



NETLIST

Datasheet
mSATAvault™ Half-Slim (SATA II)
4GB to 128GB
NLS7abcV2d – 6tuHAAvwxyz

1. OVERVIEW

Netlist, a pioneer in the development of high-density memory subsystems, is proud to offer the Half-Slim SATA II SSD form factor. The Half-Slim SATA II SSD module uses the 7 pin data cable and 15 pin power cable connector. The Netlist solution provides a fully compatible SATA II V2.6 interface to the host system and supports serial data rates to 3.0Gbps.

Netlist's Half-Slim SATA II SSD is the product of choice in applications requiring the standard form factor with high memory density, low power, high performance, high reliability and high tolerance to shock, vibration, humidity, altitude, and temperature. Because there are no moving parts to service or maintain, the Half-Slim SATA II SSD is the solution of choice for reliable alternatives to mechanical hard disk drives for high availability and mission critical applications. The on-board intelligent controller manages interface protocols, data storage and retrieval as well as Error Correcting Code (ECC), detects handling and diagnostics, power management and clock control. Specifically designed for small form factor requirements, the Netlist Half-Slim SATA II SSD is an extremely compelling solution for embedded applications such as boot loaders, virtualization systems, industrial applications, thin clients and many other applications in the enterprise environment.

The Netlist Half-Slim SATA II SSD is available in capacities of 4Gb to 128GB. The Netlist Half-Slim SATA II SSD hosts most computing or embedded operating systems with the solid-state disk technology delivering fast boot, load, and execution of applications, with no moving parts, leading to faster system responsiveness, and durability

Applications include virtualized boot loaders, boot and OS loaders, embedded storage, medical diagnostics, inventory management and barcode readers, mobiles and industrial computers, and more.

2. FEATURES

- 4GB to 128GB capacity (48-bit addressing)
 - SLC: 4GB - 32GB
 - MLC: 8GB - 128GB
- SATA II V2.6 compliant with NCQ support
 - NCQ support for up to 32 commands
 - Support for SATA II 48-bit addressing mode
 - SATA II interface for 1.5Gbps and 3.0Gbps
- Available in Industrial or Commercial Temperature:
 - Commercial: 0°C to +70°C
 - Industrial: -40°C to +85°C
- Available with MLC or SLC NAND Flash
 - Hardware ECC support for 28/32/48 bits / 2KB
 - Large Block 8kB/page NAND support
- Supports multiple Flash technologies
 - 3.3V asynchronous Flash devices
 - 1.8V and 3.3V Flash devices
 - 1.8V ONFI Flash devices
 - Octal Channel Flash Controller Interface
- ONFI 2.0 Interface Support - 4 channels max
- Integrated DDR1 memory controller supports
 - 64MB DRAM Cache
 - 16-bit bus width - 300Mbps data rate
- Dynamic and Static Wear Leveling
- Performance - SLC NAND FLASH
 - Sequential Read Bandwidth: up to 250 MB/s
 - Sequential Write Bandwidth: up to 215 MB/s
- Performance - MLC NAND FLASH
 - Sequential Read Bandwidth: up to 245 MB/s
 - Sequential Write Bandwidth: up to 210 MB/s
- Power Consumption
 - Standby: 39.8 mA
 - Read Operating: 249.4 mA
 - Write Operating: 496.5 mA
- JEDEC MO-297A Half-Slim SATA II SSD Form Factor
 - 54.00 x 39.00 (L x W)
 - SATA 22 pin connector
 - RoHS-6 compliant (Pb-free)

TABLE OF CONTENTS

1.	Overview.....	1
2.	Features.....	1
3.	mSATA Half-Slim Block Diagram.....	4
4.	Module Ordering Information.....	5
5.	Physical Specifications.....	6
6.	Reliability and Durability	7
6.1.	Wear Leveling for Flash Memory	7
7.	System Performance	8
8.	Pin and Signal Description	9
9.	DC Characteristics.....	10
10.	ATA Command Set.....	11
11.	SMART Command Set Description	15
11.1.	SMART Read Attribute - PIO Data	16
11.2.	SMART Read Attribute - Thresholds.....	17
11.3.	SMART Enable Attribute - Auto Save	18
11.4.	SMART Disable Attribute - Auto Save	18
11.5.	SMART ENABLE Operations.....	19
11.6.	SMART DISABLE Operations.....	19
11.7.	SMART Return Status	20
12.	Revision History	21

