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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.

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Revision History

Date	Revision	Description	Checked By
3/10/17	A	Initial Release. Revised based on PSFEM6XXXGSXXX_D with new PN's performance, block diagram, TBW, power consumption. Add VPFEM6030GZCDMTL	
3/19/17	B	Add performance, TBW & power for new PNs VPFEM6008GZCWMTL VPFEM6016GZCDMTL VPFEM6032GZCDMTL	
7/24/17	C	Add IOPS and MB/s performance based on IOMETER06	

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

Part Number	Length (mm)	Interface	Application	User Capacity (GB)	NAND	Temperature (C)	NAND
VPFEM6008GZCWMTL	42	SATA 6GB	Client	8	MLC	0 to 70	TSB 15nm MLC
VPFEM6016GZCDMTL	42	SATA 6GB	Client	16	MLC	0 to 70	TSB 15nm MLC
VVPFEM6032GZCBMTL	42	SATA 6GB	Client	32	MLC	0 to 70	TSB 15nm MLC
VPFEM6030GZCDMTL	42	SATA 6GB	Client	30	MLC	0 to 70	TSB 15nm MLC
VPFEM6060GZCBMTL	42	SATA 6GB	Client	60	MLC	0 to 70	TSB 15nm MLC
VPFEM6064GZCBMTL	42	SATA 6GB	Client	64	MLC	0 to 70	TSB 15nm MLC
VPFEM6120GZCAMTL	42	SATA 6GB	Client	120	MLC	0 to 70	TSB 15nm MLC
VPFEM6128GZCAMTL	42	SATA 6GB	Client	128	MLC	0 to 70	TSB 15nm MLC
VPFEM6240GZCZMTL	42	SATA 6GB	Client	240	MLC	0 to 70	TSB 15nm MLC
VPFEM6256GZCZMTL	42	SATA 6GB	Client	256	MLC	0 to 70	TSB 15nm MLC
VPFEM6480GZCFMTL	42	SATA 6GB	Client	480	MLC	0 to 70	TSB 15nm MLC
VPFEM6512GZCFMTL	42	SATA 6GB	Client	512	MLC	0 to 70	TSB 15nm MLC

Notes:

- Refer to Product Specifications for Capacity and LBA count

Client SSD's – Viking's client SSD contains sophisticated provisions to protect firmware and data from corruption due to unexpected power loss. However, should power fail unexpectedly, "in-flight" write data may be lost if the SSD power is not managed at the system level for these power fail events.

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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

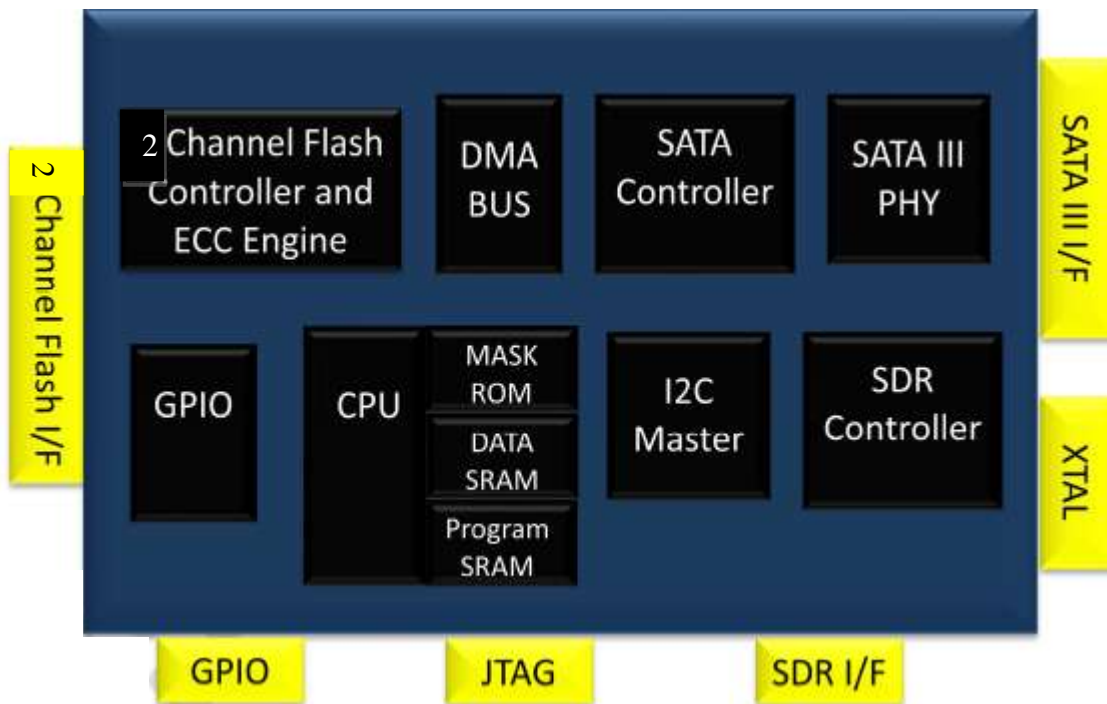
The SSD delivers the following features:

