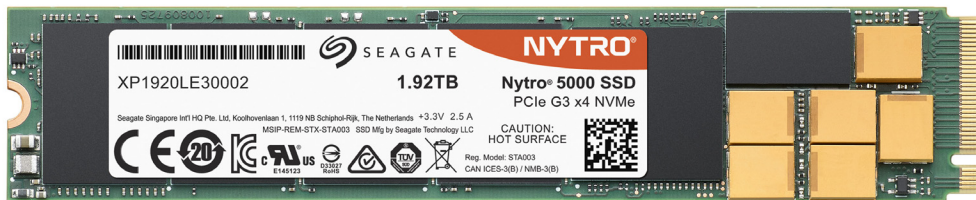# Seagate® Nytro® 5000

PCIe® Gen 3 x4 - NVMe M.2
Product Manual

100810195, Rev.D
October 2017

Document Revision History

Revision	Date	Pages affected and description of change
Rev. D	October 2017	■ Updated Section 4.4.3 Taiwan Requirements — Taiwan RoHS.
Rev. C	October 2017	■ Updated product image. ■ Updated Section 4.0 Standards and Reference Documents.
Rev. B	August 2017	■ Changed "Peak" to "Sustained" in Table 2 Performance on page 5. ■ Updated Section 1.7 Environmental Conditions to include notes on storage conditions.
Rev. A	June 2017	Initial release.

Contents

Seagate Technology Support Services

For Nytro Support, visit: http://www.seagate.com/support/by-product/ssd-and-pcie-flash/

For information regarding online support and services, visit: http://www.seagate.com/contacts/

Available services include:

- Presales & Technical support
- Global Support Services telephone numbers & business hours
- Authorized Service Centers

For information regarding Warranty Support, visit: http://www.seagate.com/support/warranty-and-replacements/

For information regarding data recovery services, visit:
http://www.seagate.com/services-software/seagate-recovery-services/recover/

For Seagate OEM and Distribution partner and Seagate reseller portal, visit: http://www.seagate.com/partners

1.0   Scope

Seagate Nytro 5000 is a PCIe Gen 3 SSD, designed with the NVMe (Non-Volatile Memory Express) interface that delivers leading performance, low latency, and world class reliability and endurance.

- **Interface**:
    - PCIe Gen 3 x4 NVMe SSD
    - Out of Band Management (SMBus) management support
    - See Section 1.6 for details.
- **Capacities**:
    - 400GB, 480GB, 800GB, 960GB, 1.6TB, 1.92TB
    - See Section 1.2 for details.
- **Components**:
    - 3D cMLC NAND Flash Memory
- **Form Factor**:
    - M.2 - 22110
- **Power**
    - Lower power than current Enterprise class products (<8.25W)
    - Power Loss Data Protection (PLDP)
    - See Section 1.4 and Section 1.5 for details.
- **Shock**
    - Non-Operating: 1500G @ 0.5ms (Gs)
- **Vibration**
    - Operating: 3.08 G_{RMS} (5-800 Hz)
    - Non-Operating: 3.00 G_{RMS} (5-500 Hz)
- **Certification**
    - CE, BSMI, KCC, C-Tick, FCC, IC, UL, TUV, CB
- **Product Compliance**
    - RoHS

- **Reliability:**
    - Mean Time Between Failure (MTBF): 2 million hours
    - Data Retention: 3 months @ 40°C
    - Sector Sizes: 4096 and 512 bytes
    - Non-recoverable Read Errors per bits read: 1 per 10E16
    - See Section 1.8 for details.
- **Endurance**
    - High Endurance models support up to 1.5 Drive Writes/day
    - Light Endurance models support up to 0.3 Drive Writes/day
    - See Section 1.9 for details.
- **Temperature**
    - Operating: 0 to 70°C (as measured by SMART)
    - Non Operating: -40 to 85°C
    - See Section 1.7 for details.
- **Airflow**
    -
    - 600 LFM for 400GB and 480GB.
    - 830 LFM for 800GB, 960GB, 1600GB and 1920GB.
    - See Section 1.7 for details.
- **Performance**
    - Varies by capacity and endurance. See Section 1.3 for details.
- **Security**
    - Self encryptions available
- **Warranty**
    - 5 years limited

1.1   Product Specifications

1.2   Models and Capacity

Table 1   Nytro 5000 M.2 512 Sector Models and Capacities

Formatted Capacity	Standard M.2 - 22110 Models	SED M.2 - 22110 Models	512 bytes LBA Count
Target Application: Mixed Workloads			
400GB	XP400HE30002	XP400HE30012	781,422,768
800GB	XP800HE30002	XP800HE30012	1,562,824,368
1600GB	XP1600HE30002	XP1600HE30012	3,125,627,568
Target Application: Read-Intensive Workloads			
480GB	XP480LE30002	XP480LE30012	937,703,088
960GB	XP960LE30002	XP960LE30012	1,875,385,008
1920GB	XP1920LE30002	XP1920LE30012	3,750,748,848

1.3   Performance

Table 2   Performance

Specification	400GB	800GB	1600GB	480GB	960GB	1.92TB	1600GB	1920GB
Sequential Read (MB/s) Sustained, 128KB	2000	2000	2000	2000	2000	2000	2040	2040
Sequential Write (MB/s) Sustained, 128KB	1200	1200	1200	1200	1200	1200	870	870
Random Read (IOPS) Sustained, 4KB QD64	240,000	245,000	245,000	240,000	245,000	245,000	242,000	242,000
Random Write (IOPS) Sustained, 4KB QD64	55,000	62,000	67,000	24,000	27,000	30,000	64,000	110,000
Random 70/30 R/W (IOPS) Sustained, 4KB QD64	110,000	135,000	143,000	67,000	77,000	87,000	163,000	224,000

NOTE   More information on Performance:

- In certain performance metrics, performance of lower capacities are limited based on the number of active dies.

