

# <u>4-ch RAIDO by SATA Host-IP Demo Instruction</u> <u>Rev1.1 22-Aug-23</u>

1	Env	vironment Requirement	2
		mo setup	
		st Menu	
		Identify Device	
		Write SSD	
		Read SSD	
		Security Erase	
		vision History	



## 4-ch RAID0 by SATA Host-IP Demo Instruction

Rev1.1 22-Aug-23

This document describes the instruction to run 4-ch RAID0 SATA Host-IP demo on FPGA development boar and SATA adapter board (AB09-FMCRAID/AB12-HSMCRAID). The demo is designed to write/verify data with four SATA-III devices. It is recommended to use same SATA devices model to run the test. User can control test operation through NiosII command shell.

#### **1** Environment Requirement

To run demo SATA Host RAID0 demo on IntelFPGA board, please prepare the following hardware/software.

- 1) IntelFPGA board:
  - ArriaV GX Starter board
  - Arria10 SoC Development board
  - Alaric board from Reflex
- 2) PC with QuartusII programmer and NiosII command shell software
- 3) SATA adapter board
  - a) For Arria10 SoC/Alaric board: AB09-FMCRAID
  - b) For ArriaV GX board: AB12-HSMCRAID
- 4) Four SATA-III devices connection at CN0-CN3 of SATA adapter board
- 5) Power adapter and ATX power supply for SSD
- 6) A cable for programming FPGA and NiosII command shell connecting between FPGA board and PC,
  - a) For Arria10 SoC/Alaric board: use micro USB cable
  - b) For ArriaV GX board: use USB A-B cable

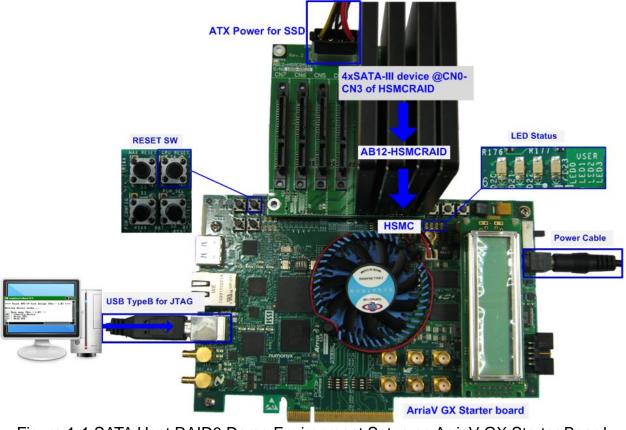


Figure 1-1 SATA Host RAID0 Demo Environment Setup on ArriaV GX Starter Board





Figure 1-2 SATA Host RAID0 Demo Environment Setup on Arria10 SoC Development Board

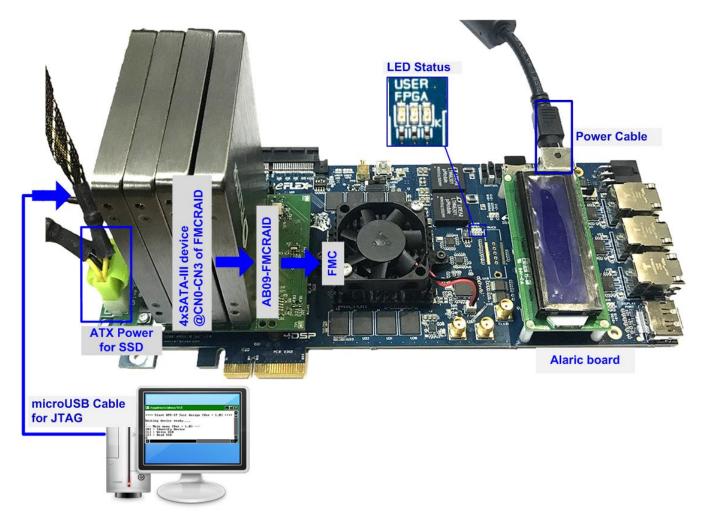


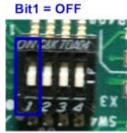
Figure 1-3 SATA Host-IP Demo Environment Setup on Alaric board

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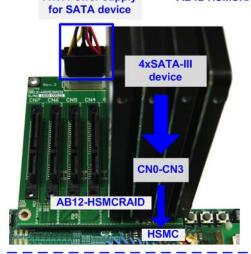
#### 2 Demo setup

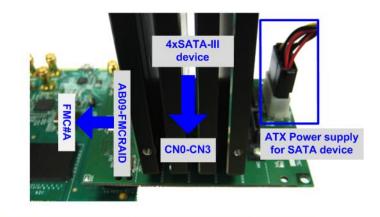
- 1) Power off system.
- 2) Setup board option.
  - a) For ArriaV GX Starter board only, set bit1 of SW4 to OFF position.



