



1. OVERVIEW

Netlist, a pioneer in the development of high-density memory subsystems, is proud to offer the mSATA Mini Flash Disk Module in a JEDEC MO-300B variation B form factor that is approximately ½ the length of typical mSATA Slim cards. The mSATA Mini module follows the same form factor as the mini PCI Express module and uses the same 52 pin PCB edge style connector. The Netlist solution provides a fully compatible SATA V2.6 interface to the host system and supports serial data rates to 3.0Gbps.

Netlist's mSATA Mini is the product of choice in applications requiring the smallest form factor, 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 mSATA Mini is the solution of choice for reliable alternatives to mechanical hard disk drives for high availability and mission critical applications. The on-card 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 mSATA Mini 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 mSATA Mini is available in capacities of 4GB to 32GB. The Netlist mSATA Mini 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

- 1GB to 32GB capacity (48 bit addressing)
- SATA V2.6 compliant with NCQ Support
 - NCQ support for up to 32 commands
 - Support for SATA 48-bit addressing mode
 - SATA interface for 1.5Gbps and 3.0Gbps
- Available in Commercial or Industrial Temperature
 - Commercial: 0°C to +70°C
 - Industrial1: -40°C to +85°C
- Available with MLC or SLC NAND Flash
 - Hardware ECC support for 28/32/48 bits per 2kB data
 - 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
 - 16bit bus width - 320Mbps
- Dynamic and Static Wear Leveling
- Performance - SLC NAND FLASH
 - Sequential Read Bandwidth: up to 263MB/s
 - Sequential Write Bandwidth: up to 213MB/s
- Performance - MLC NAND FLASH
 - Sequential Read Bandwidth: up to 264MB/s
 - Sequential Write Bandwidth: up to 215MB/s
- Power Supply voltage
 - 3.3 V +/- 0.3 VDC Power Supply
- Power Consumption
 - Read: 180 mA (typical)
 - Write: 222 mA (typical)
 - Idle: 42.7mA (typical)
- Form Factor of 26.8 x 29.85 mm (L x W)
- RoHS-6 compliant (Pb-free)

TABLE OF CONTENTS

1.	Overview.....	1
2.	Features.....	1
3.	mSATA Slim Block Diagram.....	4
4.	Module Ordering Information.....	5
5.	Physical Specifications.....	6
6.	Reliability and Durability.....	11
6.1.	Wear Leveling for Flash Memory.....	11
7.	System Performance.....	12
8.	Pin Name and Signal Description.....	13
9.	DC Characteristics.....	15
10.	ATA Command Set.....	16
11.	SMART Command Set Description.....	20
11.1.	SMART Read Attribute - PIO Data.....	21
11.2.	SMART Read Attribute - Thresholds.....	22
11.3.	SMART Enable Attribute - Auto Save.....	23
11.4.	SMART Disable Attribute - Auto Save.....	23
11.5.	SMART ENABLE Operations.....	24
11.6.	SMART DISABLE Operations.....	24
11.7.	SMART Return Status.....	25
12.	Revision History.....	26

