



# Seagate® Nytro® 5350S NVMe SSD

## Product Manual

### Nytro 5350S 15mm U.2/U.3 Read Intensive (1 DWPD)

Capacity	Standard	SED
<b>15360</b>	XP15360SE70065	XP15360SE70075
<b>7680</b>	XP7680SE70065	XP7680SE70075
<b>3840</b>	XP3840SE70065	XP3840SE70075
<b>1920</b>	XP1920SE70065	XP1920SE70075

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## Revision History

Version and Date	Description of Changes
Rev A, March 2023	First release of the document

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When referring to drive capacity, one gigabyte, or GB, equals one billion bytes and one terabyte, or TB, equals one trillion bytes. Your computer's operating system may use a different standard of measurement and report a lower capacity. In addition, some of the listed capacity is used for formatting and other functions, and thus will not be available for data storage. Actual quantities will vary based on various factors, including file size, file format, features and application software. Actual data rates may vary depending on operating environment and other factors. The export or re-export of hardware or software containing encryption may be regulated by the U.S. Department of Commerce, Bureau of Industry and Security (for more information, visit [www.bis.doc.gov](http://www.bis.doc.gov)), and controlled for import and use outside of the U.S. Seagate reserves the right to change, without notice, product offerings or specifications.

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## Seagate Technology Support Services

For SSD Support, visit: <https://www.seagate.com/support/products/>

For Compliance data, visit: <https://www.seagate.com/support>. Scroll to the Compliance heading on left.

For Firmware Download and Tools Download for Secure Erase, visit: <https://www.seagate.com/support/downloads/>

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

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. Introduction

This manual describes the Seagate® Nytro® 5350S NVMe™ (NVM Express™) SSDs. The Nytro 5350S SSD is a member of the Nytro 5050 family.

The NVMe interface meets next-generation computing demands for performance, scalability, flexibility, and high-density storage requirements. Nytro 5350S NVMe SSDs are random access storage devices that support the NVMe Protocol.

The Self-Encrypting Drive Manual, describes the interface, general operation, and security features available on Self-Encrypting Drive (SED) models. See [Section 5. Reference Documents](#).

Unless otherwise stated, the information here applies to all security versions (Standard, SED, and FIPS-certified). Product data in this manual refers only to the model numbers listed in this manual.

The data in this manual may predict future generation specifications or requirements. If you are designing a system using one of the models listed or future generation products and you need further assistance, please contact the Field Applications Engineer (FAE) or our global support services group.

**NOTE** Never disassemble or try to service items in the enclosure. Opening the enclosure voids the drive warranty.

## 2. Features

Seagate Nytro 5350S NVMe SSDs have the following features.

**Table 1 - SSD Features**

Feature	Description	
<b>Capacities (User)</b>	<ul style="list-style-type: none"> <li>See <a href="#">Section 3. Nytro 5350S Models and Capacities</a></li> </ul>	
<b>Certifications, Eco-compliance</b>	<ul style="list-style-type: none"> <li>CE, FCC, UKCA, RCM, BSMI, KCC, VCCI, CB, UL, TUV, CMIM, Microsoft WHQL</li> <li>RoHS</li> </ul>	
<b>Dimensions</b>	<ul style="list-style-type: none"> <li>Height 14.9 mm/0.587 in</li> <li>Width 70.1 mm/2.760in</li> <li>Depth 100.4mm/3.953in</li> <li>See <a href="#">Section 9.4 Mechanical specifications</a></li> </ul>	
<b>Form Factor</b>	<ul style="list-style-type: none"> <li>U.2/U.3</li> </ul>	
<b>Weight</b>	<ul style="list-style-type: none"> <li>205 g Nytro 5350S 15mm U.2/U.3</li> <li>See <a href="#">Section 9.4.1 Nytro 5350S Weights</a></li> </ul>	
<b>Endurance</b>	<ul style="list-style-type: none"> <li>See <a href="#">Section 8.2 Endurance</a></li> </ul>	
<b>Interface Compliance</b>	<ul style="list-style-type: none"> <li>PCI Express Gen4 x4 using SFF-8639 and SFF-TA-1001 (U.2/U.3 auto-detect)</li> <li>NVMe 1.4c</li> <li>Single port operation</li> </ul>	
<b>NAND</b>	<ul style="list-style-type: none"> <li>Enterprise-grade TLC, 3D</li> </ul>	
<b>Operating Systems</b>	<ul style="list-style-type: none"> <li>Windows Server 2019, Server 2022, Azure, SDDC</li> <li>Ubuntu Server 18.04, 20.04</li> <li>CentOS 7</li> </ul>	
<b>Performance Random</b>	<ul style="list-style-type: none"> <li>Read: Up to 1,700,000 IOPS</li> <li>Write: Up to 495,000 IOPS</li> </ul>	<p>Actual performance can vary depending on use conditions, and environment. See <a href="#">Section 7.2.2 Performance (Throughput)</a></p>
<b>Performance Sequential</b>	<ul style="list-style-type: none"> <li>Read: Up to 7400MB/s</li> <li>Write: Up to 7200MB/s</li> </ul>	
<b>Power Consumption</b>	<ul style="list-style-type: none"> <li>Active Power, Average: &lt;24 W</li> <li>Idle Power Average: &lt;6 W</li> </ul>	See <a href="#">Section 9.2 Power consumption</a>
<b>Power Management</b>	<ul style="list-style-type: none"> <li>Supports NVMe Power States</li> <li>Profiles: 25 W, 18 W, 14 W, 12 W, 9 W</li> <li>Supports D3hot</li> </ul>	
<b>Security</b>	<p>These drives comply with the Trusted Computing Group (TCG) Documents (apply to Self-Encrypting Drive models only)</p> <ul style="list-style-type: none"> <li>TCG Storage Architecture Core Specification, Version 2.01, Revision 2.0</li> <li>TCG Storage Security Subsystem Class Opal Specification, Version 2.01, Revision 1.0</li> </ul>	
<b>Reliability</b>	<ul style="list-style-type: none"> <li>End-to-end data path protection</li> <li>MTBF: 2.5 million hours</li> <li>UBER: 1 error in 10<sup>17</sup> bits read</li> </ul> <p>See <a href="#">Section 8.1 Read error rates</a></p>	



**Table 1 - SSD Features (continued)**

<b>Shock</b>	Shock <ul style="list-style-type: none"> <li>■ Non-Operating: 1,300 G, at 0.5 ms</li> </ul>	See <a href="#">Section 9.3 Environmental limits</a>
<b>Vibration</b>	Vibration <ul style="list-style-type: none"> <li>■ Operating: 16.3G<sub>RMS</sub> (20 to 2000 Hz, Frequency)</li> </ul>	
<b>Temperature</b>	<ul style="list-style-type: none"> <li>■ Operating: 0°C to 70°C</li> <li>■ Non-operating: -40°C to 85°C</li> </ul>	
<b>Voltage</b>	<ul style="list-style-type: none"> <li>■ These drives receive DC power +12 V (Max 13.2 V)</li> <li>■ Operation of SMBus requires application of +3.3Vaux (Max 3.6V)</li> </ul>	
<b>Warranty</b>	For warranty support details, visit: <a href="http://www.seagate.com/support/warranty-and-replacements/">http://www.seagate.com/support/warranty-and-replacements/</a> Limited Warranty with Media Usage - based on the shorter of term and endurance use of the drive.	
<b>Additional NVMe Features</b>		
<b>Nytro 5350S Standard Drives</b>		
<p>Have the following NVMe features:</p> <ul style="list-style-type: none"> <li>■ 264 I/O queue pairs</li> <li>■ 64,000 maximum entries per queue</li> <li>■ Up to 128 namespaces supported</li> <li>■ PRP and SGL data transfer schemes</li> <li>■ Weighted Command Arbitration scheme support</li> <li>■ User-selectable logical block size (512, 520, 4096, 4104, or 4160 bytes per logical block)</li> <li>■ No preventive maintenance or adjustments required</li> <li>■ Self diagnostics performed when power is applied to the drive</li> <li>■ ECC and Micro-RAID Error Recovery</li> <li>■ Vertical, horizontal, or top down mounting</li> <li>■ Device Self Test (DST)</li> <li>■ Power loss data protection</li> <li>■ Authenticated firmware download</li> <li>■ Sanitize command Block Erase support</li> </ul>		
<b>Nytro 5350S SED Drives</b>		
<p>Have all of the above NVMe features and the following features</p> <ul style="list-style-type: none"> <li>■ Automatic data encryption/decryption</li> <li>■ Controlled access</li> <li>■ Random number generator</li> <li>■ Drive locking</li> <li>■ Up to 8 independent locking bands plus one global band</li> <li>■ Sanitize Cryptographic Erase support</li> </ul>		

### 3. Nytro 5350S Models and Capacities

The following categories apply to the Nytro 5350S series.

