

FAT32-IP for SATA Demo Instruction

Rev1.0 6-Jul-23

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This document describes the instruction to run FAT32-IP for SATA demo on FPGA development board with AB09-FMCRAID/AB12-HSMCRAID adapter board. The demo is designed to write and verify data with SATA-III device. User can control test operation through NiosII command shell.

1 Environment Requirement

To demo FAT32-IP for SATA demo on Intel board, please prepare the following hardware/software.

- 1) IntelFPGA board: Intel ArriaV GX Starter board/Intel Arria10 SoC Development board
- 2) PC with QuartusII programmer and NiosII command shell software
- 3) AB09-FMCRAID for Arria10 SoC board or AB12-HSMCRAID for ArriaV GX Starter board
- 4) SATA-III device
- 5) Intel Power adapter and ATX power supply for SSD
- 6) A cable for programming FPGA and NiosII command shell connecting between FPGA board and PC,
 - USB Type-B cable in case of ArriaV GX Starter board
 - micro USB cable in case of Arria10 SoC Development board

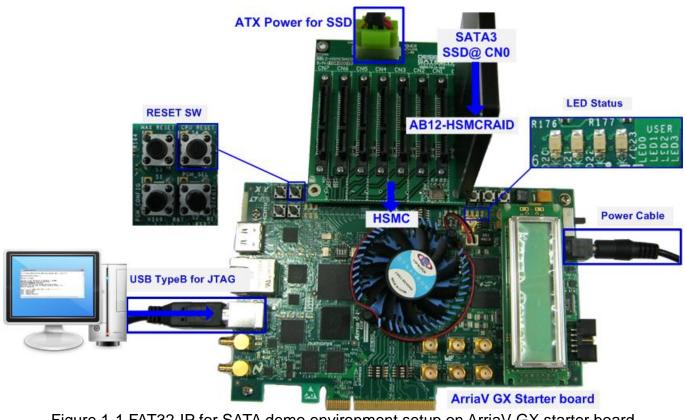
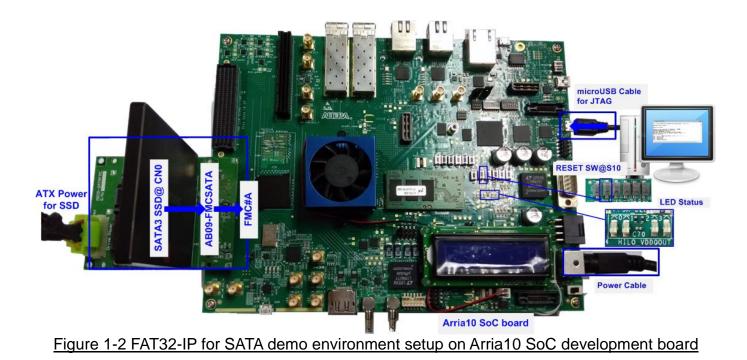


Figure 1-1 FAT32-IP for SATA demo environment setup on ArriaV GX starter board





DG

dg_fat32ip_sata_instruction_intel_en

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. Connect AB09-FMCRAID/AB12-HSMCRAID to FMC#A/HSMC connector on IntelFPGA board.
 - ii. Connect SATA-III device to CN0 on AB09/AB12.
 - iii. Connect power to power connector on AB09/AB12

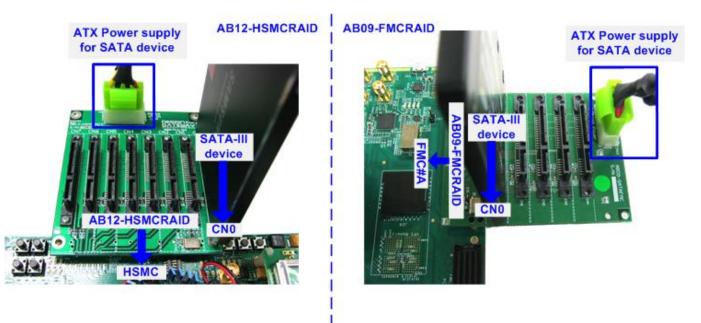
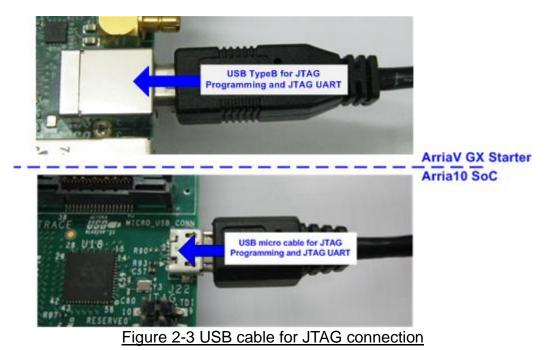


