

HCTL-IP RAID0x8 Demo Instruction

Rev1.1 15-May-19

This document describes the instruction to run 8-ch RAID0 SATA HCTL-IP on FPGA development board and AB09-FMCRAID board. The demo is designed to write/verify data with eight SATA-III devices. It is recommended to use same SATA device models to run the test. User controls test operation through NiosII command shell.

1 Environment Requirement

To run the demo on FPGA board, please prepare the following hardware/software.

- 1) IntelFPGA board: Arria10 SoC or Arria10 GX Development board
- 2) PC installing QuartusII programmer and NiosII command shell software
- 3) AB09-FMCRAID board, provided by Design Gateway
- 4) ATX power supply connecting to power connector on FMCRAID board for SATA device power
- 5) Eight SATA-III devices, inserting to CN0-CN7 of FMCRAID board
- 6) FPGA power adapter for FPGA board
- 7) Micro USB cable for programming FPGA and NiosII command shell, connecting between FPGA board and PC



Figure 1-1 HCTL-IP RAID0 demo environment setup on Arria10 SoC board







2 Demo setup

- 1) Power off system.
- 2) Connect AB09-FMCRAID as shown in Figure 2-1.
 - i. Connect AB09-FMCRAID to FMC#B for Arria10 SoC board or FMC#A for Arria10 GX board.
 - ii. Connect eight SATA-III devices to CN0-CN7 on AB09-FMCRAID board.
 - iii. Connect ATX power to power connector on AB09.



Figure 2-1 AB09 connection to FPGA board



3) Connect micro USB cable from FPGA board to PC for JTAG programming and JTAG UART.



- 4) Power on FPGA development board and ATX power supply for SATA device.
- 5) Use QuartusII Programmer to program "HSATARaid0x8.sof" file, as shown in Figure 2-3.



Figure 2-3 Programmed by QuartusII Programmer



- 6) Open NiosII Command Shell and run nios2-terminal command. After that, boot message is 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.

<pre>/cygdrive/c/altera/16.0 Run nios2-terminal nios2-terminal: connected to hardware target using nios2-terminal: "USB-BlasterII [USB-1]", device 1, nios2-terminal: (Use the IDE stop button or Ctr1-C</pre>	Green: User input JT Blue: Output to user instance 0 to terminate)
++++ Start SATA RAIDOx8 Test design [Ver = 1.0] +++ Waiting device ready SATA Gen3 Device Detect SATA Speed = Gen3	ł
<pre> Main menu [Ver = 1.0] [0] : Identify Device [1] : Write Device [2] : Read Device [3] : Security Erase</pre> Main menu to select operating command	
Figure 2-4 NiosII Terminal after boot u	qu

7) If some SATA devices are not detected, "CH[X] Not Detect" will be displayed as shown in Figure 2-5. X is referred to SATA channel number which has found the error. Please check SATA device in the error channel.

/cygdrive/c/altera/16.0	
++++ Start SATA RAI	DOx8 Test design [Ver = 1.0] ++++
Waiting device read CH[6] Not Detect CH[6] Not Detect	у
CH[6] Not Detect CH[6] Not Detect CH[6] Not Detect	SATA@CN6 is not found
CH[6] Not Detect CH[6] Not Detect CH[6] Not Detect	



8) Check LED status on FPGA board. The description of LED is shown in Table 2-1.

		Deminitori
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

- Table 2-1 | ED Definition
- 9) After programming completely, LED[0] and LED[1] are ON during RAID0 initialization process. LED[1] changes to OFF after RAID0 finishes initialization process. Now the system is ready to receive new command from user.



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3 Test Menu

3.1 Identify Device

Select '0' to send Identify device command to RAID0.

