



Industrial Grade mSATA SSD

Product Manual

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1. Introduction to Cactus Technologies Industrial Grade mSATA SSD Products

Features:

- Solid state design with no moving parts
- Industry standard mSATA Drive form factor
- Capacities from 4GB to 32GB
- Compliant with Serial ATA 2.6 specifications
- Supports Serial ATA Generation I/II transfer rate of 1.5/3.0Gbps
- Optional support for ATA SMART Feature Set
- Optional support for ATA Security Feature Set
- BCH ECC capable of correcting 8 random single bit errors per sector
- High reliability, MTBF > 4,000,000 hrs.
- Enhanced error correction, < 1 error in 10^{14} bits read
- Intelligent power management to reduce power consumption
- Voltage support: 3.3V±10%

The Cactus Technologies mSATA Solid State Drive(SSD) is a high capacity solid-state flash memory product that complies with the Serial ATA 2.6 standard and is functionally compatible with a SATA hard disk drive. Cactus mSATA SSDs provide up to 32GB of formatted storage capacity. Cactus Technologies offers two version of the mSATA product - a standard version which conforms to JEDEC MO-300B specifications and a lidded version, which uses the same MO-300B PCB but with metal lid enclosures on both top and bottom to provide for extra protection and ruggedness.

The Cactus Technologies mSATA SSD product uses high quality SLC NAND flash memory from well known vendors, such as Samsung Corporation. In addition, it include an on-drive intelligent controller that manages interface protocols, data storage and retrieval as well as ECC, defect handling and diagnostics, power management, and clock control. The controller's firmware is upgradeable, thus allowing feature enhancements and firmware updates while keeping the BOM stable.

1.1. Supported Standards

Cactus Technologies mSATA SSD is fully compatible with the following specification:

- ATA 7 Specification published by ANSI: X3.221 AT Attachment Interface for Disk Drives
- Serial ATA 2.6 Specification published by the Serial ATA International Organization
- MO-300B published by JEDEC

1.2. Product Features

Cactus Technologies Industrial mSATA SSD contains a high level, intelligent controller. This intelligent controller provides many capabilities including the following:

- Standard ATA register and command set (same as found on most magnetic disk drives).
- Manages details of erasing and programming flash memory independent of the host system
- Sophisticated defect managing capabilities (similar to magnetic disk drives).
- Sophisticated system for error recovery using powerful error correction code (ECC).
- Intelligent power management for low power operation.

1.2.1. Host and Technology Independence

Cactus Technologies Industrial mSATA SSD appears as a standard SATA disk drive to the host system. The drive utilizes a 512-byte sector which is the same as that in an IDE magnetic disk drive. To write or read a sector (or multiple sectors), the host computer software simply issues an ATA Read or Write command to the drive as per the SATA protocol. The host software then waits for the command to complete. The host system does not get involved in the details of how the flash memory is erased, programmed or read as this is all managed by the built-in controller in the drive. Also, with the intelligent on-board controller, the host system software will not require changing as new flash memory evolves. Thus, systems that support the Cactus Technologies Industrial mSATA SSD products today will continue to work with future Cactus Technologies Industrial mSATA SSDs built with new flash technology without having to update or change host software.

1.2.2. Defect and Error Management

Cactus Technologies Industrial mSATA SSD contains a sophisticated defect and error management system similar to those found in magnetic disk drives. The defect management is completely transparent to the host and does not consume any user data space.

The soft error rate for Cactus Technologies Industrial mSATA SSDs is much lower than that of magnetic disk drives. In the extremely rare case where a read error does occur, the drive has sophisticated ECC to recover the data.

These defect and error management systems, coupled with the solid-state construction, give Cactus Technologies Industrial mSATA SSDs unparalleled reliability.

1.2.3. Power Supply Requirements

Cactus Technologies Industrial mSATA SSD operates at a voltage range of 3.3 volts \pm 10%.

2. Product Specifications

For all the following specifications, values are defined at ambient temperature and nominal supply voltage unless otherwise stated.

2.1. System Environmental Specifications

Table 2-1. Environmental Specifications

		Cactus mSATA SSD
Temperature	Operating:	0° C to +70° C (Standard) -45° C to +90° C (Extended)
Humidity	Operating & Non-Operating:	8% to 95%, non-condensing
Vibration	Operating & Non-Operating:	20G, MIL-STD-883G Method 2005.2, Condition A
Shock	Operating & Non-Operating:	3,000 G, MIL-STD-883G Method 2002.4, Condition C
Altitude (relative to sea level)	Operating & Non-Operating:	100,000 feet maximum

2.2. System Power Requirements

Table 2-2. Power Requirements

		Cactus Industrial mSATA SSD
DC Input Voltage (VCC) 100 mV max. ripple (p-p)		3.3V \pm 10%
(Maximum Average Value) See Notes.	Sleep: Reading: Writing:	210 mA 360 mA 480 mA

NOTES: All values quoted are typical at ambient temperature and nominal supply voltage unless otherwise stated.

Sleep mode is specified under the condition that all drive inputs are static CMOS levels and in a “Not Busy” operating state.

2.3. System Performance

All performance timings assume the drive controller is in the default (i.e., fastest) mode.

Table 2-3. Performance

Start Up Times	Reset to ready:	35 msec typical
Read Transfer Rate		Up to 85MBytes/sec
Write Transfer Rate		Up to 80 Mbytes/sec
Controller Overhead	Command to DRQ	2 msec maximum

2.4. System Reliability

Table 2-4. Reliability

MTBF (@ 25°C)	> 4,000,000 hours
Data Reliability	< 1 non-recoverable error in 10 ¹⁴ bits READ
Endurance:	> 2,000,000 erase/program cycles

2.5. Physical Specifications

The following sections provide the physical specifications for Cactus Technologies Industrial mSATA SSD products.

