

NVMe-IP Linux Demo Instruction

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NVMe-IP Linux Demo Instruction

Rev1.0 29-Jun-23

This document describes the instruction to run NVMe-IP demo with Angstrom Linux 2014.12 OS on Arria10 SoC Development board. The demo is designed to get Identify data, write data, and read data with NVMe SSD. User controls test operation through Serial Console. To run the demo, FPGA configuration file as image file is prepared in microSD card. After that, install microSD card to FPGA board for configuration after power on board.

1 Environment Requirement

To demo NVMe-IP Linux demo on IntelFPGA board, please prepare the following hardware/software.

- 1) IntelFPGA board: Arria10 SoC Development board
- 2) PC with Serial console software, i.e. HyperTerminal
- 3) Power adapter of IntelFPGA board
- 4) NVMe SSD
- 5) 4 GB or bigger microSD card with demo image file, downloaded from http://www.dgway.com/NVMe-IP_A_E.html
- 6) miniUSB cable for Serial communication



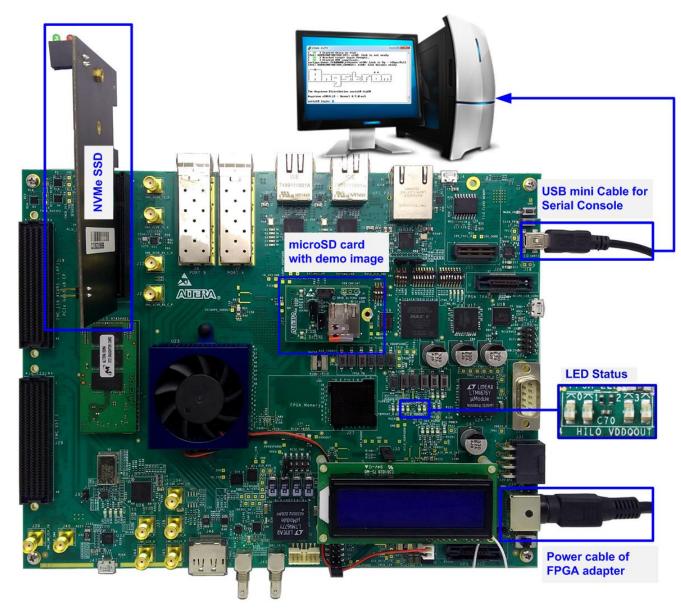


Figure 1-1 NVMe-IP Linux Demo on Arria10 SoC Development Board



2 Demo setup

2.1 Prepare demo image file to microSD Card

The sequence to prepare image file is shown as follows.

- 1) Extract "sd_card_image_a10.img.tar.gz" to get output file "sd_card_image_a10.img".
- 2) Connect microSD card to PC by using card reader.
- 3) Open "Win32DiskImage" application.
- 4) Copy "sd_card_image_a10.img" to microSD by using Win32DiskImage, as shown in Figure 2-1.
 - a. Select drive to microSD card drive.
 - b. Browse to directory path of "sd_card_image_a10.img" file.
 - c. Click "Write" to start dump data.
 - d. "Confirm overwrite" window is displayed. Click "Yes" to confirm data dump.
 - e. Wait until progress status updated from 0% to 100%. "Complete" window with "Write Successful" is displayed. Click "OK" to complete this step.

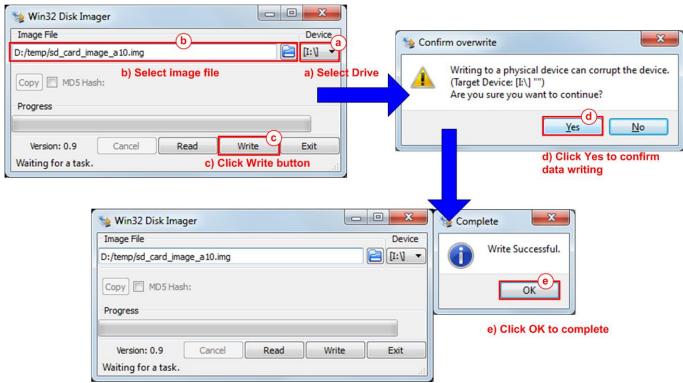


Figure 2-1 Write demo image file to microSD Card



2.2 PCIe setup and Board setup

- 1) Power off system.
- 2) Insert microSD card to the socket on daughter cards.
- 3) Connect NVMe SSD to PCle connector on FPGA board, as shown in Figure 2-2.



