2-Ch RAID0 (NVMe IP for Gen 4/NVMeG4-IP) Demo Instruction

Rev1.2   3-Aug-22

1   Overview

This document describes the instruction to run 2-ch RAID0 demo by using NVMe-IP for Gen4/NVMeG4-IP. The demo is run on FPGA development board for accessing two NVMe Gen4 SSDs as RAID0. There are six test menus for running six commands - Identify, Write, Read, SMART, Flush, and Shutdown command. User controls test operation via FPGA console.

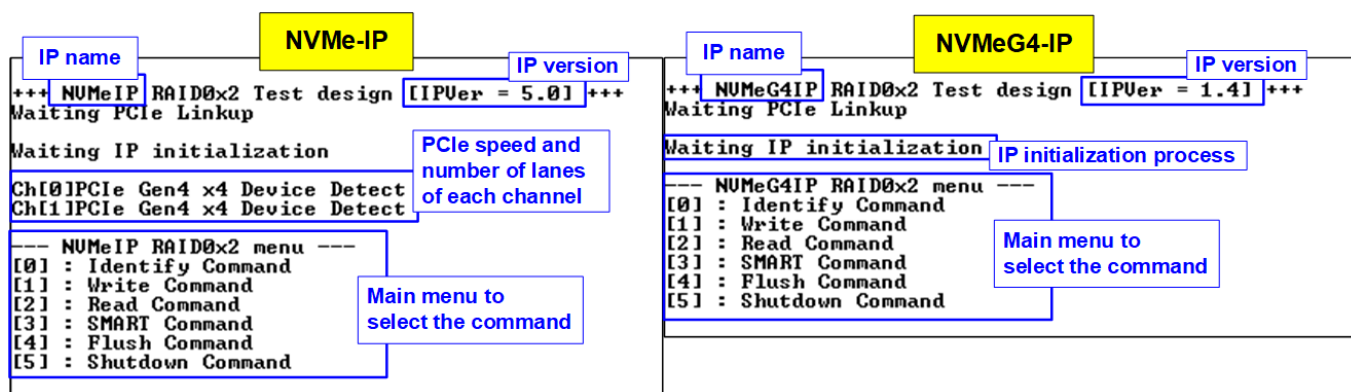After user finishes FPGA board setup following "dg_nvmeip_raid0x2_fpgasetup" document.

Figure 1-1 RAID0x2 menu after finish initialization

On welcome screen, IP name and IP version number are displayed. For standard IP (NVMe-IP), the PCIe speed and number of PCIe lanes of each channel are displayed in the next message. While NVMeG4-IP does not display because only 4-lane PCIe Gen4 SSD is supported. Finally, the test menu is displayed on the console.

2 Test Menu

2.1 Identify Command

Select '0' to send Identify command to RAID0.

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 of each SSD.
2) RAID capacity   : This value is calculated by multiplying device capacity in channel#0 by 2. Therefore, it is recommended to connect two SSDs which have the same size.
   Note: If two SSDs are different model which has different capacity, please connect the smallest capacity SSD to CH#0.

When unsupported LBA size is detected, the error message is displayed on the console, as shown in Figure 2-2.
Note: In RAID0 design, LBA size of SSD must be equal to 512-byte. Other size can be supported by modifying RAID0 controller hardware.

Figure 2-2 Error message when LBA size does not support

2.2 Write Command

Select '1' to send Write command to RAID0.

Figure 2-3 Test result when running Write command

User sets three parameters as follows.
1) Start Address: Start address to write RAID0 in 512-byte unit. The input is decimal unit when the input is only digit number. User can add "0x" to be a prefix for hexadecimal unit.
2) Transfer Length: Total transfer size in 512-byte unit. The input is decimal unit when the input is only digit number. User can add "0x" to be a prefix for hexadecimal unit.
3) Test pattern: Select test data pattern for writing RAID0. 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. While writing data, current amount of write data is displayed on the console every second to show that system is still alive. Finally, total size, total time usage, and test speed are calculated and displayed on the console to be a test result.

