



## **SATA ADVANCED TEST TOOL FOR NCQ: DRIVE MASTER PROFESSIONAL 2004**

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Drive Master Professional is a SATA interface test tool for QA and development engineers to test and verify the SATA interface protocol compliance and performance measurement. The tool supports SATA 1.0a and SATA II extension 1.1 specifications. This paper describes the advanced functions supported by the professional version for SATA testing.

### ***Major Function Supported***

Drive Master Professional 2004 supports many new SATA functions. In addition to the commands supported in the standard version, it also supports Native Command queuing (NCQ) commands. (Standard version supports complete TCQ commands.) The professional version is suitable for advanced device and host development and testing. It can be used for the system builder to verify the system compliance of the SATA specification. It can also be used for the out going QA and incoming QA to test the advanced SATA II features. The following is a list of major functions supported:

- Testing regular NCQ commands
- Testing abnormal non-queued command when queued commands outstanding
- Testing abnormal queued command issued with duplicate queue tag
- Testing response for R\_ERR on Data FIS
- Testing response for R\_ERR on non-Data FIS
- Verifying data integrity on R\_ERR tests
- Testing overlapped data integrity
- Testing random write/read compare
- Testing original queued command error is preserved
- Testing queued performance (IOPS) on small block transfer
- Testing queued performance (IOPS) on large block transfer
- Testing queued performance (IOPS) on a given queue depth
- Testing queued performance (IOPS) for multi-thread data access
- SATA Reset Creator
- SATA OOB Controller

SATA PM Controller  
SATA FIS Builder  
SATA BIST Creator  
SATA Error Logger  
SATA PMP Controller

### ***Error Logging Status Window***

The Drive Master Professional 2004 provides a detailed logging window for the SATA Registers. It displays the SStatus, SError, SControl, SActive, and SNotification in real-time. In addition, the DM 2004 Pro logs the error and counts number of occurrences of each error. The accumulated error count can be used for further validation.

### ***NCQ Screen Capture***

The following picture is captured from the DM 2004 Pro test script. The DM 2004 Pro is sending a group of NCQ read commands to the device. Because the NCQ protocol is FIS based, the disk data is sending back to the host after several read commands are queued. When the data transfer is completed, the device notifies the host with Set Device Bits FIS with the SActive indication the completed command(s). In this picture, it shows tag sequence of 6, 1, 0, 10, 15 followed by a completion of tag 6 and 1. Drive Master is able to issue any combination of tag sequences or commands, and repeatedly generate the sequence over and over again for debugging and fine tuning its implementation.

Bus Doctor - Serial ATA - 3Gb - Analyzer # 1 - [Current Capture]

File Capture View Find Bus Help

Config Sync Run Segment 0 Command Listing State Listing Timing/Waveform Data Block

Command Listing Show/Hide

Store #	Direction	FIS Type	Description	Tag	Timestamp
164	H->D	FIS 27 - Cmd: EF - SET FEATURES	LBA = 0000000 Sec Cnt = 45		-141.210760 ms
172	D->H	FIS 34 - Status: 50 - DRDY	LBA = 0000000 Sec Cnt = 45		-140.908016 ms
180	H->D	FIS 27 - Cmd: 60 - Read FPDMA Queued	LBA = 00F9365 Sec Cnt = 30	Queued command Tag = 6	-139.579068 ms
188	D->H	FIS 34 - Status: 40 - DRDY	LBA = 00F9365 Sec Cnt = 30		-9.632740 ms
196	H->D	FIS 27 - Cmd: 60 - Read FPDMA Queued	LBA = 0D0E7FA Sec Cnt = 08	Queued command Tag = 1	-8.402076 ms
204	D->H	FIS 34 - Status: 40 - DRDY	LBA = 0D0E7FA Sec Cnt = 08		-8.326900 ms
212	H->D	FIS 27 - Cmd: 60 - Read FPDMA Queued	LBA = 0CFCDD4 Sec Cnt = 00	Queued command Tag = 0	-7.019420 ms
220	D->H	FIS 34 - Status: 40 - DRDY	LBA = 0CFCDD4 Sec Cnt = 00		-6.959776 ms
228	H->D	FIS 27 - Cmd: 60 - Read FPDMA Queued	LBA = 04ABDAC Sec Cnt = 50	Queued command Tag = 10	-70.128 μs
236	D->H	FIS 34 - Status: 40 - DRDY	LBA = 04ABDAC Sec Cnt = 50		0 ns
244	H->D	FIS 27 - Cmd: 60 - Read FPDMA Queued	LBA = 02EE0E1 Sec Cnt = 78	Queued command Tag = 15	3.742664 ms
252	D->H	FIS 34 - Status: 40 - DRDY	LBA = 02EE0E1 Sec Cnt = 78		3.821948 ms
260	D->H	FIS 41 - DMA Setup - A: 0 I: 0 D: 1	DMA Tx Count = 00001C00	Transmitting Tag = 00	7.188604 ms
270	D->H	FIS 46 - Payload Data	Bytes Transferred: 7168		7.229756 ms
2,066	D->H	FIS A1 - Set Device Bits - I: 1 Err: 00	Status Hi: 04 Status Lo: 00 SActive = 00000040	Transmitting Tag = 00	7.426684 ms
2,071	D->H	FIS 41 - DMA Setup - A: 0 I: 0 D: 1	DMA Tx Count = 00000C00		15.820584 ms
2,081	D->H	FIS 46 - Payload Data	Bytes Transferred: 3072		15.860748 ms
2,853	D->H	FIS A1 - Set Device Bits - I: 1 Err: 00	Status Hi: 04 Status Lo: 00 SActive = 00000002		16.018740 ms
2,858	H->D	FIS 27 - Cmd: 60 - Read FPDMA Queued	LBA = 09300AA Sec Cnt = 58	Queued command Tag = 11	16.874540 ms
2,866	D->H	FIS 34 - Status: 40 - DRDY	LBA = 09300AA Sec Cnt = 58		16.924680 ms