- **IOMeter:** Performance results are based on IOMeter. IOMeter is available at http://sourceforge.net/projects/iometer/. IOMeter is licensed under the Intel Open Source License and the GNU General Public License.

- **Response times:** Typical response times are measured under nominal conditions of temperature and voltage as measured on a representative sample of drives.

- **Measurements:** Measurements are performed on the drive after the workload reaches steady state, including all background activities required for normal operations.

1.4   Power Consumption

The M.2 - 22110 drive receives DC power (+3.3V) through the standard M.2 interface.

Table 3   DC Requirements

Supply Voltage	M.2 - 22110
Voltage Tolerances - nominal (%)	3.3V ± 5%
DC Ripple/Noise	100mVpp max: 10Hz – 30MHz
Rise Time (Max*/Min) *10% ~ 90% Nominal Voltage	5ms* /235µs
Fall Time (Min)	100µs @ 1A max discharge
Minimum Off Time	150ms
Inrush Current (Typical Peak)	1.2A for <15ms

Table 4   Power

Specification	M.2
Max Operating Power (W)	8.25
Power State 1 (W)	6.0

NOTE   Here is more information on Power:

- NVMe Autonomous Power States are not supported.

- Typical power measurements are based on an average of drives tested under nominal conditions.

- Maximum power is defined as RMS over 100ms.

1.5   Power Loss Data Protection

The drives implement an energy storage solution called Power Loss Data Protection. This circuit maintains power to the NAND while the NAND is being programmed, even if power to the system is interrupted. Power loss data protection ensures data integrity, and prevents loss of data and the resulting errors reporting back to the host.

1.6 Out of Band Management (SMBus)

The provides sub-system management data to the host over the SMBus interface at 0x6A.

Table 5 Out of Band Management (SMBus) Protocol

Command Code	Offset (byte)	Description
0	00	**Length of Status:** Indicates number of additional bytes to read before encountering PEC. This value should always be 6 (06h) in implementations of this version of the spec.
	01	**Status Flags (SFLGS):** This field indicates the status of the NVM subsystem. **SMBus Arbitration** – Bit 7 is set '1' after a SMBus block read is completed all the way to the stop bit without bus contention and cleared to '0' if a SMBus Send Byte FFh is received on this SMBus slave address. **Drive Not Ready** – Bit 6 is set to '1' when the subsystem cannot process NVMe management commands, and the rest of the transmission may be invalid. If cleared to '0', then the NVM subsystem is fully powered and ready to respond to management commands. This logic level intentionally identifies and prioritizes powered up and ready drives over their powered off neighbors on the same SMBus segment. **Drive Functional** – Bit 5 is set to '1' to indicate an NVM subsystem is functional. If cleared to '0', then there is an unrecoverable failure in the NVM subsystem and the rest of the transmission may be invalid. **Reset Not Required** - Bit 4 is set to '1' to indicate the NVM subsystem does not need a reset to resume normal operation. If cleared to '0' then the NVM subsystem has experienced an error that prevents continued normal operation. A controller reset is required to resume normal operation. **Port 0 PCIe Link Active** - Bit 3 is set to '1' to indicate the first port's PCIe link is up (i.e., the Data Link Control and Management State Machine is in the DL_Active state). If cleared to '0', then the PCIe link is down. **Port 1 PCIe Link Active** - Bit 2 is set to '1' to indicate the second port's PCIe link is up. If cleared to '0', then the second port's PCIe link is down or not present. Bits 1-0 shall be set to '1'.
	02	**SMART Warnings:** This field shall contain the Critical Warning field (byte 0) of the NVMe SMART / Health Information log. Each bit in this field shall be inverted from the NVMe definition (i.e., the management interface shall indicate a '0' value while the corresponding bit is '1' in the log page). See the NVMe specification for bit definitions. If there are multiple controllers in the NVM subsystem, the management endpoint shall combine the Critical Warning field from every controller such that a bit in this field is: Cleared to '0' if any controller in the subsystem indicates a critical warning for that corresponding bit. Set to '1' if all controllers in the NVM subsystem do not indicate a critical warning for the corresponding bit.
	03	**Composite Temperature (CTemp):** This field indicates the current temperature in degrees Celsius. If a temperature value is reported, it should be the same temperature as the Composite Temperature from the SMART log of hottest controller in the NVM subsystem. The reported temperature range is vendor specific, and shall not exceed the range -60 to +127°C. The 8 bit format of the data is shown below. This field should not report a temperature when that is older than 5 seconds. If recent data is not available, the NVMe management endpoint should indicate a value of 80h for this field. <table><tr><td>Value</td><td>Description</td></tr><tr><td>00h-7Eh</td><td>Temperature is measured in degrees Celsius (0 to 126C)</td></tr><tr><td>7Fh</td><td>127C or higher</td></tr><tr><td>80h</td><td>No temperature data or temperature data is more the 5 seconds old.</td></tr><tr><td>81h</td><td>Temperature sensor failure</td></tr><tr><td>82h-C3h</td><td>Reserved</td></tr><tr><td>C4</td><td>Temperature is -60C or lower</td></tr><tr><td>C5-FFh</td><td>Temperature measured in degrees Celsius is represented in twos complement (-1 to -59C)</td></tr></table>
	04	**Percentage Drive Life Used (PDLU):** Contains a vendor specific estimate of the percentage of NVM subsystem NVM life used based on the actual usage and the manufacturer's prediction of NVM life. If an NVM subsystem has multiple controllers the highest value is returned. A value of 100 indicates that the estimated endurance of the NVM in the NVM subsystem has been consumed, but may not indicate an NVM subsystem failure. The value is allowed to exceed 100. Percentages greater than 254 shall be represented as 255. This value should be updated once per power-on hour and equal the Percentage Used value in the NVMe SMART Health Log Page.
	06 : 05	**Reserved:** Shall be set to 0000h.
	07	**PEC:** An 8 bit CRC calculated over the slave address, command code, second slave address and returned data. Algorithm is in SMBus Specifications.