List of Figures

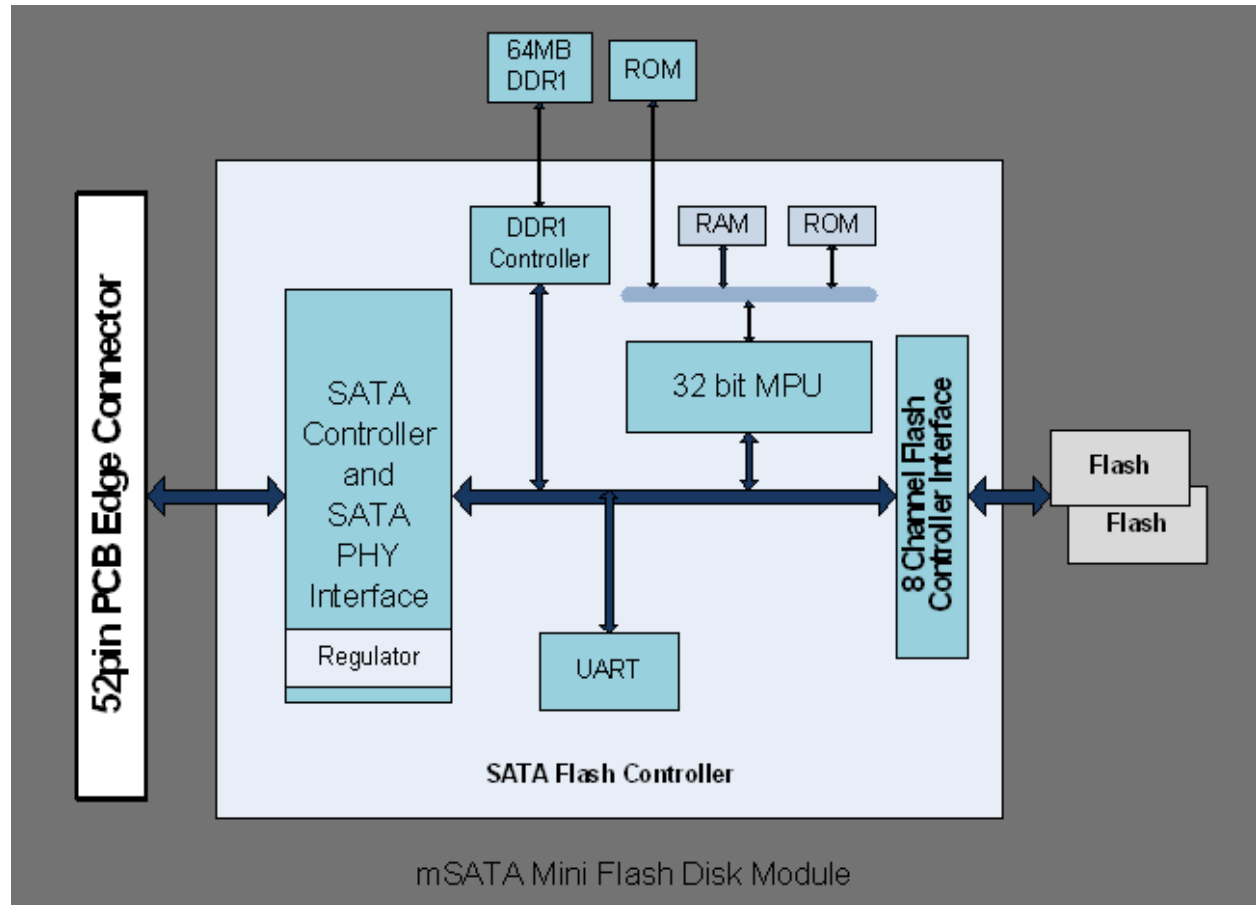
Figure 1: Netlist mSATA Mini Flash Disk Module.....	4
Figure 2: mSATA Slim Outline Dimensions	6
Figure 3: mSATA Mini Physical Dimensions (1 of 2)	7
Figure 4: mSATA Mini Physical Dimensions (2 of 2)	8

List of Tables

Table 1: Module Ordering Information: Commercial Temperature - MLC NAND Flash	5
Table 2: Module Ordering Information: Industrial Temperature - SLC NAND Flash.....	5
Table 3: mSATA Slim Form-Factor	6
Table 4: Physical Dimensions (1 of 2)	9
Table 5: Physical Dimensions (2 of 2)	9
Table 6: mSATA Mini - JEDEC MO-300B Variation B.....	10
Table 7: mSATA Mini Flash Disk Module Environmental Conditions.....	11
Table 8: System Performance.....	12
Table 9: System Information	12
Table 10: Pin and Signal Assignment	13
Table 11: Absolute Maximum Conditions.....	15
Table 12: Recommended Operating Conditions.....	15
Table 13: Input Leakage Current	15
Table 14: Logic Level Output Drive Characteristics	15
Table 15: Command Set.....	16
Table 16: Identity Drive Information	17
Table 17: SMART Command Block Register Addressing.....	20
Table 18: SMART READ Attribute Register Addressing.....	20
Table 19: Read Attribute - Normal Output	21
Table 20: Read Attribute - Input.....	21
Table 21: Attribute Description	21
Table 22: SMART Attribute Actual Data Format (all values in hex)	21
Table 23: Thresholds Attribute – Input.....	22
Table 24: THRESHOLDS ATTRIBUTE – Normal INPUT	22
Table 25: Enable Auto Save Attribute - Input	23
Table 26: Enable Auto Save Attribute - Normal Output	23
Table 27: Disable Auto Save Attribute - Input	23
Table 28: Disable Auto Save Attribute - Normal Output	23
Table 29: ENABLE SMART Access – Input	24
Table 30: ENABLE SMART Access - Normal Output	24
Table 31: DISABLE SMART Access – Input	24
Table 32: DISABLE SMART Access - Normal Output	24
Table 33: Return Status – Input.....	25
Table 34: Return Status - Normal Output.....	25