- 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

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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 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.

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2 Product Specifications

2.1 Capacity and LBA count

Raw Capacity (GB)	User Capacity (GB)	LBA Count
8	8	15,649,200
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))

2.2 Performance

Table 2-1: Maximum Sustained Read and Write Bandwidth

Capacity	Flash Structure	Performance				Power Consumption		
		CrystalDiskMark		ATTO		Read (mW)	Write (mW)	Devslp (mW)
		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)			
8GB	8GBx1, TSOP, TSB 15nm	320	105	560	540	830	765	4.9
16GB	16GBx1, TSOP, TSB 15nm	320	85	560	540	895	805	4.9
30/32GB	32GBx1, BGA, TSB 15nm	560	165	560	540	1,030	1,210	4.9
60/64GB	32GBx2, BGA, TSB 15nm	560	315	560	540	1,040	1,215	4.9
120/128GB	64GBx2, BGA, TSB 15nm	560	465	560	540	1,065	1,480	4.9
240/256GB	128GBx2, BGA, TSB 15nm	560	465	560	540	1,165	1,535	4.9
480/512GB	256GBx2, BGA, TSB 15nm	560	465	560	540	1,425	1,740	4.9

Notes:

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

Table 2-2: Sequential Read and Write Bandwidth (Iometer 06)

Capacity	Flash Type	Read MB/s (256K)	Write MB/s (256K)
8GB	15nm	537 ¹	366 ¹
16GB	15nm	537 ¹	366 ¹
32GB	15nm	537 ¹	366 ¹
64GB	15nm	537 ¹	366 ¹
128GB	15nm	537 ¹	366 ¹
256GB	15nm	537	366
512GB	15nm	537 ¹	366 ¹

Notes:

1. Estimated Performance measured using Iometer 06 with queue depth set to 32.
2. Write Cache enabled with DDR cache.
3. Tested with VPFEM5256GZIAMTL (Toshiba MLC L die)

Table 2-3: Random Read/ Write Input/Output Operations per Second (IOPS) (Iometer 06)

Capacity	Flash Type	Random Read IOPS (4K)	Random Write IOPS (4K)
8GB	15nm	14200 ¹	1100 ¹
16GB	15nm	14200 ¹	1100 ¹
32GB	15nm	14200 ¹	1100 ¹
64GB	15nm	14200 ¹	1100 ¹
128GB	15nm	14200 ¹	1100 ¹
256GB	15nm	14200	1100
512GB	15nm	14200 ¹	1100 ¹

Notes:

1. Estimated Performance measured using Iometer 06 with queue depth set to 32.
2. Write Cache enabled with DDR cache.
3. Tested with VPFEM5256GZIAMTL (Toshiba MLC L die)
4. 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).
5. Performance may vary by NAND type and host.
6. Refer to Application Note AN0006 for Viking SSD Benchmarking Methodology.
7. Data is based on SSD's using Toshiba A15nm NAND devices
8. L95A data not currently available

2.3 Timing

Table 2-4: Timing Specifications

Type	Average Latency
Power-On-to-Ready (POR)	TBD
Command to DRQ	TBD
Time to Erase (ATA Secure Erase)	TBD

Notes:

1. Device measured using Drivemaster.
2. Sector Read/Write latency measured up to 2048 block transfers (512B/sector = 1 Block)
3. Queue depth set to 32 for NCQ
4. Sequential 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)
5. DRQ (Data Transfer Requested) bit being asserted

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 2-5: 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.

