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# SATA 6Gb/s Industrial mSATA Manual



mSATA (mini-SATA, MO-300) is a non-volatile, solid-state storage device delivering Serial ATA performance, reliability and ruggedness for industrial and environmentally challenging applications.

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## Revision History

Date	Revision	Description	Checked By
2/7/17	A	Initial Release	
3/13/17	B	Revised based on PSFEM2XXXGSXXX_J with new PN's ,performance, block diagram, TBW , power consumption, DAS and DEVSLP connections	

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## Ordering Information: mSATA SSD Solid-State Drive

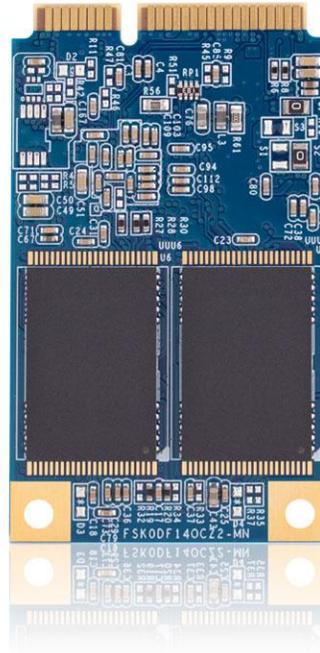
Viking P/N	Interface	Temp	User GB	Client/Ent	NAND
VPFEM2032GZCDMTL	MO-300	(0to+70'c)	32	Client	TSB 15nm MLC
VPFEM2064GZCDMTL	MO-300	(0to+70'c)	64	Client	TSB 15nm MLC
VPFEM2128GZCBMTL	MO-300	(0to+70'c)	128	Client	TSB 15nm MLC
VPFEM2256GZCAMTL	MO-300	(0to+70'c)	256	Client	TSB 15nm MLC

**Notes:**

1. Higher capacity points may be available based on customer application. Consult your local Viking Field Application Engineer.
2. SSD's ship unformatted from the factory unless otherwise requested.

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## Product Picture(s)



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**Industrial SSD's** – Viking's Industrial SSD contains sophisticated provisions to protect firmware and data from corruption due to unexpected power loss. However, an Industrial SSD by industry definition does not contain on-board capacitance. Should power fail unexpectedly, "in-flight" write data may be lost. Industrial SSD's are best used in designs that manage power fail events at the system level.

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## 1 Introduction

Viking's rugged industrial designed SSD's offer the highest flash storage reliability and performance in harsh environments such as shock, vibration, humidity, altitude, ESD, and extreme temperatures.

### 1.1 Features

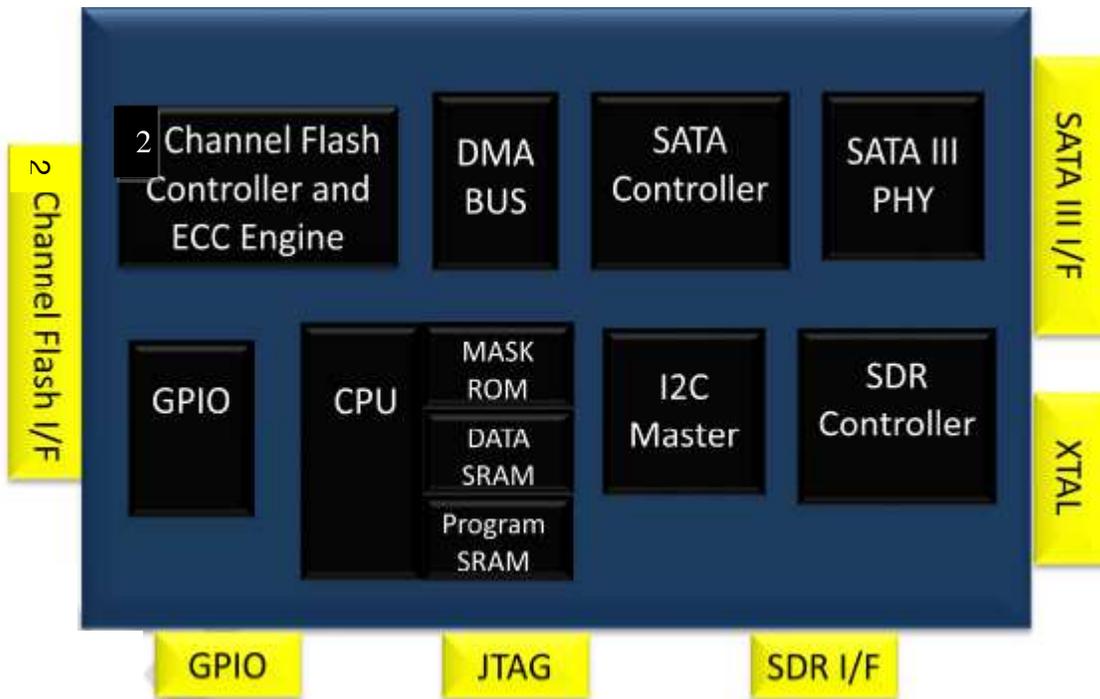
The SSD delivers the following features:

- Offers seamless SATA Revision 3.0 interface support for SATA up to 6Gb/s
- Low overall SSD power consumption
- Supports Native Command Queuing (NCQ) to 32 commands
- Compatible with all major SLC and MLC flash technologies
- S.M.A.R.T.
- Superior wear-leveling algorithm
- Efficient error recovery
- TRIM

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## 1.2 Block Diagram

Figure 1-1: High-Level Block Diagram



**Notes:**

1. Support for up to 2-channels and 2 CE in the NAND Flash interface

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### 1.3 SATA Interface

- The Serial ATA (SATA) interface is compliant with the SATA IO Serial ATA specification, revision 3.0 that supports SATA up to 6Gb/s.
- The SATA interface connects the host computer to the SSD subsystem.
- The SATA interface runs at a maximum speed of 6 Gbps (Giga-bits per second). If the host computer is unable to negotiate a speed of 6 Gbps, the SATA interface automatically renegotiates to a speed of 3 Gbps or 1.5 Gbps.

For a list of supported commands and other specifics, please see Chapter 5.

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## 2 Product Specifications

### 2.1 Capacity and LBA count

Raw Capacity (GB)	User Capacity (GB)	LBA Count
16	14	27,370,224
16	16	31,277,232
32	30	58,626,288
32	32	62,533,296
64	60	117,231,408
64	64	125,045,424
128	120	234,441,648
128	128	250,069,680
256	240	468,862,128
256	256	500,118,192

**Notes:**

1. Per LBA1-03 spec, LBA counts = (97,696,368) + (1,953,504 \* (Advertised Capacity in GBytes – 50))
2. User addressable 512byte sectors

### 2.2 Performance

**Table 2-1: Maximum Sustained Read and Write Bandwidth**

Capacity	Flash Structure	Performance			
		CrystalDiskMark		ATTO	
		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
30/32GB	32GBx1, BGA, TSB 15nm	560	165	560	540
60/64GB	32GBx2, BGA, TSB 15nm	560	315	560	540
120/128GB	64GBx2, BGA, TSB 15nm	560	465	560	540
240/256GB	128GBx2, BGA, TSB 15nm	560	465	560	540
480/512GB	256GBx2, BGA, TSB 15nm	560	465	560	540

**Notes:**

1. Performance measured using CrystalDiskMark and ATTO
2. Performance may vary from flash configuration, SDR configuration, and platform.
3. Refer to Application Note AN0006 for Viking SSD Benchmarking Methodology.
4. Data is based on SSD's using Toshiba A15nm Toggle NAND devices
5. L95A data not currently available

**Table 2-2: Random Read and Write Input/Output Operations per Second (IOPS)**

Capacity	Flash Type	Random Read IOPS	Random Write IOPS
32GB	15nm	TBD	TBD
64GB	15nm	TBD	TBD
128GB	15nm	TBD	TBD
256GB	15nm	TBD	TBD
512GB	15nm	TBD	TBD