3. mSATA SLIM BLOCK DIAGRAM

FIGURE 1: NETLIST mSATA MINI FLASH DISK MODULE



4. MODULE ORDERING INFORMATION

1GB to 32GB mSATAvault™ Mini							
Part Number: NLSFabcV2d-6TuHAAvwxzy							
abc = Memory Capacity	d =	u = Flash Type	v = Flash Die Geom.	w = #CE per Flash Loc.	x = #Flash Locs.	y = #Die per Flash Loc.	z = Special Feature
01G = 1GB 04G = 4GB 08G = 8GB 16G = 16GB 32G = 32GB	C = Commercial 0°C to +70°C I = Industrial 40°C to +85°C	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 Mini Capacity	Part Number ¹
4GB	NLSF04GV2C - 6TMHAAvwxzy
8GB	NLSF08GV2C - 6TMHAAvwxzy
16GB	NLSF16GV2C - 6TMHAAvwxzy
32GB	NLSF32GV2C - 6TMHAAvwxzy

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

mSATA Mini Capacity	Part Number ¹
1GB	NLSF01GV2I - 6TSHAAvwxzy
2GB	NLSF02GV2I - 6TSHAAvwxzy
4GB	NLSF04GV2I - 6TSHAAvwxzy
8GB	NLSF08GV2I - 6TSHAAvwxzy

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

5. PHYSICAL SPECIFICATIONS

mSATA Mini Flash Disk Module form-factor - JEDEC MO-300B (Variation B).

The host is connected to the mSATA Slim module using the 52 pin mini PCIe edge type connector.

TABLE 3: MSATA SLIM FORM-FACTOR

Length	26.80 ± 0.15 mm
Width	29.85 ± 0.15 mm
Thickness Including Label Area (Max)	3.85 mm