Input '0' to run Identify Device com	mand Green: User input Blue: Output to use
H++ Identify Device selected +++ Model Number 0: Samsung SSD 850 PR Security feature set is supported	0 1ТВ
Normal Erase Mode lime=2 minutes Model Number 1: Samsung SSD 850 PR Security feature set is supported	0 1ТВ
Model Number 2: Samsung SSD 850 PR Security feature set is supported	0 1ТВ
Model Number 3: Samsung SSD 850 PR Security feature set is supported	0 ITB
Normal Erase Mode lime=2 minutes Model Number 4: Samsung SSD 850 PR Security feature set is supported	0 1ТВ
Normal Erase Mode Time=2 minutes Model Number 5: Samsung SSD 850 PR Security feature set is supported	0 ITB
Normal Erase Mode Time=2 minutes Model Number 6: Samsung SSD 850 PR Security feature set is supported	о 1тв
Normal Erase Mode Time=2 minutes Model Number 7: Samsung SSD 850 PR	0 1ТВ
Normal Erase Mode Time=2 minutes RAID Capacity= 8193[GB]	Model name, Security feature set, and RAID capacity (Output from
Main menu [Ver = 1.0] [0] : Identify Device [1] : Write Device [2] : Read Device	
[3] : Security Erase	

Figure 3-1 Test result when running Identify device menu

When the operation is completed, the device information is displayed on NiosII command shell. The console shows four values.

- 1) SSD model number: This value is decoded from Identify device data.
- 2) Security feature: This value is decoded from Identify device data to check that the device supports to run menu 3 (Security erase command) or not.
- 3) Normal Erase Mode Time: This value is decoded from Identify device data to check the estimation time to complete Security erase command. The minimum value is 2 minutes. This information is displayed when the device supports Security feature set.
- 4) SSD capacity: This value is signal output from RAID0 block. The value is equal to eight times of SATA CH#0 capacity.

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3.2 Write Device

Select '1' to send Write command to RAID0.



Figure 3-2 Test result when running Write command

Three inputs are required for this menu.

- 1) Start LBA: Input start address to write RAID0 as 512 byte 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 as 512 byte 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 data pattern for writing to RAID0. Five patterns can be selected, i.e. 32-bit increment, 32-bit decrement, all 0, all 1, and 32-bit LFSR counter.

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 is still alive. Finally, total size, total time usage, and test speed are displayed on the console as test result.