List of Figures

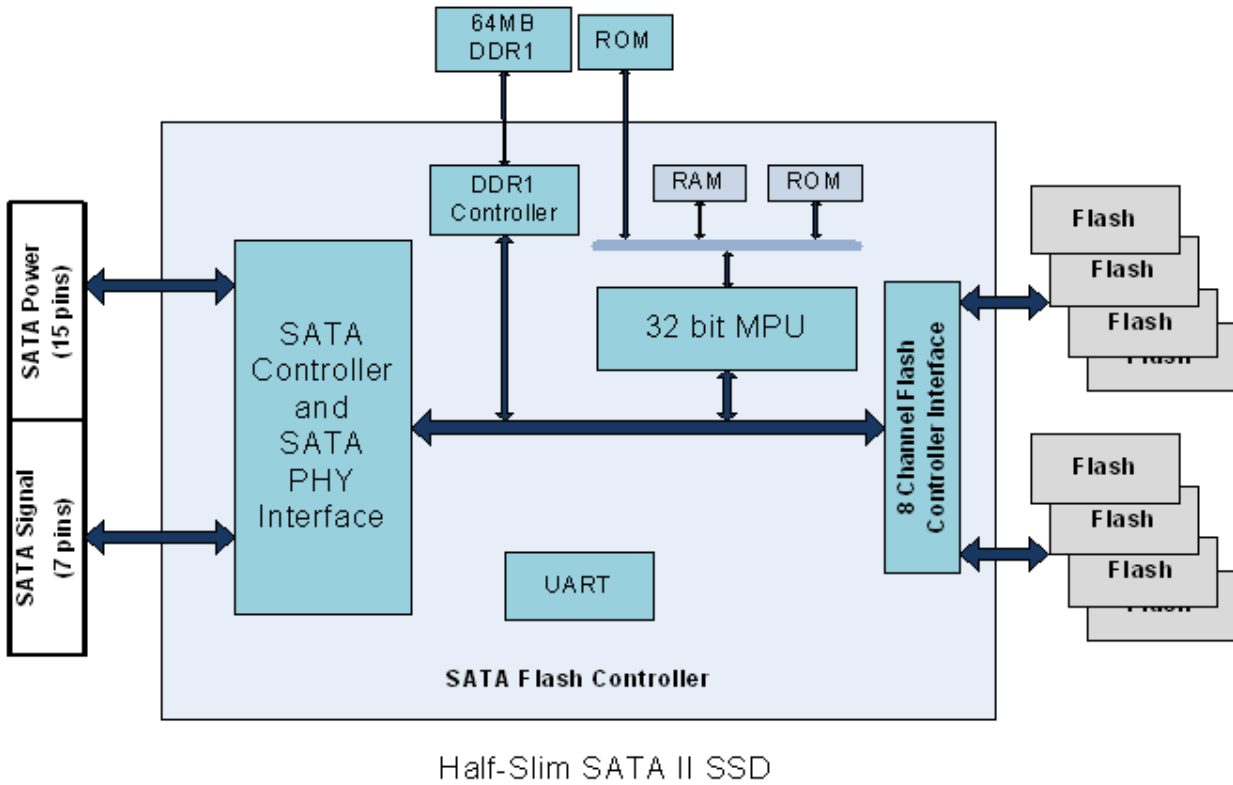
Figure 1: Netlist mSATA Half-Slim Flash Disk Module	4
Figure 2: Dimensions: 54mm(L) x 39mm (W) x 4.45mm (H).....	6
Figure 3: Top View	6

List of Tables

Table 1: Module Ordering Information: Commercial Temperature - MLC NAND Flash	5
Table 2: Module Ordering Information: Industrial Temperature - MLC NAND Flash	5
Table 3: Module Ordering Information: Industrial Temperature - SLC NAND Flash.....	5
Table 4: mSATA Half-Slim Form-Factor.....	6
Table 5: mSATA Slim Flash Disk Module Environmental Conditions	7
Table 6: System Performance	8
Table 7: Pin and Signal Assignment	9
Table 8: Power Connector Pin Assignment.....	9
Table 9: Absolute Maximum Conditions.....	10
Table 10: Recommended Operating Conditions.....	10
Table 11: Input Leakage Current	10
Table 12: Logic Level Output Drive Characteristics	10
Table 13: Power Consumption	10
Table 14: Supply Voltage	10
Table 15: Command Set.....	11
Table 16: Identity Drive Information	12
Table 17: SMART Command Block Register Addressing.....	15
Table 18: SMART READ Attribute Register Addressing.....	15
Table 19: Read Attribute - Normal Output	16
Table 20: Read Attribute - Input.....	16
Table 21: Attribute Description	16
Table 22: SMART Attribute Actual Data Format (all values in hex)	16
Table 23: Thresholds Attribute – Input.....	17
Table 24: THRESHOLDS ATTRIBUTE – Normal Output.....	17
Table 25: Enable Auto Save Attribute - Input	18
Table 26: Enable Auto Save Attribute - Normal Output	18
Table 27: Disable Auto Save Attribute - Input	18
Table 28: Disable Auto Save Attribute - Normal Output	18
Table 29: ENABLE SMART Access – Input	19
Table 30: ENABLE SMART Access - Normal Output	19
Table 31: DISABLE SMART Access – Input	19
Table 32: DISABLE SMART Access - Normal Output	19
Table 33: Return Status – Input.....	20
Table 34: Return Status - Normal Output.....	20

