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SATA 6Gb/s
M.2 SATA
Manual

M.2 SATA is a non-volatile, solid-state storage device delivering Serial ATA performance, reliability and ruggedness for environmentally challenging applications.

Revision History

Date	Revision	Description	Checked By
3/27/15	X1	Initial Release from modified PSFEM4XXXGTXXX_X3 and PN table per PSG	
5/07/15	A	Add photo, update per psg. 4/29/15 Change all PN to VPxx., remove 42/60mm references. Change all PN to VPxx., remove 42/60mm references. Remove PFAIL/DATA Hardening signaling. Changed Absolute max Vin 3.6V. Reliability table changed from 72 bit per 1KB to 120 bit per 2KB page. Changed table 4-1 Signal and Power pin 58 to Reserved for MFG_CLOCK	
5/13/15	B	Revise power consumption table. IOPS per IOmeter8. Add notes to PN table	
7/30/15	C	Add 15nm PN's	
3/1/16	D	Update PN table	
9/20/16	E	Revise logo and color scheme. Remove temp sensor and SATA attribute.	
3/20/17	F	Revise note 2 on Extended SMART Attribute Actual Data table	

Legal Information

Legal Information

Ordering Information: M.2 80mm SATA SSD Solid-State Drive

Part Number	Interface	User Capacity (GB)	NAND	Temperature (C)	NAND
VPFEM5480GTCZMTK	SATA 6GB	480	MLC	(0 to +70'c)	TSB A19nm K-die
VPFEM5480GTCZMMC	SATA 6GB	480	MLC	(0 to +70'c)	Micron 16nm L95B
VPFEM5240GTCVMTK	SATA 6GB	240	MLC	(0 to +70'c)	TSB A19nm K-die
VPFEM5240GTCAMMC	SATA 6GB	240	MLC	(0 to +70'c)	Micron 16nm L95B
VPFEM5120GTCTMTK	SATA 6GB	120	MLC	(0 to +70'c)	TSB A19nm K-die
VPFEM5120GTCBMMC	SATA 6GB	120	MLC	(0 to +70'c)	Micron 16nm L95B
VPFEM5480GTCZMTL	SATA 6GB	480	MLC	(0 to +70'c)	TSB 15nm L-die
VPFEM5240GTCAMTL	SATA 6GB	240	MLC	(0 to +70'c)	TSB 15nm L-die
VPFEM5120GTCBMTL	SATA 6GB	120	MLC	(0 to +70'c)	TSB 15nm L-die

Notes:

1. Usable capacity based on a level of over-provisioning applied to wear leveling, bad sectors, index tables etc.
2. Higher capacity points may be available based on customer application. Consult your local Viking FAE Engineer.
3. SSD's ship unformatted from the factory unless otherwise requested.
4. 1 GB = 1,000,000,000 Byte
5. One Sector = 512 Byte.

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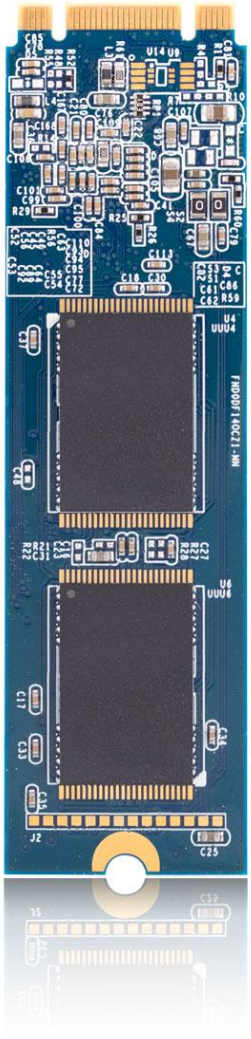
Product Picture(s)

M.2 2280 FRONT



M.2 2280 BACK

Enterprise SSD – An Enterprise SSD contains hardware and firmware that detect and manage power failures. This allows the drive to flush the controller cache and harden data to NAND flash. No data is lost or corrupted.

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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.