Table 5 Out of Band Management (SMBus) Protocol *(continued)*

Command Code	Offset (byte)	Description
8	08	**Length of identification:** Indicates number of additional bytes to read before encountering PEC. This value should always be 22 (16h) in implementations of this version of the spec.
	10 : 09	**Vendor ID:** The 2 byte vendor ID, assigned by the PCI SIG. Should match VID in the Identify Controller command response. MSB is transmitted first.
	30 : 11	**Serial Number:** 20 characters that match the serial number in the NVMe Identify Controller command response. First character is transmitted first.
	31	**PEC:** An 8 bit CRC calculated over the slave address, command code, second slave address and returned data. Algorithm is in SMBus Specifications.
32+	255 : 32	Vendor Specific: This data structure shall not exceed the maximum read length of 255 specified in the SMBus version 3 specification. Preferably length is not greater than 32 for compatibility with SMBus 2.0, additional blocks shall be on 8 byte boundaries.

NOTE   You can find a description of sub-system management data to the host over the SMBus interface in the *NVM Expresss Management Interface 1.0.*

1.6.1   Vital Product Data (VPD)

Vital Product Data (VPD) is the information that uniquely defines elements of a system. It provides the system with information such as Part Number and Serial Number. The drives store VPD in the PCIe config space, which can be structured to meet any customer requirements. An example of a VPD structure is shown in the following table:

Table 6   VPD Example

Offset	Item	Value
0	Large Resource Type ID String Tag(0 x02)	0x82 "Product Name"
1	Length	0x0021
3	Data	ABCD Super-Fast Widget Controller"
36	Large Resource Type VPD-R Tag (0x10)	0x90
37	Length	0x0059
39	VPD Keyword	"PN"
41	Length	0x08
42	Data	"6181682A"
50	VPD Keyword	"EC"
52	Length	0x0A
53	Data	"4950262536"
63	VPD Keyword	"SN"
65	Length	0x08
66	Data	"00000194"
74	VPD Keyword	"MN"
76	Length	0x04
77	Data	"1037"
81	VPD Keyword	"RV"
83	Length	0x2C
84	Data	Checksum
85	Data	Reserved (0x00)
128	Large Resource Type VPD-W Tag (0x11)	0x91
129	Length	0x007E
131	VPD Keyword	"V1"
133	Length	0x05
134	Data	"65A01"

Table 6   VPD Example

Offset	Item	Value
139	VPD Keyword	"Y1"
141	Length	0x0D
142	Data	"Error Code 26"
155	VPD Keyword	"RW"
157	Length	0x61
158	Data Reserved	(0x00)
255	Small Resource Type End Tag (0xF)	0x78

1.7   Environmental Conditions

Table 7   Temperature and Humidity

Specification		Temperature / Humidity
Temperature (°C)	Operating (as measured by SMART) Non-Operating	0 to 70 -40 to 85[1]
Temperature Gradient Maximum	Operating Non-Operating	30°C/hr 30°C/hr
Humidity	Operating Non-Operating	5%-95% 5%-95%

NOTE   1. Limited to shelf life while product is still in the shipping package.

1.7.1   Storage

You can store the drive for a maximum of 180 days in the original unopened Seagate shipping package or 60 days, unpackaged, in the defined non-operating limits (See Table 7, Temperature and Humidity). You can extend storage to 1 year packaged or unpackaged under optimal environmental conditions (<40°C, <40% relative humidity non-condensing, and non-corrosive environment).

Table 8   Shock

Specification		Shock
Shock - Maximum	Non Operating	1500 G at 0.5 ms

NOTE   Specification does not cover connection issues that might result from testing at this level.

   ■   **Operating shock:** The drive, as installed for normal operation, operates error free while subjected to intermittent shock not exceeding the specification. Shock may be applied in the X, Y, or Z-axis. Shock is not to be repeated more than once every 2 seconds.

   ■   **Non-Operating shock:** The limits of non-operating shock apply to all conditions of handling and transportation. This includes isolated drive and integrated drives. Shock may be applied in the X, Y, or Z-axis.

Table 9   Vibration

Specification		Vibration
Vibration - Profile	Operating	3.08 G_{RMS} (5-800 Hz)
Vibration - Profile	Non-Operating	3.00 G_{RMS} (5-500 Hz)

NOTE   More information on Vibration:

- **Operating vibration:** The drive, as installed for normal operation, shall operate error free while subjected to specified vibration not exceeding specification. Vibration may be applied in the X, Y, or Z-axis.

- **Non-Operating vibration:** The limits of non-operating vibration shall apply to all conditions of handling and transportation. This includes both isolated drive and integrated drives. Vibration may be applied in the X, Y, or Z-axis.

Table 10 Airflow Requirements

Airflow Definition	Unit	Ambient Temperature	400GB/480GB	800GB/960GB/ 1600GB/1920GB
Airflow Along Drive	LFM	35°C	600	830

NOTE   More information on Airflow:

- This value is for uniform laminar flow. This might reduce by 50% in case of turbulent air flow environment.

- **Airflow approach** is from thermal ground screw to M-key connector. No heat sinks are used in this specification.

- **Thermal throttling** is activated to protect critical components from damage. The host observes a reduction in power and therefore performance until PCB temperature lowers. When the PCB temperature decreases to an acceptable temperature, thermal throttling deactivates, and performance returns to normal.

1.8   Reliability

Table 11 Reliability

Specification	Reliability Data
Mean Time Between Failures (MTBF)	2 million hours
Data Retention	3 months @ 40°C
Non-recoverable Read Errors per bits read	1 per 10E16

NOTE   Here is more information on Reliability:

- **MTBF** specification is based on these assumptions for Enterprise Storage System environments: 8760 power on hours per year, 250 power on/off cycles per year, and nominal voltages. The drive achieves specified MTBF when operating in an environment that ensures the case temperatures do not exceed the temperature specifications.

