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NVMe PCIe SSD
2.5” SSD
Manual

NVMe PCIe SSD is a non-volatile, solid-state storage device delivering uncompromising performance, reliability and ruggedness for environmentally challenging applications.

Revision History

Date	Revision	Description	Checked By
9/29/16	A	Initial Release from modified PSFN22xxxxUxxx_C and vendor doc 1.0. Removed AES-256 capability (not enabled in the firmware)add VSFN227T68WCGWSM	
3/13/2017	B	Rename document to distinguish between SM and PM	

Legal Information

Legal Information

Ordering Information: 2.5 inch PCIe SSD Solid-State Drive

Part Numbers	Interface	Application	Useable Capacity (GB)[1]	SR-IOV	Port	Temperature Range	NAND
VSFN22480GWCFWSM	PCIe/NVMe	Client PM963	480 GB	N	Single	(0 to +70'c)	Samsung TLC, V3 VNAND
VSFN22960GWCFWSM	PCIe/NVMe	Client PM963	960 GB	N	Single	(0 to +70'c)	Samsung TLC V3 VNAND
VSFN221T92WCFWSM	PCIe/NVMe	Client PM963	1920 GB	N	Single	(0 to +70'c)	Samsung TLC V3 VNAND
VSFN223T84WCGWSM	PCIe/NVMe	Client PM963	3840 GB	N	Single	(0 to +70'c)	Samsung TLC V3 VNAND
VSFN227T68WCGWSM	PCIe/NVMe	Client PM963	7680 GB	N	Single	(0 to +70'c)	Samsung TLC V3 VNAND

Notes:

1. Usable capacity based on a level of over-provisioning applied to wear leveling, bad sectors, index tables etc.
2. SSD's ship unformatted from the factory unless otherwise requested.
3. 1 GB = 1,000,000,000 Byte
4. One Sector = 512 Byte.

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Product Picture(s)

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1 Introduction

Viking's 2.5 inch SSD presents outstanding performance with instant responsiveness to the host system, by applying the Peripheral Component Interconnect Express (PCIe) 3.0 interface standard, as well as highly efficient Non-Volatile Memory Express (NVMe) Protocol.

The Viking's 2.5 inch SSD delivers wide bandwidth of up to 2000 MB/s for sequential read speed and up to 1200 MB/s for sequential write speed under 7W of power. With the help of Toggle 2.0 NAND Flash interface, the Viking's 2.5 inch SSD delivers random performance of up to 430K IOPS for random 4KB read and up to 40K IOPS for random 128KB write in the sustained state.

By combining the enhanced reliability of NAND Flash memory silicon with NAND Flash management technologies, the Viking's 2.5 inch SSD delivers the extended endurance suitable for enterprise applications, in 2.5 inch form factor.

In addition, the Viking's 2.5 inch SSD supports Power Loss Protection that can guarantee that data issued by the host system are written to the storage media without any loss in the event of sudden power off or sudden power failure. Inrush current handler can protect the internal components from the electrical and physical damages.

1.1 Features

The SSD delivers the following features:

- Native-PCIe SSD for enterprise application
- LPDDR3 DRAM Buffer Memory
- PCI Express Gen3: Single port X4 lanes
- Compliant with PCI Express Base Specification Rev. 3.0
- Compliant with NVM Express Specification Rev.1.1a
- Enhanced Power-Loss Data Protection
- End-to-End Data Protection
- Support SSD Enhanced S.M.A.R.T. Feature Set
- Static and Dynamic Wear Leveling
- RoHS / Halogen-Free Compliant

1.2 PCIE Interface

- PCI Express Gen3:
- Compliant with PCI Express Base Specification Rev. 3.0
- Compliant with NVM Express Specification Rev.1.1a

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

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
512	480	937,703,088
512	512	1,000,215,216
na	800	1,562,824,368
1024	960	1,875,385,008
1024	1024	2,000,409,264
na	1600	3,125,627,568
2048	1920	3,750,748,848
2048	2048	4,000,797,360
4000	3200	6,251,233,968
4000	3840	7,501,476,528

Notes:

1. Per www.idema.org, 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

Access Type	960 GB	1920 GB	3840 GB
Sequential Read, 256K, MB/s	Up to 1800	Up to 2000	Up to 2000
Sequential Write, 256K, MB/s	Up to 930	Up to 1200	Up to 1200