**Notes:**

6. Performance measured using Iometer 08 with queue depth set to 32.
7. Write Cache enabled with DDR cache.
8. Random IOPS cover the entire range of legal logical block addresses (LBA's).  
Measurements are performed on a full drive (all LBA's have valid content).
9. Performance may vary by NAND type and host.
10. Refer to Application Note AN0006 for Viking SSD Benchmarking Methodology.
11. Data is based on SSD's using Toshiba A15nm NAND devices
12. L95A data not currently available

## 2.3 Timing

### 2.3.1 STANDBY IMMEDIATE Command

The Power-On-to-Ready time assumes a proper shutdown (power removal preceded by STANDBY IMMEDIATE command. A STANDBY IMMEDIATE before power down always performs a graceful shutdown and does not require the use of the hold-up circuit. Note that SMART attribute 174 "Unexpected Power Loss" records the number of non-graceful power cycle events.

**Table 2-3: STANDBY IMMEDIATE Timing**

Power Cycle Endurance	Min	Max	Unit
STANDBY IMMEDIATE to WE completed	-	72.9	ms

**Notes:** From Standby Immediate command to NAND Write Protect enable.

## 2.4 Electrical Characteristics

### 2.4.1 Absolute Maximum Ratings

Values shown are stress ratings only. Functional operation outside normal operating values is not implied. Extended exposure to absolute maximum ratings may affect reliability.

**Table 2-4: Absolute Maximum Ratings**

Description	Min	Max	Unit
Maximum Voltage Range for Vin	-0.2	6	V
Maximum Temperature Range	-40	85	c

## 2.4.2 Supply Voltage

The operating voltage is 3.3V

**Table 2-5: Operating Voltage**

Description	Min	Max	Unit
Operating Voltage for 3.3 V	- 5%	+5%	V

## 2.4.3 Power Consumption

All onboard power requirements of the SSD are derived from the SATA 3.3V

**Table 2-6: Typical Power Consumption**

Capacity	Flash Structure	Power Consumption		
		Read	Write	Devslp
		(mW)	(mW)	(mW)
30/32GB	32GBx1, BGA, TSB 15nm	1,030	1,210	4.9
60/64GB	32GBx2, BGA, TSB 15nm	1,040	1,215	4.9
120/128GB	64GBx2, BGA, TSB 15nm	1,065	1,480	4.9
240/256GB	128GBx2, BGA, TSB 15nm	1,165	1,535	4.9
480/512GB	256GBx2, BGA, TSB 15nm	1,425	1,740	4.9

**Notes:**

13. Measured using Toshiba A15 Toggle MLC NAND

## 2.5 Environmental Conditions

### 2.5.1 Temperature and Altitude

**Table 2-7: Temperature and Altitude Related Specifications**

Conditions	Operating	Shipping	Storage
Commercial Temperature- Ambient	0 to 70°C	-40 to 85°C	-40 to 85°C
Industrial Temperature- Ambient	-40 to 85°C	-40 to 85°C	-40 to 85°C
Humidity (non-condensing)	90% under 40C	93% under 40C	93% under 40C

**Notes:**

1. SLC flash based products may be available in the following temperature ranges:

### 2.5.2 Shock and Vibration

SSD products are tested in accordance with environmental specification for shock and vibration

**Table 2-8: Shock and Vibration Specifications**

Stimulus	Description
Shock	Acceleration Force: 1500G Half Sin Pulse Duration: 0.5ms
Vibration	Frequency/Displacement: 20Hz~80Hz/1.52mm Frequency/Acceleration: 80Hz~2000Hz/20G X, Y, Z axis/60 min for each

### 2.5.3 Electromagnetic Immunity

mSATA is an embedded product for host systems and is designed not to impair with system functionality or hinder system EMI/FCC compliance.