Figure 2-2 NVMe SSD connection on FPGA board

4) Connect mini USB cable from FPGA board to PC for Serial console, as shown in Figure 2-3.

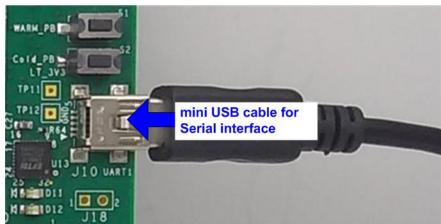


Figure 2-3 USB cable connection



5) Set SW3[1] /[2]/ [6]/ [8] = OFF position to enable JTAG of HPS, FPGA, and MAX, as shown in Figure 2-4.

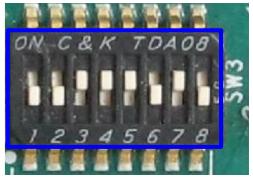


Figure 2-4 JTAG Enable for Arria10 SoC board

- 6) Connect FPGA power adapter to FPGA board, as shown in Figure 2-5.
- 7) Power on FPGA development board.

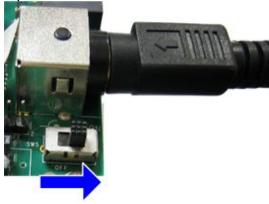


Figure 2-5 Power on FPGA board

- 8) Open Serial console software such as HyperTerminal. Software setting is BaudRate=115,200, Data=8 bit, Non-Parity, and Stop=1.
- 9) On PC Serial console, please wait Linux boot-up until login required, as shown in Figure 2-6.

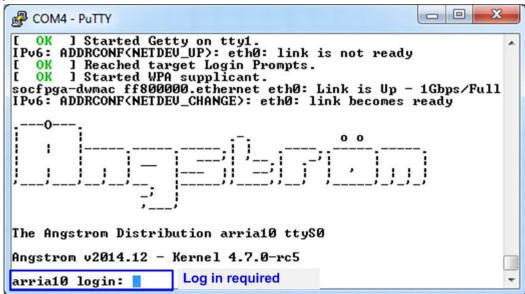


Figure 2-6 Linux Boot-up



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

Table 1 LED Definition

GPIO LED	ON	OFF
0	Normal operation	System is in reset condition
1	System is busy	Idle status
2	Error detect	Normal operation
3	Data verification fail	Normal operation



Figure 2-7 4-bit LED Status for user output

11)After programming completely, LED[0] and LED[1] are ON which mean that PCIe initialization is processing. Then, LED[1] is OFF to show that PCIe completes initialization process and system is ready to receive command from user.



Figure 2-8 LED status after program configuration file and PCIe initialization complete



3 Test Menu

Before running the test application, user must login to Linux system by login name as "root", as shown in Figure 3-1.

Figure 3-1 Login to Linux system

Next, insert module and running test application by typing following command.

- >> insmod dg_universal.ko
- >> ./dg_universal/application/dguTestApp

After that, main menu is displayed on Serial console, as shown in Figure 3-2.



Figure 3-2 Insert module and running test application



3.1 Identify Device

Select '0' to send Identify command to NVMe SSD. When operation is completed, SSD capacity and model name are displayed on the console.

```
Enter command: 0

-> Identify SSD

[OK] Model Number : Samsung SSD 960 PRO 512GB

[OK] SSD Capacity : 512 GB(s) SSD capacity output from IP

--- Main Menu [Version: 1.0] ---

[0] : Identify SSD

[1] : Write SSD

[2] : Read SSD

[3] : Dump SSD

[9] : Exit Test

Enter command:
```

Figure 3-3 Result from Identify Device menu



3.2 Write SSD

Select '1' to send Write command to NVMe SSD. Three inputs are required for this menu.

- 1) Start LBA: Input start address of SSD in sector unit. The input is decimal unit when input only digit number. User can add "0x" to be prefix when input is hexadecimal unit.
- 2) Sector Count: Input total transfer size in sector unit. The input is decimal unit when input only digit number. User can add "0x" to be prefix when input is hexadecimal unit.
- 3) Test pattern: Select test pattern of test data for writing to SSD. Five types can be selected, i.e. 32-bit increment, 32-bit decrement, all 0, all 1, and 32-bit LFSR counter.