FIGURE 2: MSATA SLIM OUTLINE DIMENSIONS

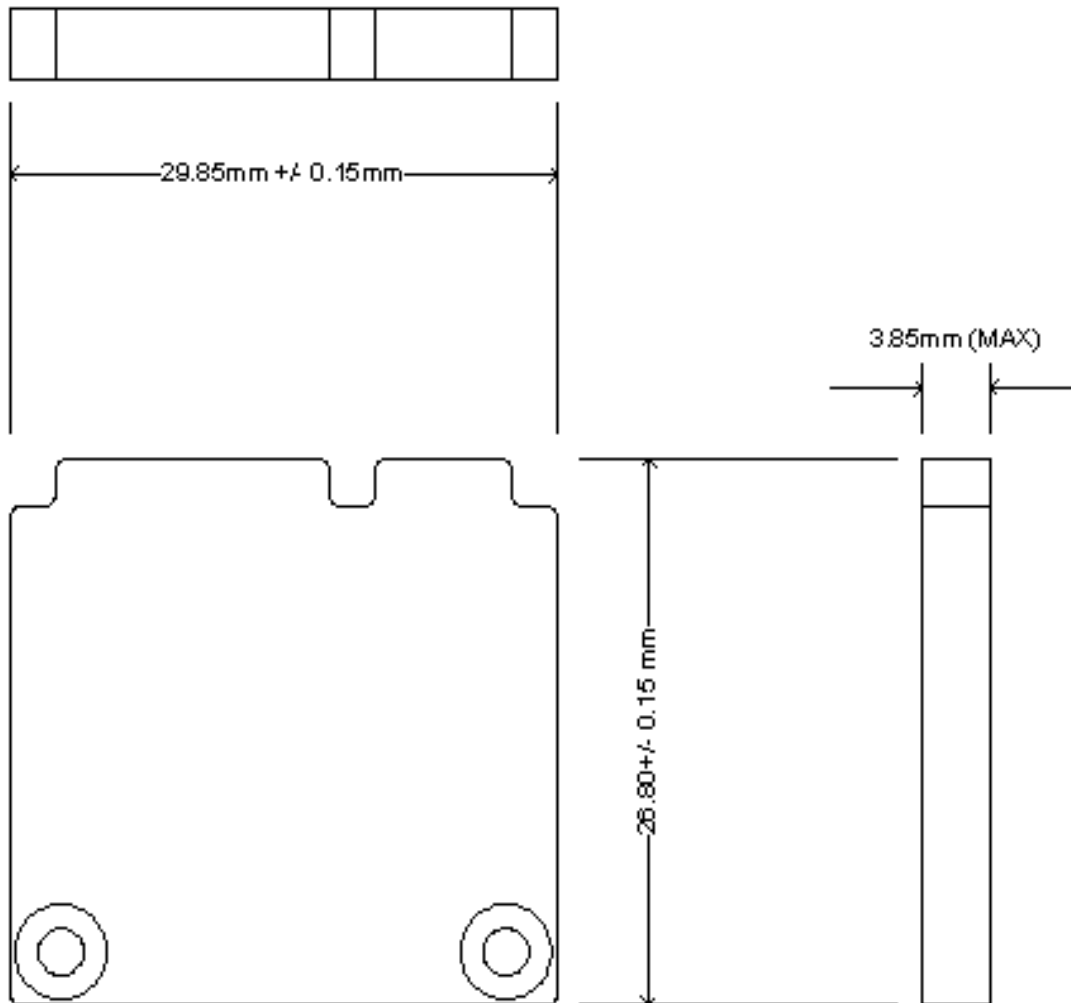


FIGURE 3: MSATA MINI PHYSICAL DIMENSIONS (1 OF 2)

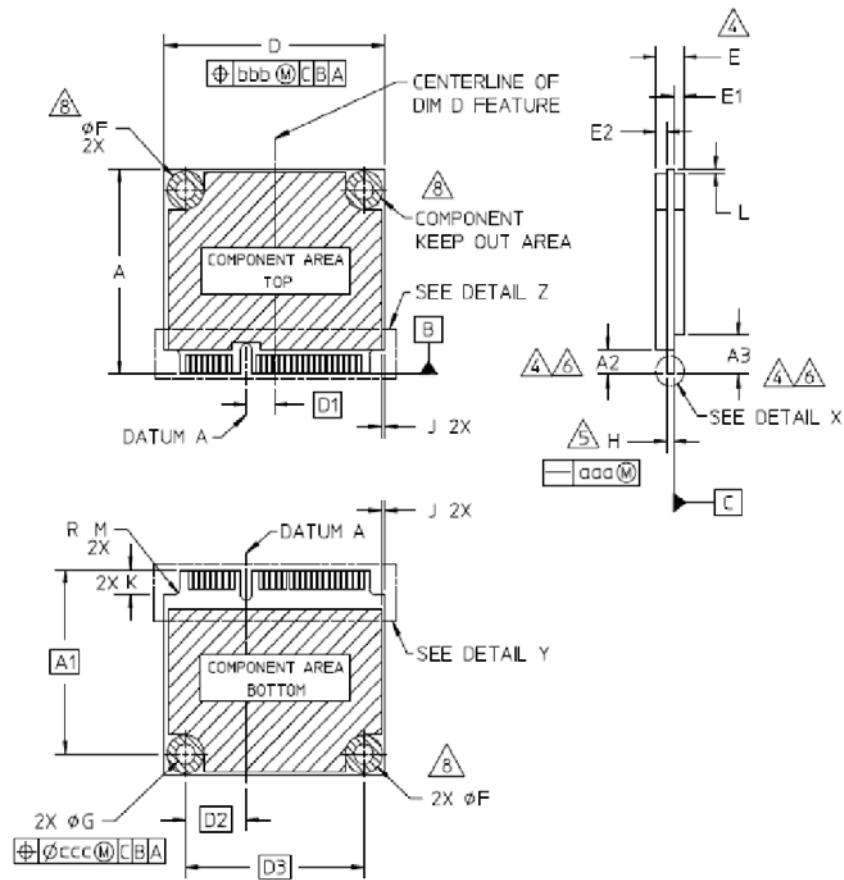


FIGURE 4: MSATA MINI PHYSICAL DIMENSIONS (2 OF 2)