- **Data Retention** is the time that NAND retains data at maximum rated endurance

1.9   Endurance

Table 12 High Capacity Models

Capacity	Model	SED/Standard	Endurance - Drive Writes Per Day
480GB	XP480LE30002	Standard	0.3
	XP480LE30012	SED	0.3
960GB	XP960LE30002	Standard	0.3
	XP960LE30012	SED	0.3
1920GB	XP1920LE30002	Standard	0.3
	XP1920LE30012	SED	0.3

Table 13 High Endurance Models

Capacity	Model	SED/Standard	Endurance - Drive Writes Per Day
400GB	XP400HE30002	Standard	1.5
	XP400HE30012	SED	1.5
800GB	XP800HE30002	Standard	1.5
	XP800HE30012	SED	1.5
1600GB	XP1600HE30002	Standard	1.5
	XP1600HE30012	SED	1.5

NOTE   Endurance rating is the expected amount of host data that can be written by product when subjected to a specified workload at a specified operating and storage temperature over the specified product life. For the specific workload to achieve this level of endurance, *please refer to JEDEC Specification JESD218*. Terabyte Writes is defined as 1x1012 Bytes.

2.0   Mechanical Information

2.1   Mechanical Dimensions and Weight - M.2 - 22110 Models

Weight: 0.49 ounces, 14 grams

Z-Height: Top side z-height is 2.0mm maximum

TYPE 22110-D2-M
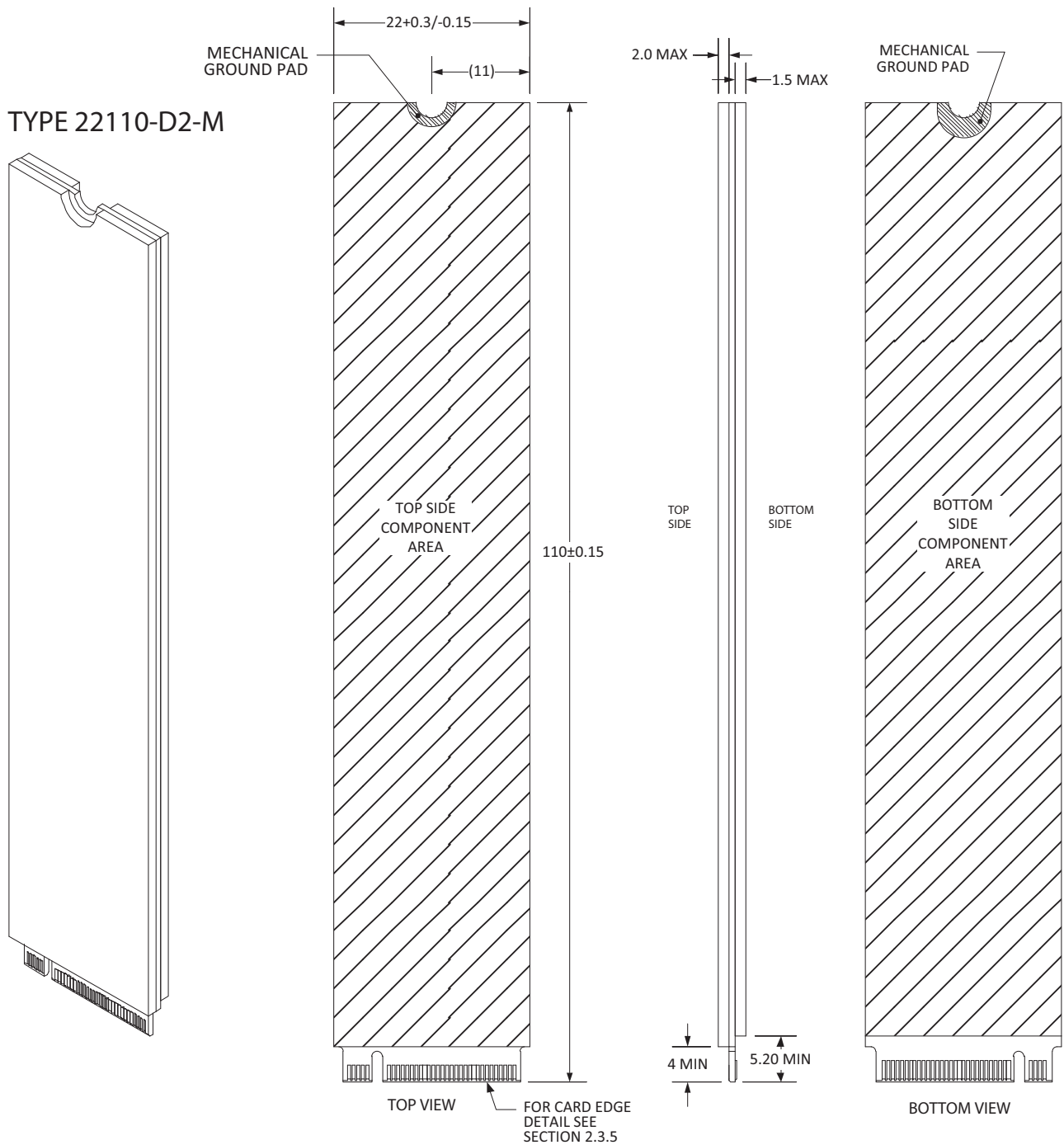
2.2   M.2 Device Plug Descriptions
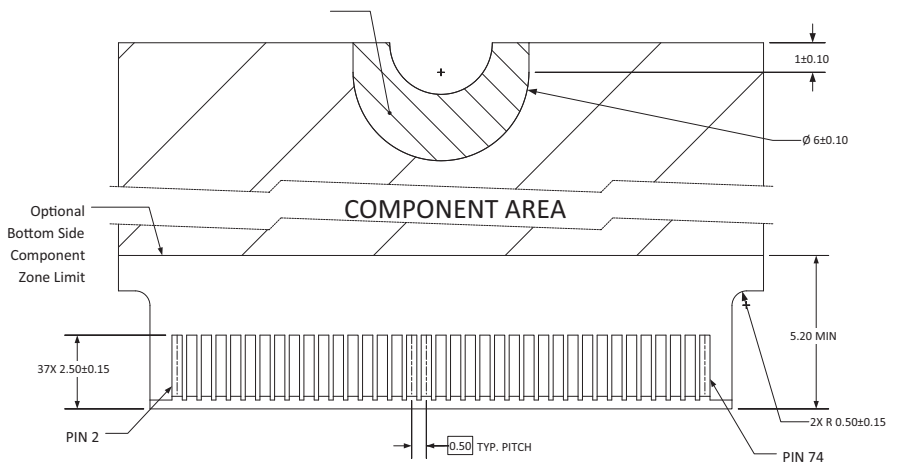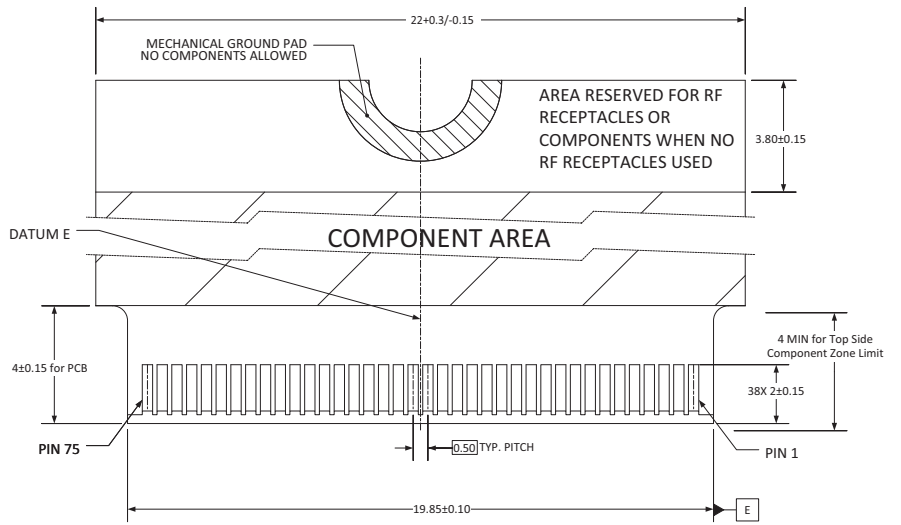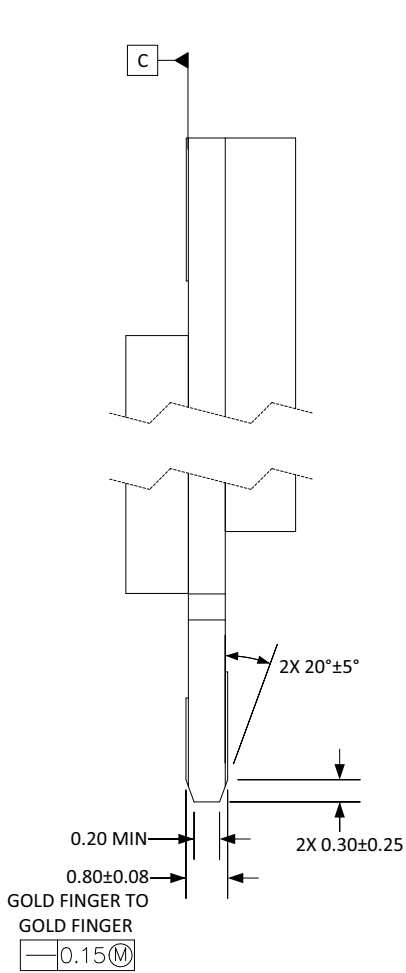
2.2.1   M.2 Pin-out