Note:
1. Typically, the performance of 2-ch RAID0 system is about two times of the performance of one SSD. It is recommended to use the same SSD model for all SSD channels for matching SSD characteristic. If the different SSD model are applied in the system, the 2-ch RAID0 performance is limited by two times of the slowest SSD performance.
2. Some SSDs shows slower performance after writing large size data to SSD. It needs to recover SSD performance by filling zero pattern or using Format command which is customized command. Please contact our sales for more information if Format command is required.

Figure 2-4 Example Test data of the 1st 512-byte of each SSD by using LFSR pattern

The stripe size in 2-ch RAID0 demo is 512-byte. For incremental, decremental, or LFSR pattern, each 512-byte data has unique 64-bit header which consists 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 1st stripe of RAID0 is mapped to the first 512-byte of SSD#0 while the 2nd stripe of RAID0 is mapped to the first 512-byte of SSD#1, as shown in Figure 2-4. The unique header is not included when running all-0 or all-1 pattern.

Figure 2-5 Error message from the invalid input

Figure 2-5 shows the example when the input is out-of-range from the recommended value. The console displays "Invalid input" and then the operation is cancelled.

2.3   Read Command

Select '2' to send Read command to RAID0.

Figure 2-6 Input and result of Read Command menu

User inputs three parameters as follows.
1) Start Address: Start address to read RAID0 in 512-byte unit. The input is decimal unit when the input is only digit number. User can add "0x" to be a prefix for hexadecimal unit.
2) Transfer Length: Total transfer size in 512-byte unit. The input is decimal unit when the input is only digit number. User can add "0x" to be a prefix for hexadecimal unit.
3) Test pattern: Select test data pattern to verify data from RAID0. 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 starts reading data from RAID0 when all inputs are valid. While reading data, current amount of read data is displayed on the console every second to show that system is still alive. Finally, total size, total time usage, and test speed are calculated and displayed on the console to be a test result.

Note:
1. *Some SSDs shows the different performance when changing test pattern. For example, the read performance when using all-zero pattern is better than using LFSR pattern.*
2. *Similar to Write command, when 2 SSDs are different, performance of RAID0 is limited by 2 times of the slowest SSD performance.*
3. *For the system that is sensitive to the read performance, the read performance of most SSDs is better when using customized IP that extends the buffer size from 256 Kbytes to 1 Mbytes. Please contact our sales for more information.*
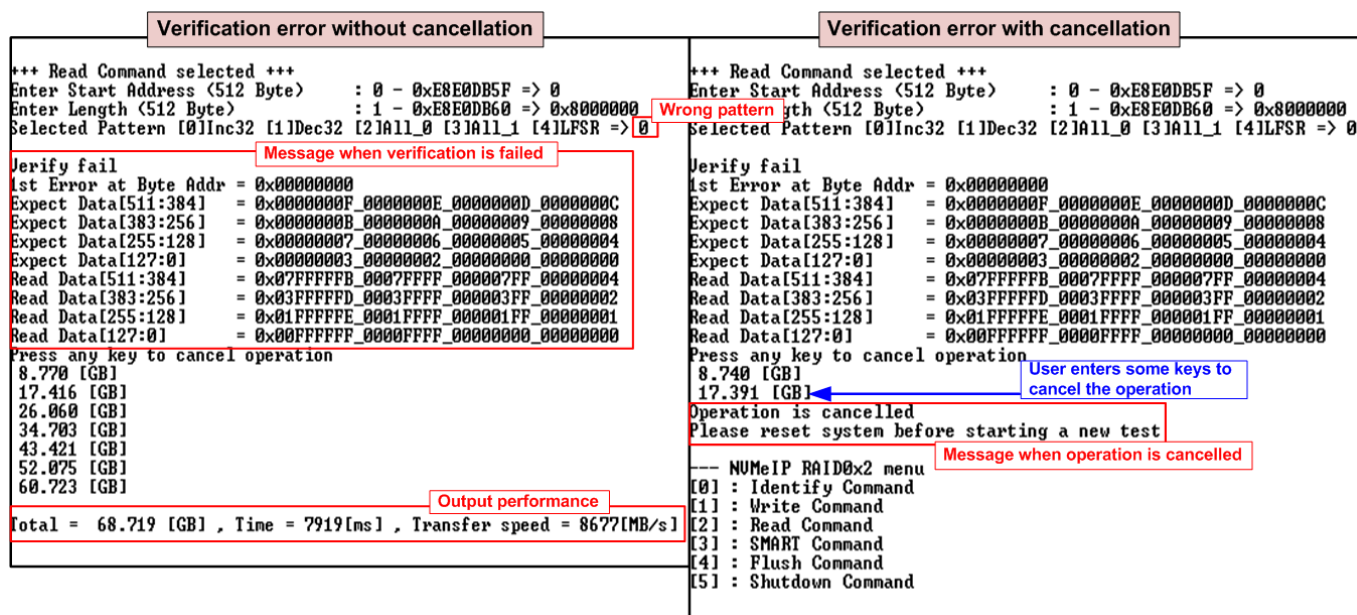
Figure 2-7 Data verification is failed