State Listing Show/Hide

Store #	H->D Data	H->D Count	Host->Device Description	D->H Data	D->H Count	Device->Host Description	Timestamp
204				3737857C	0	SOF	-8.326900 ms
205				00400034	0	FIS 34 - Reg Device->Host	-8.326872 ms

Histogram Commands Errors Data User Term FIS 27 - 0 z-in x1 z-out

Cursor: 6566 X Mark: 6566 O Mark: 0 O to X Events: 6566 O to X Time: 384.477708 ms O to X User Terms: 19

Current Segment: 0 Last Segment Captured: 0 Segment Size: 1,048,575 Events Number of Segments: 256

start Multi Application Man... Bus Doctor 1.2.9 6:35 PM

## NCQ Error Capture

The following picture is captured from the DM 2004 Pro test script. The DM 2004 Pro is sending a NCQ command with a very big LBA number. The error is displayed with a Read Log Ext command. The log data shows status 0x51, error code 0x10 for ID Not Found error.

The screenshot displays the Bus Doctor software interface, showing the following data:

**Command Listing:**

Store #	Direction	FIS Type	Description
463	D->H	FIS 34 - Status: 40 - DRDY	LBA = 0000001
481	D->H	FIS 41 - DMA Setup - A: 0 I: 0 D: 1	DMA Tx Count =
501	D->H	FIS 46 - Payload Data	Bytes Transfer
654	D->H	FIS A1 - Set Device Bits - I: 1 Err: 00	is Hi: 04 Status Lo: 00
669	H->D	FIS 27 - Cmd: 60 - Read FPDMA Queued	LBA = 0FFFFFF
691	D->H	FIS 34 - Status: 51 - DRDY, ERR	LBA = 0FFFFFF
710	H->D	FIS 27 - Cmd: 2F - READ LOG EXT	LBA = 00000000110
732	D->H	FIS A1 - Set Device Bits - I: 0 Err: 00	is Hi: 04 Status Lo: 00
747	D->H	FIS 5F - PIO Setup - Status: 58 - DRDY, DF	LBA = 0000110
767	D->H	FIS 46 - Payload Data	Bytes Transfer

**State Listing:**

Store #	H->D Data	H->D Count	Host->Device Description	D->H Data
767				3737B57C
768				0000004E
769				1051000C
770				E0FFFFFF

**Data Block:**

Store #	Hex	ASCII
768	46000000	00005110
770	FFFFFFE0	1F000000
772	00000000	00000000
774	00000000	00000000
776	00000000	00000000
778	00000000	00000000
780	00000000	00000000
782	00000000	00000000
784	00000000	00000000
786	00000000	00000000
788	00000000	00000000
790	00000000	00000000
792	00000000	00000000
794	00000000	00000000
796	00000000	00000000
798	00000000	00000000
800	00000000	00000000
807	00000000	00000000
809	00000000	00000000
811	00000000	00000000
813	00000000	00000000
815	00000000	00000000
817	00000000	00000000
819	00000000	00000000
821	00000000	00000000

**Histogram:** Shows a bar chart for FIS 27 - 0, with a cursor at store 767. The histogram shows a single bar at store 767, indicating the error state.