As shown in Figure 3-4, if all inputs are valid, the operation will be started. During writing data, current transfer size is displayed on the console to show that system still run. Finally, test performance, total size, and total time usage are displayed on the console as test result.

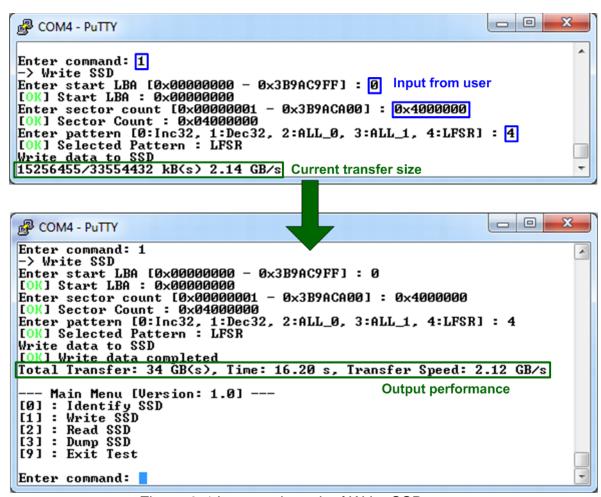


Figure 3-4 Input and result of Write SSD menu



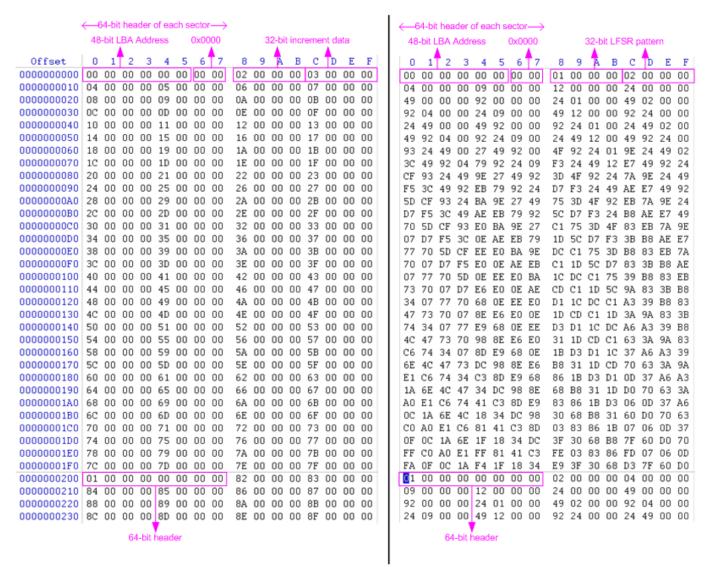


Figure 3-5 Example Test data in sector#0/#1 by increment/LFSR pattern

Test data of each sector has different 64-bit header which consists of 48-bit LBA address and 16-bit all 0 value. 48-bit LBA address is unique value for each sector. After that, the test pattern is filled following user selection such as 32-bit increment pattern (left window of Figure 3-5), 32-bit LFSR pattern (right window of Figure 3-5).



Figure 3-6 – Figure 3-8 shows error message when user input is invalid. "Input is not in range" is displayed on the console. Then, it returns to main menu to receive new command.

```
Enter command: 1

-> Write SSD
Enter start LBA [0x00000000 - 0x3B9AC9FF] : 0x3b9aca00

[ER] Input is not in range

--- Main Menu [Version: 1.0] ---

[0] : Identify SSD
[1] : Write SSD
[2] : Read SSD
[3] : Dump SSD
[9] : Exit Test

Enter command:
```

Figure 3-6 Invalid Start LBA input

```
Enter command: 1

-> Write SSD
Enter start LBA [0x0000000 - 0x3B9AC9FF]: 0
[OK] Start LBA: 0x00000000
Enter sector count [0x0000001 - 0x3B9ACA00]: 0x3b9aca01
[ER] Input is not in range

--- Main Menu [Version: 1.0] ---
[0]: Identify SSD
[1]: Write SSD
[2]: Read SSD
[3]: Dump SSD
[9]: Exit Test
Enter command:
```

Figure 3-7 Invalid Sector count input

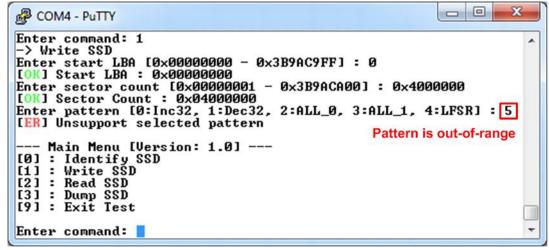


Figure 3-8 Invalid Test pattern input



3.3 Read SSD

Select '2' to send Read command to NVMe SSD. Three inputs are required for this menu.