**Table 2 - Nytro 5350S Models and Capacities**

<b>Nytro 5350S 15mm U.2/U.3 Read Intensive (1 DWPD)</b>		
<b>Capacity</b>	<b>Standard</b>	<b>SED</b>
<b>15360</b>	XP15360SE70065	XP15360SE70075
<b>7680</b>	XP7680SE70065	XP7680SE70075
<b>3840</b>	XP3840SE70065	XP3840SE70075
<b>1920</b>	XP1920SE70065	XP1920SE70075

- Nytro 5350S SED models provide for "Security of Data at Rest" as defined by the Trusted Computing Group (see <http://www.trustedcomputinggroup.org>).
- For product certification status visit <https://csrc.nist.gov/projects/cryptographic-module-validation-program/validated-modules/search>.

## 4. Safety, Standards, and Compliance

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

**NOTE**      ***The most up to date information on Safety, Standards, and Compliance for this product is available in the Seagate HDD and SSD Regulatory Compliance and Safety document. You can find this document on the Seagate Support page here:***  
<https://www.seagate.com/support/>

### 4.1 Regulatory Model

The following regulatory model numbers represent all features and configurations in this series:

- STA026 and STA030

**Table 3 - Regulatory Model Numbers by SKU**

#### **STA026**

XP7680SE70065	XP7680SE70075
XP3840SE70065	XP3840SE70075
XP1920SE70065	XP1920SE70075

#### **STA030**

XP15360SE70065	XP15360SE70075
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## 5. Reference Documents

In case of conflict between this document and the following reference documents, this document takes precedence.

### SNIA documents

SFF-8489	Serial GPIO IBPI
SFF-8639	Multifunction 6X Unshielded Connector Pinouts
SFF-8223	2.5" Drive Form Factor with Serial Connector
SFF-8447	LBA Count for Disk Drives
SFF-TA-1001	U.3 Connector

### PCI SIG documents

PCI Express Base Specification Revision 4.0, Version 1.0  
PCI Express SFF-8639 Module Specification Revision 4.0, Version 1.0

### NVM Express documents

NVM Express Base Specification Revision 1.4c  
NVM Express Management Interface Revision 1.1

### Miscellaneous documents

System Management Bus Specification Version 3.1  
I2C Bus Revision 6

### Trusted Computing Group (TCG) Documents (apply to Self-Encrypting Drive models only)

TCG Storage Architecture Core Specification Version 2.01, Revision 1.0  
TCG Storage Security Subsystem Class Opal Specification Version 2.01, Revision 1.0

### Self-Encrypting Drives Manual

Seagate part number: 100515636

## 6. Formatted capacities

Nytrio 5350S models are formatted to 512 bytes per block at time of manufacturing. The block size is user-selectable at format time. Supported block sizes are 512, 520, 4096, 4104, and 4160. Users who have the necessary equipment can modify the data block size before issuing a format command. These users can obtain different formatted capacities from those listed.

Nytrio 5350S models follow the SFF-8447 specification.

**Table 4 - Formatted Capacity Block Count (15360 GB and 7680 GB Models)**

Last Logical Block Address				
Block	15360 GB		7680 GB	
Size	Decimal	Hex	Decimal	Hex
<b>512</b>	30005842607	6FC7CD2AF	15,002,931,887	37E3E92AF
<b>520</b>	29,391,585,279	6D7DFFFF	14,685,538,559	36B5388FF
<b>4096</b>	3,750,730,325	DF8F9A55	1,875,366,485	6FC7D255
<b>4104</b>	3,724,017,663	DDF7FFFF	1,854,502,927	6E89780F
<b>4160</b>	3,673,948,159	DAFBFFFF	1,838,769,231	6D99644F

**Table 5 - Formatted Capacity Block Count (3840 GB and 1920 GB Models)**

Last Logical Block Address				
Block	3840 GB		1920 GB	
Size	Decimal	Hex	Decimal	Hex
<b>512</b>	7,501,476,527	1BF1F72AF	3,750,748,847	DF8FE2AF
<b>520</b>	7,342,769,279	1B5A9C47F	3,671,384,639	DAD4E23F
<b>4096</b>	937,684,565	37E3EE55	468,843,605	1BF1FC55
<b>4104</b>	927,251,463	3744BC07	463,625,735	1BA25E07
<b>4160</b>	919,384,615	36CCB227	459,692,311	1B665917

## 7. Performance

This section provides detailed information on performance-related features of Nytro 5350S SSDs.

### 7.1 Internal drive characteristics

Flash Memory Type	eTLC 3D NAND
Emulated LBA Size	512B, 520B, 4096B, 4104B, or 4160B
Native Programmable Page Size	16KB
Map Unit Size	4096B

### 7.2 Performance characteristics

#### 7.2.1 Response time

Response times are measured with nominal power at 25°C ambient temperature. Normal values in the table below are:

- Page-to-page response time is an average of all possible page-to-page accesses for a sequentially preconditioned drive.
- Average response time is a true statistical random average of at least 5000 measurements of accesses between programmable pages on a randomly preconditioned drive.

**Table 6 - Typical Response Time (µsec)**

	Read	Write	Notes
Page to Page	75	15	Execution time measured from receipt of the Command to the Response. Assumes no errors.
Average Latency	75	15	Typical response times are measured under nominal conditions of temperature and voltage as measured on a representative sample of drives.

These drives provide the highest possible performance under typical conditions. However, due to the nature of Flash memory technologies many factors can result in values other than those stated here.

## 7.2.2 Performance (Throughput)

This table shows throughput performance for Nytro 5350S SSDs.

**Table 7 Nytro 5350S Performance**

<b>Performance of 5350S 15mm Read Intensive Models</b>				
<b>Standard</b>	XP15360SE70065	XP7680SE70065	XP3840SE70065	XP1920SE70065
<b>SED</b>	XP15360SE70075	XP7680SE70075	XP3840SE70075	XP1920SE70075
<b>Sustained Sequential 128KB Read Transfer Rate (MB/s)</b>	7,400	7,400	7,400	7,400
<b>Sustained Sequential 128KB Write Transfer Rate (MB/s)</b>	7,200	7,200	6,900	3,700
<b>Sustained Random 4KB Read Transfer Rate (IOPS)</b>	1,700,000	1,700,000	1,700,000	1,550,000
<b>Sustained Random 4KB Write Transfer Rate (IOPS)</b>	210,000	195,000	195,000	125,000

### NOTES

- Power limit unconstrained.
- Sequential testing performed at Queue Depth = 32 after Sequential Preconditioning.
- Random testing performed at Queue Depth = 256 after Random Preconditioning.

Flash technology can produce results that differ from Seagate testing. Bandwidth limitations in the host adapter, operating system, driver limitations, and other factors can cause discrepancies. When evaluating performance of SSD devices, it is recommended to measure performance of the device in a way that resembles the targeted application using real world data and workloads. Test time should also be large enough to make sure sustainable metrics and measures are obtained.