## 2.6 Reliability

**Table 2-9: Reliability Specifications**

Parameter	Description				
MTBF	Over 2,000,000 hours				
ECC	72-bit per 1KByte				
Read Endurance	Unlimited				
Write Endurance	<b>32GB</b>	<b>64GB</b>	<b>128GB</b>	<b>256GB</b>	<b>512GB</b>
	45 TBW	90 TBW	181 TBW	262 TBW	544 TBW
Data retention	> 90 days at NAND expiration				

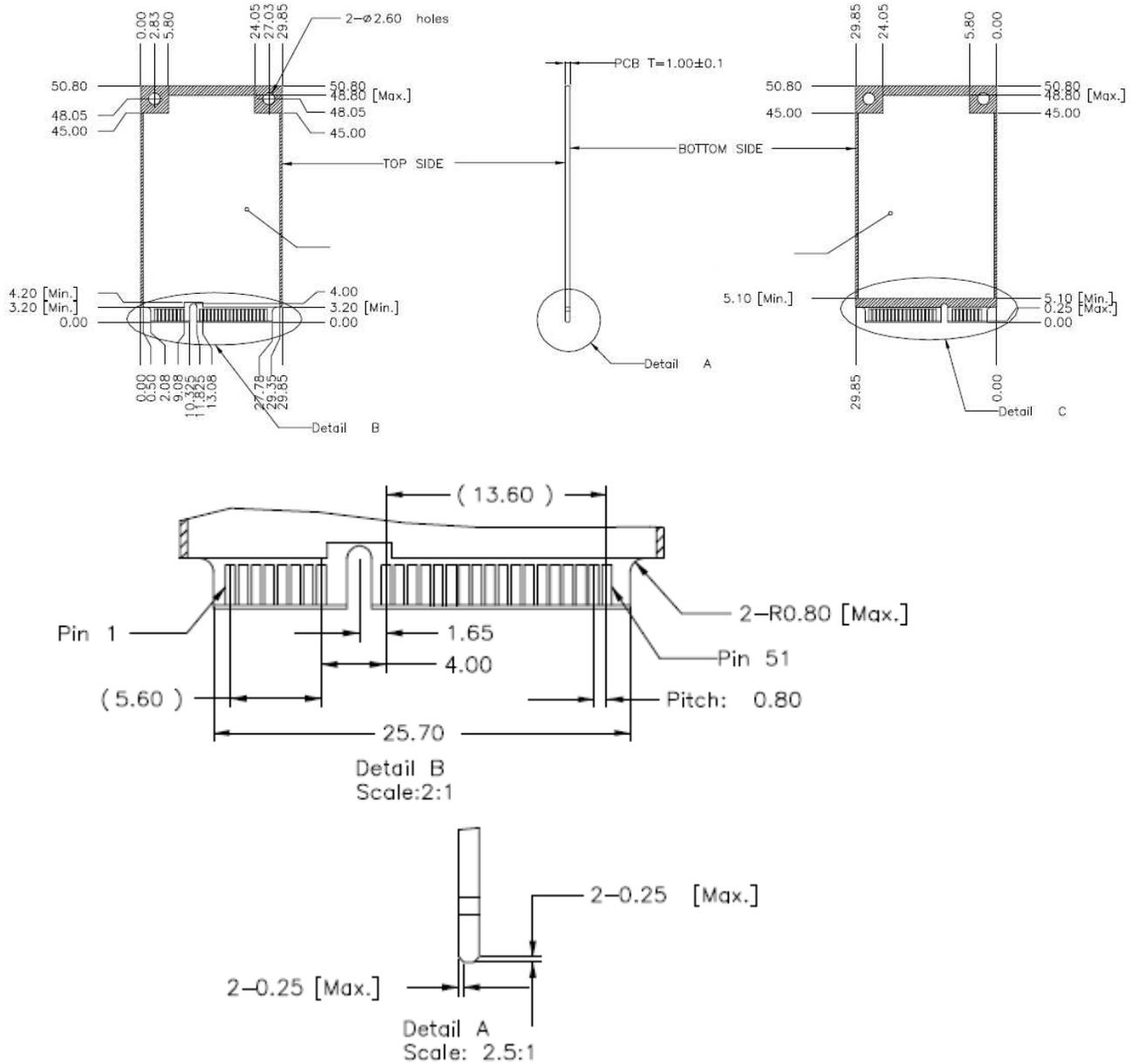
**NOTES:**

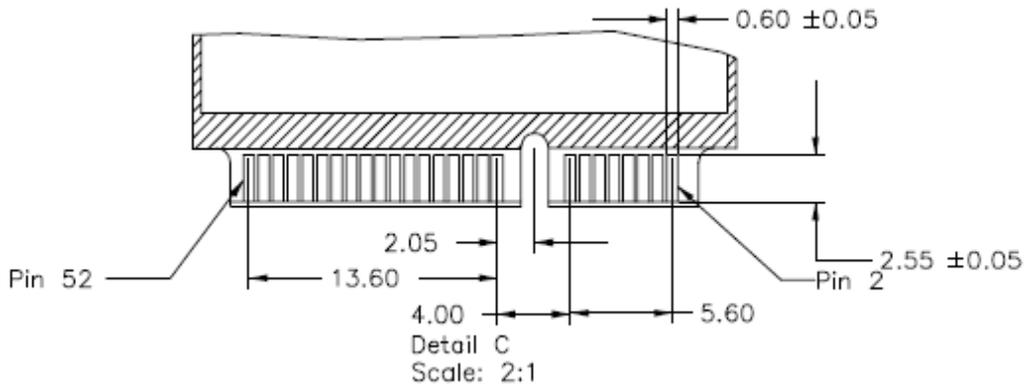
1. Samples were built using Toshiba 15nm Toggle MLC NAND.
2. TBW may differ according to flash configuration and platform.
3. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor

## 3 Mechanical Information

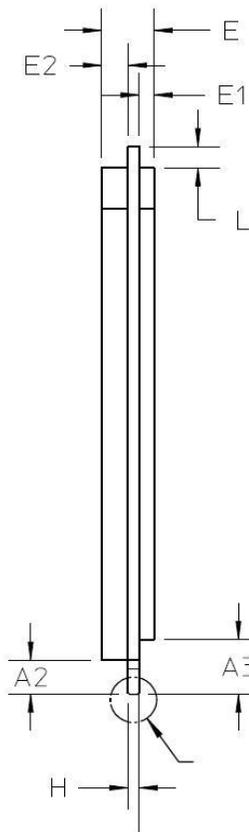
mSATA (MO-300) Form Factor	Height (mm)	Width (mm)	Length (mm)
<b>Min</b>	-	29.70	50.65
<b>Max</b>	4.85	30.00	50.95

**Figure 3-1: Dimensions**





COMMON DIMENSION TABLE				
SYMBOL	MIN	NOM	MAX	NOTES
A2	3.20	-	-	4,6
A3	5.10	-	-	4,6
H	0.90	1.00	1.10	5



mSATA FULL SIZE VARIATION A			
SYMBOL	MIN	NOM	MAX
E	-	-	4.85
E1	-	-	1.35
E2	-	-	2.40