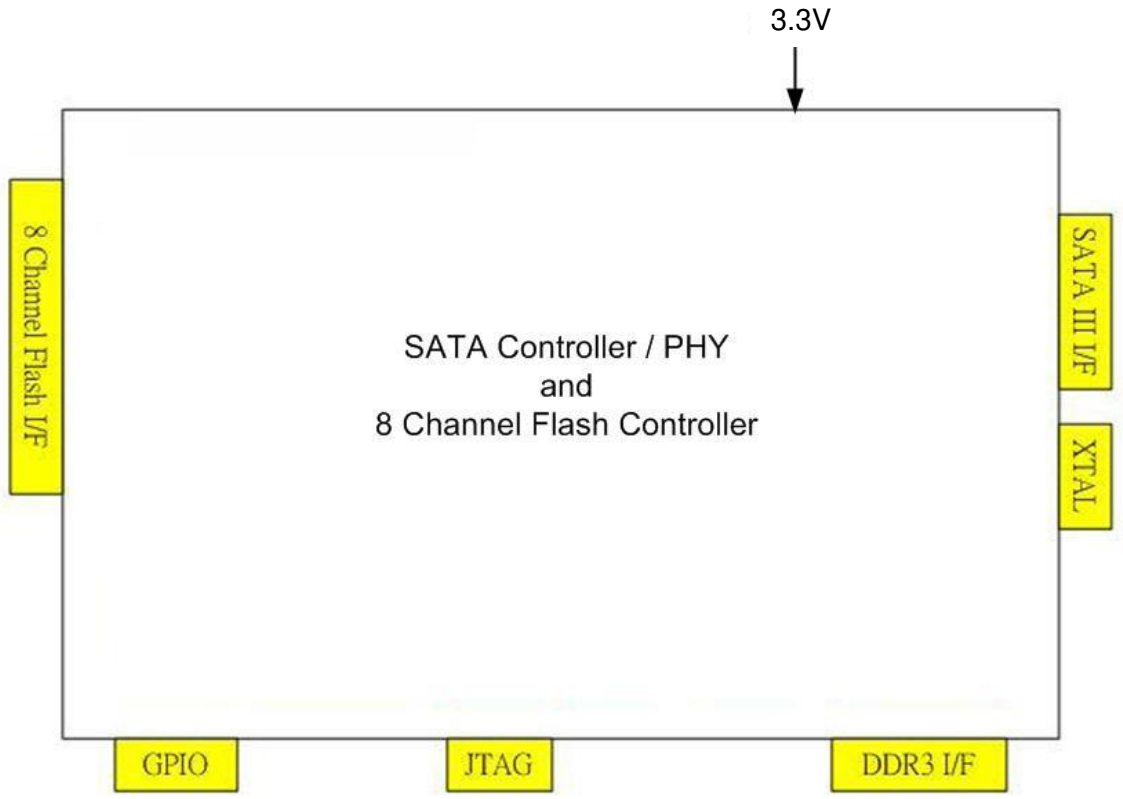
1.1 Features

The SSD delivers the following features:

- Seamless SATA Revision 3.2 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 static and dynamic wear-leveling algorithm
- Efficient error recovery
- Power hold-up circuit technology ensures no data loss resulting from an unexpected power loss and is supported for industrial temperatures
- TRIM Support
- 48-bit LBA Support

1.2 Block Diagram

Figure 1-1: High-Level Block Diagram



Notes: Support for up to 8-channels and 32 CE in the NAND Flash interface

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 6 Gbps.
- 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.

2 Product Specifications

2.1 Performance

Table 2-1: Maximum Sustained Read and Write Bandwidth

Access Type	MB/s
Sequential Read, 256K	Up to 550
Sequential Write, 256K	Up to 530

Notes:
1. Performance measured using Iometer 08
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 A19nm Toggle NAND devices

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

Access Type	IOPS
Read, 4K	Up to 100,000
Write, 4K	Up to 90,000

Notes:
1. Performance measured using Iometer 08 with queue depth set to 32.
2. Write Cache enabled with DDR cache.
3. 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).
4. Performance may vary by NAND type and host.
5. Refer to Application Note AN0006 for Viking SSD Benchmarking Methodology.
6. Data is based on SSD's using Toshiba A19nm NAND devices

2.2 Timing

Table 2-3: Timing Specifications

Type	Average Latency
Read (at 64KB)	0.14mS
Write (at 64KB)	2.12mS
Power On Ready (POR)	436mS

Notes:
1. Device measured using Drivemaster.
2. DRQ (Data Transfer Requested) bit being asserted

2.2.1 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.