## 8. Reliability specifications

These reliability specifications assume correct host and drive operational interface, including all interface timings, power supply voltages, environmental requirements, and drive mounting constraints.

### 8.1 Read error rates

Table 8 Read Error Rates

	Error Rates	Notes
<b>Unrecovered Data</b>	Less than 1 LBA in $10^{17}$ bits transferred	
<b>Miscorrected Data</b>	Less than 1 LBA in $10^{21}$ bits transferred	
<b>Interface error rate</b>	Less than 1 error in $10^{12}$ bits transferred	
<b>Mean Time Between Failure (MTBF)</b>	2.5M hours	
<b>Annualized Failure Rate (AFR)</b>	0.35%	
<b>Preventive maintenance</b>	None required	
<b>Typical Data Retention with Power removed (at 40C up to 90% of write endurance)</b>	3 months	<ul style="list-style-type: none"> <li>As NAND Flash devices age with use, the capability of the media to retain a programmed value begins to deteriorate. This deterioration is affected by the number of times a particular memory cell is programmed and subsequently erased. When a device is new, it has a powered off data retention capability of up to several years. With use the retention capability of the device is reduced. Temperature also has an effect on how long a Flash component can retain its programmed value with power removed. At high temperature the retention capabilities of the device are reduced. Data retention is not an issue with power applied to the SSD. The SSD drive contains firmware and hardware features that can monitor and refresh memory cells when power is applied.</li> </ul>
<b>Endurance Rating</b>	Method 2: TBW (per JEDEC JESD218)	<ul style="list-style-type: none"> <li>Endurance rating is how much host data you can write to the drive at a specified workload and operating and storage temperature for the specified drive life. For more information on the specific workload to achieve this level of endurance, see JEDEC Specification JESD218. TBW is defined as <math>1 \times 10^{12}</math> Bytes.</li> <li>Limited Warranty with Media Usage provides coverage for the warranty period or until the SSD Percentage Used field in the SMART Health Log reaches 100 whichever comes first.</li> </ul>

**NOTE**

Error rate specified with automatic retries and data correction with ECC enabled and all flaws reallocated.



## 8.2 Endurance

See below for Nytro 5350S Endurance results.

**Table 9 - Nytro 5350S 15 mm Endurance**

Nytro 5350S 15 mm U.2/U.3 Read Intensive(1 DWPD)				
Endurance Class	Capacity	Standard	Seagate Secure SED	Lifetime PB JEDEC
RI	15360 GB	XP15360SE70065	XP15360SE70075	28
	7680 GB	XP7680SE70065	XP7680SE70075	14
	3840 GB	XP3840SE70065	XP3840SE70075	7
	1920GB	XP1920SE70065	XP1920SE70075	3.5

## 8.3 Error rates

The error rates stated in this manual assume the following:

- The drive is operated in accordance with this manual using DC power as defined in [Section 9.2 Power consumption](#).
- Errors caused by host system failures are excluded from error rate computations.
- Assume random data.
- Default OEM error recovery settings are applied. This includes full read retries, full write retries and full retry time.

### 8.3.1 Unrecoverable Errors

An unrecoverable data error is a failure of the drive to recover data from the media. These errors occur due to read or write problems. Unrecoverable data errors are only detected during read operations, but not caused by the read. If an unrecoverable data error is detected, the command will be completed with a Status Code Type (SCT) of 2h Media and Data Integrity Errors, with code 81h Unrecovered Read Error is reported. Multiple unrecoverable data errors resulting from the same cause are treated as one error.

### 8.3.2 Interface errors

An interface error is defined as a failure of the receiver on a port to recover the data as transmitted by the device port connected to the receiver. The error may be detected as a running disparity error, illegal code, loss of word sync, or CRC error.

## 8.4 Endurance management

Customer satisfaction with Solid State Drives can be directly related to the internal algorithms which an SSD uses to manage the limited number of Program-Erase (PE) cycles that NAND Flash can withstand. These algorithms consist of Wear Leveling, Garbage Collection, Write Amplification, Deallocation, Data Retention, Lifetime Endurance Management.

### **8.4.1 Wear leveling**

The drive uses Wear Leveling to make sure that all Flash cells are written to or exercised as evenly as possible to avoid hot spots where some cells are used up faster than other locations. The drive automatically manages Wear Leveling without user interaction. The Seagate algorithm operates only when needed to ensure reliable product operation.

### **8.4.2 Garbage collection**

The drive uses Garbage Collection to consolidate valid user data into a common cell range freeing up unused or obsolete locations to be erased and used for future storage needs. The drive automatically manages Garbage Collection without user interaction. The Seagate algorithm operates only when needed to ensure reliable product operation.

### **8.4.3 Write amplification**

While Write Amplification is not an algorithm, it is a major characteristic of SSDs. Write Amplification must be accounted for by all the algorithms that the SSD implements. The Write Amplification Factor of an SSD is the ratio of Host/User data requested to be written to the actual amount of data written by the SSD internal to account for the user data and the housekeeping activities such as Wear Leveling and Garbage Collection. The Write Amplification Factor of an SSD can also be directly affected by the characteristics of the host data being sent to the SSD to write. The best Write Amplification Factor is achieved for data that is written in sequential LBAs that are aligned on 4KB boundaries. The worst case Write Amplification Factor occurs for randomly written LBA's of transfer sizes that are less than 4KB and that originate on LBA's that are not on 4KB boundaries.

### **8.4.4 Deallocation**

Deallocation is when the firmware uses the Dataset Management command, the Write Zeroes command, or the Sanitize command to deallocate logical blocks. This deallocation reduces the Write Amplification Factor of the drive during housekeeping tasks such as Wear Leveling and Garbage Collection. This happens because the drive does not need to retain data which has been classified by the host as obsolete.

### **8.4.5 Data retention**

Data Retention is another major characteristic of SSDs that must be accounted for by all the algorithms that the SSD implements. While powered up, the Data Retention of SSD cells are monitored and rewritten if the cell levels decay to an unexpected level. Data Retention when the drive is powered off is affected by Program and Erase (PE) cycles and the temperature of the drive when stored.

### **8.4.6 SSD percentage used endurance indicator**

An application can interrogate the drive through the host to determine an estimate of the percentage of device life that has been used. To accomplish this, issue a Get Log command to Log Identifier 2h. This allows applications to read the contents of the Percentage Used field in Byte 5. The Percentage Used field is defined in the NVM Express specifications available from the NVM Express consortium.

## 8.5 Reliability and service

Integrators can enhance the reliability of Seagate Nytro 5350S NVMe SSD drives by ensuring that the drive receives adequate cooling. [Section 9.5.2 Physical characteristics](#) provides temperature measurements and other information that may be used to enhance the service life of the drive. [Section 11.2 Cooling](#) provides recommended air-flow information.

### 8.5.1 Annualized Failure Rate (AFR) and Mean Time Between Failure (MTBF)

The production drive shall achieve an AFR of 0.35% (MTBF of 2,500,000 hours) when operated in an environment that ensures the case temperatures do not exceed the values specified in [Section 9.3 Environmental limits](#). Operation at case temperatures outside the specifications in [Section 9.3 Environmental limits](#) may increase the product AFR (decrease the MTBF). The AFR (MTBF) is a population statistic not relevant to individual units.

The AFR (MTBF) specification is based on the following assumptions for Enterprise Storage System environments:

- 8760 power-on hours per year.
- 250 average on/off cycles per year.
- Operations at nominal voltages.

Systems will provide adequate cooling to ensure the case temperatures specified in [Section 11.2 Cooling](#) are not exceeded. Temperatures outside the specifications in [Section 11.2 Cooling](#) will increase the product AFR and decrease the MTBF.

### 8.5.2 Preventive maintenance

No routine scheduled preventive maintenance is required.