	\leftarrow	64 - bi	t hea	ader	of e	ach	sect	or—>																									
	48	-bit L	BA	Add	ress	= 0	0>	(00 <u>0</u> 0		32	2-bit	Incre	emei	nt pa	itteri	1	_	48	bit L	BA	Addı	ess	= 1										
Offset	0	4	2	3	4	- 5	6	7	8	- 9	A	В	5	D	Е	F		0	1	2	3	4	- 5	6	7	8	9	Α	В	С	D	Е	F
0000000000	00	00	00	00	00	00	00	00	02	00	00	00	03	00	00	00		01	00	00	00	00	00	00	00	82	00	00	00	83	00	00	00
0000000010	04	00	00	00	05	00	00	00	06	00	00	00	07	00	00	00		84	00	00	00	85	00	00	00	86	00	00	00	87	00	00	00
0000000020	08	00	00	00	09	00	00	00	ΟA	00	00	00	OB	00	00	00		88	00	00	00	89	00	00	00	8A	00	00	00	8B	00	00	00
0000000030	OC	00	00	00	OD	00	00	00	0E	00	00	00	OF	00	00	00		8C	00	00	00	8D	00	00	00	8E	00	00	00	8F	00	00	00
0000000040	10	00	00	00	11	00	00	00	12	00	00	00	13	00	00	00		90	00	00	00	91	00	00	00	92	00	00	00	93	00	00	00
0000000050	14	00	00	00	15	00	00	00	16	00	00	00	17	00	00	00		94	00	00	00	95	00	00	00	96	00	00	00	97	00	00	00
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00000001B0	6C	00	00	00	6D	00	00	00	6E	00	00	00	6F	00	00	00		EC	00	00	00	ED	00	00	00	EE	00	00	00	EF	00	00	00
00000001C0	70	00	00	00	71	00	00	00	72	00	00	00	73	00	00	00		FO	00	00	00	F1	00	00	00	F2	00	00	00	FЗ	00	00	00
00000001D0	74	00	00	00	75	00	00	00	76	00	00	00	77	00	00	00		F4	00	00	00	F5	00	00	00	F6	00	00	00	F7	00	00	00
00000001E0	78	00	00	00	79	00	00	00	7A	00	00	00	7B	00	00	00		F8	00	00	00	F9	00	00	00	FA	00	00	00	FΒ	00	00	00
00000001F0	7C	00	00	00	7D	00	00	00	7E	00	00	00	7F	00	00	00		FC	00	00	00	FD	00	00	00	FE	00	00	00	FF	00	00	00
0000000200	08	00	00	00	00	00	00	00	02	04	00	00	03	04	00	00		09	00	00	00	00	00	00	00	82	04	00	00	83	04	00	00
0000000210	04	04	00	00	05	04	00	00	06	04	00	00	07	04	00	00		84	04	00	00	85	04	00	00	86	04	00	00	87	04	00	00
																	-																
	48-	bit L	BA	Addı	ress	= 6												48	-bit I	BA	Add	ress	= 7										
Offset	0	1	2	3	4	5	6	7	8	- 9	Α	В	С	D	Е	F	1	0	1	2	3	4	- 5	6	7	8	- 9	Α	В	С	D	Е	F
0000000000	06	00	00	00	00	00	00	00	02	03	00	00	03	03	00	00		07	00	00	00	00	00	00	00	82	03	00	00	83	03	00	00
0000000010	04	03	00	00	05	03	00	00	06	03	00	00	07	03	00	00		84	03	00	00	85	03	00	00	86	03	00	00	87	03	00	00
0000000020	08	03	00	00	09	03	00	00	ΟA	03	00	00	OB	03	00	00		88	03	00	00	89	03	00	00	8A	03	00	00	8B	03	00	00
0000000030	OC	03	00	00	OD	03	00	00	0E	03	00	00	OF	03	00	00		8C	03	00	00	8D	03	00	00	8E	03	00	00	8F	03	00	00
0000000040	10	03	00	00	11	03	00	00	12	03	00	00	13	03	00	00		90	03	00	00	91	03	00	00	92	03	00	00	93	03	00	00
0000000050	14	03	00	00	15	03	00	00	16	03	00	00	17	03	00	00		94	03	00	00	95	03	00	00	96	03	00	00	97	03	00	00
								Dev	#6																De	ev#7							
00000001A0	68	03	00	00	69	03	00	00	6A	03	00	00	6B	03	00	00		E8	03	00	00	E9	03	00	00	EA	03	00	00	EB	03	00	00
0000000180	6C	03	00	00	6D	03	00	00	6E	03	00	00	6F	03	00	00		EC	03	00	00	ED	03	00	00	EE	03	00	00	EF	03	00	00
0000000100	70	03	nn	nn	71	03	nn	00	72	03	nn	nn	73	03	nn	nn		FO	03	00	nn	F1	03	00	00	F2	03	nn	00	F3	03	00	00
0000000100	74	03	00	00	75	03	00	00	76	03	00	00	77	03	00	00		F4	03	00	00	F5	03	00	00	F6	03	00	00	F7	03	00	00
0000001E0	78	03	00	00	79	03	00	00	7A	03	00	00	7B	03	00	00		F8	03	00	00	F9	03	00	00	FA	03	00	00	FB	03	00	00
00000001E0	70	03	00	00	7D	03	00	nn	7F	03	00	00	7F	03	00	nn		FC	03	00	nn	FD	03	nn	00	FF	03	nn	nn	FF	03	nn	00
00000000000000	0F	00	00	00	00	00	00	00	02	07	00	00	03	07	00	00		OF	00	00	00	00	00	00	00	82	07	00	00	83	07	00	00
0000000210	04	07	00	00	05	07	00	00	06	07	00	00	07	07	00	00		84	07	00	00	85	07	00	00	86	07	00	00	87	07	00	00
	Fi	qu	re	3-	3 E	Exa	am	ple	Te	st	da	ta	in	se	cto	or#(_)/#1	of	de	vic	es	b	v ir	ncr	em	nen	t p	att	err	٦.			