2.4 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 2-6: 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 2-7: Operating Voltage

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

2.4.3 Supply Current

Table 2-8: Current Draw

Voltage	Mode	8GB	16GB	32GB	64GB	128GB	Unit
3.3V	Read (Average RMS)	N/A	N/A	325	235	395	mA
	Writes (Average RMS)	N/A	N/A	300	250	305	mA
	Idle	N/A	N/A	63	62	61	mA
	Partial	N/A	N/A	11.5	11	11	mA
	Slumber	N/A	N/A	6.7	6.4	6.9	mA
	DEVSLP	N/A	N/A	0.98	0.98	0.98	mA

Notes:

1. Measured using 128GB MLC Toshiba A19nm NAND

2.4.4 Power Consumption

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

Table 2-9: Typical Power Consumption at 3.3V

Capacity	Flash Structure	Flash Type	Read	Write	Partial	Slumber	Idle	DEVSLP
8GB	8GB x 1	TSOP, TSB 15nm	830	765	12.5	8	255	4.9
16GB	16GB x 1	TSOP, TSB 15nm	895	805	12.5	8	256	4.9
32GB	32GB x 1	TSOP, TSB 15nm	970	1,100	13	9	260	4.9
32GB	32GB x 1	BGA, TSB 15nm	1,030	1,210	12	7	255	4.9
64GB	32GB x 2	BGA, TSB 15nm	1,040	1,215	12	7	257	4.9
128GB	64GB x 2	BGA, TSB 15nm	1,065	1,480	12	7	255	4.9
256GB	128GB x2	BGA, TSB 15nm	1,165	1,535	12	7	260	4.9
512GB	256GB x2	BGA, TSB 15nm	1,425	1,740	14	10	260	4.9

Notes:

1. Units are mW

2. Measured using Toshiba A15 Toggle MLC NAND

2.5 Environmental Conditions

2.5.1 Temperature and Altitude

Table 2-10: 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

2.5.2 Shock and Vibration

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

Table 2-11: 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)

2.5.3 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.

2.6 Reliability

Table 2-12: Reliability Specifications

Parameter	Description	
MTBF	Over 2,000,000 hours	
ECC	72-bit per 1KByte	
Read Endurance	Unlimited	
Write Endurance	Capacity	TBW
	8GB	12 TBW
	16GB	23 TBW
	32GB	45 TBW
	64GB	90 TBW
	128GB	181 TBW
	256GB	262 TBW
	512GB	544 TBW
Data retention	> 90 days at NAND expiration	

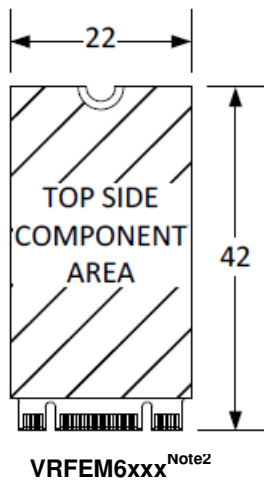
NOTES:

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

3.1 Dimensions

Figure 3-1: Dimensions

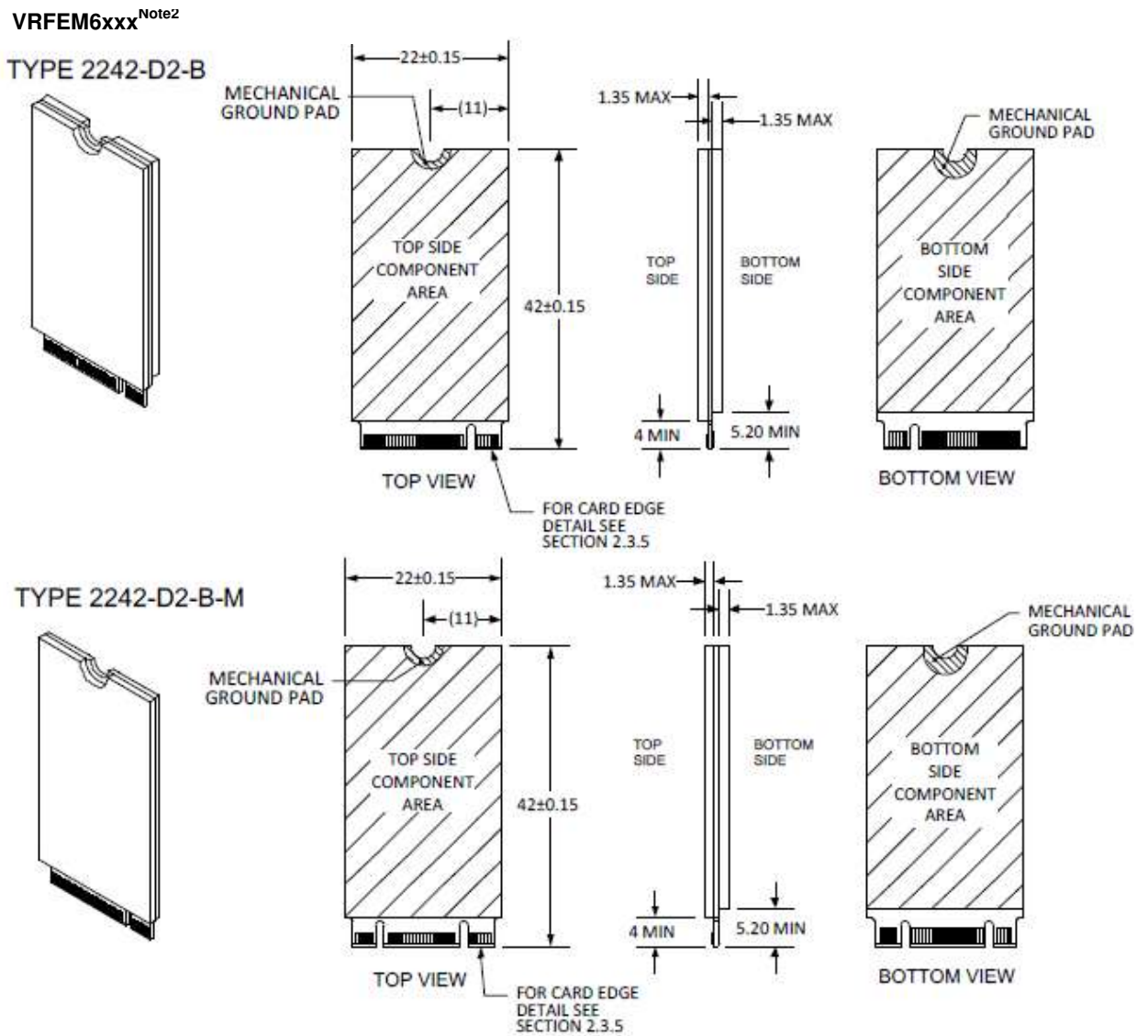


Notes:

1. All dimensions are in millimeter. General tolerance is ± 0.15 . PCB thickness 0.8 ± 0.08
2. Refer to Ordering Information table for the complete Viking part number that describes the “xxx”.

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Figure 3-2: Dimension Details for M.2 42mm length



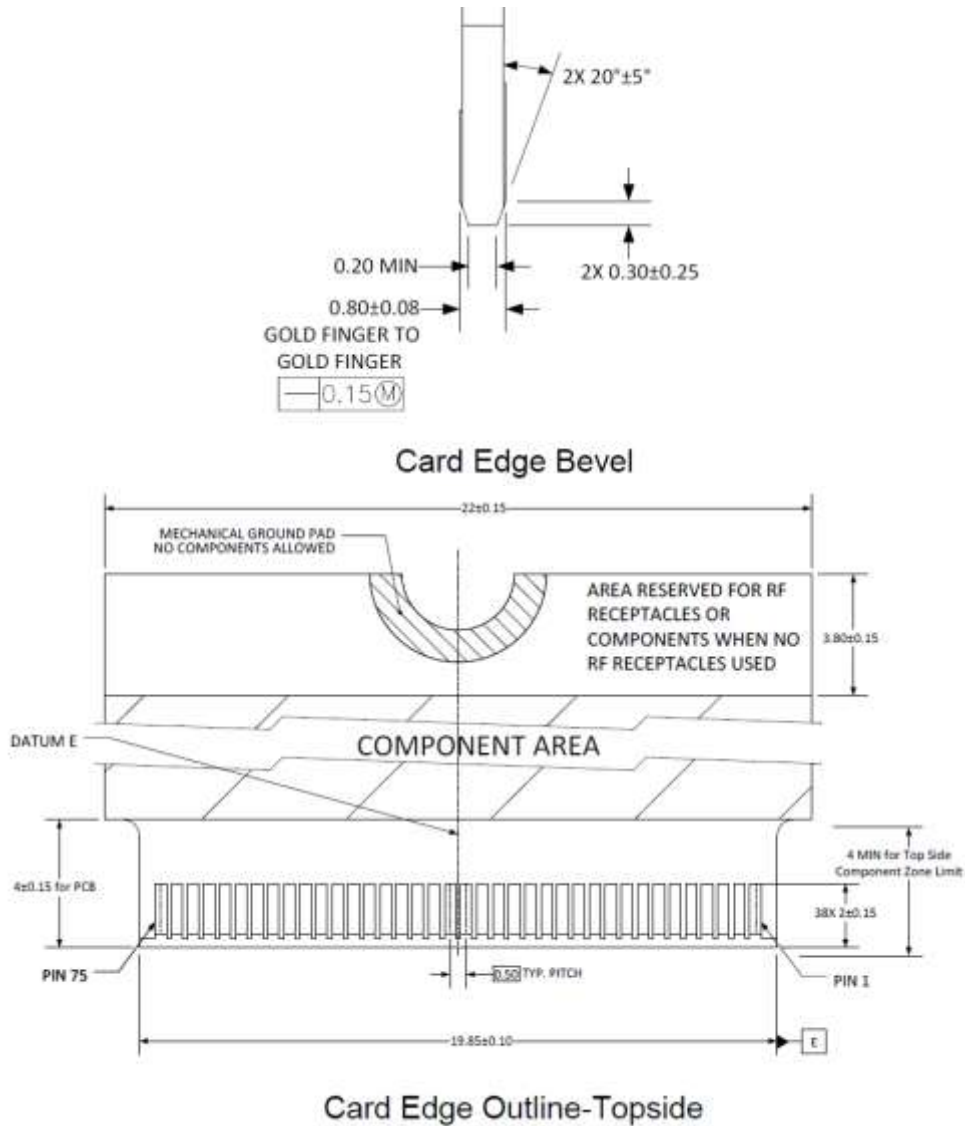
Notes:

1. All dimensions are in millimeter. General tolerance is ± 0.15 . PCB thickness 0.8 ± 0.08
2. Refer to Ordering Information table for the complete Viking part number that describes the "xxx".

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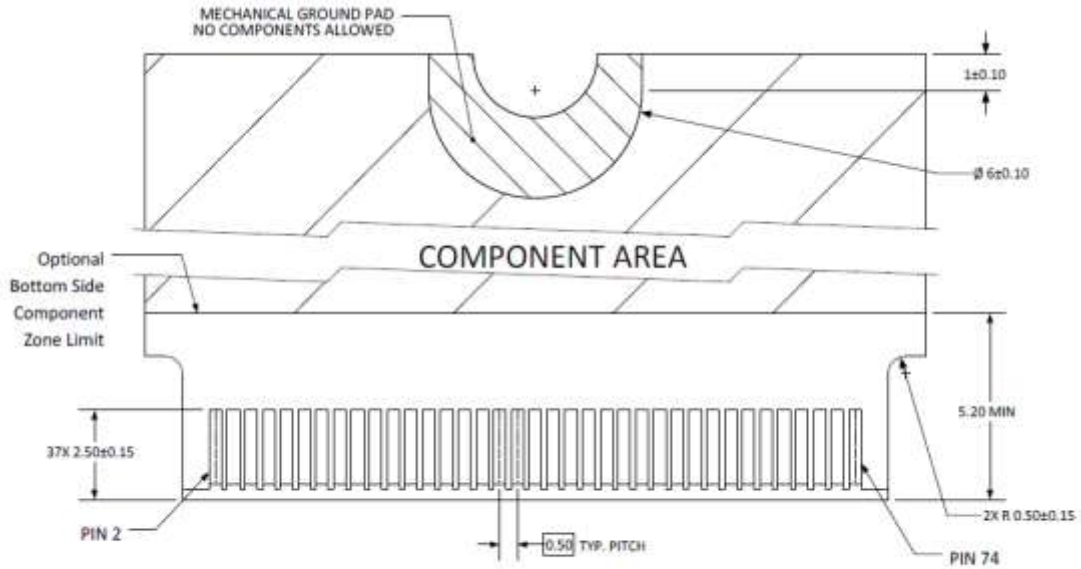
3.2 Card Edge Detail