- 1) Start LBA: Input start address of SSD in sector unit. The input is decimal unit when input only digit number. User can add "0x" to be prefix when input is hexadecimal unit.
- 2) Sector Count: Input total transfer size in sector unit. The input is decimal unit when input only digit number. User can add "0x" to be prefix when input is hexadecimal unit.
- 3) Test pattern: Select test pattern to verify data from SSD. Test pattern must be matched with the test pattern which is used during write test. Five types can be selected, i.e. 32-bit increment, 32-bit decrement, all 0, all 1, and 32-bit LFSR counter.

Similar to write test if all inputs are valid, test system will read data from SSD. Test performance, total size, and total time usage are displayed after end of transfer. "Invalid input" will be displayed if some input values are out-of-range.

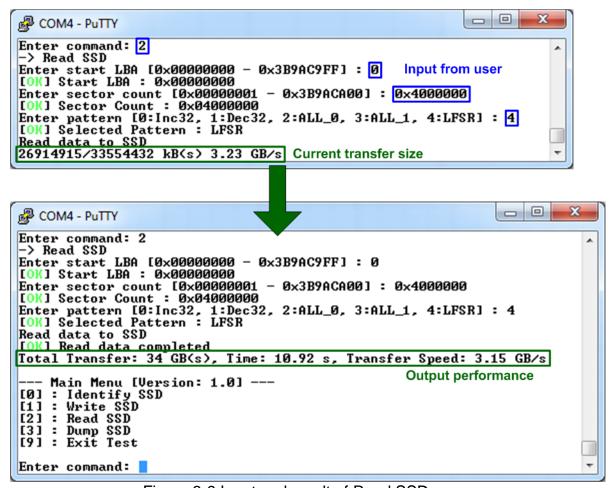


Figure 3-9 Input and result of Read SSD menu



Figure 3-10 shows the error message when data verification is failed. "verification fail" is displayed with Read data and Expected data. User must wait until the test is completed.

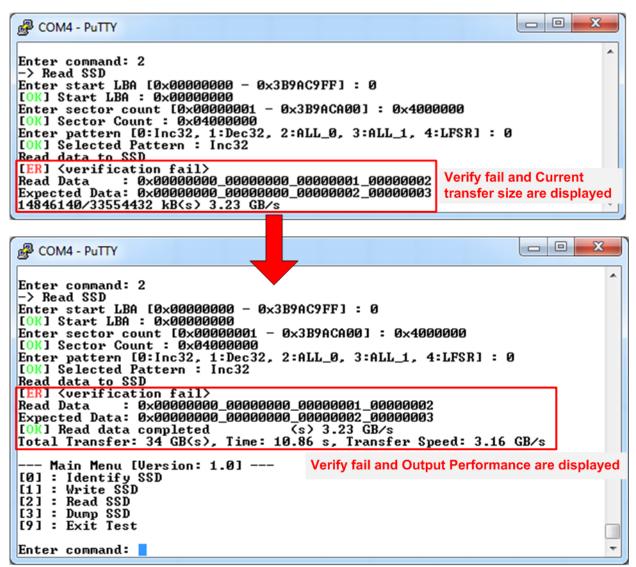


Figure 3-10 Data verification is failed



3.4 Dump SSD

Select '3' to send Dump command to NVMe SSD. Only one input is required for this menu.

Start LBA: Input start address of SSD in sector unit. The input is decimal unit when input only digit number. User can add "0x" to be prefix when input is hexadecimal unit.

Similar to write and read test if the input is valid, test system will return data 1 sector (512 byte) from SSD.