Notes:

1. Based on PCI Express Gen3 x4, Random performance measured using FIO 2.1.3 in Linux RHEL 6.5(Kernel 2.6.32) with queue depth 32 by 4 workers and Sequential performance with queue depth 32 by 1 worker. Actual performance may vary depending on use conditions and environment.
2. Refer to Application Note AN0006 for Viking SSD Benchmarking Methodology.
3. Tested on Oakgate at 100% entropy

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

Access Type	960 GB	1920 GB	3840 GB
Read, 4K, IOPS	Up to 350K	Up to 430K	Up to 430K
Write, 4K, IOPS	Up to 30K	Up to 40K	Up to 40K

Notes:

1. Based on PCI Express Gen3 x4, Random performance measured using FIO 2.1.3 in Linux RHEL 6.5(Kernel 2.6.32) with queue depth 32 by 4 workers and Sequential performance with queue depth 32 by 1 worker. Actual performance may vary depending on use conditions and environment.
2. Refer to Application Note AN0006 for Viking SSD Benchmarking Methodology
3. Tested on Oakgate at 100% entropy

2.3 Timing / Latency

Table 2-3: Timing Specifications

Type	960, 1920 (GB)	3840 GB
Random Read/Write Latency	85/50 us	85/50 us
Sequential Read/Write Latency	15/15 us	15/15 us
Power On Ready (POR), Drive Ready Time, 3840 GB	10 sec	20 sec

Notes:

1. The random latency is measured by using FIO 2.1.3 in Linux RHEL 6.5(Kernel 2.6.32) and 4KB transfer size with queue depth 1 by 1 worker
2. The sequential latency is measured by using FIO 2.1.3 in Linux RHEL 6.5(Kernel 2.6.32) and 4KB transfer size with queue depth 1 by 1 worker

2.4 Quality of Service (QoS)

Quality of Service (99%)	Unit	QD=1	QD=32
Read(4KB)	ms	0.1	0.3
Write(4KB)	ms	0.06	1.5

Quality of Service (99.99%)	Unit	QD=1	QD=32
Read(4KB)	ms	0.2	0.6
Write(4KB)	ms	0.08	1.6

Notes:

1. QoS is measured using Fio 2.1.3 (99 and 99.99%) in Linux RHEL 6.5 (Kernel 2.6.32) with queue depth 1, 32 on 4KB random read and write.
2. QoS is measured as the maximum round-trip time taken for 99 and 99.99% of commands to host

.

2.5 Electrical Characteristics

2.5.1 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.

2.5.2 Supply Voltage

The operating voltage is 12V

Table 2-4: Operating Voltage

Description	Min	Max	Unit
Operating Voltage for 12 V (+/- 8%)	- 8%	+ 8%	V

2.5.3 Power Consumption

All onboard power requirements of the SSD are derived from the PCIe 12V rail.

Table 2-5: Typical Power Consumption at 12V

Capacity	Active Read (max RMS)	Active Write (max RMS)	Idle (typ.)
3200GB	7.3 W	7.0 W	2.5 W
1920GB	6.8 W	6.4 W	2.5 W
960GB	6.7 W	6.3 W	2.5 W

Notes:

1. Power consumption was measured in the 12V power pins of the connector plug in SSD. The active and idle power is defined as the highest averaged power value, which is the maximum RMS average value over 100 ms duration.
2. The measurement condition for active power is assumed for 100% sequential read and write.
3. The idle state is defined as the state that the host system can issue any commands into SSD at any time.

2.6 Environmental Conditions

2.6.1 Temperature and Altitude

Table 2-6: Temperature and Altitude Related Specifications

Conditions	Operating	Shipping	Storage
Commercial Temperature- Case [1]	0 to 70°C	-40 to 85°C	-40 to 85°C
Humidity (non-condensing)	-	95% under 65C, 500hrs	95% under 65C

Notes:

1. Tc is measured at the surface of NAND Flash package

2.6.2 Shock and Vibration

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

Table 2-7: Shock and Vibration Specifications

Stimulus	Description
Shock(non-operating)	1500G (0.5ms duration x,y,z with 1/2 sine wave)
Vibration (non-operating)	20 G (20min /axis on 3 axes) (10 ~ 2,000 Hz, Sinusoidal)