Pin	Description	Description	Pin
74	3.3V	GND	75
72	3.3V	GND	73
70	3.3V	GND	71
68	N/C	N/C	69
66	Module Key	N/C	67
64		Module Key	65
62			63
60			61
58	MFG reserved		59
56	MFG reserved	GND	57
54	N/C	RefClkp	55
52	CLKREQ# (I/O)(0/3.3V)	RefClkn	53
50	PERST# (I)(0/3.3V)	GND	51
48	N/C	PERp0	49
46	N/C	PERn0	47
44	ALERT# (O)	GND	45
42	SMB_DATA (I/O)	PETp0	43
40	SMB_CLK (I/O)	PETn0	41
38	N/C	GND	39
36	N/C	PERp1	37
34	N/C	PERn1	35
32	N/C	GND	33
30	N/C	PETp1	31
28	N/C	PETn1	29
26	N/C	GND	27
24	N/C	PERp2	25
22	N/C	PERn2	23
20	N/C	GND	21
18	3.3V	PETp2	19
16	3.3V	PETn2	17
14	3.3V	GND	15
12	3.3V	PERp3	13
10	LED1#	PERn3	11
8	N/C	GND	9
6	N/C	PETp3	7
4	3.3V	PETn3	5
2	3.3V	GND	3
		GND	1

3.0   Interface requirements

3.1   PCIe features

The Seagate Nytro SSD supports NVMe spec 1.2a. Below is a table showing the supported Features, Op-code, and whether vendor specific, mandatory, or optional.