2.5.1. mSATA SSD Physical Specifications

1. mSATA FULL SIZE
VARIATION A

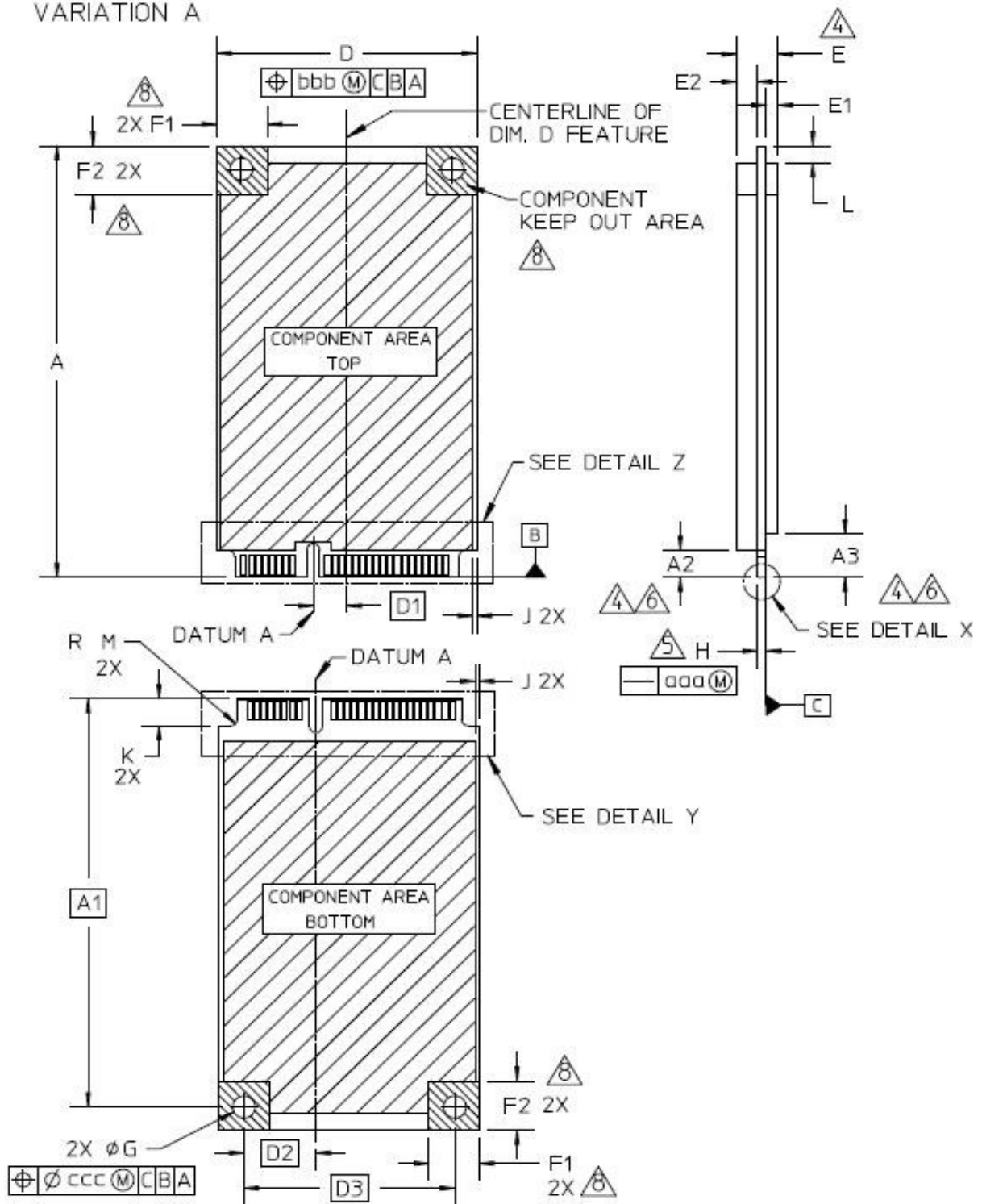


Figure 2-1. mSATA SSD Dimensions

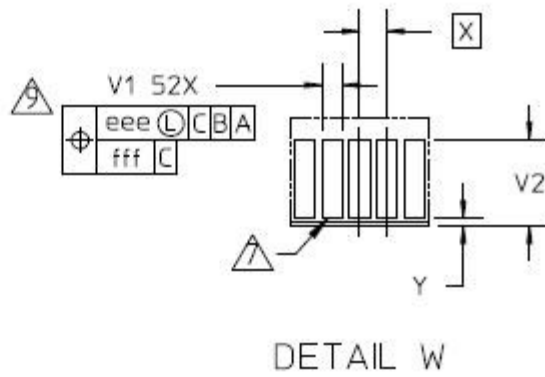
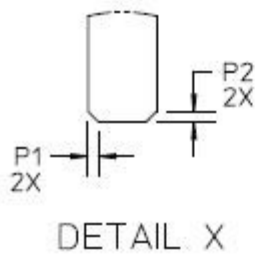
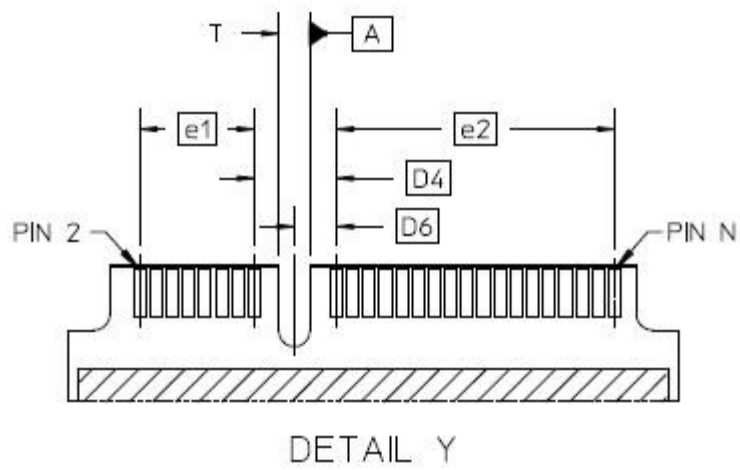
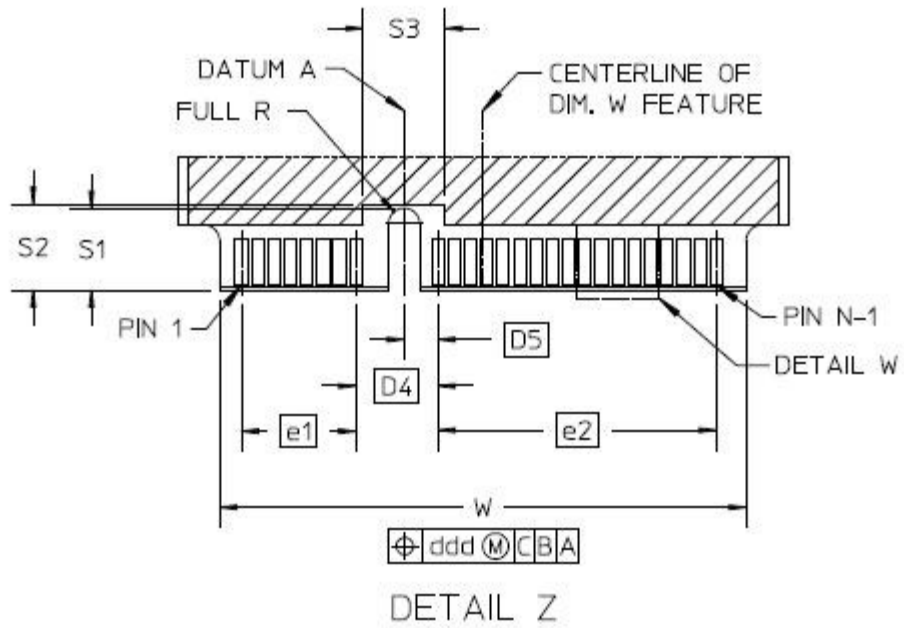