**Cursor:** 767, X Mark: 0, O Mark: 0, X to O Events: 0, X to O Time: 0 ns, X to O User Terms: ?

**Current Segment:** 0, Last Segment Captured: N/A, Segment Size: 131,071 Events, Number of Segments: 128

## R\_ERR on Register FIS Handling

The following picture shows the handling of the R\_ERR for the D2H Register FIS 34. This example shows the host R\_ERR on the Register FIS of a SEEK command; the device retransmits the same FIS.

The screenshot displays the Bus Doctor interface with the following data:

**Command Listing:**

Store #	Direction	FIS Type	Description	Tag	Timestamp
1,862	D->H	FIS 34 - Status: 50 - DRDY	LBA = 0000001 Sec Cnt = 01		5.750430604 sec
1,880	H->D	FIS 27 - Cmd: 70 - SEEK	LBA = 0000001 Sec Cnt = 01		6.143486664 sec
1,902	D->H	FIS 34 - Status: 50 - DRDY	LBA = 0000001 Sec Cnt = 01		6.144276148 sec
1,922	H->D	FIS 27 - Cmd: 70 - SEEK	LBA = 0000064 Sec Cnt = 01		22.082486620 sec
1,944	D->H	FIS 34 - Status: 50 - DRDY	LBA = 0000064 Sec Cnt = 01		22.083253564 sec

**State Listing:**

Store #	H->D Data	H->D Count	Host->Device Description	D->H Data	D->H Count	Device->Host Description
1,944				3737B57C	0	SOF
1,945				00504034	0	FIS 34 - Reg Device->Host DRDY Status = 0x50 Error = 0x00 I = 1 PM Port = 0 - Default Port Dev/Head = 0xE0 Cyl High = 0x00 Cyl Low = 0x00 Sec Num = 0x64
1,946				E0000064	1	Cyl High(exp) = 0x00 Cyl Low(exp) = 0x00 Sec Num(exp) = 0x00 Sec Cnt(exp) = 0x00 Sec Cnt = 0x01 Reserved
1,947				00000000	2	
1,948				00000001	3	
1,949				00000000	4	
1,950				7B439091	5	
1,951						CRC - Good
1,952				D5D5B57C		EOF
1,953				5858B57C		WTRM
1,954	5555B57C		R_IP	5858B57C		WTRM
1,955	5555B57C		R_IP			
1,956	5656B57C		R_ERR			
1,957	5656B57C		R_ERR			
1,958				5757B57C		X_RDY
1,959				5757B57C		X_RDY
1,960	4A4A957C		R_RDY			
1,961	4A4A957C		R_RDY			
1,962				3737B57C		SOF
1,963				00504034	0	FIS 34 - Reg Device->Host DRDY Status = 0x50

**Histogram:** Shows a signal trace for FIS 27 - 0. The cursor is at store 1922. The histogram shows a series of pulses representing data events.

**Bottom Status Bar:** Shows "Current Segment: 0", "Last Segment Captured: N/A", "Segment Size: 131,071 Events", and "Number of Segments: 128".

## R\_ERR on Data FIS Handling

The following picture shows the handling of the R\_ERR response on Data FIS. Drive Master is sending the Read DMA command. After the host receives the read data it responds with R\_ERR. The device detects the R\_ERR and responds with 0x51 0x84 for the UDMA CRC error. This R\_ERR is generated by the DM 2004 Pro test script.

**Command Listing**

Store #	Direction	FIS Type	Description	Taq	Timestamp
402	D->H	FIS 34 - Status: 50 - DRDY	LBA = 00003E8 Sec Cnt = 01		4.349738752 sec
423	H->D	FIS 27 - Cmd: C8 - Read DMA	LBA = 0000001 Sec Cnt = 01		10.124378752 sec
445	D->H	FIS 46 - Payload Data	Bytes Transferred: 512		10.131584352 sec
592	D->H	FIS 34 - Status: 51 - DRDY, ERR	LBA = 0000001 Sec Cnt = 01		10.718116200 sec

  