Table 14 PCIe Features

Feature ID	M/O	Description	Supported
01h	M	Arbitration	Yes
02h	M	Power Management	Yes
03h	O	LBA Range Type	No
04h	M	Temperature Threshold	Yes
05h	M	(Time limited) Error Recovery	Yes
06h	O	Volatile Write Cache	No
07h	M	Number of Queues	Yes
08h	M	Interrupt Coalescing	Yes
09h	M	Interrupt Vector Configuration	Yes
0Ah	O	Write Atomicity	No
0Bh	M	Asynchronous Event Configuration	Yes
0Ch	O	Autonomous Power State Transition	No
0Dh	O	Host Memory Buffer	No
80h	O	Software Progress Marker	No
81h	O	Host Identifier	No
82h	O	Reservation Notification Mask	No
83h	O	Reservation Persistence	No
C0h	VS	System Time	Yes
C1h	VS	Test Unit Ready	Yes
C2h	VS	Media Life Left Threshold	Yes

3.2   Interface Commands Supported:

The Seagate Nytro SSD supports all the mandatory NVMe Admin and I/O command-sets in *NVMe spec 1.2a*. In addition, several optional commands are also supported. Below are tables showing the Commands, Op-code, whether Admin or IO and mandatory or optional:

Table 15 Supported I/O Commands

Feature ID	M/O	Command	Supported
00h	M	Flush	Yes
01h	M	Write	Yes
02h	M	Read	Yes
04h	O	Write Uncorrectable	Yes
05h	O	Compare	No
08h	O	Write Zones	Yes
09h	O	Dataset Management - Trim	Yes
		Dataset Management - IDW	No
		Dataset Management - IDR	No

Table 15 Supported I/O Commands *(continued)*

Feature ID	M/O	Command	Supported
0Dh	O	Reservation Register	No
0Eh	O	Reservation Report	No
11h	O	Reservation Acquire	No
12h	O	Reservation Release	No

Table 16 Supported Admin Commands

Op-code	M/O	Command	Supported
00h	M	Delete I/O SQ	Yes
01h	M	Create I/O SQ	Yes
02h	M	Get log Page	Yes
04h	M	Delete I/O CQ	Yes
05h	M	Create I/O CQ	Yes
06h	M	Identify	Yes
08h	M	Abort	Yes
09h	M	Set Features	Yes
0Ah	M	Get Features	Yes
0Ch	M	Async Event Request	Yes
0Dh	O	Namespace Management	No
10h	M	Firmware Commit	Yes
11h	M	Firmware Image Download	Yes
15h	O	Namespace Attachment	No
80h	O	Format NVM	Yes
81h	O	Security Send	Yes
82h	O	Security Receive	Yes
C0h	VS	Diagnostic Send	Yes
C1h	VS	Diagnostic Receive	Yes

3.3   Log Page Support

The Seagate Nytro SSD supports the following mandatory log pages defined in NVMe 1.2a specification.

Table 17 Log Page Support

Log Page	M/O	Description	Supported
01h	M	Error Information	Yes
02h	M	SMART/Health Information	Yes
03h	M	Firmware Slot Information	Yes
05h	O	Commands Supported and Effects Log	Yes
C4h	VS	Extended SMART Attributes	Yes
C5h	VS	List of Supported Log Pages	Yes
C8h	VS	Recent history Log Page	Yes
CBh	VS	PCIe Error Counter Log	Yes

3.4   SMART Attributes

The following table lists the supported SMART attributes.

Table 18 SMART Attributes (Log Identifier 02h)

Byte	# of Bytes	Attribute	Description
0	1	**Critical Warning:** These bits, if set, flag various warning sources. Bit 0: Available Spare is below Threshold Bit 1: Temperature has exceeded Threshold Bit 2: Reliability is degraded due to excessive media or internal errors Bit 3: Media is placed in Read- Only Mode Bit 4: Volatile Memory Backup System has failed (e.g., enhanced power loss capacitor test failure) Bits 5-7: Reserved	Any of the critical warning can be tied to asynchronous event notification. Drive Health Indicator defined under bytes 3095-3076 of Identify Controller may still indicate "healthy" status when the critical warning flag is set.
1	2	Temperature: Overall Device current temperature in Kelvin	For AIC, this reports the NAND temperature, for 2.5-inch FF, this reports the case temperature,
3	1	Available Spare: Contains a normalized percentage (0 to 100%) of the remaining spare capacity available	Starts from 100 and decrements.
4	1	Available Spare Threshold	Threshold is set to 10%.
5	1	Percentage Used Estimate (Value allowed to exceed 100%)	A value of 100 indicates that the estimated endurance of the device has been consumed, but may not indicate a device failure. The value is allowed to exceed 100. Percentages greater than 254 shall be represented as 255. This value shall be updated once per power-on hour (when the controller is not in a sleep state).
32	16	Data Units Read (in LBAs)	Contains the number of 512 byte data units the host has read from the controller; this value does not include metadata. This value is reported in thousands (i.e., a value of 1 corresponds to 1000 units of 512 bytes read) and is rounded up. When the LBA size is a value other than 512 bytes, the controller shall convert the amount of data read to 512-byte units.
48	16	Data Units Write (in LBAs)	Contains the number of 512 byte data units the host has written to the controller; this value does not include metadata. This value is reported in thousands (i.e., a value of 1 corresponds to 1000 units of 512 bytes written) and is rounded up. When the LBA size is a value other than 512 bytes, the controller shall convert the amount of data written to 512-byte units. For the NVM* command set, logical blocks written as part of Write operations shall be included in this value. Write Uncorrectable commands shall not impact this value.
64	16	Host Read Commands	Contains the number of read commands issued to the controller.
80	16	Host Write Commands	Contains the number of write commands issued to the controller.