Figure 2-2 AB12 connection to FPGA board



4) Connect USB Type B 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) For ArriaV GX Starter board only, open "Clock Control" application, select 1st tab (U4), set CLK0 frequency = 150 MHz, and click "Set New Frequency" button to program 150 MHz clock.

\land Clock Contro	I		
F_vco	: 000MHz		Disable all
Registers	1	Frequency (MHz)	
CLk0	-	CLK0 150.00	Disable CLK0 📃
CLK1	-	CLK1 150.00	Disable CLK1 📃
CLK2	-	CLK2 150.00	Disable CLK2 🔲
СLКЗ	-	CLK3 150.00	Disable CLK3 📃
	read	Default	Set New Frequency
Messages			
/USB-Blas 2210Z) H		ocalhost (USB-1)	/5M(1270ZF324
Figure 2	-4 Set clock	frequency for	ArriaV GX board



7) Use QuartusII Programmer to program "FAT32SataTest.sof" file, as shown in Figure 2-5.

Quartus Prime Prog e <u>E</u> dit <u>V</u> iew P	P <u>r</u> ocessing <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp			Searcl	h altera.com	
Hardware Setup		Mode: JTA	G	▼ Pro	gress: 10	00% (Succe	essful)
Enable real-time ISP	to allow background program	nming when available					
Mu Start	File	Device	Checksum	Usercode	Program/ Configure	Verify	Blank- Check
Stop	D:/Pin/FAT32/FAT32Sat <none></none>	10AS066N3F40 SOCVHPS	1D268BCA 00000000	FFFFFFF <none></none>			
Auto Detect	<none> <none></none></none>	5M2210Z 5M2210Z	00000000 00000000	<none> <none></none></none>			
Add File							
Change File	•						
Add Device							
በት ^{ነው} Up መካከ Down							
	10AS066N3 TDO	F40 SOC\	/HPS	5M2210Z	5M2	2210Z	
	•		III				4
AII 😢 🔝	A <	>		60 E	ind 💏 F	Find Ne <u>x</u> t	
Type ID 1 209061	Message Ended Programmer	operation at	Tue Oct 03	11:00:18 2	017		
4							Þ
System (6) Pro	ocessing						

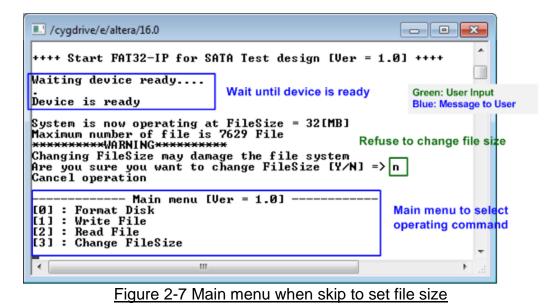
Figure 2-5 Programmed by QuartusII Programmer



8) Open NiosII Command Shell and run nios2-terminal command. Boot message is displayed. User can set file size by press 'y' or 'Y'. If user refuses to set file size, it will be set to default (32 MB). After that, main menu is displayed on the command shell, as shown in Figure 2-6 and Figure 2-7.

<pre>/cygdrive/e/altera/16.0</pre>	
++++ Start FAT32-IP for SATA Test design [Ver =	1.0] ++++
Waiting device ready Device is ready Wait until device is ready	
System is now operating at FileSize = 32[MB] Maximum number of file is 7629 File **************************	Green: User Input Blue: Message to User
Changing FileSize may damage the file system Are you sure you want to change FileSize [Y/N] =	ه.
Enter FileSize 'Y' to confirm [0] : 32 MB [1] : 64 MB [2] : 128 MB [3] : 256 MB [4] : 512 MB [5] : 1024 MB [6] : 2048 MB =>3 Select file size = 256 MB	m to change file size
File size changed System is now operating at FileSize = 256[MB] Maximum number of file is 953 File	Maximum number of file is updated following new file size
Please format disk before use Press 'y' to confirm to format disk =>y 'Y' to for .Format Disk complete	mat disk
Main menu [Ver = 1.0] [0] : Format Disk [1] : Write File [2] : Read File [3] : Change FileSize	Main menu to select operating command
•	

Figure 2-6 Main menu when confirm to set file size





9) Check LED status on FPGA board. The description of LED is follows.