2.6.3 Electromagnetic Immunity

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

2.7 Reliability

Table 2-8: Reliability Specifications

Parameter	Description		
Uncorrectable Bit Error Rate	1 sector per 10^{17} bits read		
MTBF	2,000,000 hours		
Read Endurance	Unlimited		
Write Endurance	**960GB**	**1924GB**	**3840GB**
	1366 TBW	2733 TBW	5466 TBW
Drive Write per day	1.3 DWPD over 3 years		
Data retention	> 90 days at NAND expiration		

Notes:
1. The reliability specification follows JEDEC standards JESD218A and JESD219A
2. TBW=(GB capacity x DWPD x 365 x years)/1000

2.8 Data Security

2.8.1 Power Loss Protection

By using internal back-up power technology, the Viking SSD supports power loss protection feature to guarantee the reliability of data requested by the host system. When power is unpredictably lost, the SSD can detect automatically this abnormal situation and transfer all user data and meta-data cached in DRAM into the Flash media during any SSD operations.

2.8.2 Sudden Power Off and Recovery

If power interruption is detected, the SSD dumps all cached user data and meta data to NAND Flash. The SSD could protect even the user data in DRAM from sudden power off while SSD is used with cache on. Commonly, data is protected all of the operation period.

2.8.2.1 Time to Ready Sequence

In normal power-off recovery status, the SSD needs less than 11 seconds to reach operating mode where SSD works perfectly with cache-on state. SSD is ready to respond identify Device command during FTL OPEN. When the sudden power-off occurs, the user data in DRAM will be dumped into the NAND Flash using the stored power in the capacitor. In sudden power-off recovery condition, mapping data will be loaded or the FTL meta data be rebuilt perfectly for initial max. 30 seconds in case of 960GB. During this period, Identify Device command is still supported. This is called Sudden Power Off and Recovery.