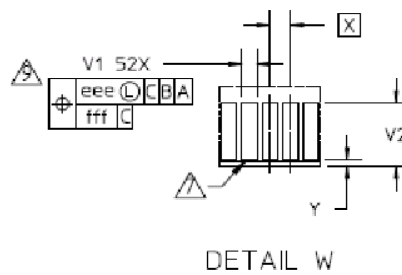
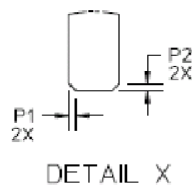
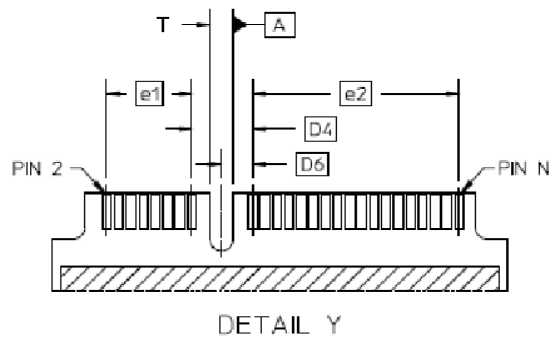
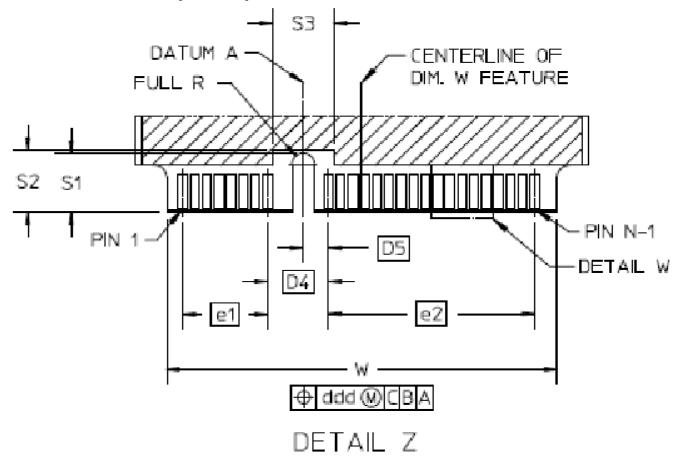


TABLE 4: PHYSICAL DIMENSIONS (1 OF 2)

COMMON DIMENSION TABLE				
SYMBOL	MIN	NOM	MAX	NOTES
A2	3.20	-	-	4.6
A3	5.10	-	-	4.6
D	29.70	29.85	30	
G	2.50	2.60	2.70	
H	0.90	1.00	1.10	5
J	0.50	-	-	
K	3.20	-	-	
M	-	-	0.80	
P1	-	-	0.25	
P2	-	-	0.25	
S1	3.90	4.00	4.10	
S2	4.20	-	-	
S3	4.00	-	-	
T	1.40	1.50	1.60	
V1	0.55	0.60	0.65	
V2	2.40	2.55	2.70	
W	25.55	25.70	25.85	
Y	-	-	0.25	
N		52		
ISSUE	A			
REF	14 -131			

TABLE 5: PHYSICAL DIMENSIONS (2 OF 2)

SYMBOL	VALUE
D1	3.85
D2	8.25
D3	24.20
D4	4.00
D5	1.65
D6	2.05
e1	5.60
e2	13.60
X	0.80
ISSUE	A
REF	14-131
NOTES	1, 2, 3

TABLE 6: mSATA MINI - JEDEC MO-300B VARIATION B

SYMBOL	mSATA FULL SIZE VARIATION A			NOTES
	MIN	NOM	MAX	
A	26.65	26.80	26.95	
A1	23.90 BASIC			
E	-	-	3.85	4
E1	-	-	1.35	
E2	-	-	1.50	
F	-	-	-	8
F1	4.90	5.00	5.10	8
F2	-	-	-	8
L	0.5	-	-	
ISSUE	B			
REF	14-131			
NOTES	1, 2, 3			

NOTES :

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M-1994
2. TOLERANCES ON ALL DIMENSIONS ± 0.15 UNLESS OTHERWISE SPECIFIED.
3. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE SPECIFIED.
4. DIMENSIONS APPLICABLE WHEN COMPONENTS ARE MOUNTED ON BOTH SIDES.
5. CARD THICKNESS APPLIES ACROSS TABS AND INCLUDES PLATING AND/OR METALIZATION.
6. BORDER OF COMPONENT AREA.
7. EDGE OF CONTACT PADS SHALL BE FREE OF BURRS AND EXTERNAL TIE BARS.
8. COMPONENT AND ROUTING (TOP/BOTTOM LAYER) KEEP OUT AREA FOR HOLD DOWN SOLUTIONS.