Table 18 SMART Attributes (Log Identifier 02h) *(continued)*

Byte	# of Bytes	Attribute	Description
96	16	Controller Busy Time (in minutes)	Contains the amount of time the controller is busy with I/O commands. The controller is busy when there is a command outstanding to an I/O Queue (specifically, a command was issued by way of an I/O Submission Queue Tail doorbell write and the corresponding completion queue entry has not been posted yet to the associated I/O Completion Queue). This value is reported in minutes.
112	16	Power Cycles	Contains the number of power cycles.
128	16	Power On Hours	Contains the number of power-on hours. This does not include time that the controller was powered and in a low power state condition.
144	16	Unsafe Shutdowns	Contains the number of unsafe shutdowns. This count is incremented when a shutdown notification (CC.SHN) is not received prior to loss of power.
160	16	Media Errors	Contains the number of occurrences where the controller detected an unrecovered data integrity error. Errors such as uncorrectable ECC, CRC checksum failure, or LBA tag mismatch are included in this field.
176	16	Number of Error Information Log Entries	Contains the number of Error Information log entries over the life of the controller.

4.0   Standards and Reference Documents

Each Hard Drive and Solid State Drive ("drives") has a product label that includes certifications that are applicable to that specific drive. The following information provides an overview of requirements that may be applicable to the drive.

4.1   Regulatory Model Numbers

The following model numbers represent the indicated form factors and features of all configurations within the series:

Regulatory Models as Documented in the Declaration of Conformity (DoC):

- STA003 - (represents M.2 22110)

4.2   Standards

The drives are recognized in accordance with UL 60950-1 as tested by UL, CSA 60950-1 as tested by CSA, and EN60950-1 as tested by TUV.

4.3   Agency and Safety Certifications

4.3.1   Safety Certification

These products are certified to meet the requirements of UL/cUL 60950-1, EN 60950-1, and may also include, IEC 62368, UL 62368 and EN 62368.

4.3.2   Electromagnetic Compatibility

The drive, as delivered, is designed for system integration and installation into a suitable enclosure prior to use. The drive is supplied as a subassembly and is not subject to Subpart B of Part 15 of the FCC Rules and Regulations nor the Radio Interference Regulations of the Canadian Department of Communications.

The design characteristics of the drive serve to minimize radiation when installed in an enclosure that provides reasonable shielding. The drive is capable of meeting the Class B limits of the FCC Rules and Regulations of the Canadian Department of Communications when properly packaged; however, it is the user's responsibility to assure that the drive meets the appropriate EMI requirements in their system. Shielded I/O cables may be required if the enclosure does not provide adequate shielding. If the I/O cables are external to the enclosure, shielded cables should be used, with the shields grounded to the enclosure and to the host controller.

4.3.3   Electromagnetic susceptibility

The drive as delivered is tested to meet susceptibility requirements in a representative enclosure. It is the responsibility of those integrating the drive within their systems to perform those tests required and design their system to ensure that equipment operating in the same system as the drive or external to the system does not adversely affect the performance of the drive. See Section 1.4, "Power Consumption."

4.3.4   Electromagnetic compliance

Seagate uses an independent laboratory to confirm compliance with the directives/standards for CE Marking and C-Tick Marking. The drive was tested in a representative system for typical applications. The selected system represents the most popular characteristics for test platforms. The system configurations include:

- Typical current use microprocessor
- Keyboard
- Monitor/display
- Printer
- Mouse

Although the test system with this Seagate model complies with the directives/standards, we cannot guarantee that all systems will comply. The computer manufacturer or system integrator shall confirm EMC compliance and provide the appropriate marking for their product.

4.3.5 **European Union (EU) CE Marking Requirements**

Drives that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (2014/30/EU) put into force on 20 April 2016. Testing is performed to the levels specified by the product standards for Information Technology Equipment (ITE). Emission levels are defined by EN 55032:2012, Class B and the immunity levels are defined by EN 55024:2010.

The drives also meet the requirements of The Low Voltage Directive (LVD) 2014/35/EU.

Seagate drives are tested in representative end-user systems. Although CE-marked Seagate drives comply with all relevant regulatory requirements and standards for the drives, Seagate cannot guarantee that all system-level products into which the drives are installed comply with all regulatory requirements and standards applicable to the system-level products. The drive is designed for operation inside a properly designed system (e.g., enclosure designed for the drive), with properly shielded I/O cable (if necessary) and terminators on all unused I/O ports. Computer manufacturers and system integrators should confirm EMC compliance and provide CE marking for the system-level products.

For compliance with the RoHS "Recast" Directive 2011/65/EU (RoHS 2), .

4.3.6 **Australian RCM Compliance Mark**

If this model has the RCM Marking it complies with the Australia/New Zealand Standard AS/NZ CISPR22 and meets the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communications and Media Authority (ACMA).

4.3.7 **Canada ICES-003**

If this model has the ICES-003:2016 marking it complies with requirements of ICES tested per ANSI C63.4-2014.

4.3.8 **South Korean Certification Mark**

The South Korean KC Certification Mark means the drives comply with paragraph 1 of Article 11 of the Electromagnetic Compatibility control Regulation and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Radio Research Agency (RRA) Communications Commission, Republic of Korea.These drives have been tested and comply with the Electromagnetic Interference/Electromagnetic Susceptibility (EMI/EMS) for Class B products. Drives are tested in a representative, end-user system by a Korean-recognized lab.

기 종 별	사 용 자 안 내 문
B 급 기기 (가정용 방송통신기자재)	이 기기는 가정용(B 급) 전자파적합기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

4.3.9 **Morocco Commodity Mark**

Seagate drives are tested for compliance and comply with the European Union (EU) Electromagnetic Compatibility (EMC) Directive 2014/30/EU and the Low Voltage Directive (LVD) 2014/35/EU. Accordingly, the drives also meet the requirements of Morocco's Order of the Minister of Industry, Trade, Investment and Digital Economy No. 2574-14 of 29 Ramadan 1436 (16 July 2015) on electromagnetic compatibility of equipment.