#### Figure 2-1 Set SW to select clock input for ArriaV GX Starter board

- 3) Setup RAID adapter board.
  - i. For Arria 10 SoC Development board/Alaric board: Connect AB09-FMCRAID to FMC#A
    - For ArriaV GX Starter board: Connect AB12-HSMCRAID to HSMC
  - ii. Connect four SATA-III devices to CN0-CN3 on AB09/AB12.
  - iii. Connect power to power connector on AB09/AB12
  - ATX Power supply AB12-HSMCRAID AB09-FMCRAID





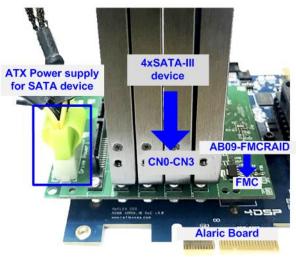
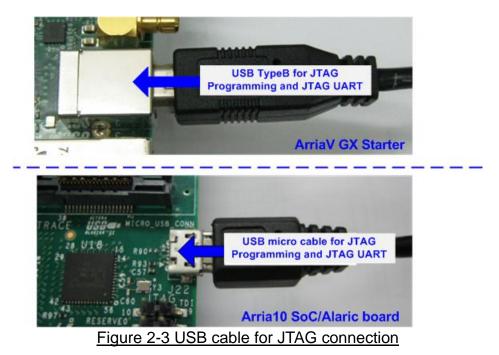


Figure 2-2 AB09/AB12 connection to FPGA board



4) Connect USB Type A or micro USB cable from FPGA board to PC for JTAG programming and JTAG UART.



- 5) Power on FPGA development board and power supply for SATA device.
- 6) Open "Clock Control" application to program 150 MHz clock for Altera board.
  - a) For ArriaV GX Starter board only, select 1<sup>st</sup> tab (U4), set CLK0 frequency = 150 MHz, and click "Set New Frequency" button.

\land Clock Contro	I			- • •						
F_vco	: 000MHz									
Registers		Fre	quency (MHz)	Disable all 📃						
CLK0	-	CLK0	150.00	Disable CLK0 📃						
CLK1	-	CLK1	150.00	Disable CLK1 📃						
CLk2	-	CLK2	150.00	Disable CLK2 🔲						
СГКЗ	-	CLK3	150.00	Disable CLK3 📃						
	read		Default	Set New Frequency						
Messages										
/USB-BlasterII on localhost (USB-1)/5M(1270ZF324  2210Z) EPM2210@2										
Figure 2	-4 Set clock	frequ	ency for A	ArriaV GX board						



#### 7) Use QuartusII Programmer to program "HSATARaid0x4.sof" file, as shown in Figure 2-5.

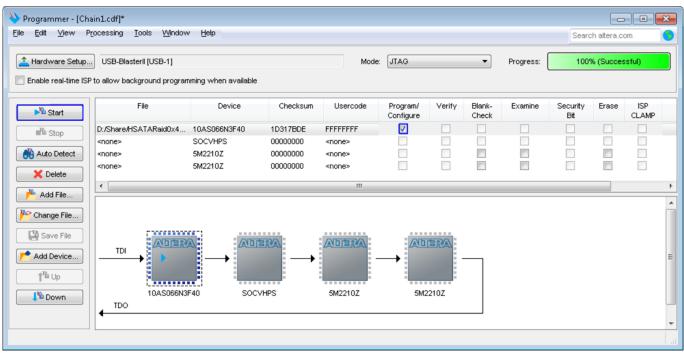


Figure 2-5 Programmed by QuartusII Programmer

8) Open NiosII Command Shell and run nios2-terminal command. Boot message are displayed.

"Waiting device ready" message is displayed during system initialization.

"SATA Gen3 Device Detect" shows SATA speed after complete RAID0 initialization. Main menu is displayed to receive command from user.

nios2-terminal: "Arria10 IDK	hardware target using JTAG UART on cable [USB-1]", device 1, instance 0 [top button or Ctrl-C to terminate)						
Waiting device ready	Wait SATA Linkup						
SATA Gen3 Device Detect	SATA Speed = Gen3						
Main menu [Ver = 1.3] [0] : Identify Device [1] : Write SSD [2] : Read SSD [3] : Security Erase	Main menu to select operating command						
•							
Figure 2.6 Nigell Terminel							

Figure 2-6 NiosII Terminal



9) If any SATA devices are not detected, error message that "CHX Not Detect" will be displayed as shown in Figure 2-7. Please check SATA device in the error channel.