TABLE 1

COMMON DIMENSION TABLE				
SYMBOL	MIN	NOM	MAX	NOTES
A2	3.20	–	–	4,6
A3	5.10	–	–	4,6
D	29.70	29.85	30.00	
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			
NOTES	1, 2, 3			

TABLE 2

GD&T BASIC DIMENSIONS		
SYMBOL	VALUE	NOTES
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 3

TOLERANCES OF FORM AND POSITION		
SYMBOL	VALUE	NOTES
aaa	0.22	
bbb	0.10	
ccc	0.10	
ddd	0.10	
eee	0.10	
fff	0.05	
ISSUE	A	
REF	14-131	
NOTES	1, 2, 3	

TABLE 4

mSATA FULL SIZE VARIATION A			
SYMBOL	MIN	NOM	MAX
A	50.65	50.80	50.95
A1	48.05 BASIC		
E	–	–	4.85
E1	–	–	1.35
E2	–	–	2.40
F	–	–	–
F1	5.65	5.80	5.95
F2	5.65	5.80	5.95
L	2.00	–	–
ISSUE	A		
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.

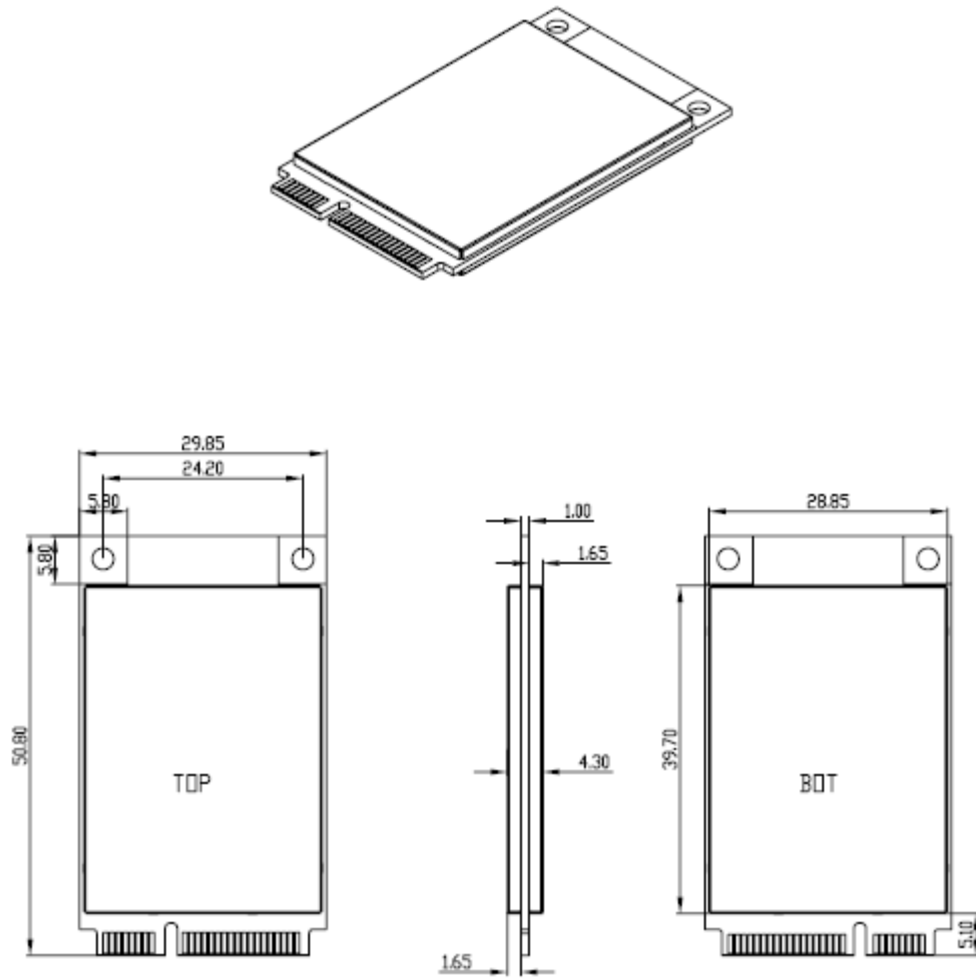


Figure 2-2. mSATA SSD w/metal enclosure

3. Interface Description

The following sections provide detailed information on the Cactus Technologies Industrial mSATA SSD interface.

3.1. SSD Pin Assignments and Pin Type

Cactus mSATA SSD signal pinout conforms to SATA-IO specifications. The signal/pin assignments and descriptions are listed in Table 3-5.