3. mSATA HALF-SLIM BLOCK DIAGRAM

FIGURE 1: NETLIST mSATA HALF-SLIM FLASH DISK MODULE



4. MODULE ORDERING INFORMATION

4GB to 128GB mSATAvault™ Half-Slim								
Part Number: NLS7abcV2d-6tuHAAvwxzy								
abc = Memory Capacity	d =	t = Flash Mfgr.	u = Flash Type	v = Flash Die Geom.	w = #CE per Flash Loc.	x = #Flash Locs.	y = #Die per Flash Loc.	z = Special Feature
04G = 4GB 08G = 8GB 16G = 16GB 32G = 32GB 64G = 64GB 128 = 128GB	C = Commercial 0°C to +70°C I = Industrial 40°C to +85°C	S = Samsung T = Toshiba M = Micron	S = SLC M = MLC	4 = 4x nm 3 = 3x nm 2 = 2x nm 1 = 1x nm	1 = 1 CE per Flash Location 2 = 2 CE per Flash Location 4 = 4 CE per Flash Location 8 = 8 CE per Flash Location	1 = 1 Flash Locations 2 = 2 Flash Locations 4 = 4 Flash Locations 8 = 8 Flash Locations	1 = 1 Die per Flash Location 2 = 2 Die per Flash Location 4 = 4 Die per Flash Location 8 = 8 Die per Flash Location	0 = Std. Product

TABLE 1: MODULE ORDERING INFORMATION: COMMERCIAL TEMPERATURE - MLC NAND FLASH

mSATA Slim Capacity	Part Number ¹
8GB	NLS708GV2C-6TMHAAvwxzy
16GB	NLS716GV2C-6TMHAAvwxzy
32GB	NLS732GV2C-6TMHAAvwxzy
64GB	NLS764GV2C-6TMHAAvwxzy
128GB	NLS7128V2C-6TMHAAvwxzy

TABLE 2: MODULE ORDERING INFORMATION: INDUSTRIAL TEMPERATURE - MLC NAND FLASH

mSATA Slim Capacity	Part Number ¹
8GB	NLS708GV2I-6TMHAAvwxzy
16GB	NLS716GV2I-6TMHAAvwxzy
32GB	NLS732GV2I-6TMHAAvwxzy
64GB	NLS764GV2I-6TMHAAvwxzy
128GB	NLS7128V2I-6TMHAAvwxzy

TABLE 3: MODULE ORDERING INFORMATION: INDUSTRIAL TEMPERATURE - SLC NAND FLASH

mSATA Slim Capacity	Part Number ¹
4GB	NLS704GV2I-6TSHAAvwxzy
8GB	NLS708GV2I-6TSHAAvwxzy
16GB	NLS716GV2I-6TSHAAvwxzy
32GB	NLS732GV2I-6TSHAAvwxzy

¹ Contact Factory or local Sales/FAE support for complete part number ordering information.

5. PHYSICAL SPECIFICATIONS

Half-Slim SATA II SSD form-factor (JEDEC MO-297A)

TABLE 4: MSATA HALF-SLIM FORM-FACTOR

Length	54 ± 0.30 mm
Width	39 ± 0.30 mm
Thickness Including Label Area (Max)	4.45 mm

FIGURE 2: DIMENSIONS: 54MM(L) x 39MM (W) x 4.45MM (H)

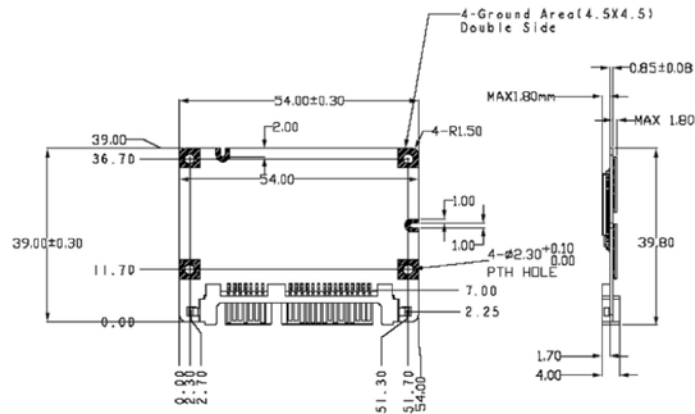
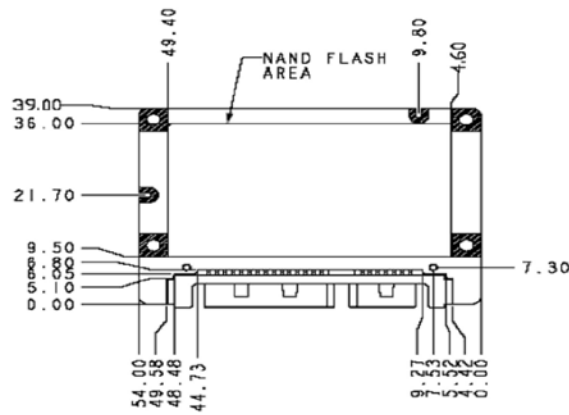