Figure 3-3: Dimension Details for M.2 card edge

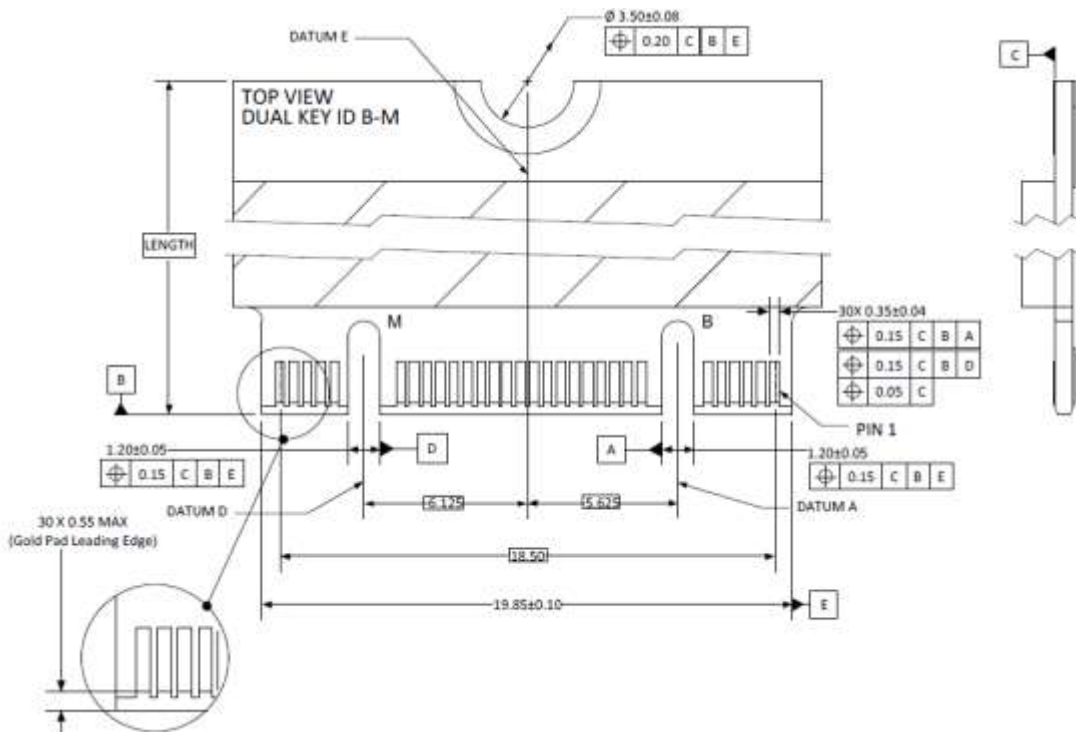


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Figure 3-4: Dimension Details for M.2 connector and notch



Card Edge Outline-Backside



Key notch detail

3.3 M.2 SSD Weight

Table 3-1: M.2 SSD weight

Length	Weight	Unit of measure
42 mm	< 7	Grams

4 Pin and Signal Descriptions

4.1 Signal and Power Description Tables

Table 4-1: M.2 SATA Connector Pin Signal Definitions

Pin	Description	Description	Pin
74	3.3V	CONFIG_2 = GND	75
72	3.3V	GND	73
70	3.3V	GND	71
68	SUSCLK(32kHz) (I)(0/3.3V)	CONFIG_1 = GND	69
66	Module Key	N/C	67
64	Module Key	Module Key	65
62	Module Key	Module Key	63
60	Module Key	Module Key	61
58	N/C	Module Key	59
56	Reserved for MFG_DATA	GND	57
54	N/C	N/C	55
52	N/C	N/C	53
50	N/C	GND	51
48	N/C	SATA-A+	49
46	N/C	SATA-A-	47
44	N/C	GND	45
42	N/C	SATA-B-	43
40	N/C	SATA-B+	41
38	DEVSLP (I)(0/3.3V)	GND	39
36	N/C	N/C	37
34	N/C	N/C	35
32	N/C	GND	33
30	N/C	N/C	31
28	N/C	N/C	29
26	N/C	GND	27
24	N/C	N/C	25
22	N/C	N/C	23

Pin	Description	Description	Pin
20	N/C	CONFIG_0 = GND	21
18	Module Key	Module Key	19
16	Module Key	Module Key	17
14	Module Key	Module Key	15
12	Module Key	Module Key	13
10	DAS/DSS# (I/O)	N/C	11
8	N/C	N/C	9
6	N/C	N/C	7
4	3.3V	N/C	5
2	3.3V	GND	3
		CONFIG_3 = GND	1

Notes:

1. No connect on the host side.
2. Socket-2 SATA-based SSD Module pinout per PCI Express M.2 Specification, Revision 1.0 (p134)

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

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

Description	Op Code	Description	Op Code
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:

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