L	2.00	-	-

**Notes:** All dimensions are in millimeters

### 3.1 mSATA SSD Weight

The weight of the mSATA (mini-SATA, MO-300) SSD is approximately 8 grams.

## 4 Pin and Signal Descriptions

### 4.1 Signal and Power Description Tables

**Table 4-1: Mini PCIe Connector Pin Signal Definitions**

Pin #	Type	Description
P1	Reserved	No Connect
P2	+3.3V	3.3V
P3	Reserved	No Connect
P4	GND	Return Current Path
P5	Reserved	No Connect
P6	Reserved	No Connect
P7	Reserved	No Connect
P8	Reserved	No Connect
P9	GND	Return Current Path
P10	Reserved	No Connect
P11	Reserved	No Connect
P12	Reserved	No Connect
P13	Reserved	No Connect
P14	Reserved	No Connect
P15	GND	Return Current Path
P16	Reserved	No Connect
P17	Reserved	No Connect
P18	GND	Return Current Path
P19	Reserved	No Connect
P20	Reserved	No Connect
P21	GND	Return Current Path
P22	Reserved	No Connect
P23	+B	Host Receiver Differential Signal Pair
P24	+3.3V	3.3V Source
P25	-B	Host Receiver Differential Signal Pair
P26	GND	Return Current Path
P27	GND	Return Current Path