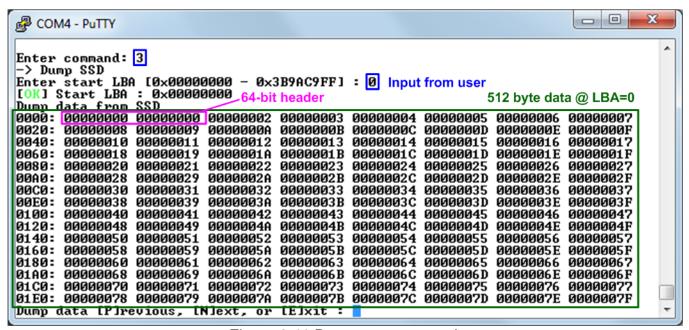


Figure 3-11 Dump menu example

After displaying one data sector, another input is required. Input 'p' to display the previous sector of Start LBA. Input 'n' to display the next sector of Start LBA. Input 'e' to go back to main menu.



As shown in Figure 3-12, when input 'n' to show the data of the next sector, Start LBA is increased by 1 (from 0 to 1).

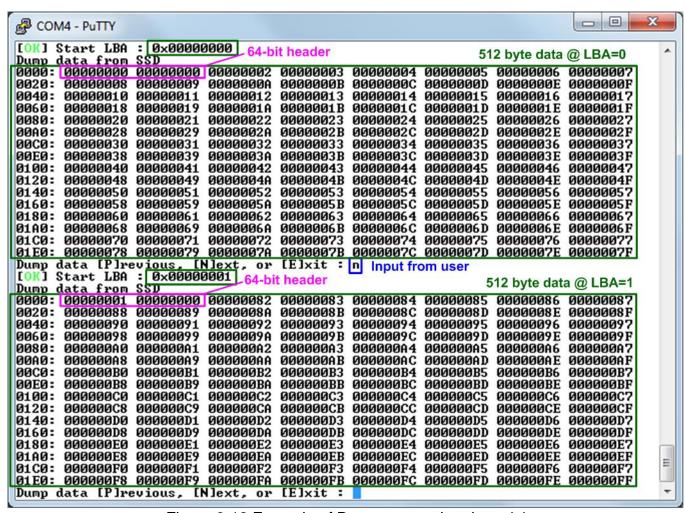


Figure 3-12 Example of Dump menu when input 'n'