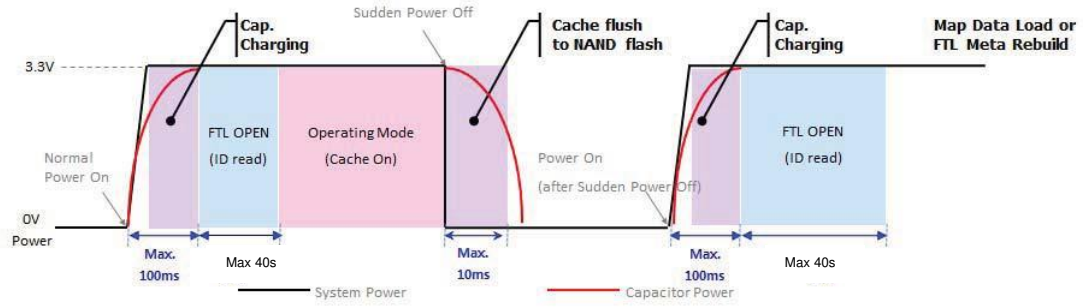

Figure 2-1: Sudden Power on-off operation

FTL Open time

	960GB
FTL open (ID read)	30 sec

3 Mechanical Information

3.1 Dimensions

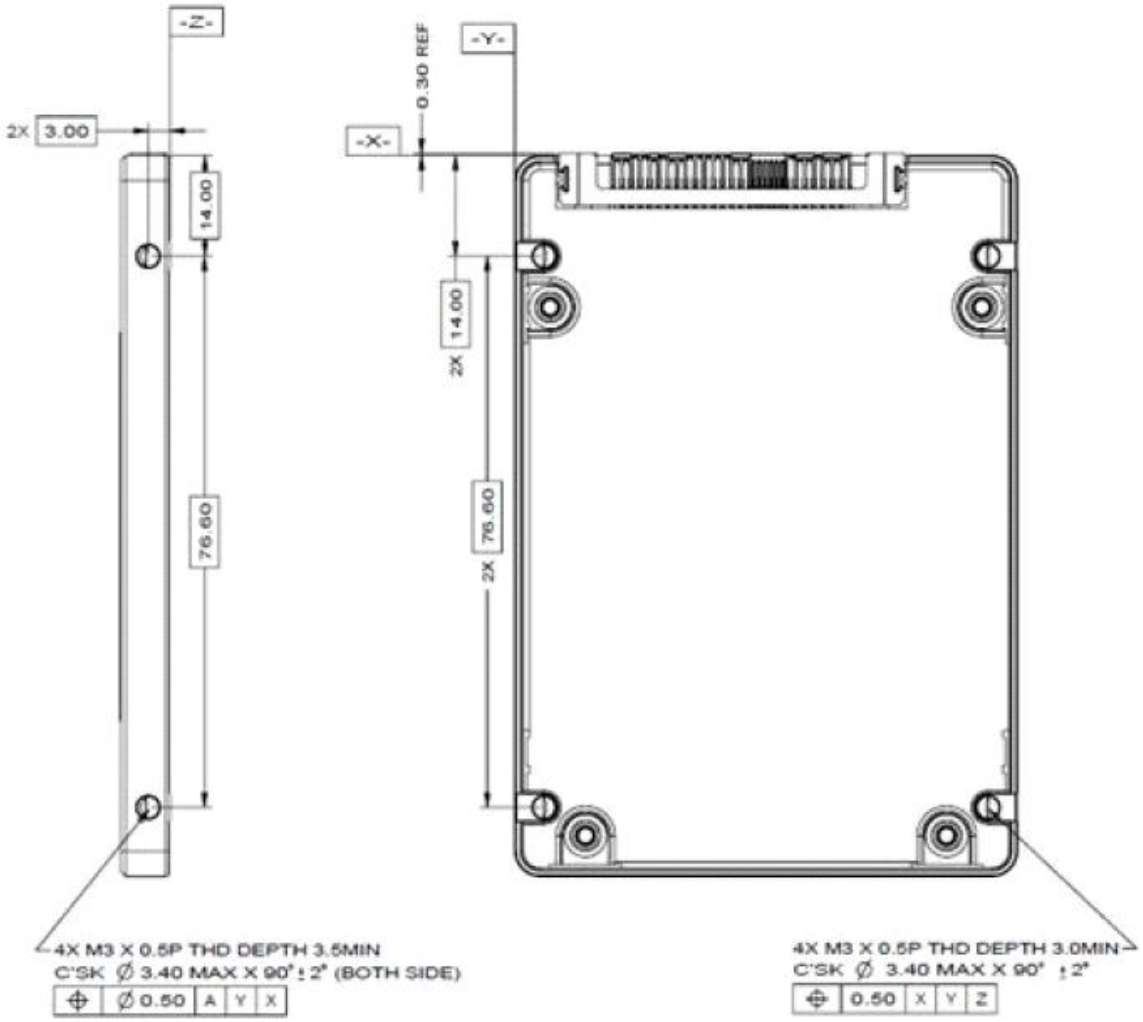

Figure 3-1: SDD Dimensions

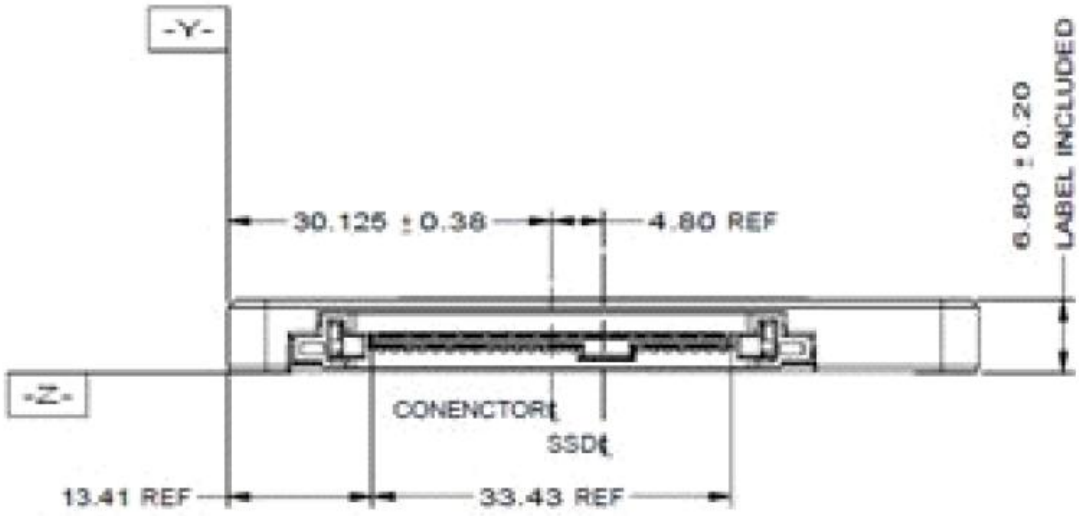

Figure 3-2: SDD Dimensions, Side View