Pin #	Type	Description
P28	Reserved	No Connect
P29	GND	Return Current Path
P30	NC	No Connect
P31	-A	Host Transmitter Differential Signal Pair
P32	NC	No Connect
P33	+A	Host Transmitter Differential Signal Pair
P34	GND	Return Current Path
P35	GND	Return Current Path
P36	Reserved	No Connect
P37	GND	Return Current Path
P38	Reserved	No Connect
P39	+3.3V or 5.0V	3.3V or 5.0V Source
P40	GND	Return Current Path
P41	+3.3V or 5.0V	3.3V or 5.0V Source
P42	Reserved	No Connect
P43	NC	No Connect
P44	DEVSLP	Enter/Exit Device sleep mode
P45	Optional	No Connect, Vendor Specific / Manufacturing Pin <sup>2</sup>
P46	Reserved	No Connect
P47	Optional	No Connect , Vendor Specific / Manufacturing Pin <sup>2</sup>
P48	Reserved	No Connect , Reserved
P49	DAS	Device Activity Signal
P50	GND	Return Current Path
P51	Presence Detection	Shall be pulled to GND by device <sup>1</sup>
P52	+3.3V or 5.0V	3.3V or 5.0V Source

**Notes:**

1. Presence detection pin provided for tamper proof functionality
2. No connect on the host side.

## 4.2 Hot Plug Support

Hot Plug insertion and removal are supported in the presence of a proper connector and appropriate operating system (OS) support as described in the SATA 2.6 specification. This product supports Asynchronous Signal Recovery and will issue an unsolicited COMINIT when first mated with a powered connector to guarantee reliable detection by a host system without hardware device detection.

## 5 Command Sets

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## 5.1 ATA Commands

**Table 5-1: Supported ATA Commands**

Description	Op Code	Description	Op Code
Check power mode	E5h	Security Disable Password	F6h
Data Set management	06h	Security Erase Prepare	F3h
DCO	B1h	Security Erase Unit	F4h
Download Microcode PIO	92h	Security Freeze Lock	F5h
Download Microcode DMA	93h	Security Set Password	F1h
Execute drive diagnostic	90h	Security Unlock	F2h
Flush cache	E7h	Seek	70h
Flush cache Ext	EAh	Set features	EFh
Identify device	ECh	Set Max Address	F9h
Idle	E3h	Set Max Address Ext	37h
Idle immediate	E1h	Set multiple mode	C6h
Initialize drive parameters	91h	Sleep	E6h
Read buffer	E4h	Smart	B0h
Read DMA (w/o retry)	C9h	Standby	E2h
Read DMA (w/retry)	C8h	Standby immediate	E0h
Read DMA Ext	25h	Write buffer	E8h
Read FPDMA QUEUED	60h	Write DMA (w/o retry)	CBh
Read Log Ext	2Fh	Write DMA (w/retry)	CAh
Read multiple	C4h	Write DMA Ext	35h
Read multiple Ext	29h	Write DMA FUA Ext	3Dh
Read native max address	F8h	Write FPDMA QUEUED	61h
Read native max Ext	27h	Write Log Ext	3Fh
Read sector(s) (w/o retry)	21h	Write multiple	C5h
Read sector(s) (w/retry)	20h	Write multiple Ext	39h
Read sector(s) Ext	24h	Write multiple FUA Ext	CEh
Read Verify Ext	42h	Write sector(s) (w/o retry)	31h
Read verify sector(s) (w/o retry)	41h	Write sector(s) (w/retry)	30h
Read verify sector(s) (w/retry)	40h	Write sector(s) Ext	34h
Recalibrate	10h	Write uncorrectable	45h

### 5.1.1 48-Bit Address Command Set

SSD supports the 48-Bit Address command set consisting of:

- Flush Cache Ext
- Read DMA Ext
- Read native Max Address Ext
- Read Sector(s) Ext
- Set Max Address Ext
- Write DMA Ext
- Write Multiple Ext
- Write Sector(s) Ext

### 5.1.2 ATA General Feature Command Set

SSD supports the ATA General Feature command set consisting of:

- Download Microcode
- Executive Device Diagnostics
- Flush Cache
- Identify Device
- NOP (optional)
- Read Buffer (optional)
- Read DMA
- Read Multiple
- Read Sector(s)
- Read Verify Sector(s)
- Seek
- Set Features
- Set Multiple Mode
- Write Buffer (optional)
- Write DMA
- Write Multiple
- Write Sector(s)

### 5.1.3 Device Configuration Overlay Command Set

SSD supports the Device Configuration Overlay command set consisting of:

- Device Configuration Freeze Lock
- Device Configuration Identity
- Device Configuration Restore
- Device Configuration Set

### 5.1.4 General Purpose Log Command Set

SSD supports the General Purpose Log command set consisting of:

- Read Log Ext

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- Write Log Ext

### 5.1.5 Host Protected Area Command Set

SSD supports the Host Protected Area command set consisting of:

- Read Native Max Address
- Read Native Max Address Ext
- Set Max Address
- Set Max Address Ext
- Set Max Freeze Lock (optional)
- Set Max Lock (optional)
- Set Max Set Password (optional)
- Set Max Unlock (optional)

### 5.1.6 Power Management Command Set

SSD supports the Power Management command set consisting of:

- Check Power Mode
- Idle
- Idle Immediate
- Sleep
- Standby
- Standby Immediate
- Slumber
- Partial Mode

### 5.1.7 Security Mode Feature Set

SSD supports the Security Mode command set consisting of:

- Security Set Password (OPCODE: F1h)
- Security Unlock (OPCODE: F2h)
- Security Erase Prepare (OPCODE: F3h)
- Security Erase Unit (OPCODE: F4h)
- Security Freeze Lock (OPCODE: F5h)
- Security Disable Password (OPCODE: F6h)
- Standby Immediate

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### 5.1.8 Identify Device Data

The table below lists the sector data that will be returned by the SSD upon an IDENTIFY DEVICE command.

**Table 5-2: List of Device Identification**

Word	F: Fixed V: Variable X: Both	Default Value	Description
0	F	0040h	General configuration bit-significant information
1	X	See *1	Obsolete – Number of logical cylinders (16383)
2	V	C837h	Specific configuration
3	X	0010h	Obsolete – Number of logical heads (16)
4-5	X	00000000h	Retired
6	X	003Fh	Obsolete – Number of logical sectors per logical track (63)
7-8	V	00000000h	Reserved for assignment by the Compact Flash Association
9	X	0000h	Retired
10-19	F	Varies	Serial number (20 ASCII characters)
20-21	X	0000h	Retired
22	X	0000h	Obsolete
23-26	F	Varies	Firmware revision (8 ASCII characters)
27-46	F	Varies	Model number (xxxxxxx)
47	F	8010h	7:0- Maximum number of sectors transferred per interrupt on MULTIPLE commands
48	F	0000h	Reserved
49	F	2F00h	Capabilities
50	F	4000h	Capabilities
51-52	X	00000000h	Obsolete
53	F	0007h	Words 88 and 70:64 valid
54	X	See *1	Obsolete – Number of logical cylinders (16383)
55	X	0010h	Obsolete – Number of logical heads (16)
56	X	003Fh	Obsolete – Number of logical sectors per track (63)
57-58	X	See *2	Obsolete – Current capacity in sectors –
59	F	0110h	Number of sectors transferred per interrupt on MULTIPLE commands
60-61	F	See *3	Total number of user addressable sectors
62	X	0000h	Obsolete
63	F	0407h	Multi-word DMA modes supported/selected
64	F	0003h	PIO modes supported
65	F	0078h	Minimum Multiword DMA transfer cycle time per word
66	F	0078h	Manufacturer's recommended Multiword DMA