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 1 LED Definition

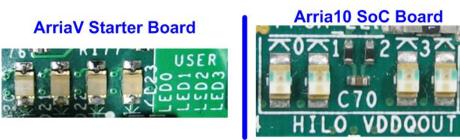


Figure 2-8 4-bit LED Status for user output

After programming complete, LED[0] and LED[1] are ON during FAT32 initialization process. Then, LED[1] is OFF to show that FAT32 –IP for SATA completes initialization process and now system is ready to receive command from user.

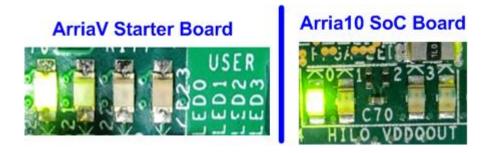


Figure 2-9 LED status after program configuration file and FAT32-IP initialization complete



3 Test Menu

3.1 Format Disk

Select '0' to send Format disk command to the SATA device. After the operation is completed, the system shows current operation file size and maximum number of file, as shown in Figure 3-1.

/cygdrive/e/altera/16.0	×
0 +++ Format Disk selected +++ Press 'y' to confirm to format disk => y 'Y' to confirm format dis Format Disk complete System is now operating at FileSize = 32[MB] Maximum number of file is 7629 File Current file size an maximum number	nd
Main menu [Ver = 1.0] [0] : Format Disk [1] : Write File [2] : Read File [3] : Change FileSize	÷
· · · · · · · · · · · · · · · · · · ·	t

Figure 3-1 Result from Format Disk menu



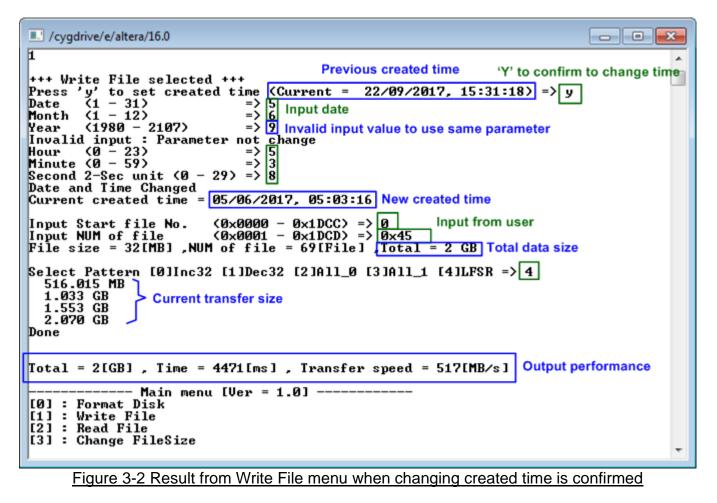
3.2 Write File

Select '1' to send Write command to the SATA device. After that, users are asked to set created time of file. Users can input 'y' or 'Y' to confirm to change created time or input others to refuse. If user choose to refuse, the created time will be set to default (default created time is 22 Sep 2017, 15:31:18).

The details of created time are shown as in Figure 3-2. Next, users can input created time of file. If input is invalid, invalid message will be displayed. Only parameter that is input with invalid value is not changed. Then, the new created time is displayed.

After setting created time process is done, user inputs by the following steps.

- 1) Start file No Input a number of the first written file. The input can be decimal unit or add prefix "0x" for hexadecimal unit.
- 2) NUM of file Input total transfer size in file unit. The input can be decimal unit or add prefix "0x" for hexadecimal unit.
- 3) Select pattern Select pattern of test data for writing to device. Five types can be selected, e.g. 32-bit increment, 32-bit decrement, all 0, all 1, and 32-bit LFSR counter.