FIGURE 3: TOP VIEW



6. RELIABILITY AND DURABILITY

TABLE 5: mSATA SLIM FLASH DISK MODULE ENVIRONMENTAL CONDITIONS

Operating Temperature	Commercial: 0°C to 70°C, or Industrial: -40°C to 85°C
Vibration	20G (80 - 2000Hz)
Humidity	95% non-condensing with T _{AMB} less than 55°C
ESD Level	Contact discharge: Up to 8 kV Air discharge: Up to 15kV
Acoustic Noise	0 dB
Shock	1,500G (0.5ms)

6.1. WEAR LEVELING FOR FLASH MEMORY

The Netlist Half-Slim SATA II SSD module makes use of advanced flash wear leveling and bad block management techniques. Wear leveling is performed with the use of reserved buffer blocks. "Wear leveled" blocks are swapped with replacement blocks that have the fewest erase cycles. Bad block management ensures that defective blocks created during device operation are mapped out and never accessed. In this manner, the life of the entire device is extended.

7. SYSTEM PERFORMANCE

TABLE 6: SYSTEM PERFORMANCE

Bench Mark	Type	Unit	4GB_SLC_INDU	8GB_SLC_INDU	16GB_SLC_INDU	32GB_SLC_INDU
Iometer	Seq. Read 128K	MBps	241.33	241.1	241.29	240.81
	Seq. Write 128K	MBps	67.32	222.33	105.2	201.56
	Rand. Read 4K	MBps	66.15	66.68	63.45	70.71
	Rand. Write 4K	MBps	15.15	25.1	24.86	46.37
	Rand. Read 4K	IOPS	16934.33	17069.28	16242.68	18102.42
	Rand. Write 4K	IOPS	3878.26	6424.55	6364.5	11871.15
Toshiba part number			TC58NVG3S0ETAIO	TH58NVG4S0ETAKO	TH58NVG5S0ETAKO	TH58NVG6S2ELAMO
Device Page size			4	4	4	8
Number of Dies			1	2	4	4
Numbers of Channels			1	1	1	2
Number of planes			2	2	2	2
Number of CE per device			1	2	2	2
Flash devices per module			4	4	4	4
Total CEs per module			4	8	8	8
Device Package type			TSOP	TSOP	TSOP	LGA
ATTO	Max Seq. Read	MBps	255.04	255.04	255.37	254.5
	Max. Seq. Write	MBps	172.08	179.55	192.99	220.48
Crystal Disk Mark	Seq. Read	MBps	251.9	248	252.4	248.4
	Seq. Write	MBps	214.4	196.3	194.3	216.6
	Rand. Read (4K, QD1)	MBps	60.4	58.2	60.15	55.74
	Rand. Write (4K, QD1)	MBps	43.89	41	41.68	41.83
	Rand. Read (4K, QD32)	MBps	68.03	68.72	69.82	69.81
	Rand. Write (4K, QD32)	MBps	46.88	43.12	43.11	41.83

8. PIN AND SIGNAL DESCRIPTION

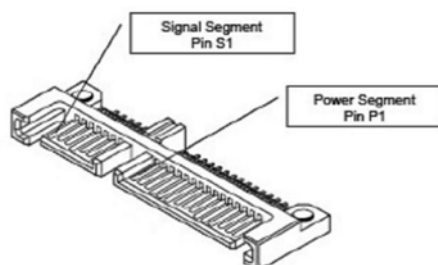


TABLE 7: PIN AND SIGNAL ASSIGNMENT

Pin	Signal Name	Signal Description
S1	SATA GND	SATA Ground Return, 2nd mate
S2	TX_OUT	Host Transmitter Differential Signal - Positive
S3	TX_OUT	Host Transmitter Differential Signal - Negative
S4	SATA GND	SATA Ground Return, 2nd mate
S5	RX_IN	Host Receiver Differential Signal - Negative
S6	RX_IN	Host Receiver Differential Signal - Positive
S7	SATA GND	SATA Ground Return, 2nd mate

TABLE 8: POWER CONNECTOR PIN ASSIGNMENT

Pin Number	Function
P1	Not used (3.3V)
P2	Not used (3.3V)
P3	Not used (3.3V Pre-Charge)
P4	GND
P5	GND
P6	GND
P7	5V Pre-Charge
P8	5V
P9	5V
P10	GND
P11	RESERVED
P12	GND
P13	Not Used (12V Pre-Charge)
P14	Not Used (12V)
P15	Not Used (12V)

9. DC CHARACTERISTICS

Following Tables define the D.C. Characteristics for the Module using the conditions listed below.