Table 2-4: STANDBY IMMEDIATE Timing

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

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

2.3 Electrical Characteristics

2.3.1 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 2-5: Absolute Maximum Ratings

Description	Min	Max	Unit
Maximum Voltage Range for Vin	-0.2	3.6	V
Maximum Temperature Range	-40	85	c

2.3.2 Supply Voltage

The operating voltage is 3.3V

Table 2-6: Operating Voltage

Description	Min	Max	Unit
Operating Voltage for 3.3 V (+/- 5%)	3.135	3.465	V

2.3.3 Power Consumption

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

Table 2-7: Typical Power Consumption at 3.3V

Capacity	Flash: TSBA19	Read()	Write	Idle	Partial	Slumber
128GB	8GBx1Diex16CE	2.224	3.446	0.505	0.0911	0.0911
256GB	8GBx1Diex32CE	2.21	4.31	0.566	0.0695	0.068
512GB	8GBx2Diex32CE	2.335	4.431	0.632	0.0824	0.0798
1TB	16GBx2Diex32CE	2.481	4.234	0.651	0.1014	0.1009

Capacity	Flash: M L95B	Read()	Write	Idle	Partial	Slumber
128GB	16GBx1Diex8CE	2.193	2.524	0.625	0.1158	0.0716
256GB	16GBx1Diex16CE	2.161	3,624	0,571	0.0675	0,0659
512GB	16GBx2Diex16CE	2.39	3.971	0.567	0.1199	0.0968

Notes:

1. The average value of power consumption is achieved based on 100% conversion efficiency.
2. The measured power voltage is 5V.
3. Samples were built of Toshiba A19nm Toggle MLC NAND flash and measured under ambient temperature.
4. Sequential R/W is measured while testing 400MB sequential R/W 5 times by CrystalDiskMark.
5. Power Consumption may differ according to flash configuration and platform.

2.4 Environmental Conditions

2.4.1 Temperature and Altitude

Table 2-8: 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

2.4.2 Shock and Vibration

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

Table 2-9: Shock and Vibration Specifications

Stimulus	Description
Shock	500G, 2ms
Vibration	20 – 80 Hz/1.52mm 80 – 2000 Hz/20G (X,Y,Z axis / 30 min for each)

2.4.3 Electromagnetic Immunity

M.2 is an embedded product for host systems and is designed not to impair with system functionality or hinder system EMI/FCC compliance.

2.5 Reliability

Table 2-10: Reliability Specifications

Parameter	Description					
ECC	120 bit per 2KB page					
Read Endurance	Unlimited					
Write Endurance	**32GB**	**64GB**	**128GB**	**256GB**	**512GB**	**1024GB**
	79 TBW	158 TBW	317 TBW	635 TBW	1272 TBW	2548 TBW
Data retention	> 90 days at NAND expiration					

2.6 Data Security

2.6.1 Encryption

The SSD drive is a self-encrypting drive (SED), with a bulk data encryption feature that provides automatic hardware-based data security and enhanced secure erase capability.

A self-encrypting drives, scrambles data using a data encryption key as it is written to the drive and then descrambles it with the key as it is retrieved. This gives the user the highest level of data protection available and provides a fast

erase simply by deleting the encryption key, eliminating the need for time consuming data-overwrite. Data on the drive is instantly rendered unreadable.

The SSD supports AES-256 encryption and ATA Secure Erase features to protect sensitive data.

The SSD drives support the following security features:

- AES 256 on the fly support.
- RSA 512/1024/2048
- SHA 160/256/512
- TCG OPAL SSC V1.0

2.6.2 Quick Erase

Quick Erase has been designed to remove data under prompt and urgent situation and is triggered by sending an ATA Command.