Table 3-5. mSATA SSD Pin Assignments and Pin Type

Pin #	Assignment	Description	Pin #	Assignment	Description
1	N/A	N/A	27	GND	Return Current Path
2	+3.3V	3.3V source	28	N/A	N/A
3	N/A	N/A	29	GND	Return Current Path
4	GND	Return Current Path	30	N/A	N/A
5	N/A	N/A	31	Rx-	SATA Differential
6	N/A	N/A	32	N/A	N/A
7	N/A	N/A	33	Rx+	SATA Differential
8	N/A	N/A	34	GND	Return Current Path
9	GND	Return Current Path	35	GND	Return Current Path
10	N/A	N/A	36	Reserved	No Connect
11	N/A	N/A	37	GND	Return Current Path
12	N/A	N/A	38	Reserved	No Connect
13	N/A	N/A	39	+3.3V	3.3V source
14	N/A	N/A	40	GND	Return Current Path
15	GND	Return Current Path	41	+3.3V	3.3V source
16	N/A	N/A	42	N/A	N/A
17	N/A	N/A	43	GND	Return Current Path
18	GND	Return Current Path	44	N/A	N/A
19	N/A	N/A	45	Reserved	N/A
20	N/A	N/A	46	N/A	N/A
21	GND	Return Current Path	47	Reserved	N/A
22	N/A	N/A	48	N/A	N/A
23	Tx+	SATA Differential	49	DA/DSS	Device Activity / Disable Staggered Spin Up
24	+3.3V	3.3V source	50	GND	Return Current Path
25	Tx-	SATA Differential	51	Presence Detection	Shall be pulled to GND by device
26	GND	Return Current Path	52	+3.3V	3.3V source

3.2. Electrical Specifications

The following table defines all D.C. Characteristics for the mSATA SSD products. Unless otherwise stated, conditions are:

$$V_{cc} = 3.3V \pm 10\%$$

$$T_a = -45^{\circ}C \text{ to } 90^{\circ}C$$

3.2.1. Absolute Maximum Ratings

Parameter	Symbol	MIN	MAX	Units
Storage Temperature	T _s	-65	+150	°C
Operating Temperature	T _A	-45	+90	°C
Vcc with respect to GND	V _{cc}	-0.3	3.6	V

3.2.2. DC Characteristics

Parameter	Symbol	MIN	MAX	Units
Input Voltage	V _{in}	-0.5	V _{cc} + 0.5	V
Output Voltage	V _{out}	-0.3	V _{cc} + 0.3	V
Input Leakage Current	I _{li}	-10	10	uA
Output Leakage Current	I _{lo}	-10	10	uA
Input/Output Capacitance	C _i /C _o		10	pF
Operating Current	I _{cc}			mA
Sleep Mode			210	
Active			480	

3.2.3. AC Characteristics

Cactus mSATA SSD products conforms to all AC timing requirements as specified in the Serial ATA specifications. Please refer to that document for details of AC timing for all operation modes of the device.

4.ATA Drive Register Set Definition and Protocol

The communication to or from the mSATA SSD is done using FIS. Legacy ATA protocol is supported by using the legacy mode defined in the SATA specifications. In this mode, the FIS has defined fields which provide all the necessary ATA task file registers for control and status information. The Serial ATA interface does not support Primary/Secondary or Master/Slave configurations. Each SATA channel supports only one SATA device, with the register selection as defined by the ATA standard.

4.1. ATA Task File Definitions

The following sections describes the usage of the ATA task file registers. Note that the Alternate Status Register of legacy ATA is not defined for SATA drives.

4.1.1. Data Register

The Data Register is a 16-bit register, and it is used to transfer data blocks between the SSD data buffer and the Host.

4.1.2. Error Register

This register contains additional information about the source of an error when an error is indicated in bit 0 of the Status register. The bits are defined as follows:

D7	D6	D5	D4	D3	D2	D1	D0
BBK	UNC	0	IDNF	0	ABRT	0	AMNF

- Bit 7 (BBK)** This bit is set when a Bad Block is detected.
Bit 6 (UNC) This bit is set when an Uncorrectable Error is encountered.
Bit 5 This bit is 0.
Bit 4 (IDNF) The requested sector ID is in error or cannot be found.
Bit 3 This bit is 0.
Bit 2 (Abort) This bit is set if the command has been aborted because of a status condition: (Not Ready, Write Fault, etc.) or when an invalid command has been issued.
Bit 1 This bit is 0.
Bit 0 (AMNF) This bit is set in case of a general error.

4.1.3. Feature Register

This register provides information regarding features of the SSD that the host can utilize.

4.1.4. Sector Count Register

This register contains the number of sectors of data requested to be transferred on a read or write operation between the host and the SSD. If the value in this register is zero, a count of 256 sectors is specified. If the command was successful, this register is zero at command completion. If not successfully completed, the register contains the number of sectors that need to be transferred in order to complete the request.

4.1.5. Sector Number (LBA 7-0) Register

This register contains the starting sector number or bits 7-0 of the Logical Block Address (LBA) for any SSD data access for the subsequent command.

4.1.6. Cylinder Low (LBA 15-8) Register

This register contains the low order 8 bits of the starting cylinder address or bits 15-8 of the Logical Block Address.

4.1.7. Cylinder High (LBA 23-16) Register

This register contains the high order bits of the starting cylinder address or bits 23-16 of the Logical Block Address.

4.1.8. Drive/Head (LBA 27-24) Register

The Drive/Head register is used to select the drive and head. It is also used to select LBA addressing instead of cylinder/head/sector addressing. The bits are defined as follows:

D7	D6	D5	D4	D3	D2	D1	D0
1	LBA	1	DRV	HS3	HS2	HS1	HS0

Bit 7 This bit is set to 1.

Bit 6 LBA is a flag to select either Cylinder/Head/Sector (CHS) or Logical Block Address Mode (LBA). When LBA=0, Cylinder/Head/Sector mode is selected. When LBA=1, Logical Block Address is selected. In Logical Block Mode, the Logical Block Address is interpreted as follows:
 LBA07-LBA00: Sector Number Register D7-D0.
 LBA15-LBA08: Cylinder Low Register D7-D0.
 LBA23-LBA16: Cylinder High Register D7-D0.
 LBA27-LBA24: Drive/Head Register bits HS3-HS0.

Bit 5 This bit is set to 1.

Bit 4 (DRV) DRV is the drive number. This should always be set to 0.