### 8.5.3 Hot plugging the drive

When a drive is powered on by switching the power or hot plugging, the drive runs a self test and attempts to detect and train the PCIe links. Link training happens on all lanes simultaneously. If there's a problem training a link or at a specific speed, the link may be downgraded to fewer links or lower link speed without reporting an error. The system maintainer needs to check the link status.

If self test detects a failure, the drive may still link and enumerate on the PCIe bus. If the Power Loss Protection (PLP) circuitry fails, the drive reports an error and becomes Read Only unless configured otherwise. Other errors can result in the drive not responding to the Controller Enable event (setting CC.EN = 1b).

**NOTE** The systems integrator is responsible for assuring that no temperature, energy, voltage hazard, or ESD potential hazard is presented during the hot connect/disconnect operation. Discharge the static electricity from the drive carrier prior to inserting it into the system.

### 8.5.4 SMART

SMART is an acronym for Self-Monitoring Analysis and Reporting Technology. This technology is intended to recognize conditions that indicate imminent drive failure and is designed to provide sufficient warning of a failure to allow administrators to back up the data before an actual failure occurs.

**NOTE** The drive's firmware monitors specific attributes for degradation over time but can't predict instantaneous drive failures.

Each monitored attribute has been selected to monitor a specific set of failure conditions in the operating performance of the drive and the thresholds are optimized to minimize "false" and "failed" predictions.

### **8.5.5 Thermal monitor**

Seagate Nytro 5350S NVMe SSD drives implement a temperature warning system which:

1. Signals the host if the composite temperature exceeds the warning threshold, indicating an overheat condition during which the controller continues to operate.
2. Signals the host if the composite temperature exceeds the critical threshold, indicating an overheat condition which can prevent continued operation of the drive.
3. Saves a log entry on the drive which exceeds the temperature value.

A temperature sensor monitors the drive temperature and issues a warning composite over the interface when the temperature exceeds a set threshold.

The thermal monitor system generates an Asynchronous Event Report with code 0Dh to indicate the drive has logged a temperature excursion in the Persistent Event Log.

### **8.5.6 Device Self Test**

Device Self Test (DST) is a technology designed to recognize drive fault conditions that qualify the drive as a failed unit. DST validates the functionality of the drive at a system level. There are two test coverage options implemented in DST:

1. Extended test
2. Short test

The most thorough option is the extended test that performs various tests on the drive and scans every logical block address (LBA) of the drive. The short test is time-restricted and limited in length—it does not scan the entire media contents, but does some fundamental tests and scans portions of the media. If DST encounters an error during either of these tests, it reports a "diagnostic failed" condition. If the drive fails the test, remove it from service and return it to Seagate for service.

#### **8.5.6.1 DST failure definition**

The drive will present a "diagnostic failed" condition through the self-tests results value of the diagnostic log page if a functional failure is encountered during DST. The drive parameters are not modified to test the drive more stringently, and the recovery capabilities are not reduced. All retries and recovery processes are enabled during the test. If data is recoverable, no failure condition will be reported regardless of the recovery processes required to recover the data. The following conditions are considered DST failure conditions:

- Read error after recovery attempts are exhausted
- Write error after recovery attempts are exhausted

#### **8.5.6.2 Implementation**

This section provides all of the information necessary to implement the DST function on this drive.

#### **8.5.6.3 State of the drive prior to testing**

The drive must be in a ready state before issuing the Device Self-test command. There are multiple reasons why a drive may not be ready, some of which are valid conditions, and not errors. For example, a drive may be in process of doing a Format NVM, or another DST. It is the responsibility of the host application to determine the "not ready" cause.

#### 8.5.6.4 Engage DST

To run DST, submit the Device Self-test command with the appropriate Self-test Code (STC) (1h for the short test or 2h for the extended test) in Command Dword 10, bits 03:00.

DST has two options:

Short test (Self Test Code: 1h)

The short test provides a time-limited test that tests as much of the drive as possible within 120 seconds. The short test does not scan the entire media contents, but does some fundamental tests and scans portions of the media. A complete read/verify scan is not performed and only factual failures will report a "test failed" condition. This option provides a quick confidence test of the drive.

Extended test (Self Test Code: 2h)

The extended test empirically tests critical drive components. The read operation tests the media contents. The integrity of the media is checked through a read/verify scan of the media. The anticipated length of the Extended test is reported through the Extended Device Self-Test Time field in the Identify Controller data structure.

#### 8.5.6.5 Log page entries

When the drive begins DST, it creates a new entry in the Self-test Result Data Structure in Log Identifier 06h. The new entry is created by inserting a new self test data structure starting at byte 4h of the Device Self-test Log. Existing data is moved to make room for the new data structure. The drive reports 20 result data structures in the log. If there are more than 20 result data structures, the oldest data structure is deleted. The new data structure is initialized.

#### 8.5.6.6 Abort

Abort test options include:

- Applications can use the abort code Fh in the Self-test Code field of the Device Self-test command. This causes a result of 1h (self-test aborted by a Device Self-test command) to appear in the result bits (3:0) of the Device Self-test Status field.
- Any Controller-level reset that affects the controller performing the device self-test. This causes 2h (self-test aborted by a Controller Level Reset) to appear in the result bits of the Device Self-test Status field.

### 8.5.7 Product warranty

For information regarding warranty support details, visit:  
<http://www.seagate.com/support/warranty-and-replacements/>

**Limited Warranty with Media Usage:** This warranty is based on the shorter of term and endurance usage of the drive.

### 8.5.8 Shipping

When transporting or shipping a drive, use only a Seagate-approved container. Keep the original box. Seagate approved containers are easily identified by the Seagate Approved Package label. Shipping a drive in a non-approved container voids the drive warranty.

Seagate repair centers may refuse receipt of components improperly packaged or obviously damaged in transit. Contact the authorized Seagate distributor to purchase additional boxes. Seagate recommends shipping by an air-ride carrier experienced in handling computer equipment.

#### **8.5.8.1 Product repair and return information**

Seagate customer service centers are the only facilities authorized to service Seagate drives. Seagate does not sanction any third party repair facilities. Any unauthorized repair or tampering with the factory seal voids the warranty.

#### **8.5.8.2 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 (refer to environmental section in this manual). 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). During any storage period you must follow the drive non-operational temperature, humidity, wet bulb, atmospheric conditions, shock, vibration, magnetic and electrical field specifications.

## 9. Physical and electrical specifications

This section provides information relating to the physical and electrical characteristics of the drive.

### 9.1 Power specifications

The 2.5" drive receives DC power(+12V and optionally +3.3Vaux) through the PCIe interface. The minimum current loading for each supply voltage is not less than 1.7% of the maximum operating current shown. Both +12V and +3.3Vaux supplies should employ separate ground returns.

Where power is provided to multiple drives from a common supply, careful consideration for individual drive power requirements should be noted. Where multiple units are powered on simultaneously, the peak starting current must be available to each device.

Parameters, other than start, are measured after a 10-minute warm up.

**Table 10 - +12V Requirements**

Supply Tolerance	+10% / -10%
Absolute Maximum Voltage	13.38V
Supply Rise Time	2 to 100 ms
Supply Drop Time	0.1 to 500 ms
Typical Capacitance	TBD $\mu$ f

**Table 11 - +3.3V Requirements**

Supply Tolerance	+5% / -5%
Absolute Maximum Voltage	3.63V
Supply Rise Time	2 to 100 ms
Supply Drop Time	0.1 to 500 ms
Typical Capacitance	TBD $\mu$ f

### 9.1.1 Conducted noise immunity

Noise is specified as a periodic and random distribution of frequencies covering a defined frequency. Maximum allowed noise values given below are peak-to-peak measurements and apply at the drive power connector.

- 350 mV pp from 100 Hz to 10 MHz
- 150 mV pp from 10 MHz to 80 MHz

## 9.2 Power consumption

Power requirements for the drives are listed in the tables in this section. Typical power measurements are based on an average of drives tested, under nominal conditions, using the listed input voltage at 60°C internal temperature.