/cygdrive/e/altera/16.0

```
1

+++ Write File selected +++ Current created time Refuse to change created time

Press 'y' to set created time (Current = 22/09/2017, 15:31:18) => n

Input Start file No. (0x0000 - 0x1DCC) => 0

Input NUM of file (0x0001 - 0x1DCD) => 0x45

File size = 32[MB] ,NUM of file = 69[File] ,Total = 2 GB

Select Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR => 4

516.066 MB

1.034 GB

1.554 GB

2.073 GB

Done

Total = 2[GB] , Time = 4467[ms] , Transfer speed = 518[MB/s]

------ Main menu [Ver = 1.0] -------

[0] : Format Disk

[1] : Write File

[2] : Read File

[3] : Change FileSize
```

Figure 3-3 Result from Write File menu when changing created time is refused

As shown in Figure 3-2 and Figure 3-3, if all inputs are valid, the operation will be started. Total data size is displayed first. Then, current transfer size is displayed out to the command shell every second during writing operation to show that system still operates. When operation is done, test performance (data written size, time usage, and transfer speed) is displayed on the command shell.



Organize 👻 🦳 Open				- 🗔 (
☆ Favorites	Name	Date modified	Туре	Size				
Nesktop	FILE0000.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
\rm Downloads	FILE000A.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
🕮 Recent Places	FILE000B.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	FILE000C.BIN	9/22/2017 3:31 PM	BIN File	32,768 KE				
词 Libraries	FILE000D.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
Documents	FILE000E.BIN	9/22/2017 3:31 PM	BIN File	32,768 KE				
J Music	FILE000F.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
Pictures	FILE0001.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
📑 Videos	FILE001A.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	FILE001B.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
👰 Computer	FILE001C.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
鑑 Local Disk (C:)	FILE001D.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
💼 Local Disk (D:)	FILE001E.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
🗐 CD Drive (F:)	FILE001 F.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
👝 DG_FAT32 (G:)	FILE0002.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	FILE002A.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
📬 Network	FILE002B.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	FILE002C.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	FILE002D.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	FILE002E.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	FILE002F.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	FILE0003.BIN	9/22/2017 3:31 PM	BIN File	32,768 K				
	•							

Figure 3-4 Example test files that written by Write File command

Test data is written to the SATA device as a file with constant file size. The File is named FILExxxx.BIN, when xxxx is a file number in hexadecimal unit, as shown in Figure 3-4.