Test data is split into 512 byte unit. 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 the user.

Figure 3-3 shows the example when using 32 bit increment pattern. The stripe size of RAID0 demo is 512 byte. So, the data is switched to the next device when finishing each 512 byte data.

The test data sequence is arranged from Disk#0, #1, ..., #7, and then skips to the next 512 byte address of Disk#0, #1, ... #7, and so on. The header shows the address of test data in 512 byte unit. To calculate the disk number from the test data address, the following equation can be applied.

Device number = <Test data address in 512 byte unit> mod 8.

Dev#0 stores test data address = 0, 8, 16, ... Dev#1 stores test data address = 1, 9, 17, ...

Dev#7 stores test data address = 7, 15, 23, ...

The test data address could be checked from 48 bit address in the header of each 512 byte unit data in the device.



Figure 3-4 shows the example when the input is less than or more than the recommended range for each parameter. The console displays "Invalid input" and then the operation is cancelled.



Figure 3-4 Error message when the input is invalid

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3.3 Read Device

Select '2' to send Read command to RAID0.

Cygdrive/c/altera/16.0	ormal
+++ Read Device selected +++ Enter Start LBA : 0 - 0x3B9DE957 Enter Sector Count : 1 - 0x3B9DE Selected Pattern [0]Inc32 [1]Dec 4.486 GB 8.993 GB 13.499 GB 18.005 GB Current transfer	$F => 0 9580 => 0 x8000000 32 [2]A11_0 [3]A11_1 [4]LFSR=> 0 size$
58.556 GB 63.062 GB 67.568 GB	Output performance
Tota1 = 68[GB] , $Time = 15[s]$,	Transfer speed = 4504[MB/s]
<pre> Main menu [Ver = 1.0] [0] : Identify Device [1] : Write Device [2] : Read Device [3] : Security Erase</pre>	
Figure 3-5 Test result v	when running Read command

Three inputs are required for this menu.

- 1) Start LBA: Input start address to read RAID0 as 512 byte 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 as 512 byte 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 data pattern to verify data from RAID0. Test pattern must be matched with the test pattern using in Write device menu. 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 device menu, the test system will read data from RAID0 when all inputs are vaild. 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 end of transfer.



Figure 3-6 and Figure 3-7 show the example of 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 data, and the read data. User presses any key to cancel read operation or wait until the read process is completed.

If the user waits until the read command completes, the output performance from the read process will be displayed. The user can continue to run the system test if the error is caused from the wrong test pattern input.

If the user cancels the read operation, the command will not complete in the good sequence. It is recommended to power off/on all SATA devices and press "RESET" button to restart the system.