TABLE 9: ABSOLUTE MAXIMUM CONDITIONS

Parameter	Symbol	Conditions
Input Voltage	V_{CC}	-5V +/- 5%
Voltage on any pin except V_{CC} with respect to GND.	V	-0.5V min. to V_{CC} + 0.5V max.
Storage Temperature	T_{ST}	-50°C to +125°C

TABLE 10: RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	MIN	TYP	MAX	UNIT
Input Voltage	V_{CC}	4.75	5	5.25	V
Commercial Temperature	T_{AMB_C}	0°		70°	C
Industrial Temperature	T_{AMB_I}	-40°		+85°	C

TABLE 11: INPUT LEAKAGE CURRENT

Parameter	Symbol	Conditions	MIN	TYP	MAX	Units
Input Leakage Current	I_L	$V_{IH} = V_{CC}$ $V_{IL} = GND$	-1		1	μA

TABLE 12: LOGIC LEVEL OUTPUT DRIVE CHARACTERISTICS

Parameter	Symbol	MIN	TYP	MAX	Units
Logic High Output Voltage	V_{OH}	$V_{CC} - 0.3V$		V_{CC}	V
Logic Low Output Voltage	V_{OL}	0		0.4V	V
Logic High Input Voltage	V_{IH}	$V_{CC} \times 0.8V$		V_{CC}	V
Logic Low Input Voltage	V_{IL}	0		$V_{CC} \times 0.2V$	V
Tri-State Leakage Current	I_{L_HIZ}	-10	+/- 1	10	μA

TABLE 13: POWER CONSUMPTION

Parameter	Value (mA)
Idle	39.8 ²
Write	496.5 ²
Read	249.4 ²

TABLE 14: SUPPLY VOLTAGE

Parameter	Rating
Operating Voltage	5V +/- 5%
Max . Ripple	100mV, 0~30 MHz

² This data is based on 32GB (64Gbit MLC x4) statistic

10. ATA COMMAND SET

This section defines the software requirements and commands the host sends to the Half-Slim SATA II SSD Half-Slim SATA II SSD module. Commands are issued by loading the required registers in the command block with the supplied parameters, and then writing the command code to the Command Register. The manner in which a command is accepted varies. There are three classes (see Table 17: ATA Command Set) of command acceptance, all dependent on the host not issuing commands unless the Half-Slim SATA II SSD is not busy (BSY=0).

All commands listed in this specification shall be implemented. Commands can be implemented as "no operation" to meet this requirement. The Security Mode feature set (command codes F1, F2, F3, F4, F5, and F6) should not be implemented unless the device is intended to be used in an embedded, non-removable application. The Security Mode feature set was not designed for removable devices and certain problems may be encountered when using these commands in a removable application. This specification introduces some new commands and features.

Upon receipt of a Class 1 command, the Half-Slim SATA II SSD sets BSY within 400 ns.

Upon receipt of a Class 2 command, the Half-Slim SATA II SSD sets BSY within 400 ns, sets up the sector buffer for a write operation, sets DRQ within 700 ns, and clears BSY within 400 ns of setting DRQ.

Upon receipt of a Class 3 command, the Half-Slim SATA II SSD sets BSY within 400 ns, sets up the sector buffer for a write operation, sets DRQ within 20 ms (assuming no re-assignments), and clears BSY within 400 ns of setting DRQ.

TABLE 15: COMMAND SET

Command Set	OP Code (hex)	Command Set	OP Code (hex)
Check Power Mode	E5	Security Disable Password	F6
Data Set Management	06	Security Erase Prepare	F3
DCO	B1	Security Erase Unit	F4
Download Microcode PIO	92	Security Freeze Lock	F5
Download MicroCode DMA	93	Security Set Password	F1
Execute Drive Diagnostics	90	Security Unlock	F2
Flush Cache	E7	Seek	70
Flush Cache Ext	EA	Set Features	EF
Identify Device	EC	Set Max Address	F9
Idle	E3	Set Max Address Ext	37
Idle Immediate	E1	Set Multiple Mode	C6
Initialize Drive Parameters	91	Sleep	E6
Read Buffer	E4	SMART	B0
Read DMA (without Retry)	C9	Standby	E2
Read DMA (with Retry)	C8	Standly Immediate	E0
Read DMA Ext	25	Write Buffer	E8
Read FPDMA Queued	60	Write DMA (without Retry)	CB
Read Log Ext	2F	Write DMA (with Retry)	CA
Read Multiple	C4	Write DMA Ext	35
Read Multiple Ext	29	Write DMA FUA Ext	3D
Read Native Max Address	F8	Write FDMA Queued	61
Read Native Max Ext	27	Write Log Ext	3F
Read Sectors (without Retry)	21	Write Multiple	C5
Read Sectos (with Retry)	20	Write Multiple Ext	39
Read Sectors Ext	24	Write Multiple FUA ext	CE
Read Verify Ext	42	Write Sectors(without Retry)	31
Read Verify Sectors(without Retry)	41	Write Sectors(with Retry)	30

Command Set	OP Code (hex)	Command Set	OP Code (hex)
Read Verify Sectors(with Retry)	40	Write Sectors Ext	34
Recalibrate	10	Write Uncorrectable	45