•	—Te	st d	ata	with	1 32-	bit i	ncr	emer	nt pa	tter	n da	ta-				•	•			Tes	t dat	ta w	ith 3	32-bit	LFS	SR p	atte	rn d	lata•			•
	4 −6	4-bit	hea	der	of ea	ich s	secto	or-															secto	or->								
		8-bit																			value e size											
	(File	nan	ne x i ctor c				~000	0000	n –	32	2-bit i	ncre	men	t dat	а				ector			· · · ·	0000	0000		32-	bit I	FSR	patt	ern d	ata	
0.000		50									,					-																_
Offset	0	1.	4	3	4	5	6		8	9	A	В	C	D	E	F	0	1	2	3	4	5	6	_	8	9	À	_	С	D	E	F
00000000	00		00			00			02		00					00	00	00						00	01	00		00	02			00
00000010	04	00	00	00	05 09	00 00	00	00	06	00 00	00	00	07 0B	00 00	00 00	00	04	00	00	00	09	00	00	00	12	00		00				00
00000020		00	00	00	09 0D	00			0A 0E	00	00	00	0B 0F	00	00	00	49	00	00	00	92	00	00	00		01		00				00
00000040		00	00	00	11	00		00	12	00	00	00	13	00		00	92	04	00	00	24	09		00		12		00				00
00000050	14		00	00	15	00			16	00	00	00	17	00		00	24 49	49 92	00 04	00 00	49 92	92 24		00 00	92 24	24 49		00	24 49			00 00
00000060		00	00				00			00	00	00				00	47 93	24	49	00	27		92			49 92		00 01			24 49	
00000070		00	00	00	1D	00	00	00	1E	00	00	00	1F	00		00	3C	49	92	04	79	92		09	F3	24		12	E7			24
00000080		00	00	00	21		00		22	00	00	00	23		00		CF	93	24	49	9E			92	3D	4F	92	24	7A			49
00000090		00	00	00	25	00	00	00	26	00	00	00	27	00		00	F5	3C	49	92	EB		92	24		F3	24					92
04000000	28	00	00	00	29	00	00	00	2A	00	00	00	2B	00		00	5D		93	24	BA	9E	27	49	75	3D	4F	92				24
000000B0	2C	00	00	00	2D	00	00	00	2E	00	00	00	2F	00	00	00	D7		3C	49	AE		79			D7		24				49
000000C0	30	00	00	00	31	00	00	00	32	00	00	00		00	00	00	70			93			9E	27	C1			4F				9E
000000D0	34	00	00	00	35	00	00	00	36	00	00	00	37	00	00	00	07	D7	F5	3C	0E		EB	79	1D	5C		F3			ÀΕ	E7
000000E0	38	00	00	00	39	00	00	00	ЗA	00	00	00	3B	00	00	00	77	70	5D	CF	EE	ΕO	BA	9E	DC	C1	75	3D	B8	83	EB	7A
000000F0	3C	00	00	00	ЗD	00	00	00	3E	00	00	00	ЗF	00	00	00	70	07	D7	F5	ΕO	0E	ÀΕ	EB	C1	1D	5C	D7	83	3B	B8	ÀΕ
00000100	40	00	00	00	41	00	00	00	42	00	00	00	43	00	00	00	07	77	70	5D	0E	ΕE	E0	BA	1C	DC	C1	75	39	B8	83	EB
00000110	44	00	00	00	45	00	00	00	46	00	00	00	47	00	00	00	73	70	07	D7	E6	ΕO	0E	ΑE	CD	C1	1D	5C	9A	83	3B	B8
00000120	48	00	00	00	49	00	00	00	4A	00	00	00	4B	00	00	00	34	07	77	70	68	0E	ΕE	E0	D1	1C	DC	C1	АЗ	39	B8	83
00000130	4C	00	00	00			00		4E	00	00	00		00	00	00	47	73	70	07	8E	E6	E0	0E	1D	CD	C1	1D	ЗA	9A	83	ЗB
00000140	50		00	00	51	00	00	00	52	00	00	00	53	00		00	74	34	07	77	E9	68	0E	EE	D3	D1	1C	DC	Α6	АЗ	39	B8
00000150	54		00	00	55	00	00	00	56	00	00	00	57	00		00	4C	47	73	70	98		E6	E0		1D	CD	C1	63	ЗA	9A	83
00000160		00	00				00			00	00						C6	74	34	07	8D		68					1C				39
00000170		00	00	00		00	00	00	5E	00	00	00	5F	00		00	6E	4C	47	73	DC			E6	B8							9A
00000180	60		00	00	61	00	00	00	62	00	00	00	63	00	00		E1	C6	74	34	C3			68				D1	OD			A3
00000190		00	00	00	65	00		00	66	00	00	00				00	14	6E	4C	47			98			B8						3A
000001A0 000001B0	6C	00 00	00	00 00	69 6D	00 00	00 00	00 00	6A 6E	00 00	00	00 00	6B 6F	00 00	00 00	00	A0		C6	74		C3	8D					D3				A6
00000180		00	00	00		00		00	72	00	00	00	ьг 73			00	0C	14	6E	4C	18		DC	98	30	68	B8	31				63
000001D0		00	00	00	75	00	00	00	76	00	00	00	77	00	00		CO				81					83						37
000001E0		00	00			00			7A	00	00	00	7B	00			OF	OC		6E			34		3F	30		B8	7F			70
000001E0		00			7D				7E	00	00	00	7F	00		00	FF FA	C0 0F			FF F4				FE E9	03 3F					06 60	0D D0
00000200	01				00			_	82	00	00	00	83	00	00		01	00			00			00	02	3F 00		00			00	
00000210		00			85				86	00			87				09	00	00		12			00	24	00		00				00
00000220		00									00										24							00			00	
					head								-				12	00			head		50	50		95	00	50	~ -		50	00
		Fin					'nn	بامم	ς Τ/	hot	da	to.	in	~~	oto	\r#(<u>ה</u> ר	#1	-				hnt	/LF) n	ott,	- rr				
		110	uit	80	-0		ai	npie		531	ua	ud	111	36		л#(J - (# 1	by				5111		J	v p	aut	511	-			

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Data in the test file inserts 64-bit header every 512-byte. The header is unique value in one SATA device. The first 32-bit header is calculated by (file name x file size) + sector offset in the file. The remaining 32-bit data is 0. After that, the test pattern is filled following user selection such as 32-bit increment pattern (left window of Figure 3-5) and 32-bit LFSR pattern (right window of Figure 3-5).