Bit 3 (HS3) When operating in the Cylinder, Head, Sector mode, this is bit 3 of the head number. It is Bit 27 in the Logical Block Address mode.

Bit 2 (HS2) When operating in the Cylinder, Head, Sector mode, this is bit 2 of the head number. It is Bit 26 in the Logical Block Address mode.

Bit 1 (HS1) When operating in the Cylinder, Head, Sector mode, this is bit 1 of the head number. It is Bit 25 in the Logical Block Address mode.

Bit 0 (HS0) When operating in the Cylinder, Head, Sector mode, this is bit 0 of the head number. It is Bit 24 in the Logical Block Address mode.

4.1.9. Status Registers

These registers return the status when read by the host. Reading the Status register does clear a pending interrupt while reading the Auxiliary Status register does not. The meaning of the status bits are described as follows:

D7	D6	D5	D4	D3	D2	D1	D0
BUSY	RDY	DWF	DSC	DRQ	CORR	0	ERR

- Bit 7 (BUSY)** The busy bit is set when the device has access to the command buffer and registers and the host is locked out from accessing the command register and buffer. No other bits in this register are valid when this bit is set to a 1.
- Bit 6 (RDY)** RDY indicates whether the device is capable of performing operations requested by the host. This bit is cleared at power up and remains cleared until the device is ready to accept a command.
- Bit 5 (DWF)** This bit, if set, indicates a write fault has occurred.
- Bit 4 (DSC)** This bit is set when the device is ready.
- Bit 3 (DRQ)** The Data Request is set when the device requires that information be transferred either to or from the host through the Data register.
- Bit 2 (CORR)** This bit is set when a Correctable data error has been encountered and the data has been corrected. This condition does not terminate a multi-sector read operation.
- Bit 1 (IDX)** This bit is always set to 0.
- Bit 0 (ERR)** This bit is set when the previous command has ended in some type of error. The bits in the Error register contain additional information describing the error.

4.1.10. Device Control Register

This register is used to control the drive interrupt request and to issue an ATA soft reset to the drive. The bits are defined as follows:

D7	D6	D5	D4	D3	D2	D1	D0
HOB	X	X	X	1	SW Rst	-IEn	0

- Bit 7** This bit is used in 48-bit addressing mode. When cleared, the host can read the most recently written values of the Sector Count, Drive/Head and LBA registers. When set, the host will read the previous written values of these registers. A write to any Command block register will clear this bit.
- Bit 6** This bit is an X (Do not care).
- Bit 5** This bit is an X (Do not care).
- Bit 4** This bit is an X (Do not care).
- Bit 3** This bit is ignored by the drive.
- Bit 2 (SW Rst)** This bit is set to 1 in order to force the drive to perform an AT Disk controller Soft Reset operation. The drive remains in Reset until this bit is reset to '0'.
- Bit 1 (-IEn)** The Interrupt Enable bit enables interrupts when the bit is 0. When the bit is 1, interrupts from the drive are disabled. This bit is set to 0 at power on and Reset.
- Bit 0** This bit is ignored by the drive.

4.1.11. Drive Address Register

This register is provided for compatibility with the AT disk drive interface. It is recommended that this register not be mapped into the host's I/O space because of potential conflicts on Bit 7. The bits are defined as follows:

D7	D6	D5	D4	D3	D2	D1	D0
X	-WTG	-HS3	-HS2	-HS1	-HS0	-nDS1	-nDS0

- Bit 7** This bit is unknown.
Implementation Note:
Conflicts may occur on the host data bus when this bit is provided by a Floppy Disk Controller operating at the same addresses as the SSD. Following are some possible solutions to this problem:
1. Locate the SSD at a non-conflicting address (i.e., Secondary address (377) when a Floppy Disk Controller is located at the Primary addresses).
 2. Do not install a Floppy and a SSD in the system at the same time.
 3. Implement a socket adapter that can be programmed to (conditionally) tri-state D7 of I/O address 3F7/377 when a SSD product is installed and conversely to tri-state D6-D0 of I/O address 3F7/377 when a floppy controller is installed.
 4. Do not use the SSD's Drive Address register. This may be accomplished by either a) If possible, program the host adapter to enable only I/O addresses 1F0-1F7, 3F6 (or 170-177, 176) to the SSD or b) if provided use an additional Primary/Secondary configuration in the SSD that does not respond to accesses to I/O locations 3F7 and 377. With either of these implementations, the host software must not attempt to use information in the Drive Address Register.
- Bit 6 (-WTG)** This bit is 0 when a write operation is in progress, otherwise, it is 1.
Bit 5 (-HS3) This bit is the negation of bit 3 in the Drive/Head register.
Bit 4 (-HS2) This bit is the negation of bit 2 in the Drive/Head register.
Bit 3 (-HS1) This bit is the negation of bit 1 in the Drive/Head register.
Bit 2 (-HS0) This bit is the negation of bit 0 in the Drive/Head register.
Bit 1 (-nDS1) This bit is 0 when drive 1 is active and selected.
Bit 0 (-nDS0) This bit is 0 when the drive 0 is active and selected.

5.ATA Command Description

This section defines the ATA command set supported by the Cactus mSATA SSDs.

5.1. ATA Command Set

Table 5-6 summarizes the supported ATA command set .

Table 5-6. ATA Command Set

COMMAND	Code	FR	SC	SN	CY	DH
Check Power Mode	E5h or 98h	-	-	-	-	D
Execute Drive Diagnostic	90h	-	-	-	-	-
Flush Cache	E7h	-	-	-	-	Y
Flush Cache Ext	EAh	-	-	-	-	Y
Identify Drive	ECh	-	-	-	-	D