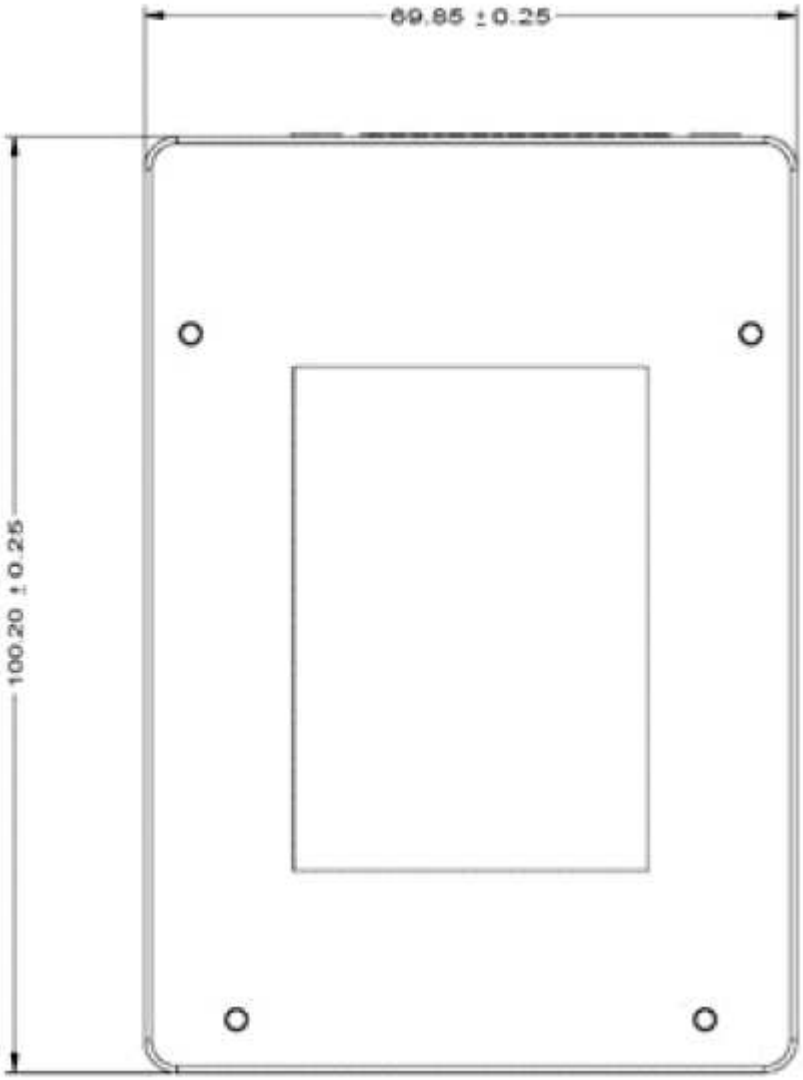

Figure 3-3: SDD Dimensions, Top View 1

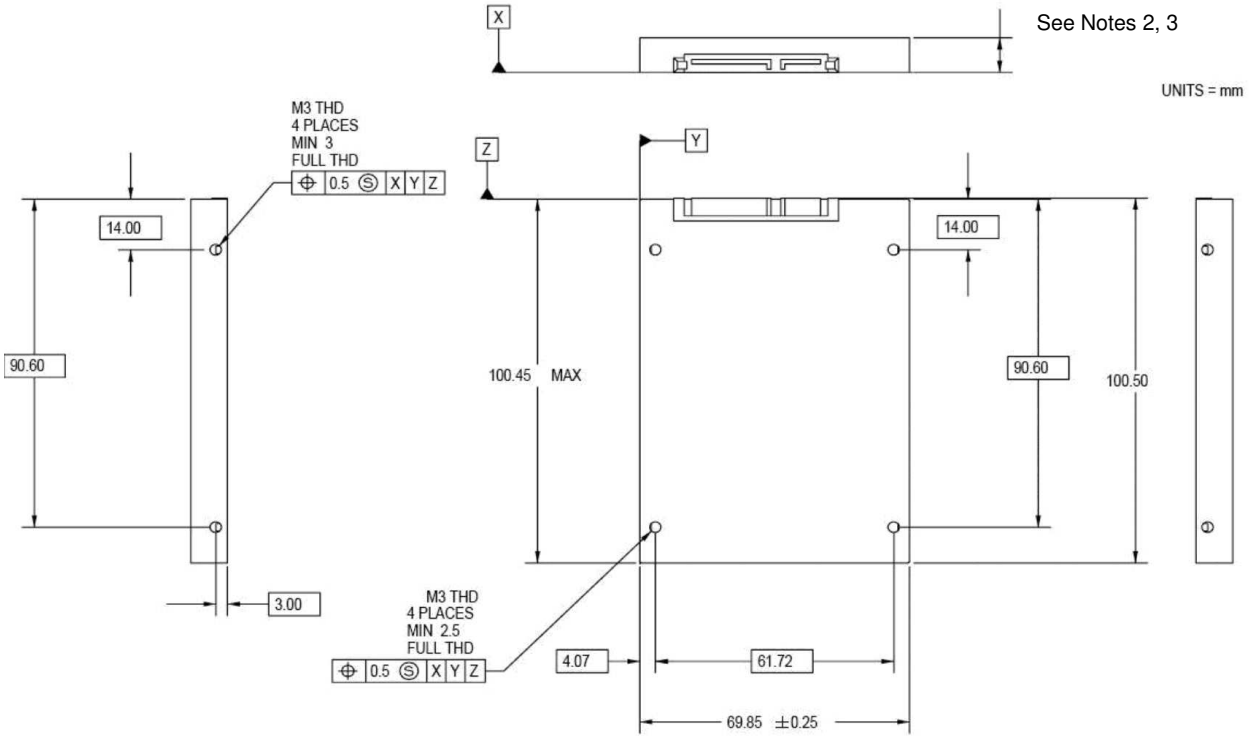

Figure 3-4: Dimensions

Notes:

1. All dimensions are in millimeter. General tolerance is ± 0.15.

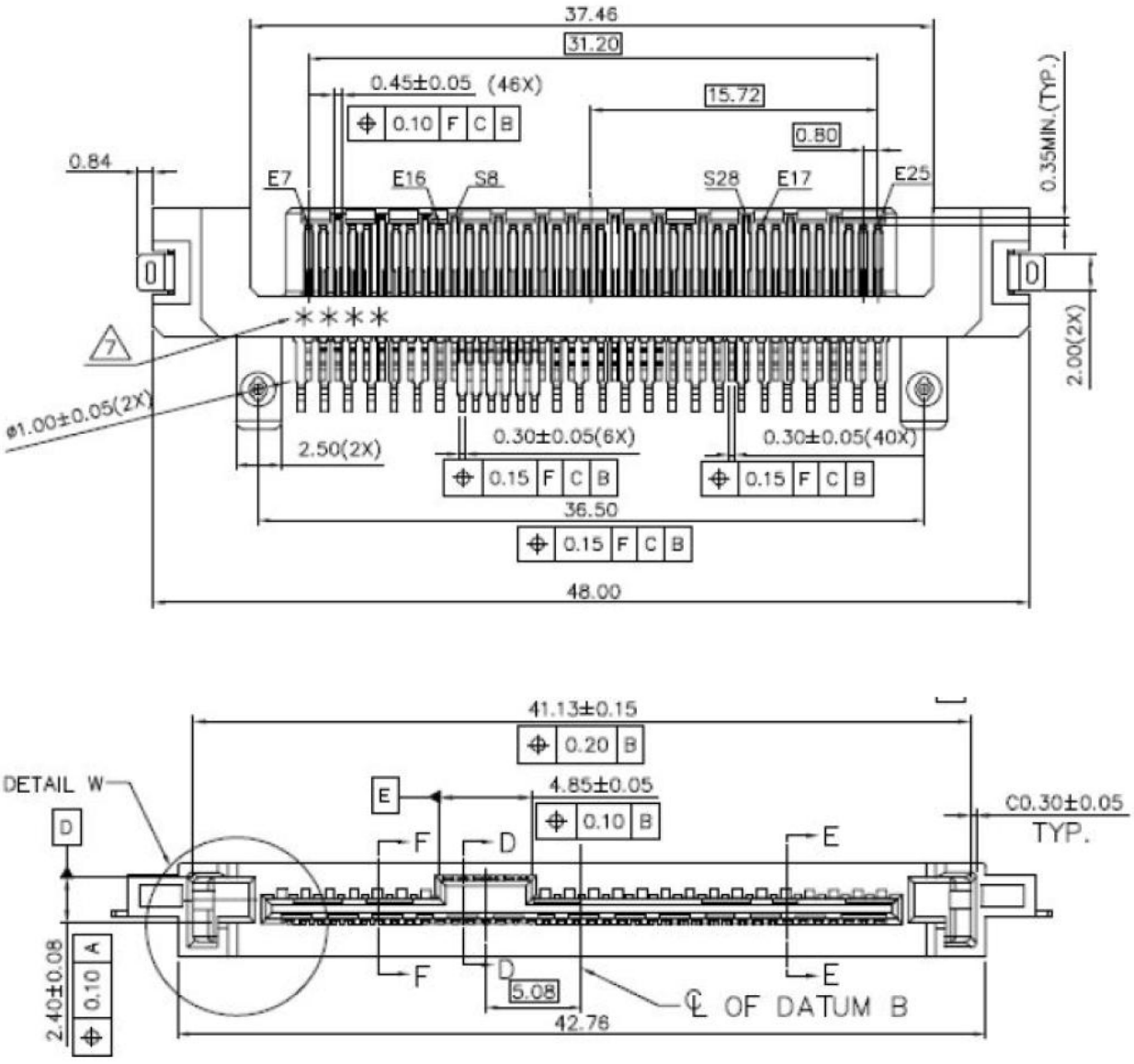

Figure 3-5: Dimension Details for 2.5 inch connector

Notes:

1. FOXCONN connector

3.2 2.5 inch SSD Weight

Table 3-1: 2.5 inch SSD weight

Weight	Unit of measure
Up to 70	Grams

4 Pin and Signal Descriptions

4.1 Signal and Power Description Tables

Table 4-1: 2.5 inch PCIE Connector Pinouts

Pin #	Assignment	Description	Pin #	Assignment	Description
S1	GND	Ground	E7	RefClk0+	PCIe Reference Clock +
S2	Not Used	Floated	E8	RefClk0	PCIe Reference Clock
S3	Not Used		E9	GND	Ground
S4	GND	Ground	E10	PETp0	PCIe Transmit+ (lane 0)
S5	Not Used		E11	PETn0	PCIe Transmit- (lane 0)
S6	Not Used		E12	GND	Ground
S7	GND	Ground	E13	PERn0	PCIe Receive- (lane 0)
E1	REFCLK1+	Grounded	E14	PERp0	PCIe Receive+ (lane 0)
E2	REFCLK1	Grounded	E15	GND	Ground
E3	3.3V AUX		E16	Not Used	
E4	ePERST1#	Floated	S8	GND	Ground
E5	ePERST0#		S9	Not Used	
E6	RSVD		S10	Not Used	
P1	Not Used		S11	GND	Ground
P2	Not Used		S12	Not Used	
P3	Not Used		S13	Not Used	

Pin #	Assignment	Description	Pin #	Assignment	Description
P4	IfDet #	Grounded	S14	GND	Ground
P5	GND	Ground	S15	Not Used	
P6	GND	Ground	S16	GND	Ground
P7	Not Used		S17	PETp1	PCIe Transmit+ (lane 1)
P8	Not Used		S18	PETn1	PCIe Transmit- (lane 1)
P9	Not Used		S19	GND	Ground
P10	PRSNT #	Presence	S20	PERn1	PCIe Receive- (lane 1)
P11	Activity	Drive Active	S21	PERp1	PCIe Receive+ (lane 1)
P12	GND	Ground	S22	GND	Ground
P13	12 V	Primary Power	S23	PETp2	PCIe Transmit+ (lane 2)
P14	12 V	Primary Power	S24	PETn2	PCIe Transmit- (lane 2)
P15	12 V	Primary Power	S25	GND	Ground
			S26	PERn2	PCIe Receive- (lane 2)
			S27	PERp2	PCIe Receive+ (lane 2)
			S28	GND	Ground
			E17	PETp3	PCIe Transmit+ (lane 3)
			E18	PETn3	PCIe Transmit- (lane 3)
			E19	GND	Ground
			E20	PERn3	PCIe Receive- (lane 3)
			E21	PERp3	PCIe Receive+ (lane 3)
			E22	GND	Ground
			E23	SMClk	SMBus Clock
			E24	SMDat	SMBus Data
			E25	DualPortEn#	