Figure 3-6 – Figure 3-8 show error messages when user's input is invalid. "Invalid input" message is displayed on the command shell, and then returns to main menu to receive new command.

/cygdrive/e/altera/16.0
1
++++ Write File selected +++
Press 'y' to set created time (Current = 22/09/2017, 15:31:18) => n
Input Start file No. (0x0000 - 0x1DCC) => 0xFFFF Out-of-range start file number
++++ INUALID INPUT ++++ Error message
------ Main menu [Ver = 1.0] -----[0] : Format Disk
[1] : Write File
[2] : Read File
[3] : Change FileSize



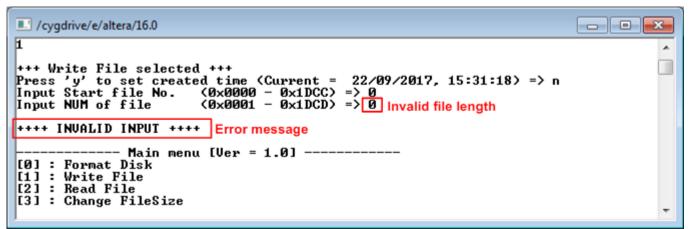


Figure 3-7 Invalid file length input

/cygdrive/e/altera/16.0
1
++++ Write File selected +++
Press 'y' to set created time (Current = 22/09/2017, 15:31:18) => n
Input Start file No. (0x0000 - 0x1DCC) => 0
Input NUM of file (0x0001 - 0x1DCD) => 1
File size = 32[MB],NUM of file = 1[File],Total = 32 MB
Select Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR => 9 Invalid pattern
++++ INVALID INPUT ++++ Error message
------ Main menu [Ver = 1.0] -----[0] : Format Disk
[1] : Write File
[2] : Read File
[3] : Change FileSize

Figure 3-8 Invalid pattern input



3.3 Read File

Select '2' to read file to the SATA device. Three inputs are required for this menu.

- 1) Start file No Input a number of the first read file. The input can be decimal unit or add prefix "0x" for hexadecimal unit.
- NUM of file Input total transfer size in file unit. The input can be decimal unit or add prefix "0x" for hexadecimal unit.

Select pattern – Select pattern to verify data from device. Test pattern must be matched with written data. Five types can be selected, e.g. 32-bit increment, 32-bit decrement, all 0, all 1, and 32-bit LFSR counter

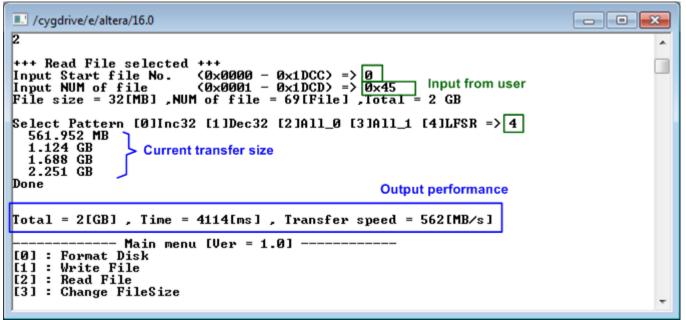


Figure 3-9 Result and input from Read File menu with successful verification

Similar to write test, if all inputs are valid, the operation will be started. Total data size is displayed first. Then, current transfer size is displayed out to the console every second during reading operation to show that system still operates. Final stage, test performance is displayed when the transfer is done. "Invalid input" will be displayed if any inputs are invalid.

Figure 3-10 and Figure 3-11 show the error message when data verification is failed. "Verify fail" message is displayed with name of the first file that error occurs, error address, expected data, and read data. User can press some keys to cancel the operation or wait until all read process complete.