- Startup power  
Startup power is measured from the time of power-on to the time that the drive reaches operating condition and can process media access commands.
- Peak operating mode  
During peak operating mode, the drive is tested in various read and write access patterns to simulate the worst-case power consumption.
- Idle mode power  
Idle mode power is measured with the drive powered up and ready for media access commands, with no media access commands having been received from the host.

### 9.2.1 Direct Current consumption by voltage rail

The tables in [Section 9.2.2 Power consumption by model and capacity](#) list the single port active power consumption measured under various workloads for each mode.

Points to be noted about the tables:

- Measured with average reading DC ammeter. Instantaneous +12V current peaks will exceed these values. Power supply at nominal voltage. N (number of drives tested) = 3, 60 Degrees C internal.
- See [Section 9.1.1 Conducted noise immunity](#). Specified voltage tolerance includes ripple, noise, and transient response.



## 9.2.2 Power consumption by model and capacity

Table 12 - Power consumption by model and capacity

Nytro 5350S 15 mm, 1920 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	Power (W)
Average Idle Current	0.48	5.7
Maximum Start Current		
Average DC	0.99	11.8
Maximum DC (Peak)	1.16	
Operating Current (Random Read)		
Average DC	1.10	13.2
Maximum DC	1.12	13.5
Maximum DC (peak)	1.32	
Operating Current (Random Write)		
Average DC	1.28	15.3
Maximum DC	1.50	17.9
Maximum DC (peak)	2.00	
Operating Current (Sequential Read)		
Average DC	0.87	10.5
Maximum DC	0.90	10.8
Maximum DC (peak)	1.17	
Operating Current (Sequential Write)		
Average DC	1.48	17.6
Maximum DC	1.52	18.2
Maximum DC (peak)	2.12	
Nytro 5350S 15 mm, 3840 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	Power (W)
Average Idle Current	0.48	5.7
Maximum Start Current		
Average DC	1.08	13.0
Maximum DC (Peak)	1.31	
Operating Current (Random Read)		
Average DC	1.24	14.6
Maximum DC	1.29	15.2
Maximum DC (peak)	1.50	

Table 12 - Power consumption by model and capacity (continued)

<b>Operating Current (Random Write)</b>		
Average DC	1.42	16.7
Maximum DC	1.65	19.3
Maximum DC (peak)	2.41	
<b>Operating Current (Sequential Read)</b>		
Average DC	0.96	11.4
Maximum DC	1.00	11.9
Maximum DC (peak)	1.30	
<b>Operating Current (Sequential Write)</b>		
Average DC	1.54	18.1
Maximum DC	1.69	19.8
Maximum DC (peak)	2.40	
<b>Nytro 5350S 15 mm, 7680 GB Power Consumption</b>		
<b>Parameter</b>		
Voltage	+12V	NA
Regulation	+/-5%	NA
	<b>Current (A)</b>	<b>Power (W)</b>
Average Idle Current	0.47	5.6
<b>Maximum Start Current</b>		
Average DC	1.05	12.6
Maximum DC (Peak)	1.46	
<b>Operating Current (Random Read)</b>		
Average DC	0.95	11.4
Maximum DC	0.99	12.7
Maximum DC (peak)	2.08	
<b>Operating Current (Random Write)</b>		
Average DC	1.00	12.0
Maximum DC	1.06	12.7
Maximum DC (peak)	2.08	
<b>Operating Current (Sequential Read)</b>		
Average DC	0.96	11.5
Maximum DC	0.98	11.7
Maximum DC (peak)	1.29	
<b>Operating Current (Sequential Write)</b>		
Average DC	1.01	12.1
Maximum DC	1.07	12.8
Maximum DC (peak)	2.09	

**Table 12 - Power consumption by model and capacity (continued)**

<b>Nytro 5350S 15 mm, 15360 GB Power Consumption</b>		
<b>Parameter</b>		
<b>Voltage</b>	+12V	NA
<b>Regulation</b>	+/-5%	NA
	<b>Current (A)</b>	<b>Power (W)</b>
<b>Average Idle Current</b>	0.59	7.1
<b>Maximum Start Current</b>		
<b>Average DC</b>	1.15	13.8
<b>Maximum DC (Peak)</b>	1.44	
<b>Operating Current (Random Read)</b>		
<b>Average DC</b>	1.34	16.0
<b>Maximum DC</b>	1.37	16.3
<b>Maximum DC (peak)</b>	1.62	
<b>Operating Current (Random Write)</b>		
<b>Average DC</b>	1.62	19.3
<b>Maximum DC</b>	1.77	21.1
<b>Maximum DC (peak)</b>	2.58	
<b>Operating Current (Sequential Read)</b>		
<b>Average DC</b>	1.01	12.1
<b>Maximum DC</b>	1.04	12.5
<b>Maximum DC (peak)</b>	1.31	
<b>Operating Current (Sequential Write)</b>		
<b>Average DC</b>	1.67	19.9
<b>Maximum DC</b>	1.75	20.9
<b>Maximum DC (peak)</b>	2.62	

## 9.3 Environmental limits

Temperature and humidity values experienced by the drive must be such that condensation does not occur on any drive part. Altitude and atmospheric pressures are specified to a standard day at 58.7°F (14.8°C). Maximum wet bulb temperature is 84.2°F (29°C).

**NOTE** To maintain optimal performance drives should be run at nominal case temperatures.

### 9.3.1 Temperature

#### 9.3.1.1 Operating

The drive meets the operating specifications over a 32°F to 167°F (0°C to 70°C) drive internal temperature range with a maximum temperature gradient of 36°F (20°C) per hour.

**NOTE** Internal temperature swings greater than 55°C during over a 3 day time period may cause an elevated read error rate.

The maximum allowable drive internal temperature is 70°C. If the enclosure environment is unable to keep the internal temperature below this value the drive will reduce write activity to avoid over temperature condition. When the internal temperature is equal or greater than 65°C the drive will issue a SMART thermal warning.

The MTBF specification for the drive assumes the operating environment is designed to maintain nominal internal temperature. The rated MTBF is based upon a sustained internal temperature of 122°F (50°C). Occasional excursions in operating temperature between the rated MTBF temperature and the maximum drive operating internal temperature may occur without impact to the rated MTBF temperature. However continual or sustained operation at internal temperatures beyond the rated MTBF temperature will degrade the drive MTBF and reduce product reliability.

Air flow across the drive is expected under moderate to heavy write data workloads to stay under internal temperature limits described in this section. To confirm that the required cooling is provided, place the drive in its final mechanical configuration, and perform highest data throughput for the given application. If unknown writing large transfers sequentially on both port will consume the most current. After the temperatures stabilize, read the internal temperature of the drive using Seagate SeaChest or SeaTools utilities available at <http://www.seagate.com>.

#### 9.3.1.2 Non-operating

-40° to 167°F (-40° to 75°C) package ambient with a maximum gradient of 36°F (20°C) per hour. This specification assumes that the drive is packaged in the shipping container designed by Seagate for use with drive.

### 9.3.2 Relative humidity

The values below assume that no condensation on the drive occurs.

- Operating
  - 5% to 95% non-condensing relative humidity with a maximum gradient of 20% per hour.
- Non-operating
  - 5% to 95% non-condensing relative humidity.

### 9.3.3 Effective altitude (sea level)

- Operating  
-1000 to +10,000 feet (-304.8 to +3048 meters)
- Non-operating  
-1000 to +40,000 feet (-304.8 to +12,192 meters)

### 9.3.4 Shock and vibration

Shock and vibration limits specified in this document are measured directly on the drive chassis. If the drive is installed in an enclosure to which the stated shock and/or vibration criteria is applied, resonances may occur internally to the enclosure resulting in drive movement in excess of the stated limits. If this situation is apparent, it may be necessary to modify the enclosure to minimize drive movement.

The limits of shock and vibration defined within this document are specified with the drive mounted by any of the four methods shown in [Figure 7, Recommended mounting, on page 45](#), and in accordance with the restrictions the [Section 11.3 Drive mounting](#).