COMMAND	Code	FR	SC	SN	CY	DH
Idle	E3h	-	Y	-	-	D
Idle Immediate	E1h	-	-	-	-	D
Initialize Drive Parameters	91h	-	Y	-	-	Y
Read DMA	C8h or C9h	-	Y	Y	Y	Y
Read DMA Ext	25h	-	Y	Y	Y	Y
Read FPDMA Queued	60h	Y	Y	Y	Y	Y
Read Log Ext	2Fh	Y	Y	Y	Y	Y
Read Multiple	C4h	-	Y	Y	Y	Y
Read Multiple Ext	29h	-	Y	Y	Y	Y
Read Sector(s)	20h or 21h	-	Y	Y	Y	Y
Read Sector(s) Ext	24h	-	Y	Y	Y	Y
Read Verify Sector(s)	40h or 41h	-	Y	Y	Y	Y
Read Verify Sector(s) Ext	42h	-	Y	Y	Y	Y
Recalibrate	1Xh	-	-	-	-	D
Security Disable Password	F6h	-	-	-	-	D
Security Erase Prepare	F3h	-	-	-	-	D
Security Erase Unit	F4h	-	-	-	-	D
Security Freeze Lock	F5h	-	-	-	-	D
Security Set Password	F1h	-	-	-	-	D
Security Unlock	F2h	-	-	-	-	D
Seek	7Xh	-	-	Y	Y	Y
Set Features	EFh	Y	-	-	-	D
Set Multiple Mode	C6h	-	Y	-	-	D
Set Sleep Mode	E6h	-	-	-	-	D
SMART	B0h	Y	-	-	Y	D
Stand By	E2h	-	-	-	-	D
Stand By Immediate	E0h	-	-	-	-	D
Write DMA	CAh or CBh	-	Y	Y	Y	Y
Write DMA Ext	35h	-	Y	Y	Y	Y
Write DMA FUA Ext	3Dh	-	Y	Y	Y	Y
Write FPDMA Queued	61h	Y	Y	Y	Y	Y
Write Multiple	C5h	-	Y	Y	Y	Y
Write Multiple Ext	39h	-	Y	Y	Y	Y
Write Multiple FUA Ext	CEh	-	Y	Y	Y	Y
Write Sector(s)	30h or 31h	-	Y	Y	Y	Y
Write Sector(s) Ext	34h	-	Y	Y	Y	Y

Definitions: FR = Features Register, SC = Sector Count Register, SN = Sector Number Register, CY = Cylinder Registers, DH = Drive/Drive/Head Register.

Y—The register contains a valid parameter for this command. For the Drive/Head Register Y means both the drive and head parameters are used; D—only the drive parameter is valid and not the head parameter.

Note: 1. For SATA drives, the drive number is always 0.

5.1.1. Identify Drive—ECH

The Identify Drive command enables the host to receive parameter information from the drive. This command has the same protocol as the Read Sector(s) command. The parameter words in the buffer have the arrangement and meanings defined in Table 5-7. All reserved bits or words are zero. Table 5-7 is the definition for each field in the Identify Drive Information.

Table 5-7. Identify Drive Information

Word Address	Default Value	Total Bytes	Data Field Type Information
0	0040H	2	General configuration bit-significant information.
1	XXXXH	2	Default number of cylinders; capacity dependent.
2	C837H	2	Reserved.
3	00XXH	2	Default number of heads; capacity dependent.
4	XXXXH	2	Number of unformatted bytes per track.
5	XXXXH	2	Number of unformatted bytes per sector.
6	XXXXH	2	Default number of sectors per track; capacity dependent.
7-8	XXXXH,XXX XH	4	Number of sectors per drive (Word 7 = MSW, Word 8 = LSW); capacity dependent.
9	000EH	2	Reserved.
10-19	aaaa	20	Serial number in ASCII (Right Justified).
20	XXXXH	2	Retired
21	XXXXH	2	Retired
22	0003FH	2	Obsolete
23-26	aaaa	8	Firmware revision in ASCII . Big Endian Byte Order in Word.
27-46	aaaa	40	Model number in ASCII (Left Justified) Big Endian Byte Order in Word.
47	8001H	2	Maximum number of sectors on Read/Write Multiple command
48	4000H	2	Double Word not supported.
49	2F00H	2	Capabilities: DMA Supported (bit 8), LBA supported (bit 9).
50	4000H	2	Reserved.
51	0280H	2	PIO data transfer cycle timing mode
52	0000H	2	Single Word DMA data transfer cycle timing mode (not supported).
53	0007H	2	Data fields 54-58,64-70 and 88 are valid.
54	XXXX	2	Current numbers of cylinders.
55	00XX	2	Current numbers of heads.
56	XXXX	2	Current sectors per track.
57-58	XXXX	4	Current capacity in sectors (LBAs) (Word 57 = LSW, Word 58 = MSW).
59	0000H	2	Multiple sector setting is valid; low byte is capacity dependent.
60-61	XXXX	4	Total number of sectors addressable in LBA Mode.
62	0000H	2	Reserved
63	0007H	2	Multiword DMA modes 0-2 are supported; upper byte reflects currently selected MWDMA mode.
64	0003H	2	Advanced PIO modes supported (modes 3 and 4)
65	0078H	2	Minimum MWDMA cycle time per word is 120ns.
66	0078H	2	Recommended MWDMA cycle time is 120ns.

Word Address	Default Value	Total Bytes	Data Field Type Information
67	0078H	2	Minimum PIO cycle time without IORDY flow control is 120ns.
68	0078H	2	Minimum PIO cycle time with IORDY flow control is 120ns.
69-74	0000H	10	Reserved
75	0000H	2	Queue depth of 1
76	0106H	2	Supports SATA NCQ, Gen 1, Gen2 signaling rates
77	0000H	2	Reserved
78	0004H	2	Supports DMA Setup Auto-Activate optimization
79	0000H	2	Status of word 78 features
80	01FEH	2	Supports ATA7 standard.
81	0021H	2	No minor revision reported.
82	0069H	2	PACKET Command, Security Mode feature sets not supported; SMART feature supported
83	7400H	2	48-bit mode supported; Flush Cache/Flush Cache Ext supported.
84	4060H	2	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT supported
85	XXXXH	2	Feature status
86	XXXXH	2	Feature status
87	XXXXH	2	Feature status
88	203FH	2	UDMA Modes 0-5 supported.
89-91	0000H	6	Reserved
92	XXXXH	2	Master password revision code
93	XXXXH	2	COMRESET result
94	80FEH	2	Acoustic management values
95-99	0000H	10	Reserved
100-103	XXXXH	8	Maximum user LBA for 48-bit addressing mode.
104-127	0000H	48	Reserved
128	XXXXH	2	Security status
129-255	-		Reserved