APPLICATION NOTES :

9. RECOMMENDED PLATING FOR THE CONTACT PADS ARE,
 - A) PREFERABLE PLATING : ELECTROLYTIC GOLD PLATING 0.76 MICROMETERS MINIMUM OVER ELECTROLYTIC NICKEL 2.00 MICROMETERS MINIMUM.
 - B) ALTERNATE PLATING : GOLD PLATING 0.05 TO 0.75 MICROMETERS OVER NICKEL 2.00 MICROMETERS MINIMUM. MUST USE AN ELECTRONIC CONTACT GRADE CORROSIVE BARRIER LUBRICANT.

6. RELIABILITY AND DURABILITY

TABLE 7: mSATA MINI FLASH DISK MODULE ENVIRONMENTAL CONDITIONS

Operating Temperature	Commercial: 0°C to 70°C, or Industrial: -40°C to 85°C
Vibration	15G (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)
Typical Power Requirements	3.3V +/- 10% Idle: 42.7mA Read: 180 mA Write: 222 mA

6.1. WEAR LEVELING FOR FLASH MEMORY

The Netlist mSATA Mini module makes use of the 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 8: SYSTEM PERFORMANCE

Utility	Test	Unit	4GB MLC	4GB SLC	8GB MLC	8GB SLC	16GB MLC	32GB MLC
Iometer	Seq. Read 128K	MBps	252.12	252.12	251.45	251.74	252.09	252.17
	Seq. Write 128K	MBps	25.62	28.21	32.38	46.37	32.28	64.78
	Rand. Read 4K	MBps	55.37	52.89	55.47	55.46	55.58	55.38
	Rand. Write 4K	MBps	3.55	6.47	5.76	10.73	5.52	11.74
	Rand. Read 4K	IOPS	14175.59	13538.80	14199.41	14198.48	14228.70	14176.63
	Rand. Write 4K	IOPS	909.30	1656.64	1474.43	2747.54	1412.59	3005.57
Configuration	Device Page size		8	4	8	4	8	8
	Number of Dies		1	4	2	4	4	8
	Numbers of Channels		1	1	1	2	1	2
	Number of planes		2	2	2	2	2	2
	Number of CE per device		1	2	2	2	2	4
	Flash devices per module		1	1	1	1	1	1
	Total CEs per module		1	2	2	2	2	4
	Device Package type		TSOP	TSOP	TSOP	LGA	TSOP	LGA
ATTO	Max Seq. Read	MBps	266.43	266.29	265.12	265.79	266.19	265.53
	Max. Seq. Write	MBps	126.33	138.23	189.03	185.47	212.21	204.91
Crystal Disk Mark	Seq. Read	MBps	263.60	263.70	263.80	264.00	263.80	263.80
	Seq. Write	MBps	213.60	172.00	213.20	215.50	212.00	205.00
	Rand. Read (4K, QD1)	MBps	48.42	49.72	48.34	50.18	48.40	48.26
	Rand. Write (4K, QD1)	MBps	47.36	47.83	45.25	44.00	43.70	42.69
	Rand. Read (4K, QD32)	MBps	54.62	55.44	54.50	54.60	54.58	54.41
	Rand. Write (4K, QD32)	MBps	50.94	51.73	49.04	47.67	48.46	44.74

TABLE 9: SYSTEM INFORMATION

Mother Board MFG	MSI	Windows	XP
MB Part Number	P67A-GD65	Type	Professional
PCI Slot	x1 (Gen 2.0)	Version	2002
CPU	Intel Core i3-2100, 3.10GHz, 3MB Cache, LGA1155, 65W	Service Pack	3
Memory	Dual channel, 4GB(total), PC3-10660 (1333MT/s)	Windows	XP