<pre>+++ Read Device selected +++ Enter Start LBA : 0 - 0x3B9DE957F => 0 Enter Sector Count : 1 - 0x3B9DE9580 => 0x8000000 Selected Pattern [0]Inc32 [1]Dec32 [2]Al1_0 [3]Al1_1 [4]LFSR=> 4 Verify fail Ist Error at Byte Addr = 0x00000000 Expect Data[255-128] = 0x0007FFFF FFF80004_0003FFFF FFFC0002 Expect Data[127- 0] = 0x0001FFFF FFFE0001_0000000 0000000 Read Data [127- 0] = 0x0000003_0000002_00000000_0000000 Press any key to cancel operation 4.496 GB 9.002 GB 13.508 GB 18.014 GB 58.565 GB 63.069 GB 67.575 GB Output performance Total = 68[GB], Time = 15[s], Transfer speed = 4505[MB/s]</pre>	/cygdrive/c/altera/16. Verification error without cancellatio 2	n
<pre>Verify fail Ist Error at Byte Addr = 0x00000000 Expect Data[255-128] = 0x0007FFFF FFF80004_0003FFFF_FFFC0002 Expect Data[127- 0] = 0x0001FFFF_FFFE0001_00000005_00000000 Read Data [127- 0] = 0x00000003_00000002_00000000_0000000 Press any key to cancel operation 4.496 GB 9.002 GB 13.508 GB 18.014 GB 58.565 GB 63.069 GB 67.575 GB Output performance Total = 68[GB], Time = 15[s], Transfer speed = 4505[MB/s] </pre>	+++ Read Device selected +++ Enter Start LBA : 0 - 0x3B9DE957F => 0 Enter Sector Count : 1 - 0x3B9DE9580 => 0x8000000 Selected Pattern [0]Inc32 [1]Dec32 [2]A11_0 [3]A11_1	Wrong pattern [4]LFSR=> 4
58.565 GB 63.069 GB 67.575 GB Total = 68[GB], Time = 15[s], Transfer speed = 4505[MB/s] Main menu [Ver = 1.0] [0] : Identify Device [1] : Write Device [2] : Read Device [3] : Security Erase	Verify fail 1st Error at Byte Addr = 0x0000000 Expect Data[255-128] = 0x0007FFFF FF80004_0003FFFF Expect Data[127- 0] = 0x0001FFFF FFE0001_0000000 Read Data [255-128] = 0x00000007_00000006_00000000 Read Data [127- 0] = 0x00000003_00000002_000000000 Press any key to cancel operation 4.496 GB 9.002 GB 13.508 GB 18.014 GB	FFFC0002 00000000 00000004 00000000
<pre> Main menu [Ver = 1.0] [0] : Identify Device [1] : Write Device [2] : Read Device [3] : Security Erase</pre>	58.565 GB 63.069 GB 67.575 GB Total = 68[GB] , Time = 15[s] , Transfer speed = 4505	out performance
	<pre> Main menu [Ver = 1.0] [0] : Identify Device [1] : Write Device [2] : Read Device [3] : Security Erase</pre>	



Select /cygdrive/c/altera 2	ror with can	cellation	1
+++ Read Device selected +++ Enter Start LBA : O - 0x3B9DE957F Enter Sector Count : I - 0x3B9DE9 Selected Pattern [0]Inc32 [1]Dec3	=> 0 580 => 0x80 2 [2]A11_0	00000 [3]A11_L	[4]IFSR=> 4
Verify fail Ist Error at Byte Addr = 0x000000 Expect Data[255-128] = 0x0007FF Expect Data[127-0] = 0x0001FF Read Data [255-128] = 0x000000 Read Data [127-0] = 0x000000 Press any key to cancel operation 4.494 GB Operation is cancelled	00 FF_FFF80004 FF_FFFE0001 07_00000006 03_00000002	0003FFF 0000000 0000000 0000000 User pres	erification is failed F_FFFC0002 0_00000000 5_00000004 0_00000000 sses some keys to be operation
Please reset system before start Main menu [Ver = 1.0] [0] : Identify Device [1] : Write Device [2] : Read Device [3] : Security Erase	new test Message wh	een the op	eration is cancelled
Figure 3-7 Data verification is faile	ed and press	key to ca	ancel operation

15-May-19



3.4 Security Erase

Select '3' to send Security Erase command to RAID0. Please confirm that all SATA devices support 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 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 3-9 shows the example when user inputs other keys to cancel the command.

Select /cygdrive/c/altera/16.0	
3	
+++ Security Erase selected +++	Warning message
Security Erase will erase all contents o	n the Device
It may use long time for this operation	
Press 'y' to confirm : Y 0 1 2 3 4	the operation
<u>Security Erase complete</u> Time = 5819[ms]	
Total time usage	
Main menu [ver = 1.0]	
<pre>[0] : Identify Device</pre>	
<pre>[1] : Write Device</pre>	
[2] : Read Device	
[3] : Security Erase	

Figure 3-8 Test result when running Security Erase command



Figure 3-9 Cancel Security Erase command



4 Revision History

Revision	Date	Description
1.0	9-Mar-18	Initial version release
1.1	15-May-19	Support Arria10 GX board