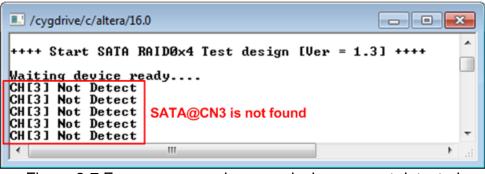


Figure 2-7 Error message when any devices are not detected

10)Check LED status on FPGA board. The description of LED is shown as follows. Note: LED [3] is not available on Alaric board. There are three LEDs on the board.

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Table 1 LED Definition										
<b>GPIO LED</b>	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 2-8 4-bit LED Status for user output

11)After programming completely, LED[0] and LED[1] are ON during RAID0 initialization process. LED[1] is OFF after RAID0 completes initialization process and system is ready to receive command from user.

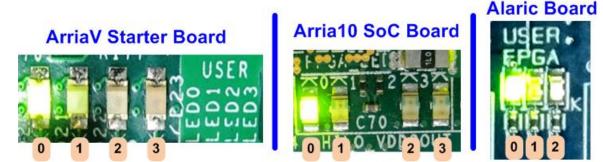


Figure 2-9 LED status after program configuration file and RAID0 initialization complete

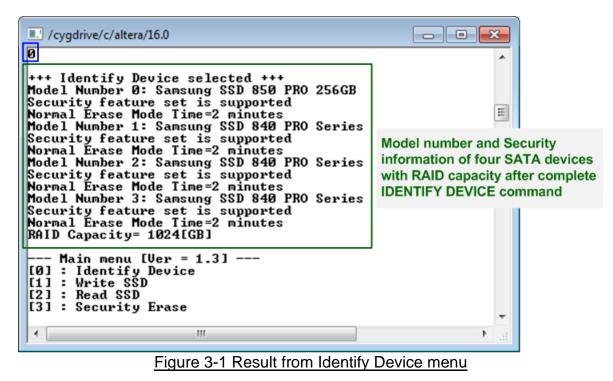


#### 3 Test Menu

#### 3.1 Identify Device

Select '0' to send Identify device command to RAID0. When operation is completed, four information are displayed on NiosII command shell, i.e.

- 1) SSD model number
- 2) Security feature set is supported or not. If any devices are not supported, user must not use menu 3 for the test.
- 3) Normal Erase Mode Time: This is estimation time to complete security erase command. Minimum valid value is 2 minutes. This information is displayed when the device can support Security feature set.
- 4) SSD capacity which is output value from RAID0 block. The value is equal to four times of SATA CH#0 capacity.





#### 3.2 Write SSD

Select '1' to send Write command to RAID0. Three inputs are required for this menu.

1) Start LBA: Input start address of RAID0 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 RAID0. Five types can be selected, i.e. 32-bit increment, 32-bit decrement, all 0, all 1, and 32-bit LFSR counter.

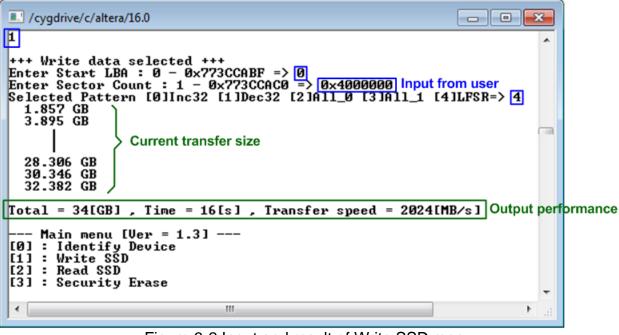


Figure 3-2 Input and result of Write SSD menu

As shown in Figure 3-2, if all inputs are valid, the operation will be started. During writing data, current transfer size is displayed on the console every second to show that system still run. Finally, test performance, total size, and total time usage are displayed on NiosII command shell as test result.