Appendix A. Ordering Information

Model KD**X**F**Y**T-602S-**M**

Where: **X** is drive capacities:

4G ----- 4GB
8G ----- 8GB
16G ----- 16GB
32G ----- 32GB

Where **Y** is temperature:

Blank ----- Standard temperature (0° C to +70° C)
I ----- Extended temperature (-45° C to +90° C)

Where **T** is memory type:

Blank ----- Samsung
T ----- Toshiba (only for 32GB)

Where **M** is form factor:

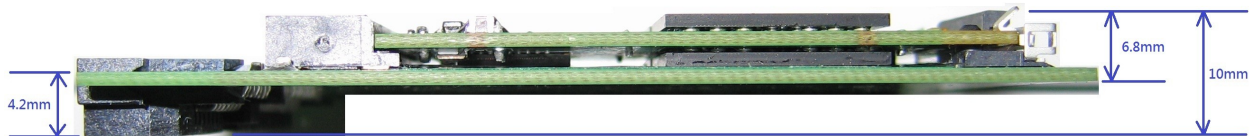
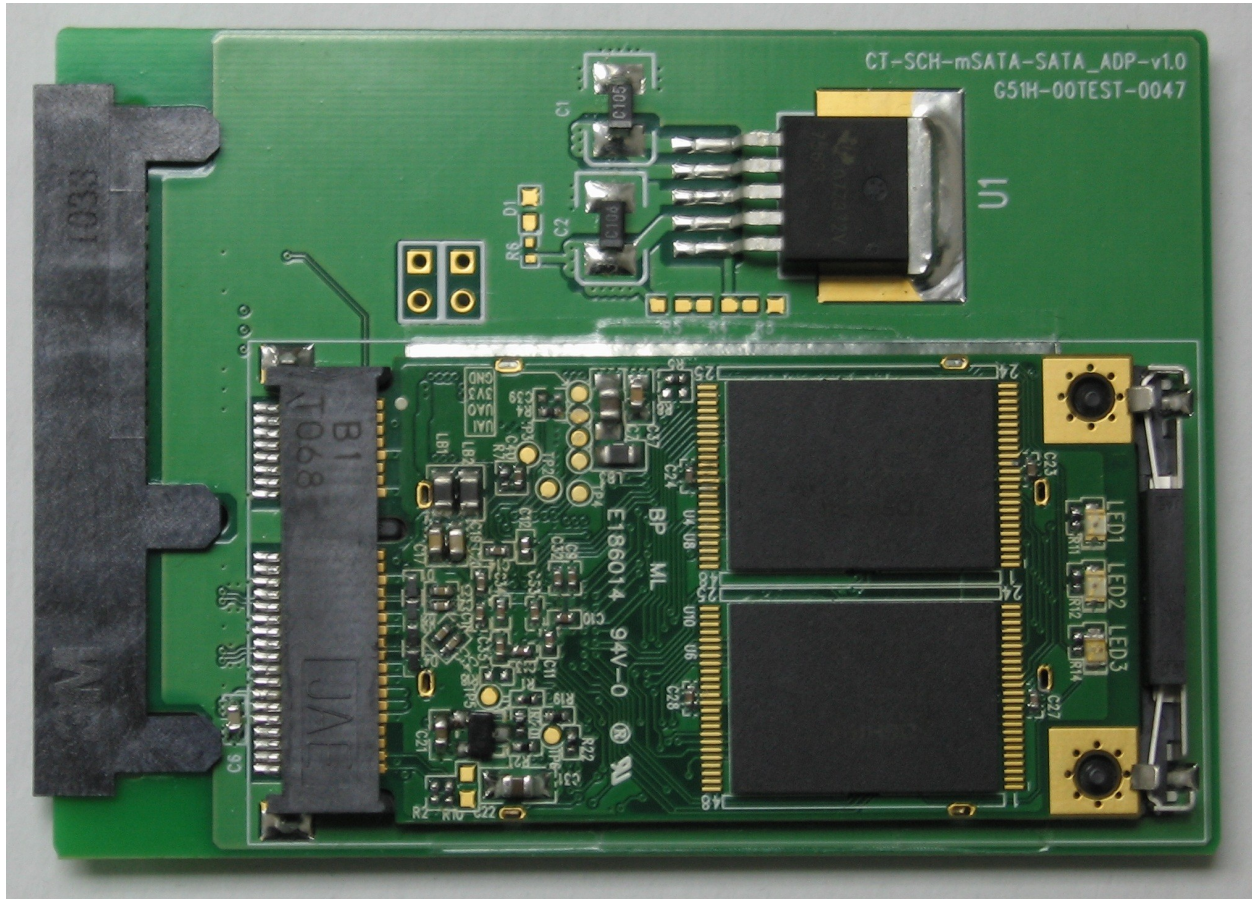
M1 ----- without lid
M2 ----- with lid