Input Info of Executing Quick Erase Command

Register	7	6	5	4	3	2	1	0
Features	01h							
Sector Count	2Fh							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	A0h							
Command	6Fh							

Normal Output Info of Executing Quick Erase Command

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head Register:
DEV shall indicate the selected device.
Status Register:
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

2.6.3 Military Secure Erase / Sanitization/ Purge Routines

Many government and military organizations such as NIST/NSA define their own standard and procedures for performing a Military Secure Erase which overwrite different patterns to sanitize the flash media. Some of the more common military or government purge routines are defined in the following table and the data security features of the drive comply with Department of Defense (DoD) and US military data security standards.

Table 2-11: Military Secure Erase / Sanitize Routines

Standard	Action	SSD Code[1]
NSA/CSS 9-12	Erase and overwrite all locations with a known unclassified pattern. Verify the overwrite procedure by randomly rereading the overwritten information to confirm that only the known pattern can be recovered.	Note 1
NSA/CSS 130-2	Erase the media and overwrite with random data 2 times, then erase and overwrite with a character	Note 1
DoD5220.22-M	Erase the media and overwrite with single character, then erase again	Note 1
NISPOMSUP Chap 8, Sect.8-501	Erase the media and overwrite with single character, then erase again and overwrite with single character, then erase again and overwrite with random character then erase again	Note 1
USA Army 380-19	Erase the media and overwrite with random data, erase and overwrite with a character, then erase and overwrite with complement of the character	Note 1
Navy NAVSO P-5239-26	Erase the media and overwrite with random data, then erase again	Note 1
Air Force AFSSI 5020	Erase the media and overwrite with pattern, repeat 3 times	Note 1
Air Force AFSSI 8580	TBD	Note 1

Notes:
1. Enabled using ATA commands

2.6.3.1 AFSSI 5020

Pattern:
1) To erase the whole disk.
2) To fill the whole disk with random data.

Input Info of Executing AFSSI 5020 Command

Register	7	6	5	4	3	2	1	0
Features	02h							
Sector Count	2Fh							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	A0h							
Command	6Fh							

Normal Output Info of Executing AFSSI 5020 Command

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head Register:
DEV shall indicate the selected device.
Status Register:
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

2.6.3.2 DOD 5220.22-M

Pattern:
1) To fill the whole disk with fixed character pattern of 0x55.
2) To erase the whole disk.

Input Info of Executing DoD 5220.22-M Command

Register	7	6	5	4	3	2	1	0
Features	03h							
Sector Count	2Fh							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	A0h							
Command	6Fh							

Normal Output Info of Executing DoD 5220.22-M Command

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head Register:
DEV shall indicate the selected device.
Status Register:
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

2.6.3.3 USA NAVY NAVSO P-5239-26

Pattern:
1) To erase the whole disk.
2) To fill the whole disk with random data.
3) To erase the whole disk again.

Input Info of Executing USA Navy NAVSO P-5239-26 Command

Register	7	6	5	4	3	2	1	0
Features	04h							
Sector Count	2Fh							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	A0h							
Command	6Fh							

Normal Output Info of Executing USA Navy NAVSO P-5239-26 Command

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head Register:
DEV shall indicate the selected device.
Status Register:
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

2.6.3.4 NSAMANUAL 130-2

Pattern:
1) To erase the whole disk.
2) To fill the whole disk with random data.
3) To fill the whole disk with random data one more time.
4) To erase the whole disk again.
5) To fill the whole disk with fixed character pattern of 0x55.

Input Info of Executing NSA Manual 130-2 Command

Register	7	6	5	4	3	2	1	0
Features	05h							
Sector Count	2Fh							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	A0h							
Command	6Fh							

Normal Output Info of Executing NSA Manual 130-2 Command

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head Register:
DEV shall indicate the selected device.
Status Register:
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.

ERR shall be cleared to zero.

2.6.3.5 USA-ARMY 380-19

Pattern:
1) To erase the whole disk.
2) To fill the whole disk with random data.
3) To fill the whole disk with fixed character pattern of 0x55.
4) To fill the whole disk with fixed character pattern of 0xAA.

Input Info of Executing USA-Army 380-19 Command

Register	7	6	5	4	3	2	1	0
Features	06h							
Sector Count	2Fh							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	A0h							
Command	6Fh							

Normal Output Info of Executing USA-Army 380-19 Command

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder High	na							
Cylinder Low	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head Register:
DEV shall indicate the selected device.
Status Register:
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.