8. PIN NAME AND SIGNAL DESCRIPTION

TABLE 10: PIN AND SIGNAL ASSIGNMENT

Pin	Signal Name	Signal Description
1	NC	No Connect
2	3.3V	3.3V Source
3	NC	No Connect
4	DGND	Digital Ground
5	NC	No Connect
6	NC	No Connect
7	NC	No Connect
8	NC	No Connect
9	DGND	Digital Ground
10	NC	No Connect
11	NC	No Connect
12	NC	No Connect
13	NC	No Connect
14	NC	No Connect
15	DGND	Digital Ground
16	NC	No Connect
17	NC	No Connect
18	DGND	Digital Ground
19	NC	No Connect
20	NC	No Connect
21	SATA GND	SATA Ground Return
22	NC	No Connect
23	TX_OUT	Host Receiver Differential Signal - Positive
24	3.3V	3.3V Source
25	TX_OUT	Host Receiver Differential Signal - Negative
26	SATA GND	SATA Ground Return
27	SATA GND	SATA Ground Return
28	NC	No Connect
29	SATA GND	SATA Ground Return
30	NC	No Connect
31	RX_IN	Host Transmitter Differential Signal - Negative
32	NC	No Connect
33	RX_IN	Host Transmitter Differential Signal - Positive
34	DGND	Digital Ground
35	SATA GND	SATA Ground Return
36	NC	No Connect
37	SATA GND	SATA Ground Return
38	NC	No Connect
39	3.3V	3.3V Source
40	DGND	Digital Ground
41	3.3V	3.3V Source
42	NC	No Connect
43	NC	No Connect
44	NC	No Connect
45	NC	No Connect
46	NC	No Connect
47	NC	No Connect

Pin	Signal Name	Signal Description
48	NC	No Connect
49	DA/DSS	Option for LED Output
50	DGND	Digital Ground
51	GND	Default Connection to Ground
52	3.3V	3.3V Source

9. DC CHARACTERISTICS

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

$V_{CC} = 3.3V \pm 5\%$;

TABLE 11: ABSOLUTE MAXIMUM CONDITIONS

Parameter	Symbol	Conditions
Input Voltage	V_{CC}	-0.3V min. to 3.6V max.
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 12: RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	MIN	TYP	MAX	UNIT
Input Voltage	V_{CC}	3.0	3.3	3.6	V
Commercial Temperature	T_{AMB_C}	0°		70°	C
Industrial Temperature	T_{AMB_I}	-40°		+85°	C

TABLE 13: 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 14: 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

10. ATA COMMAND SET

This section defines the software requirements and commands the host sends to the mSATA Mini 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 mSATA Mini 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 mSATA Mini sets BSY within 400 ns.

Upon receipt of a Class 2 command, the mSATA Mini 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 mSATA Mini 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

No.	Command Set	OP Code (hex)	No.	Command Set	OP Code (hex)
1	Check Power Mode	E5	30	Security Disable Password	F6
2	Data Set Management	06	31	Security Erase Prepare	F3
3	DCO	B1	32	Security Erase Unit	F4
4	Download Microcode PIO	92	33	Security Freeze Lock	F5
5	Download Microcode DMA	93	34	Security Set Password	F1
6	Execute Drive Diagnostics	90	35	Security Unlock	F2
7	Flush Cache	E7	36	Seek	70
8	Flush Cache Ext	EA	37	Set Features	EF
9	Identify Device	EC	38	Set Max Address	F9
10	Idle	E3	39	Set Max Address Ext	37
11	Idle Immediate	E1	40	Set Multiple Mode	C6
12	Initialize Drive Parameters	91	41	Sleep	E6
13	Read Buffer	E4	42	SMART	B0
14	Read DMA - (without Retry)	C9	43	Standby	E2
15	Read DMA - (with Retry)	C8	44	Standby Immediate	E0
16	Read DMA Ext	25	45	Write Buffer	E8
17	Read FPDMA Queued	60	46	Write DMA (without Retry)	CB
18	Read Log Ext	2F	47	Write DMA (with Retry)	CA
19	Read Multiple	C4	48	Write DMA Ext	35
20	Read Multiple Ext	29	49	Write DMA FUA Ext	3D
21	Read Native Max Address	F8	50	Write FDMA Pqueued	61
22	Read Native Max Ext	27	51	Write Log Ext	3F
23	Read Sector(s) (without Retry)	21	52	Write Multiple	C5
24	Read Sector(s) (with Retry)	20	53	Write Multiple Ext	39
25	Read Sector(s) Ext	24	54	Write Multiple FUA Ext	CE
26	Read Verify Ext	42	55	Write Sector(s)	31