#### 9.3.4.1 Shock

- Operating - normal

The drive, as installed for normal operation, shall operate error free while subjected to intermittent shock not exceeding:

1000 Gs at a maximum duration of 0.5ms (half sinewave)

Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than once every 2 seconds.

**NOTE** This specification does not cover connection issues that may result from testing at this level.

- Non-operating

The limits of non-operating shock shall apply to all conditions of handling and transportation. This includes both isolated drives and integrated drives.

The drive subjected to non-repetitive shock not exceeding:

1000 Gs at a maximum duration of 0.5ms (half sinewave), shall not exhibit device damage or performance degradation.

Shock may be applied in the X, Y, or Z axis.

- Packaged

Seagate finished drive bulk packs are designed and tested to meet or exceed applicable ISTA and ASTM standards. Volume finished drives will be shipped from Seagate factories on pallets to minimize freight costs and ease material handling. Seagate finished drive bulk packs may be shipped individually. For less than full shipments, instructions are printed on the bulk pack carton for minimum drive quantities and proper drive placement.

#### 9.3.4.2 **Vibration**

- Operating - normal

The drive s installed for normal operation, shall comply with the complete specified performance while subjected to vibration applied in the X, Y, or Z axis.

Operating normal translational random shaped profile: 5-800 Hz, 2.17 GRMS

- Operating - abnormal

Equipment as installed for normal operation shall not incur physical damage while subjected to periodic vibration:

Vibration occurring at these levels may degrade operational performance during the abnormal vibration period. Specified operational performance will continue when normal operating vibration levels are resumed. This assumes system recovery routines are available.

Operating abnormal translational random shaped profile:10-2000 Hz, 16.3 Grms

- Non-operating

The limits of non-operating vibration shall apply to all conditions of handling and transportation. This includes both isolated drives and integrated drives.

The drive shall not incur physical damage or degraded performance as a result of vibration.

Vibration may be applied in the X, Y, or Z axis.

Non-operating translational random shaped profile: 10-2000 Hz, 16.3 Grms

**NOTE** This specification does not cover connection issues that may result from testing at this level.

#### 9.3.5 **Air cleanliness**

The drive is designed to operate in a typical office environment with minimal environmental control.

#### 9.3.6 **Corrosive environment**

Seagate electronic drive components pass accelerated corrosion testing equivalent to 10 years exposure to light industrial environments containing sulfurous gases, chlorine and nitric oxide, classes G and H per ASTM B845. However, this accelerated testing cannot duplicate every potential application environment.

Users should use caution exposing any electronic components to uncontrolled chemical pollutants and corrosive chemicals as electronic drive component reliability can be affected by the installation environment. The silver, copper, nickel and gold films used in Seagate products are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. Materials used in cabinet fabrication, such as vulcanized rubber, that can outgas corrosive compounds should be minimized or eliminated. The useful life of any electronic equipment may be extended by replacing materials near circuitry with sulfide-free alternatives.

Seagate recommends that data centers be kept clean by monitoring and controlling the dust and gaseous contamination. Gaseous contamination should be within ANSI/ISA 571.04-2013 G1 classification levels (as measured on copper and silver coupons), and dust contamination to ISO 14644-1 Class 8 standards, and MTBF rated conditions as defined in the Annualized Failure Rate (AFR) and Mean Time Between Failure (MTBF) section.



## 9.4.1 Nytro 5350S Weights

Table 13 Nytro 5350S Weights

Nytro 5350S 15mm U.2/U.3 weight by model				
Endurance Class	Capacity in GB	Standard	SED	Weight (g)
RI	15360	XP15360SE70065	XP15360SE70075	170
RI	7680	XP7680SE70065	XP7680SE70075	205
RI	3840	XP3840SE70065	XP3840SE70075	205
RI	1920	XP1920SE7065	XP1920SE70075	205

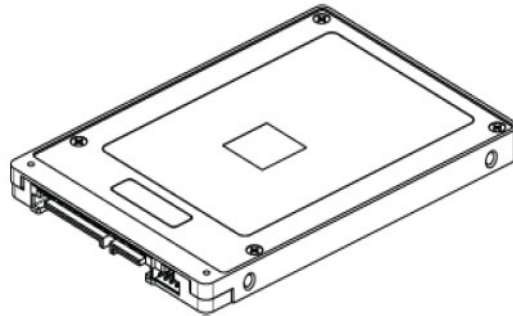


## 9.5 Connector specification

### 9.5.1 Connector specification

Figure 2, *Physical Interface*, on page 33 shows the location of the SFF-8639 (U2) connector. Figure 3, *NVMe device plug dimensions*, on page 34 and Figure 4, *NVMe device plug dimensions (detail)*, on page 35 provide the dimensions of the NVMe connector. Details of the physical, electrical, and logical characteristics are provided within this section.

