13073 GB
Total Data Read (Raw data)      : 0x00000000_00000000_00000000_018595B8
Total Data Written              : 17334 GB
Total Data Written (Raw data)   : 0x00000000_00000000_00000000_02049295
Power On Cycles                 : 480 Times
Power On Hours                  : 91 Hours
Unsafe Shutdowns                : 314 Times

SMART Command Complete

--- Main menu [IPVer = 1.3] ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command
```

Data output decoded from SMART command

Figure 2-8 Test result when running SMART Command

When finishing the operation, SMART/Health Information (output from SMART command) is displayed as shown in Figure 2-8. 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 bytes.
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 bytes.
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

2.5 Flush Command

Select ‘4’ to send Flush command to NVMe SSD.

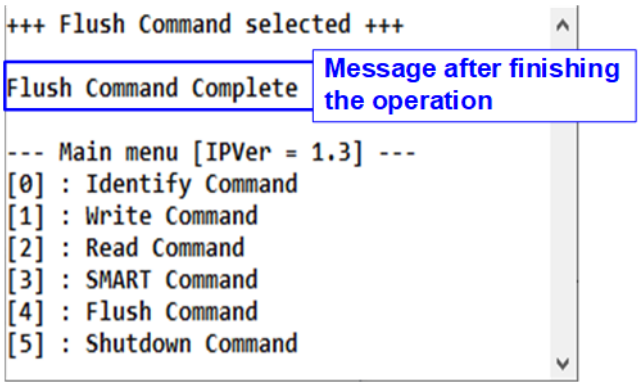

Figure 2-9 Test result when running Flush command

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

2.6 Shutdown Command

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

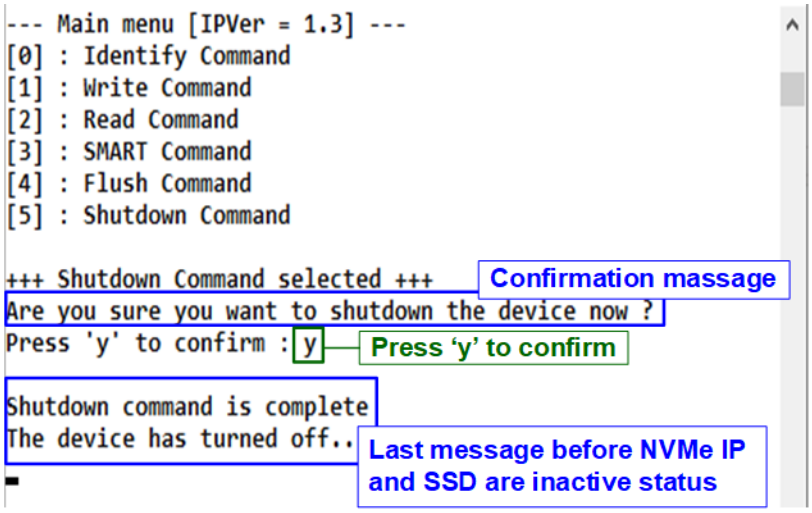

Figure 2-10 Shutdown Command with confirmation

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.

3 Revision History

Revision	Date	Description
1.0	1-May-20	Initial version release
2.0	16-Dec-20	Remove FPGA setup from the document