TABLE 16: IDENTITY DRIVE INFORMATION

Word Address	F: Fixed V: Variable X: Both	Default Value (hex)	Data Field Type Information
0	F	045A	General configuration - bit significant information
1	X	3FFF	Obsolete - Number of Logical Cylinders (16,383)
2	V	0000	Specific Configuration
3	X	0010	Obsolete - Number of Logical Heads (16)
4 - 5	X	02007E00	Retired
6	X	003F	Obsolete - Number of Logical Sectors per Track (63)
7 - 8	V	00000000	Reserved for Assignment by the Compact Flash Association
9	X	0000	Retired
10 - 19	F	xxxx	Serial Number in ASCII (20 Characters)
20 - 21	X	0000	Retired
22	X	0000	Obsolete
23 - 26	F	xxxx	Firmware revision in ASCII (8 Characters)
27 - 46	F	xxxx	Model Number in ASCII
47	F	8001	7:0 - Maximum number of sectors transferred per interrupt on MULTIPLE commands
48	F	0000	Reserved
49	F	0F00	Capabilities
50	F	4000	Capabilities
51 - 52	X	00000200	Obsolete
53	F	0007	Words 88 and 70:64 are valid
54	X	3FFF	Obsolete - Number of Logical Cylinders (16383)
55	X	0010	Obsolete - Number of Logical Heads (16)
56	X	003F	Obsolete - Number of Logical Sectors per Track (63)
57 - 58	X	00FBFC10	Obsolete
59	F	0100	Number of Sectors Transferred per Interrupt on MULTIPLE Commands
60 - 61	F	64GB - XXXXXXXX 32GB - 037DFF40	Total Number of User Addressable Sectors
62	X	0000	Obsolete
63	F	0007	Multi-word DMA modes Supported / Selected
64	F	0003	PIO modes supported
65	F	0078	Minimum Multi-word DMA transfer cycle time per word
66	F	0078	Manufacturer's recommended Multi-word DMA transfer cycle time
67	F	0078	Minimum PIO transfer cycle time without flow control
68	F	0078	Minimum PIO transfer cycle time with IORDY flow control
69 - 70	F	0000	Reserved
71 - 74	F	0000	Reserved for the IDENTIFY PACKET DEVICE Command
75	F	0000	Queue Depth
76	F	0002	SATA II Capabilities
77	F	0000	Reserved - future Serial ATA Definition
78	F	0000	Serial ATA Features Supported
79	V	0000	Serial ATA Features Enabled

Word Address	F: Fixed V: Variable X: Both	Default Value (hex)	Data Field Type Information
80	F	00F8	Major Version Number
81	F	0021	Minor Version Number
82	F	7429	Command Set Supported
83	F	7008	Command Set Supported
84	F	4000	Command Set / Feature Supported Extension
85	V	7028	Command Set / Feature Enabled
86	V	3000	Command Set / Feature Enabled
87	V	4000	Command Set / Feature Default
88	V	007F	Ultra DMA Modes
89	F	0000	Time Required for Security Unit Erase Completion
90	F	0000	Time Required for Enhanced Security Erase Completion
91	V	0000	Current Advanced Power Management Value
92	V	0000	Master Password Revision Code
93	F	0000	Hardware Reset Result. The contents of bits (12:0) of this word shall change only during the execution of a hardware Reset.
94	V	0000	Vendor's Recommended and Actual Acoustic Management Value
95	F	0000	Stream Minimum Request Size
96	V	0000	Streaming Transfer Time - DMA
97	V	0000	Streaming Access Latency - DMA and PIO
98 - 99	F	0000	Streaming Performance Granularity
100 - 103	V	128GB - XXXXXXXX 64GB - XXXXXXXX 32GB - XXXXXXXX 16GB - XXXXXXXX	Maximum User LBA for 48-bit Address Feature Set
104	V	0000	Streaming Transfer Time - PIO
105	F	0000	Maximum number of 512-byte blocks per DATA SET MANAGEMENT command
106	F	0000	Physical sector size / Logical sector size
107	F	0000	Inter-seek delay for ISO-7770 acoustic testing in microseconds
108 - 111	F	0000	Unique ID
112 - 115	F	0000	Reserved
116	V	0000	Reserved
117 - 118	F	0000	Words per Logical Sector
119	F	0000	Supported Settings
120	F	0000	Command Set / Feature Enabled/Supported
121 - 126	F	0000	Reserved
127	F	0000	Removable Media Status Notification Feature Set Support
128	V	0000	Security Status
129 - 159	X	0000	Vendor Specific
160	F	0000	Compact Flash Association (CFA) Power Mode 1
161 - 175	X	0000	Reserved for Assignment by the CFA
176 - 205	V	0000	Current Media Serial Number
206 - 216	F	0000	Reserved
217	F	0000	Non-rotating Media Device
218 - 221	F	0000	Reserved
222	F	0000	Reserved
223 - 233	F	0000	Reserved
234		0000	Reserved

Word Address	F: Fixed V: Variable X: Both	Default Value (hex)	Data Field Type Information
235		0000	Reserved
236 - 254	F	0000	Reserved
255	X	varies	Integrity Word (Checksum and Signature)

11. SMART COMMAND SET DESCRIPTION

Communication to or from the device through Data Register and 7 Command Block Registers(28bit Command Format) includes: Feature Register, Error Register, Sector Count Register, Sector Number Register, Cylinder Low Register, Cylinder High Register, Drive Head Register, Status Register, Command Register.