**Figure 2 Physical Interface**



**Figure 3 NVMe device plug dimensions**

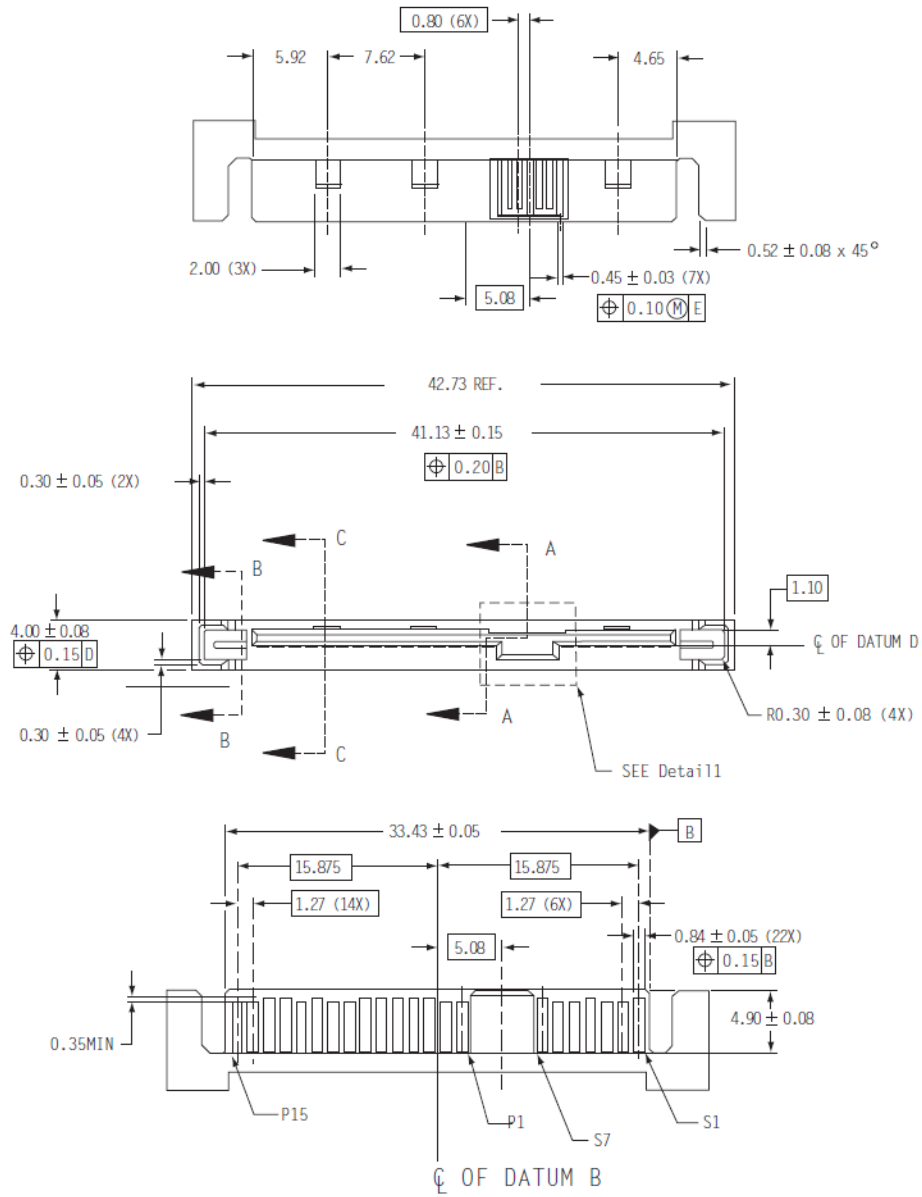
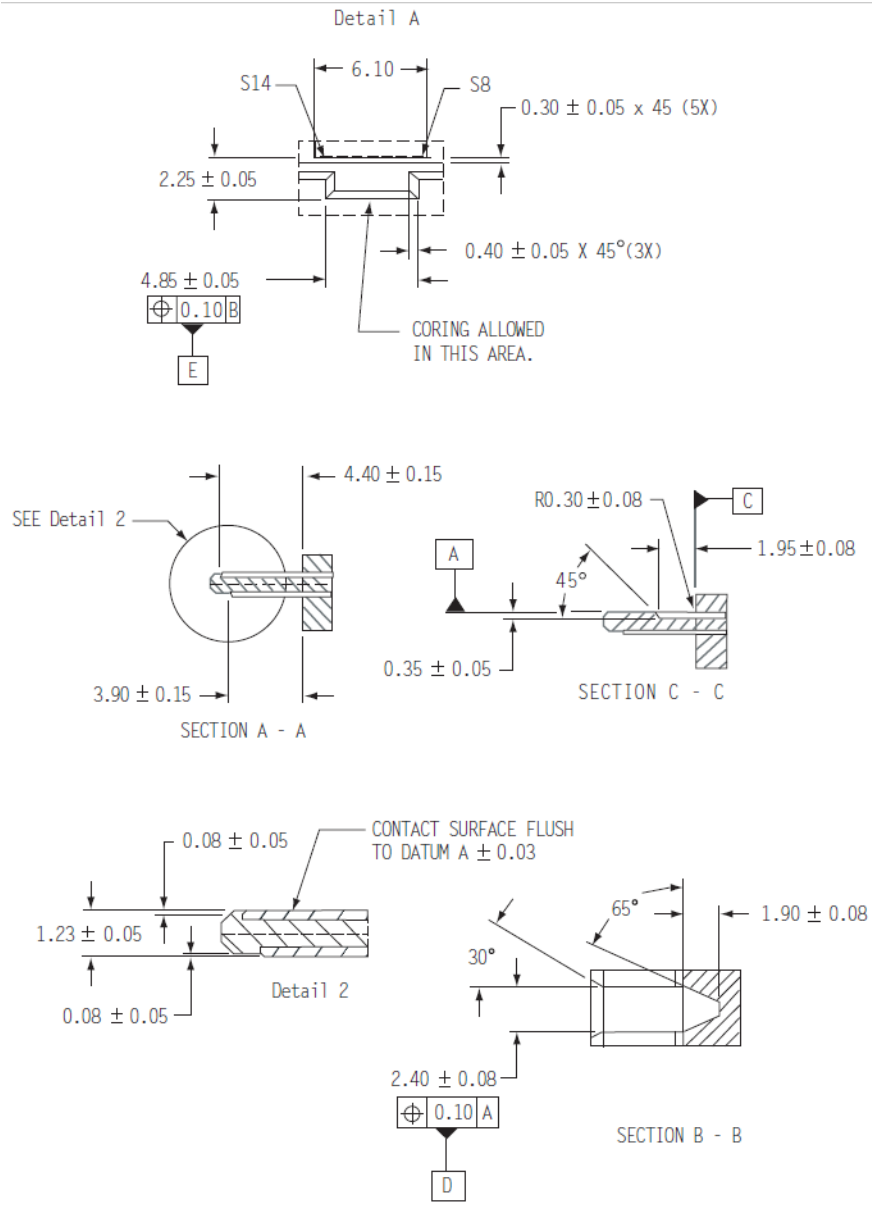


Figure 4 NVMe device plug dimensions (detail)



## **9.5.2 Physical characteristics**

This section defines physical interface connector.

## **9.5.3 Connector requirements**

Contact a preferred connector manufacturer for mating part information. Part numbers for NVMe connectors will be provided in a future revision of this publication when production parts are available from major connector manufacturers.

## **9.5.4 Electrical description**

NVMe drives use the device connector for:

- DC power
- PCIe links
- Activity LED
- SMBus interface

This connector can plug directly into a backpanel or accept cables.

## 9.5.5 Pin descriptions

This section provides a pin-out of the NVMe device and a description of the functions provided by the pins.

**Table 14 SFF-8639 connector pin descriptions**

Pin	Name	Description	Pin	Name	Description
<b>S1</b>	GND	Ground	E7	REFCLK+	Reference Clock Port 0 Positive
S2	PETp0 (U.3)	Transmitter differential pair, U.3 Lane 0 Positive	E8	REFCLK-	Reference Clock Port 0 Negative
S3	PETn0 (U.3)	Transmitter differential pair, U.3 Lane 0 Negative	E9	GND	Ground
<b>S4</b>	GND	Ground	E10	PETp0 (U.2)	Transmitter differential pair, Lane 0 Positive
S5	PERn0 (U.3)	Receiver differential pair, U.3 Lane 0 Negative	E11	PETn0 (U.2)	Transmitter differential pair, Lane 0 Negative
S6	PERp0 (U.3)	Receiver differential pair, U.3 Lane 0 Positive	E12	GND	Ground
<b>S7</b>	GND	Ground	E13	PERn0 (U.2)	Receiver differential pair, Lane 0 Negative
			E14	PERp0 (U.2)	Receiver differential pair, Lane 0 Positive
			E15	GND	Ground
			E16	HPT1	Host Port Type-1
E1	NU	Not used	S8	GND	Ground
E2	NU	Not used	S9	PETp1 (U.3)	Transmitter differential pair, U.3 Lane 1 Positive
E3	3.3V_AUX	+3.3V Auxiliary Power (Required for SMBus operation)	S10	PETn1 (U.3)	Transmitter differential pair, U.3 Lane 1 Negative
E4	CLKREQ#	Clock request	S11	GN	Ground
E5	PERST#	Fundamental reset	S12	PERn1 (U.3)	Receiver differential pair, U.3 Lane 1 Negative
E6	IfDet2#	Interface Detect 2 (drive type)	S13	PERp1 (U.3)	Receiver differential pair, U.3 Lane 1 Positive
			S14	GND	Ground
P1	WAKE#	Signal for Link reactivation	S15	HPT0	Host Port Type-0
P2	NU	Not Used	S16	GND	Ground
<b>P3</b>	PWRDIS	Power Disable	S17	PETp1 (U.2) / PETp2 (U.3)	Transmitter differential pair, Lane 1 Positive
<b>P4</b>	IfDet#	Interface Detect (drive type)	S18	PETn1 (U.2) / PETn2 (U.3)	Transmitter differential pair, Lane 1 Negative
<b>P5</b>	GND	Ground	S19	GND	Ground
<b>P6</b>	GND	Ground	S20	PERn1 (U.2) / PERn2 (U.3)	Receiver differential pair, Lane 1 Negative
<b>P7</b>	NU	Not Used	S21	PERp1 (U.2) / PERp2 (U.3)	Receiver differential pair, Lane 1 Positive
P8	NU	Not Used	S22	GND	Ground
P9	NU	Not Used	S23	PETp2 (U.2) / PETp3 (U.3)	Transmitter differential pair, Lane 2 Positive
<b>P10</b>	PRSNT#	Presence Detect (also drive type)	S24	PETn2 (U.2) / PETn3 (U.3)	Transmitter differential pair, Lane 2 Negative
P11	ACTIVITY#	Activity signal from the drive	S25	GND	Ground

**Table 14 SFF-8639 connector pin descriptions (continued)**

<b>P12</b>	Hot-Plug	Ground	S26	PERn2 (U.2) / PERn3 (U.3)	Receiver differential pair, Lane 2 Negative
<b>P13</b>	+12V_pre	12V Power	S27	PERp2 (U.2) / PERp3 (U.3)	Receiver differential pair, Lane 2 Positive
P14	+12V	12V Power	S28	GND	Ground
P15	+12V	12V Power	E17	PETp3 (U.2)	Transmitter differential pair, Lane 3 Positive
			E18	PETn3 (U.2)	Transmitter differential pair, Lane 3 Negative
			E19	GND	Ground
			E20	PERn3 (U.2)	Receiver differential pair, Lane 3 Negative
			E21	PERp3 (U.2)	Receiver differential pair, Lane 3 Positive
			E22	GND	Ground
			E23	SMBCLK	SMBus (System Management Bus) clock
			E24	SMBDAT	SMBus (System Management Bus) data
			E25	DUALPORTEN#	Dual port Enable and Host Port Type control

**NOTES**

- Pins marked Bold are long pins (1st to mate) that assist hot plugging.