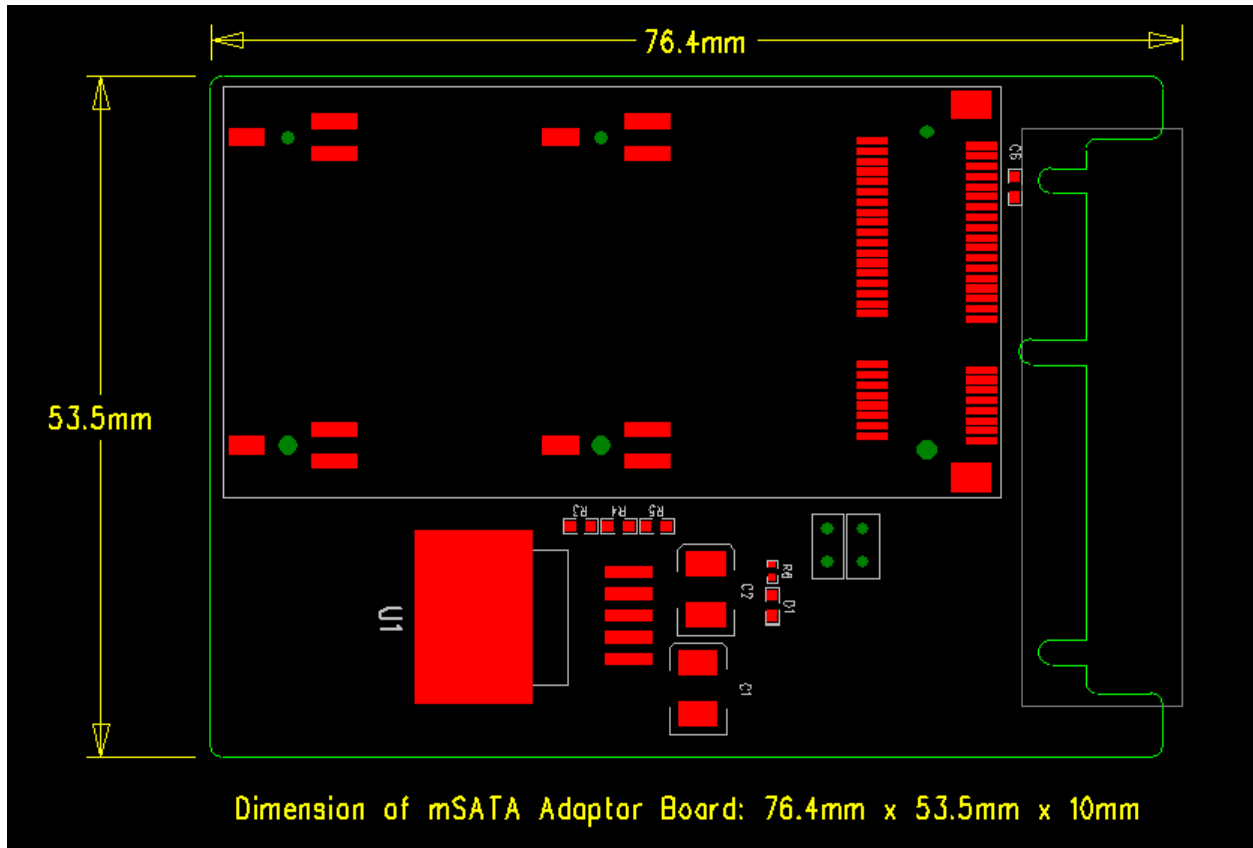
Example:

- (1) 8GB mSATA SSD ----- KD8GF-602S-M1
- (2) 8GB mSATA SSD Extended Temp ----- KD8GFI-602S-M1
- (3) 8GB mSATA SSD with lid ----- KD8GF-602S-M2
- (4) 32GB mSATA SSD ----- KD32GFT-602S-M1

Appendix B. mSATA Adapter Board

To assist our customers in the design and testing of Cactus Technologies mSATA products, we have made available an mSATA adapter board. This board has an mSATA socket with locking clips and connects to the host via a standard 2.5" SATA SSD connector. The following pictures shows the adapter with the mSATA SSD installed and the overall dimensions:





Customers who are interested in obtaining samples of this adaptor board, please contact your local Cactus sales representatives.

Appendix C. Technical Support Services

C.1. Direct Cactus Technical Support

Cactus Technologies Limited
Suite C, 15/F, Capital Trade Center
62 Tsun Yip Street, Kwun Tong
Kowloon, Hong Kong

Tel: +852-27972261
Fax: +852-27973777
Email: tech@cactus-tech.com

Appendix D.Cactus Worldwide Sales Offices

Cactus Technologies Limited
Suite C, 15/F, Capital Trade Center
62 Tsun Yip Street, Kwun Tong
Kowloon, Hong Kong

Tel: +852-27972277

Fax: +852-27973777

Email: sales@cactus-tech.com

Appendix E.Limited Warranty

I. WARRANTY STATEMENT

Cactus Technologies warrants its Industrial Grade products only to be free of any defects in materials or workmanship that would prevent them from functioning properly for five years from the date of purchase. This express warranty is extended by Cactus Technologies Limited to customers of our products.

II. GENERAL PROVISIONS

This warranty sets forth the full extent of Cactus Technologies' responsibilities regarding the Cactus Technologies Industrial Grade Flash Storage Products. Cactus Technologies, at its sole option, will repair, replace or refund the purchase price of the defective product. Cactus Technologies' guarantees our products meet all specifications detailed in our product manuals. Although Cactus Technologies' products are designed to withstand harsh environments and have the highest specifications in the industry, they are not warranted to never have failure and Cactus Technologies does not warranty against incidental or consequential damages. Accordingly, in any use of products in life support systems or other applications where failure could cause injury or loss of life, the products should only be incorporated in systems designed with appropriate redundancy, fault tolerant or backup features.

III. WHAT THIS WARRANTY COVERS

For products found to be defective within five years of purchase, Cactus Technologies will have the option of repairing, replacing or refunding the purchase price the defective product, if the following conditions are met:

A. The defective product is returned to Cactus Technologies for failure analysis as soon as possible after the failure occurs.

B. An incident card filled out by the user, explaining the conditions of usage and the nature of the failure, accompanies each returned defective product.

C. No evidence is found of abuse or operation of products not in accordance with the published specifications, or of exceeding maximum ratings or operating conditions.

All failing products returned to Cactus Technologies under the provisions of this limited warranty shall be tested to the product's functional and performance specifications. Upon confirmation of failure, each product will be analyzed, by whatever means necessary, to determine the root cause of failure. If the root cause of failure is found to be not covered by the above provisions, then the product will be returned to the customer with a report indicating why the failure was not covered under the warranty.

This warranty does not cover defects, malfunctions, performance failures or damages to the unit resulting from use in other than its normal and customary manner, misuse, accident or neglect; or improper alterations or repairs. Cactus Technologies Limited may repair or replace, at its discretion, any product returned by its customers, even if such product is not covered under warranty, but is under no obligation to do so.

IV. RECEIVING WARRANTY SERVICE

According to Cactus Technologies warranty procedure, defective product should be returned only with prior authorization from Cactus Technologies Limited. Please contact Cactus Technologies Customer Service department (tech@cactus-tech.com) with the following information: product model number and description, nature of defect, conditions of use, proof of purchase and purchase date. If approved, Cactus Technologies will issue a Return Material Authorization or Product Repair Authorization number. Ship the defective product to:

Cactus Technologies Limited
Suite C, 15/F, Capital Trade Center
62 Tsun Yip Street, Kwun Tong
Kowloon, Hong Kong