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/cygdrive/e/altera/16.0

2 +++ Read File selected +++ Input Start file No. (0x0000 - 0x1DCC) => 0 Input NUM of file (0x0001 - 0x1DCD) => 0x60 File size = 32[MB],NUM of file = 96[File],Total = 3 GB Select Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR => 4 561.960 MB 1.125 GB 1.688 GB 2.251 GB *********Uerify fail******* File name : FILE0045.bin Verify fail without cancel operation Byte Address : 0x00000008 Expect data : 0x008A0001 Read data : 0x00000000 Press any key to cancel operation 2.814 GB Done Total = 3[GB] , Time = 5723[ms] , Transfer speed = 562[MB/s] - Main menu [Ver = 1.0] ------[0] : Format Disk [1] : Write File [2] : Read File [3] : Change FileSize

Figure 3-10 Data verification is failed and user does not cancel operation

/cygdrive/e/altera/16.0	
2	*
+++ Read File selected +++ Input Start file No. <0x0000 - 0x1DCC> => 0 Input NUM of file <0x0001 - 0x1DCD> => 0x80 File size = 32[MB] ,NUM of file = 128[File] ,Total = 4 GB	
Select Pattern [0]Inc32 [1]Dec32 [2]All_0 [3]All_1 [4]LFSR => 4 561.944 MB 1.124 GB 1.688 GB 2.251 GB	
*********/Verify fail*******Verify fail withFile name: FILE0045.bincancel operationByte Address: 0x00000008cancel operationExpect data: 0x008A0001Read data: 0x00000000Press any key to cancel operation	
2.814 GB 3.377 GB Please reset system before start new test Operation is cancelled	
Main menu [Ver = 1.0] [0] : Format Disk [1] : Write File [2] : Read File [3] : Change FileSize	-
Finung 0.44 Data warification is failed and warmania and	

Figure 3-11 Data verification is failed and user cancels operation



3.4 Change File Size

Select '3' to change file size. After selecting menu, current file size and warning message are displayed on the console. Then, user can input 'y' or 'Y' to confirm to change file size or input others to cancel the operation.

After confirming to change file size, the selecting file size menu is displayed. User can select the new file size here. When changing file size is completed, the system updates current operating file size and maximum file number.

When file size is changed, a request to format disk message is asked. Then, user can input 'y' or 'Y' to accept format disk operation or input others to refuse.

<u>Note</u>: Changing file size may damage to the file system. Therefore, user should format disk after the operation to delete files in the device.

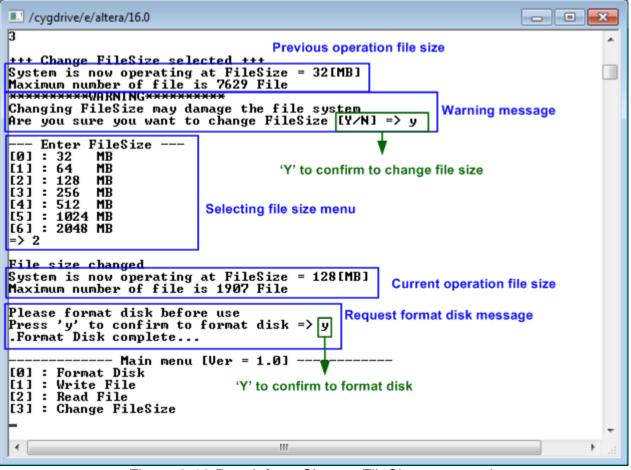


Figure 3-12 Result from Change FileSize command



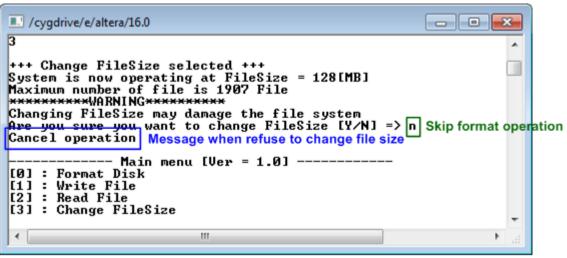


Figure 3-13 Cancel Change FileSize command



4 Revision History

Revision	Date	Description
1.0	4-Oct-17	Initial version release