#### dg\_satahostraid\_instruction\_intel\_en.doc ←64-bit header of each sector→

	· ·		.BA					0000		22	<b>b</b> 14 1	Eer	R pat					48-	bit L	BA	Addr	ess	= 1										
Offset	10	-		3				47	8		A			D		F	1	n	4	2	3	4	5	6	7	8	9	А	в	с	D	Е	F
0000000000					-						_					00			00		-		00	-		-	-	00		-	-	_	-
0000000010													24					-					00					00					
0000000020													49										01					00					
0000000030													92										12					00					
0000000040													24					49	92	00	00	92	24	01	00	24	49	02	00	49	92	04	00
0000000050													49					92	24	09	00	24	49	12	00	49	92	24	00	93	24	49	00
							Dis	sk#0																	D	isk#	1						
																			~ ~														
00000001A0													06										86					37					
0000001B0													60												31			70 0D					
00000001C0													07 7F										83 30					OD DO					
00000001E0													FD										03					06					
00000001E0																DO							3F					60					
0000000200	_															00							00					00					
0000000210																00							00					00					
1	1		BA A																		Addr												
Offset	0		~	2	4	-	~	-			~		~			P		0		2	3	4	5	6	7	8	9	А	в	с	D	F	F
0000000000					-		-	7	8 04					D	_	F			00				<u> </u>		00	-	-	00	_	-	-	_	-
00000000010									49														00					00					
00000000020									92														03					00					
0000000030													49										ЗF					00					
0000000040									49									FF	FF	01	00	FF	FF	03	00	FF	FF	07	00	FF	FF	OF	00
0000000050	24	49	12	00	49	92	24	00	93	24	49	00	27	49	92	00		FF	FF	1F	00	FF	FF	ЗF	00	FE	FF	7F	00	FD	FF	FF	00
							Dis	k#2																	Di	sk#	3						
	00		1.0	<b>D</b> 2	0.0	0.0	27		00	1 2	<b>CF</b>	40	10	24	D.C.	~~		62	24	50	4 F	C4	48	Δ1	ar	80	<b>Q</b> 1	42	30	12	22	95	72
00000001A0 00000001B0									0C C0														40 8C					29					
00000001B0									OF														C4					91					
0000000100									OF FF																14			18					
00000001E0									FA														85					89					
00000001E0									A7														5F					90					
0000000200									OC														00					00					
0000000210									C9									ЗF	00	00	00	7F	00	00	00	FF	00	00	00	FF	01	00	00
																	<u>س</u> ر ح			ام ا	<b>.</b>	~~	~ h	1		חי		44~					

Figure 3-3 Example Test data in sector#0/#1 of 4 devices by 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 LFSR pattern (as shown in Figure 3-3).

Stripe size in 4-ch RAID0 demo is 1 sector (512-byte). So, LBA address in the header of 1<sup>st</sup> sector in Disk#0, Disk#1, Disk#2, and Disk#3 are equal to 0, 1, 2 and 3 sequentially. The address in the header of the next sector for Disk#0 is 4.



Figure 3-4 – Figure 3-6 shows error message when user input is invalid. "Invalid input" message is displayed on NiosII command shell. Then, it returns to main menu to receive new command.

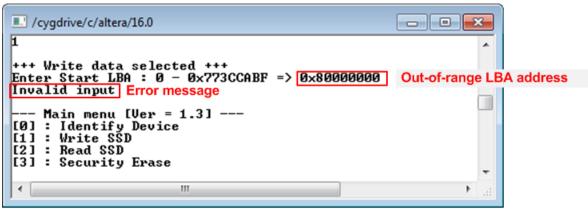


Figure 3-4 Invalid Start LBA input

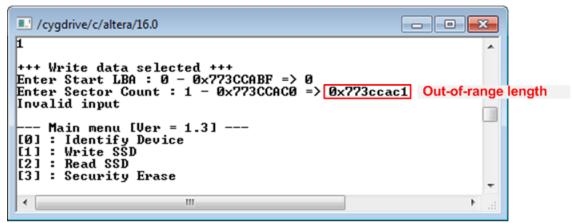


Figure 3-5 Invalid Sector count input

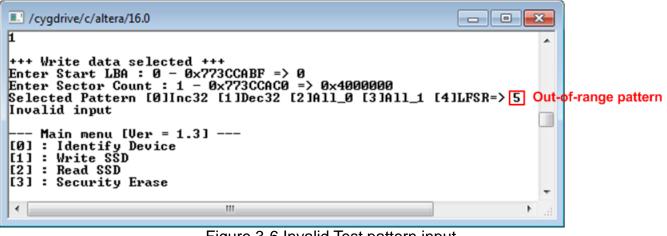


Figure 3-6 Invalid Test pattern input



#### 3.3 Read SSD

Select '2' to send Read command to RAID0. Three inputs are required for this menu.

1) Start LBA: Input start address of RAID0 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 RAID0. 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.