Direction: Input = from Host to Device; Output = from Device to Host

TABLE 17: SMART COMMAND BLOCK REGISTER ADDRESSING

Offset Address	Read	Write	Value Type
0x00	Data	Data	WORD
0x01	Error	Feature	BYTE
0x02	Sector Count	Sector Count	BYTE
0x03	Sector Number - (LBA low current)	Sector Number - (LBA low current)	BYTE
0x04	Cylinder Low - (LBA mid current)	Cylinder Low - (LBA mid current)	BYTE
0x05	Cylinder High - (LBA high current)	Cylinder High - (LBA high current)	BYTE
0x06	Drive Head	Drive Head	BYTE
0x07	Status	Command	BYTE

TABLE 18: SMART READ ATTRIBUTE REGISTER ADDRESSING

ID	Vendor Command	Feature	Sector Count	Sector Number	Cylinder Low	Cylinder High	Drive Head	Command
0	SMART READ Attribute	0xD0	0x01	XX	0x4F	0xC2	0xA0	0xB0
1	SMART READ Attribute Thresholds	0xD1	0x01	XX	0x4F	0xC2	0xA0	0xB0
2	SMART ENABLE Attributes AUTOSAVE	0xD2	0xF1	XX	0x4F	0xC2	0xA0	0xB0
3	SMART DISABLE Attribute AUTOSAVE	0xD2	0x00	XX	0x4F	0xC2	0xA0	0xB0
5	SMART ENABLE Operations	0xD8	XX	XX	0x4F	0xC2	0xA0	0xB0
6	SMART DISABLE Operations	0xD9	XX	XX	0x4F	0xC2	0xA0	0xB0
7	SMART Return Status	0xDA	XX	XX	0x4F	0xC2	0xA0	0xB0

11.1. SMART READ ATTRIBUTE - PIO DATA

This command will return 1 sector of SMART Read Attribute information. PIO Data Protocol

TABLE 19: READ ATTRIBUTE - NORMAL OUTPUT

Register	7	6	5	4	3	2	1	0
Error					XX			
Sector Count					XX			
Sector Number - (LBA low current)					XX			
Cylinder Low - (LBA mid current)					XX			
Cylinder High - (LBA high current)					XX			
Drive Head					XX			
Status					0x50			

TABLE 20: READ ATTRIBUTE - INPUT

Register	7	6	5	4	3	2	1	0
Feature					0xD0			
Sector Count					0x01			
Sector Number - (LBA low current)					XX			
Cylinder Low - (LBA mid current)					0x4F			
Cylinder High - (LBA high current)					0xC2			
Drive Head	1	0	1	0	0	0	0	0
Command					0xB0			

TABLE 21: ATTRIBUTE DESCRIPTION

Attribute ID (hex)	Description
01	Number of accumulated, uncorrectable errors. Range (0 - 255)
09	Power on hours count. Range (0 - 4294967295)
0C	Drive power cycle count. (Accumulated power ON/OFF cycles)
A8	SATA PHY error count. Only accumulated from power ON (clears to Zero when power OFF) This value includes all PHY error counts; except - Data FIS CRC, code error, disparity error, command FIS CRC
AA	Bad Block Count
AD	Erase Count
C0	Number of unexpected power loss
DA	Number of accumulated CRC errors (read/write data FIS CRC errors)

TABLE 22: SMART ATTRIBUTE ACTUAL DATA FORMAT (ALL VALUES IN HEX)

0	1	2	3	4	5	6	7	8	9	10	11	
ID (hex)	Flag	Flag	Value	Worse	DATA						Threshold	
01	0B	00	64	64	0	0	ECC error	0	0	0	0	32
09	12	00	64	64	Power ON hours		0	0	0	0	0	00
0C	12	00	64	64	Power ON / OFF cycles				0	0	0	00
A8	12	00	64	64	SATA II PHY error count				0	0	0	00
AA	03	00	Note ³	Note ³	Early BAD block #		0	0	Later BAD block #		0	0A
AD	12	00	64	64	AVG erase count		MAX erase count		0	0	0	00

³ Formula to calculate percentage (%) of spare blocks (value from 100 to 1). Spare Block Percentage = $((\text{MABN} - \text{CBBN}) / \text{MABN}) * 100$; where MABN = Maximum Acceptable Bad Block Number and CBBN = Current Bad Block Number.