As shown in Figure 3-13, when input 'p' to show the data of the previous sector, Start LBA is decreased by 1 (from 1 to 0).

```
0
                                                                                      X
COM4 - PuTTY
[OK] Start LBA : 0x00000001 64-bit header
                                                               512 byte data @ LBA=1
      000000001
                00000000 00000082
                                    00000083
                                             00000084 00000085
                                                                 000000086
                                                                           000000087
                00000089
0020:
                                    0000008B
                                                                           0000008F
      88000000
                          0000008A
                                              0000008C
                                                       0000008D
                                                                 0000008E
0040:
      00000090
                00000091
                          00000092
                                    00000093
                                              00000094
                                                       00000095
                                                                 00000096
                                                                           00000097
      00000098
                00000099
                          0000009A
                                    0000009B
                                              0000009C
                                                       0000009D
                                                                 0000009E
                                                                           0000009F
0060:
                                              0000000A4
0080:
      000000A0
                000000A1
                          000000A2
                                    000000A3
                                                       000000A5
                                                                 000000A6
                                                                           000000A7
                000000A9
                                    000000AB
00A0:
      8A000000
                          000000AA
                                              000000AC
                                                       000000AD
                                                                 000000AE
                                                                           000000AF
00C0:
      000000B0
                000000B1
                                              000000B4
                          000000B2
                                    000000B3
                                                       000000B5
                                                                 000000B6
                                                                           000000B7
00E0:
      000000B8
                000000B9
                          000000BA
                                    000000BB
                                              000000BC
                                                       000000BD
                                                                 000000BE
                                                                           000000BF
0100:
      00000000
                000000C1
                          000000C2
                                    000000C3
                                              000000C4
                                                       000000C5
                                                                 000000C6
                                                                           000000C7
      000000008
                          ФФФФФФСА
0120:
                000000009
                                    ФФФФФФСВ
                                              ФФФФФФСС
                                                       000000CD
                                                                 000000CE
                                                                           000000CF
                                              000000D4
0140:
      000000D0
                000000D1
                          000000D2
                                    000000D3
                                                       000000D5
                                                                 000000D6
                                                                           000000D7
                000000D9
                                    000000DB
                                              000000DC
                                                       000000DD
0160:
      000000D8
                          000000DA
                                                                 000000DE
                                                                           000000DF
0180:
      000000E0
                000000E1
                          000000E2
                                    000000E3
                                              000000E4
                                                       000000E5
                                                                 000000E6
                                                                           000000E7
                                    000000EB
01A0:
      000000E8
                000000E9
                          000000EA
                                             000000EC
                                                       000000ED
                                                                 000000EE
                                                                           000000EF
                                                                 000000F6
01C0: 000000F0
                000000F1
                          000000F2
                                    000000F3
                                             000000F4 000000F5
                                                                           000000F7
                                    000000FB 000000FC 000000FD 000000FE 000000FF
      000000F8 000000F9
                          000000FA
01E0:
Dump data [P]revious, [N]ext, or [E]xit
[OK] Start LBA : 0x00000000 64-bit header
                                   [E]xit : p Input from user
                                                                512 byte data @ LBA=0
Dump data from SSD
0000: 00000000 00000000 00000002
                                                                 00000006 000000007
                                    00000003 00000004 00000005
      80000000
                90000009
                          A0000000
                                    0000000B
                                             0000000C 0000000D
                                                                 0000000E 0000000F
0020:
0040:
      00000010
                00000011
                          00000012
                                    00000013
                                              00000014
                                                       00000015
                                                                 00000016
                                                                           00000017
0060:
      00000018
                00000019
                          0000001A
                                    0000001B
                                              0000001C
                                                       0000001D
                                                                 0000001E
                                                                           0000001F
0080:
      00000020
                00000021
                          00000022
                                    00000023
                                              00000024
                                                       00000025
                                                                 00000026
                                                                           00000027
00A0:
      00000028
                00000029
                          0000002A
                                    0000002B
                                              0000002C
                                                       0000002D
                                                                 0000002E
                                                                           0000002F
                00000031
00C0:
      00000030
                          00000032
                                    00000033
                                              00000034
                                                       00000035
                                                                 00000036
                                                                           00000037
00E0:
      00000038
                00000039
                          0000003A
                                    0000003B
                                              0000003C
                                                       0000003D
                                                                 0000003E
                                                                           0000003F
0100:
      00000040
                00000041
                          00000042
                                    00000043
                                              00000044
                                                       00000045
                                                                 00000046
                                                                           00000047
0120:
      00000048
                00000049
                          0000004A
                                    0000004B
                                              0000004C
                                                       0000004D
                                                                 0000004E
                                                                           0000004F
0140:
      00000050
                00000051
                          00000052
                                    00000053
                                              00000054
                                                       00000055
                                                                 00000056
                                                                           00000057
0160:
      00000058
                00000059
                          0000005A
                                    0000005B
                                              0000005C
                                                       0000005D
                                                                 0000005E
                                                                           0000005F
0180:
      00000060
                00000061
                          00000062
                                    00000063
                                              00000064
                                                       00000065
                                                                 00000066
                                                                           00000067
      00000068
                00000069
                          0000006A
                                    0000006B
                                             0000006C 0000006D
                                                                 0000006E
                                                                           0000006F
01A0:
                                             00000074 00000075
0000007C 0000007D
                                                                 00000076
      00000070 00000071 00000072
                                    00000073
01C0:
                                                                           00000077
      00000078 00000079
                                    0000007B
                          0000007A
                                                                 0000007E
                                                                           0000007F
01E0:
                       [N]ext, or [E]xit:
Dump data [P]revious,
```

Figure 3-13 Example of Dump menu when input 'p'

Main menu is displayed when user input 'e' to exit Dump menu, as shown in Figure 3-14.

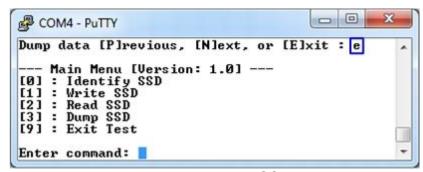


Figure 3-14 Exit Dump SSD menu



3.5 Exit Test

Select '9' to exit test application.

```
COM4 - PuTTY

--- Main Menu [Version: 1.0] ---
[0]: Identify SSD
[1]: Write SSD
[2]: Read SSD
[3]: Dump SSD
[9]: Exit Test

Enter command: 9
root@arria10:~#
```

Figure 3-15 Exit test application



4 Revision History

Revision	Date	Description	
1.0	19-Feb-18	Initial version release	