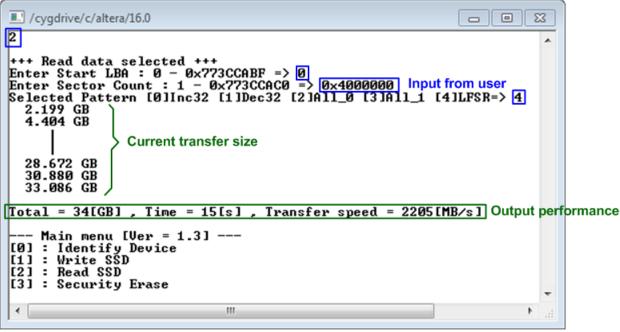


Figure 3-7 Input and result of Read SSD menu

Similar to write test if all inputs are valid, the operation will read data from RAID0 system. Test performance, total size, and total time usage are displayed after end of transfer. "Invalid input" will be displayed if any input value is out-of-range.



Figure 3-8 and Figure 3-9 show the error message when data verification is failed. "Verify fail" message is displayed with error address, expected data, and read data. User can press any key to cancel read operation or wait until all read process complete.

"RESET" button should be pressed to restart the system when user cancel the operation. Note: Alaric board does not have "RESET" button

/cygdrive/c/altera/16.0	- • •
2	~
+++ Read data selected +++ Enter Start LBA : 0 - 0x773CCABF => 0 Enter Sector Count : 1 - 0x773CCACO => 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 = 0x0000003_00000002_00000000_000000 Read Data = 0x00000002_00000001_00000000_000000 Press any key to cancel operation 2.201 GB 4.407 GB	00 00
Verify fail without	
28.675 GB cancel operation 30.881 GB 33.088 GB	
Total = 34[GB] , Time = 15[s] , Transfer speed = 2205[MB/s]	
Main menu [Ver = 1.3] [0] : Identify Device [1] : Write SSD [2] : Read SSD [3] : Security Erase	
·	E. I

Figure 3-8 Data verification is failed, but wait until read complete

/cygdrive/c/altera/16.0	- • •
2 +++ Read data selected +++ Enter Start LBA : 0 - 0x773CCABF => 0 Enter Sector Count : 1 - 0x773CCAC0 => 0x4000000 Selected Pattern [0]Inc32 [1]Dec32 [2]A11_0 [3]A11_1 [4]LFS]	^ R=> Ø
Verify fail1st Error at Byte Addr = 0x00000000Expect DataRead Data= 0x0000002_0000001_0000000_00000Press any key to cancel operationOperation is cancelledPlease reset system before start new testcancel operation	000
Main menu [Ver = 1.3] [0] : Identify Device [1] : Write SSD [2] : Read SSD [3] : Security Erase	
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Figure 3-9 Data verification is failed, and press key to cancel operation



#### 3.4 Security Erase

Select '3' to send Security Erase command to RAID0. Please confirm that RAID0 supports Security Erase feature by using Identify device menu. The estimated time of security erase operation is also displayed in Identify device menu.

After selecting the menu, confirmation message is displayed on NiosII command shell. User can input 'y' or 'Y' to continue security erase operation or input other keys to cancel operation.

Number 0-9 is displayed NiosII command shell every second to show that system still run. After complete the operation, total time usage is displayed as a test result.

Figure 3-11 shows the example when user inputs other keys to cancel the command.

/cygdrive/c/altera/16.0	- • •	•
3		^
+++ Security Erase selected +++ Security Erase will erase all contents on SSD It may use long time for this operation Press 'y' to confirm : y -> 'y' to continue operation Ø 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 Security Erase complete Time = 18[s]	Warning mess n Total Time u	
Main menu [Ver = 1.3] [0] : Identify Device [1] : Write SSD [2] : Read SSD [3] : Security Erase	_	-
<	•	н

Figure 3-10 Result from Security Erase command

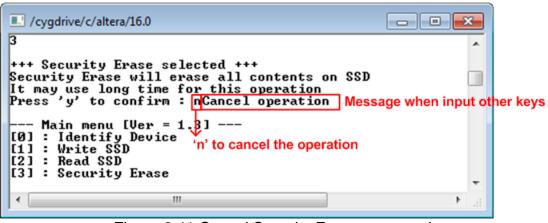


Figure 3-11 Cancel Security Erase command



### 4 Revision History

Revision	Date	Description
1.0	24-Nov-16	Initial version release
1.1	11-Oct-17	Add LFSR pattern and Alaric board