0	1	2	3	4	5	6	7	8	9	10	11	
ID (hex)	Flag	Flag	Value	Worse	DATA						Threshold	
					(max = 65535)			(max = 65535)				
C0	12	00	64	64	Accidental power loss count #				0	0	0	00
DA	0B	00	64	64	CRC error count number				0	0	0	32

11.2. SMART READ ATTRIBUTE - THRESHOLDS

This command will return 1 sector of SMART Thresholds Attribute information. PIO Data Protocol

TABLE 23: THRESHOLDS ATTRIBUTE – INPUT

Register	7	6	5	4	3	2	1	0
Feature	0xD1							
Sector Count	0x01							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	0x4F							
Cylinder High - (LBA high current)	0xC2							
Drive Head	1	0	1	0	0	0	0	0
Command	0xB0							

TABLE 24: THRESHOLDS ATTRIBUTE – NORMAL OUTPUT

Register	7	6	5	4	3	2	1	0
Error	XX							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	XX							
Cylinder High - (LBA high current)	XX							
Drive Head	XX							
Status	0x50							

11.3. SMART ENABLE ATTRIBUTE - AUTO SAVE

This command will Enable the optional attribute, Auto Save, feature of the device. Non-PIO Data protocol

TABLE 25: ENABLE AUTO SAVE ATTRIBUTE - INPUT

Register	7	6	5	4	3	2	1	0
Feature	0xD2							
Sector Count	0xF1							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	0x4F							
Cylinder High - (LBA high current)	0xC2							
Drive Head	1	0	1	0	0	0	0	0
Command	0xB0							

TABLE 26: ENABLE AUTO SAVE ATTRIBUTE - NORMAL OUTPUT

Register	7	6	5	4	3	2	1	0
Error	XX							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	XX							
Cylinder High - (LBA high current)	XX							
Drive Head	XX							
Status	0x50							

11.4. SMART DISABLE ATTRIBUTE - AUTO SAVE

This command will Disable the optional attribute, Auto Save, feature of the device. Non-PIO Data protocol.

TABLE 27: DISABLE AUTO SAVE ATTRIBUTE - INPUT

Register	7	6	5	4	3	2	1	0
Feature	0xD2							
Sector Count	0x00							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	0x4F							
Cylinder High - (LBA high current)	0xC2							
Drive Head	1	0	1	0	0	0	0	0
Command	0xB0							

TABLE 28: DISABLE AUTO SAVE ATTRIBUTE - NORMAL OUTPUT

Register	7	6	5	4	3	2	1	0
Error	XX							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	XX							
Cylinder High - (LBA high current)	XX							
Drive Head	XX							
Status	0x50							

11.5. SMART ENABLE OPERATIONS

This command will enable access to all SMART capabilities within the device. Non-PIO data protocol.

TABLE 29: ENABLE SMART ACCESS – INPUT

Register	7	6	5	4	3	2	1	0
Feature	0xD8							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	0x4F							
Cylinder High - (LBA high current)	0xC2							
Drive Head	1	0	1	0	0	0	0	0
Command	0xB0							

TABLE 30: ENABLE SMART ACCESS - NORMAL OUTPUT

Register	7	6	5	4	3	2	1	0
Error	XX							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	XX							
Cylinder High - (LBA high current)	XX							
Drive Head	XX							
Status	0x50							

11.6. SMART DISABLE OPERATIONS

This command will disable access to all SMART capabilities within the device, including any and all timer and event count functions exclusively related to this feature. Non-PIO data protocol.

TABLE 31: DISABLE SMART ACCESS – INPUT

Register	7	6	5	4	3	2	1	0
Feature	0xD9							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	0x4F							
Cylinder High - (LBA high current)	0xC2							
Drive Head	1	0	1	0	0	0	0	0
Command	0xB0							

TABLE 32: DISABLE SMART ACCESS - NORMAL OUTPUT

Register	7	6	5	4	3	2	1	0
Error	XX							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	XX							
Cylinder High - (LBA high current)	XX							
Drive Head	XX							
Status	0x50							

11.7. SMART RETURN STATUS

This command will return the reliability status of the device to the Host. Non-PIO data protocol.

Status Return:

If Current Reserved Block > 3; Return 0x4F, 0xC2

If Current Reserved Block <= 3; Return 0xF4, 0x2C (Exceeded threshold detection condition)

TABLE 33: RETURN STATUS – INPUT

Register	7	6	5	4	3	2	1	0
Feature	0xDA							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	0x4F							
Cylinder High - (LBA high current)	0xC2							
Drive Head	1	0	1	0	0	0	0	0
Command	0xB0							

TABLE 34: RETURN STATUS - NORMAL OUTPUT

Register	7	6	5	4	3	2	1	0
Error	XX							
Sector Count	XX							
Sector Number - (LBA low current)	XX							
Cylinder Low - (LBA mid current)	XX							
Cylinder High - (LBA high current)	XX							
Drive Head	XX							
Status	0x50							

12. REVISION HISTORY

Revision	Date	Author	Notes
0v1	09/27/2011	HS	Preliminary
0v2	10/18/2011	HS	Added performance numbers
0v5	05/01/2012	HS	Added 8GB MLC PN Added PN decoder
1v0	03/07/2014	BR	Updated Part Numbers

Disclaimer of Warranties and Liability

Netlist, Inc. reserves the right to make changes to specifications and product descriptions such as, but not limited to, numbers, parameters and other technical information contained herein at any time, with or without notice. Netlist disclaims all warranties, express or implied, concerning the information on this datasheet. Netlist disclaims all liability for any harm alleged to arise from the use of the information on this datasheet.

© Netlist, Inc., 2014. All rights reserved. 175 Technology, Suite 150, Irvine, CA 92618