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. Otherwise, the operation is still run until finishing Read command operation. After that, the output performance is displayed on the console.

When cancelling the operation, the Read command still runs as the background process and may not finish in a good sequence. It is recommended to power-off/on FPGA board and adapter board (if connected).

2.4 SMART Command

Select '3' to send SMART command to RAID0.


```
+++ SMART Command selected +++          Data output decoded
                                        from SMART command
++ ch[0]
<< Health Status >>
Remaining Life  : 98%

<< SMART Log Information Ch[0] >>                      SSD#0
Percentage Used                 : 2%
Temperature                     : 38 Degree Celsius
Total Data Read                 : 22813 GB
Total Data Read (Raw data)      : 0x00000000_00000000_00000000_02A7D6F6
Total Data Written              : 43483 GB
Total Data Written (Raw data)   : 0x00000000_00000000_00000000_050FD072
Power On Cycles                 : 427 Times
Power On Hours                  : 93 Hours
Unsafe Shutdowns                : 367 Times


++ ch[1]
<< Health Status >>
Remaining Life  : 94%

<< SMART Log Information Ch[1] >>                      SSD#1
Percentage Used                 : 6%
Temperature                     : 35 Degree Celsius
Total Data Read                 : 124309 GB
Total Data Read (Raw data)      : 0x00000000_00000000_00000000_0E7879EE
Total Data Written              : 159989 GB
Total Data Written (Raw data)   : 0x00000000_00000000_00000000_129FC0C1
Power On Cycles                 : 17820 Times
Power On Hours                  : 701 Hours
Unsafe Shutdowns                : 17608 Times

SMART Command Complete

--- NVMeIP RAID0x2 menu ---
[0] : Identify Command
[1] : Write Command
[2] : Read Command
[3] : SMART Command
[4] : Flush Command
[5] : Shutdown Command
```

Figure 2-8 Test result when running SMART command

When finishing the operation, SMART/Health Information (output from SMART command) of two SSDs are displayed as shown in Figure 2-8. The console shows Health status and SMART log information. Health status shows the remaining life of the SSD in percent unit which is calculated from Percentage Used in the SMART log information.

The SMART log information shows seven parameters, described as follows.
1) Percentage Used: Display SSD usage in percent unit.
2) Temperature in °C unit.
3) Total Data Read decoded as GB/TB unit. Also, raw data without decoding is displayed by 32 digits of hex number (128 bits). The unit size of raw data is 512,000 bytes.
4) Total Data Written decoded as GB/TB unit. Also, raw data without decoding is displayed by 32 digits of hex number (128 bits). The unit size of raw data is 512,000 bytes.
5) Power On Cycles: Display the number of power cycles.
6) Power On Hours: Display the period of time in hours to show how long the SSD has been powered on.
7) Unsafe Shutdowns: Display the number of unsafe shutdowns of SSD

2.5   Flush Command

Select '4' to send Flush command to RAID0.

Figure 2-9 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 RAID0.

Figure 2-10 Test result when running Shutdown command

The confirmation message is displayed on the console. User enters 'y' or 'Y' to confirm the operation or enters 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 and User needs to power off/on the test system to start new test operation.

3 Revision History

Revision	Date	Description
1.2	3-Aug-22	Support NVMe-IP for Gen4
1.1	20-Jul-21	Remove FPGA setup topic and update test result
1.0	8-May-20	Initial version release