**State Listing**

Store #	H->D Data	H->D Count	Host->Device Description	D->H Data	D->H Count	Device->Host Description	Timestamp
580				00000000	127	DATA	28 ns
581				00000000	128	DATA	28 ns
582				0D4A6450	129	DATA: ASCII =JdP	24 ns
583						CRC - Good	28 ns
584				D5D5B57C		EOF	
585				5858B57C		WTRM	28 ns
586	5656B57C		R_ERR	5858B57C		WTRM	24 ns
587	5656B57C		R_ERR				316 ns
588				5757B57C		X_RDY	24 ns
589				5757B57C		X_RDY	586.5 ms
590	4A4A957C		R_RDY				28 ns
591	4A4A957C		R_RDY				328 ns
592				3737B57C		SOF	28 ns
593				84514034	0	FIS 34 - Reg Device->Host DRDY, ERR Status = 0x51 Error = 0x84 I = 1 PM Port = 0 - Default Port	24 ns
594				E0000001	1	Dev/Head = 0xE0 Cyl High = 0x00 Cyl Low = 0x00 Sec Num = 0x01	28 ns
595				00000001	2	Cyl High(exp) = 0x00 Cyl Low(exp) = 0x00 Sec Num(exp) = 0x01	28 ns
596				00000001	3	Sec Cnt(exp) = 0x00 Sec Cnt = 0x01	28 ns
597				00000000	4	Reserved	24 ns
598				CD03E49D	5		28 ns
599						CRC - Good	28 ns
				D5D5B57C		EOF	

  

**Histogram** (Commands checked)

Cursor: 592 | X Mark: 0 | O Mark: 0 | X to O Events: 0 | X to O Time: 0 ns | X to O User Terms: ?

Current Segment: 0 | Last Segment Captured: N/A | Segment Size: 131,071 Events | Number of Segments: 128

## R\_ERR NCQ Handling

The following picture shows the handling of the R\_ERR response. On the NCQ command, the R\_ERR should be taken care of by the host. On the Set Device Bits FIS, the R\_ERR should be retried by the device.

**Command Listing**

Store #	Direction	FIS Type	Description	Tag	Timestamp
135	H->D	FIS 27 - Cmd: 60 - Read FPDMA Queued	LBA = 0000001 Sec Cnt = 00	Queued command Tag = 0	69.501366216 sec
157	D->H	FIS 34 - Status: 40 - DRDY	LBA = 0000001 Sec Cnt = 00		69.625762472 sec
177	D->H	FIS 41 - DMA Setup - A: 0 I: 0 D: 1	DMA Tx Count = 00000200	Transmitting Tag = 00	69.630235908 sec
199	D->H	FIS 46 - Payload Data	Bytes Transferred: 512		69.630276980 sec
341	D->H	FIS A1 - Set Device Bits - I: 1 Err: 00	is Hi: 04 Status Lo: 01 SActive = 0000		69.630620364 sec
356	H->D	FIS 27 - Cmd: 2F - READ LOG EXT	LBA = 00000000110 Sec Cnt = 0001		73.036715984 sec

  

**State Listing**

Store #	H->D Data	H->D Count	Host->Device Description	D->H Data	D->H Count	Device->Host Description
332						CRC - Good
333				D5D5B57C		EOF
334				5858B57C		WTRM
335	5656B57C		R_ERR	5858B57C		WTRM
336	5656B57C		R_ERR			
337				5757B57C		X_RDY
338				5757B57C		X_RDY
339	4A4A957C		R_RDY			
340	4A4A957C		R_RDY			
341				3737B57C		SOF
342				004140A1	0	FIS A1 - Set Device Bit Error = 0x00 Status Hi = 0x4 Status Lo = 0x1 I = 1 PM Port = 0 - Default Port
343				00000000	1	SActive
344				2C4C9434	2	CRC
345						CRC - Good
346				D5D5B57C		EOF
347				5858B57C		WTRM
348	5555B57C		R_IP	5858B57C		WTRM
349	5555B57C		R_IP			
350	5656B57C		R_ERR			
351	5656B57C		R_ERR			
352	5757B57C		X_RDY			
353	5757B57C		X_RDY			
354				4A4A957C		R_RDY
355				4A4A957C		R_RDY
356	3737B57C		SOF			
357	002F8027	0	FIS 27 - Req Host->Device			

  

**Histogram** (FIS 27 - 0)

Cursor: 356 | X Mark: 0 | O Mark: 0 | X to O Events: 0 | X to O Time: 0 ns | X to O User Terms: ?

Current Segment: 0 | Last Segment Captured: N/A | Segment Size: 131,071 Events | Number of Segments: 128