No.	Command Set	OP Code (hex)	No.	Command Set	OP Code (hex)
				(without Retry)	
27	Read Verify Sector(s) (without Retry)	41	56	Write Sector(s) (with Retry)	30
28	Read Verify Sector(s) (with Retry)	40	57	Write Sector(s) Ext	34
29	Recalibrate	10	58	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	X	7E00	Retired
5	X	0200	Retired
6	X	003F	Obsolete - Number of Logical Sectors per Track (63)
7 - 8	V	0	Reserved for Assignment by the Compact Flash Association
9	X	0000	Retired
10 - 19	F	xxxx	Serial Number in ASCII (20 Characters)
20	X	0002	Retired
21	X	0002	Retired
22	X	0004	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	X	0200	Obsolete
52	X	0000	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	X	FC10	Obsolete
58	X	00FB	Obsolete
59	F	0100	Number of Sectors Transferred per Interrupt on MULTIPLE Commands
60 - 61	F	037DFF40 (32GB)	Total Number of User Addressable Sectors
62	X	0	Obsolete
63	F	0007	Multi-word DMA modes Supported / Selected
64	F	0003	Advance Transfer 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

Word Address	F: Fixed V: Variable X: Both	Default Value (hex)	Data Field Type Information
67	F	0078	Minimum PIO transfer cycle time without flow control
68	F	0078	Minimum PIO transfer cycle time with IORDY flow control
69	F	0010	Additional Supported (Supports Download microcode DMA)
70	F	0000	Reserved
71	F	0	Reserved for the IDENTIFY PACKET DEVICE Command
72	F	0	Reserved for the IDENTIFY PACKET DEVICE Command
73	F	0	Reserved for the IDENTIFY PACKET DEVICE Command
74	F	0	Reserved for the IDENTIFY PACKET DEVICE Command
75	F	0	Queue Depth
76	F	0002	SATA Capabilities
77	F	0	Reserved - future Serial ATA Definition
78	F	0000	Serial ATA Features Supported
79	V	0000	Serial ATA Features Enabled
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	0	Current Advanced Power Management Value
92	V	0000	Master Password Revision Code
93	F	0	Hardware Reset Result. The contents of bits (12:0) of this word shall change only during the execution of a hardware Reset.
94	V	0	Vendor's Recommended and Actual Acoustic Management Value
95	F	0	Stream Minimum Request Size
96	V	0	Streaming Transfer Time - DMA
97	V	0	Streaming Access Latency - DMA and PIO
98	F	0	Streaming Performance Granularity
99	F	0	Streaming Performance Granularity
100 - 103	V	xxxxxxx - 32GB	Maximum User LBA for 48-bit Address Feature Set
104	V	0	Streaming Transfer Time - PIO
105	F	0	Reserved
106	F	0	Physical Sector Size / Logical Sector Size
107	F	0	Interseek Delay for ISO-7779 Acoustic Testing (in microseconds)
108 - 111	F	0	Unique ID
112 - 115	F	0	Reserved
116	V	0	Reserved
117 - 118	F	0	Words per Logical Sector
119	F	0	Supported Settings
120	F	0	Command Set / Feature Enabled / Supported
121 - 126	F	0	Reserved
127	F	0	Removable Media Status Notification Feature Set Support
128	V	0	Security Status

Word Address	F: Fixed V: Variable X: Both	Default Value (hex)	Data Field Type Information
129 - 159	X	0	Vendor Specific
160	F	0	Compact Flash Association (CFA) Power Mode 1
161 - 175	X	0	Reserved for Assignment by the CFA
176 - 205	V	0	Current Media Serial Number
206 - 216	F	0	Reserved
217	F	0	Reserved
218 - 221	F	0	Reserved
222	F	0	Reserved
223 - 233	F	0	Reserved
234		0	Reserved
235		0	Reserved
236 - 254	F	0	Reserved
255	X	xxxx	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 PHY error count				0	0	0	00
AA	03	00	Note ²	Note ²	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

² Formula to calculate percentage (%) of spare blocks (value from 100 to 1). Spare Block Percentage = $((MABN - CBBN)/MABN)*100$; 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 INPUT

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
0v97	06/10/2011	TK	Initial Draft Release
0v98	07/25/2011	HS	Changed the module thickness from 4.0 mm to 4.85 mm according to JEDEC MO-300B specification
1v0	08/05/2011	HS	Tables were reformatted, the document was promoted to datasheet, PDS was changed to DS. Promoted to Rev 1.
1v1	02/17/2012	HS	Part numbers were updated to new Netlist part numbering scheme. The vibration test requirement was changed from 20G to 15G.
1v2	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