For drives with the Morocco Mark, Seagate has added the Moroccan Commodity Mark to the drives provided to the OEM for the sale of Customer Kits produced by our OEM customers that are intended to be incorporated into the OEM's finished system-level product by an end user. The Customer Kits are considered 'devices' under Morocco's Order of the Minister of Industry, Trade, Investment and Digital Economy No. 2574-14 of 29 Ramadan 1436 (16 July 2015) on electromagnetic compatibility of equipment.

4.3.10 **Taiwanese BSMI**

Drives with the Taiwanese certification mark comply with Chinese National Standard, CNS13438.

For compliance with the Taiwan Bureau of Standards, Metrology and Inspection's (BSMI) requirements,

4.3.11   FCC verification

These drives are intended to be contained solely within a personal computer or similar enclosure (not attached as an external device). As such, each drive is considered to be a subassembly even when it is individually marketed to the customer. As a subassembly, no Federal Communications Commission verification or certification of the device is required.

Seagate has tested this device in enclosures as described above to ensure that the total assembly (enclosure, disk drive, motherboard, power supply, etc.) does comply with the limits for a Class B computing device, pursuant to Subpart J, Part 15 of the FCC rules. Operation with noncertified assemblies is likely to result in interference to radio and television reception.

Radio and television interference. This equipment generates and uses radio frequency energy and if not installed and used in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception.

This equipment is designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television, which can be determined by turning the equipment on and off, users are encouraged to try one or more of the following corrective measures:

- Reorient the receiving antenna.
- Move the device to one side or the other of the radio or TV.
- Move the device farther away from the radio or TV.
- Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.

If necessary, users should consult a dealer or an experienced radio/television technician for additional suggestions. Users may find helpful the following booklet prepared by the Federal Communications Commission: *How to Identify and Resolve Radio-Television Interference Problems*. This booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Refer to publication number 004-000-00345-4.

4.4   Environmental protection

Seagate designs its products to meet environmental protection requirements worldwide, including regulations restricting certain chemical substances.

4.4.1   European Union Restriction of Hazardous Substance Law

4.4.1.1   Restriction of Hazardous Substances in Electrical and Electronic Equipment

Seagate drives are designed to be compliant with the European Union RoHS "Recast" Directive 2011/65/EU (RoHS 2) as amended by Directive (EU) 2015/863. The RoHS2 restricts the use of certain hazardous substances such as Lead, Cadmium, Mercury, Hexavalent Chromium, Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ether (PBDE), BisBis(2-Ethylhexyl) phthalate (DEHP), Benzyl butyl phthalate (BBP), Dibutyl phthalate (DBP), and Diisobutyl phthalate (DIBP) in electrical and electronic equipment (EEE).

4.4.1.2   Substances of Very High Concern (SVHC)

The European Union REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) Regulation (EC) 1907/2006 regulates chemicals shipped into and used in Europe. A number of parts and materials in Seagate products are procured from external suppliers. We rely on the representations of our suppliers regarding the presence of REACH substances in these articles and materials. Our supplier contracts require compliance with our chemical substance restrictions, and our suppliers document their compliance with our requirements by providing full-disclosure material content declarations that disclose inclusion of any REACH-regulated substance in such articles or materials. Product-specific REACH declarations are available upon request through your Seagate Sales Representative.

4.4.2　China Requirements —China RoHS 2

China RoHS 2 refers to the Ministry of Industry and Information Technology Order No. 32, effective July 1, 2016, titled Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products. To comply with China RoHS 2, Seagate determined this product's Environmental Protection Use Period (EPUP) to be 20 years in accordance with the *Marking for the Restricted Use of Hazardous Substances in Electronic and Electrical Products,* SJT 11364-2014.

Table 19　China - Hazardous Substances

	有害物质 Hazardous Substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{+6})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷电路板组装 PCBA	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制。

This table is prepared in accordance with the provisions of SJ/T 11364-2014

O：表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

O：Indicates that the hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T26572.

X：表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

X：Indicates that the hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T26572.

4.4.3　Taiwan Requirements — Taiwan RoHS

Taiwan RoHS refers to the Taiwan Bureau of Standards, Metrology and Inspection's (BSMI) requirements in standard CNS 15663, Guidance to reduction of the restricted chemical substances in electrical and electronic equipment. Seagate products must comply with the "Marking of presence" requirements in Section 5 of CNS 15663, effective January 1, 2018. This product is Taiwan RoHS compliant.

The following table meets the Section 5 "Marking of presence" requirements.

Table 20　Taiwan - Restricted Substances

設備名稱：硬盤設備 **/SSD**，型號：僅適用于内部使用 Equipment Name: Hard Disk Device/SSD, Type Designation: Internal Use Only						
單元 Unit	限用物質及其化學符號 Restricted Substance and its chemical symbol					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{+6})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷电路板组装 PCBA	—	O	O	O	O	O

备考 1. "O" 係指該項限用物質之百分比含量未超出百分比含量基準值。

Note 1. "O" indicates that the percentage content of the restricted substance does not exceed the percentage of reference value of presence.

备考 2. "—" 係指該項限用物質為排除項目。

Note 2. "—" indicates that the restricted substance corresponds to the exemption.

4.5   Reference Documents

In case of conflict between this document and any referenced document, this document takes precedence.

Table 21 Reference Documents

	Location

PCIe specifications:
 	
    PCIe - PCI Express Electromechanical specification, revision 3.0
 	
    NVMe - Non Volatile Memory Express specification 1.2a
 	
    PCIe CEM - PCI Express Card Electromechanical specification, revision 1.1
 	
    PCI Express M.2 Specification, revision 1.1
	www.pcisig.com
	www.nvmexpress.org

Trusted Computing Group (TCG) Documents
 	
    TCG Storage Architecture Core Specification, Rev. 1.0
 	
    Storage Work Group Security Subsystem Class:
    Opal, Version 2.00"
	www.trustedcomputinggroup.org

Solid State Drive Requirements and Endurance Test Methods
 	
    JESD218
 	
    JESD219
	www.jedec.org