**9.5.6 Power**

Three +12 volt pins provide power to the drive, 2 short and 1 long.

The current return for the +12 volt power supply is through the common ground pins.

The supply current and return current must be distributed as evenly as possible among the pins.

Current to the drive through the long power pins may be limited by the system to reduce inrush current to the drive during hot plugging.

There is no power control switch on the drive. However, power can be cycled on the drive by using the Power Disable (PWRDIS) feature (that is, drive Pin 3 high) as defined by the PCI Express SFF-8639 Module specification.

## 10. About self-encrypting drives

Self-encrypting drives (SEDs) offer encryption and security services for the protection of stored data, commonly known as *protection of data at rest*. These drives are compliant with the Trusted Computing Group (TCG) Opal Storage Specifications as detailed in Section.

The Trusted Computing Group (TCG) is an organization sponsored and operated by companies in the computer, storage and digital communications industry. The Seagate SED models comply with the standards published by the TCG.

To use the security features in the drive, the host must be capable of constructing and issuing the following two NVMe commands:

- Security Send
- Security Receive

These commands are used to convey the TCG protocol to and from the drive in the appropriate command payloads.

### 10.1 Data encryption

Encrypting drives use one in-line encryption engine for each port, employing AES-256 data encryption in XEX-based tweaked-codebook mode with ciphertext stealing (XTS) to encrypt all data prior to being written on the media and to decrypt all data as it is read from the media. The encryption engines are always in operation and cannot be disabled.

The 32-byte Data Encryption Key (DEK) is a random number which is generated by the drive, never leaves the drive, and is inaccessible to the host system. The DEK is itself encrypted when it is stored on the media and when it is in volatile temporary storage (DRAM) external to the encryption engine. A unique data encryption key is used for each of the drive's possible 9 data bands (see [Section 10.5 Data bands](#)).

### 10.2 Controlled access

The drive has two security providers (SPs) called the "Admin SP" and the "Locking SP." These act as gatekeepers to the drive security services. Security-related commands will not be accepted unless they also supply the correct credentials to prove the requester is authorized to perform the command.

#### 10.2.1 Admin SP

The Admin SP allows the drive's owner to enable or disable firmware download operations (see Section 6.4). Access to the Admin SP is available using the SID (Secure ID) password or the MSID (Manufacturers Secure ID) password.

#### 10.2.2 Locking SP

The Locking SP controls read/write access to the media and the cryptographic erase feature. Access to the Locking SP is available using the BandMasterX or EraseMaster passwords. Since the drive owner can define up to 9 data bands on the drive, each data band has its own password called BandMasterX where X is the number of the data band (0 through 8).

### 10.2.3 Default password

When the drive is shipped from the factory, all passwords are set to the value of MSID. This 32-byte random value can only be read by the host electronically over the interface. After receipt of the drive, it is the responsibility of the owner to use the default MSID password as the authority to change all other passwords to unique owner-specified values.

## 10.3 Random number generator (RNG)

The drive has a 32-byte hardware RNG that it uses to derive encryption keys or, if requested to do so, to provide random numbers to the host for system use, including using these numbers as Authentication Keys (passwords) for the drive's Admin and Locking SPs.

## 10.4 Drive locking

In addition to changing the passwords, as described in [Section 10.2.3 Default password](#), the owner should also set the data access controls for the individual bands.

The variable *LockOnReset* should be set to *PowerCycle* to ensure that the data bands will be locked if power is lost. In addition *ReadLockEnabled* and *WriteLockEnabled* must be set to true in the locking table in order for the bands *LockOnReset* setting of *PowerCycle* to actually lock access to the band when a *PowerCycle* event occurs. This scenario occurs if the drive is removed from its cabinet. The drive will not honor any data READ or WRITE requests until the bands have been unlocked. This prevents the user data from being accessed without the appropriate credentials when the drive has been removed from its cabinet and installed in another system.

When the drive is shipped from the factory, the firmware download port is unlocked allowing the drive to accept any attempt to download new firmware. The drive owner must use the SID credential to lock the firmware download port before firmware updates will be rejected.

## 10.5 Data bands

When shipped from the factory, the drive is configured with a single data band called Band 0 (also known as the Global Data Band) which comprises LBA 0 through LBA max. The host may allocate Band1 by specifying a start LBA and an LBA range. The real estate for this band is taken from the Global Band. An additional 7 Data Bands may be defined in a similar way (Band2 through Band8) but before these bands can be allocated LBA space, they must first be individually enabled using the *EraseMaster* password.

Data bands cannot overlap but they can be sequential with one band ending at LBA (x) and the next beginning at LBA (x+1).

Each data band has its own drive-generated encryption key and its own user-supplied password. The host may change the Encryption Key or the password when required. The bands shall be aligned to 4KB LBA boundaries.



## 10.6 Cryptographic erase

A significant feature of SED drives is the ability to perform a cryptographic erase. This involves the host telling the drive to change the data encryption key for a particular band. Once changed, the data is no longer recoverable since it was written with one key and will be read using a different key. Since the drive overwrites the old key with the new one, and keeps no history of key changes, the user data can never be recovered. This creates an instantaneous data erase and is very useful if the drive is to be scrapped or redispositioned. Erased sectors are unmapped and return all zeros if read.

## 10.7 Authenticated firmware download

In addition to providing a locking mechanism to prevent unwanted firmware download attempts, the drive also only accepts download files which have been cryptographically signed by the appropriate Seagate Design Center.

Three conditions must be met before the drive will allow the download operation:

1. The download must be an SED file. A standard (base) drive (non-SED) file will be rejected.
2. The download file must be digitally signed and authenticated.
3. As with a non-SED drive, the download file must pass the acceptance criteria for the drive. For example it must be applicable to the correct drive model, and have compatible revision and customer status.

## 10.8 Power requirements

The standard drive models and the SED drive models have identical hardware, however the security and encryption portion of the drive controller ASIC is enabled and functional in the SED models. This represents a small additional drain on the 12V supply of about 150mW in power consumption. See the tables in [Table 9.2.2, Power consumption by model and capacity](#) for power requirements on the standard (non-SED) drive models.

## 10.9 Supported commands

The SED models support the following two commands in addition to the commands supported by the standard (non-SED) models as listed in [Table 17, NVMe Admin and I/O Commands](#).

- Security Send
- Security Receive

## 10.10 Sanitize - Cryptographic Erase

This command cryptographically erases all user data on the drive by destroying the current data encryption key and replacing it with a new data encryption key randomly generated by the drive. The Crypto Erase Sanitize operation is NVMe Command Identifier 84h and selecting the Sanitize Action (SANACT) code 100b (Start a Crypto Erase sanitize operation.).

## 10.11 RevertSP

SED models support the RevertSP feature which erases all data in all bands on the device and returns the contents of all SPs (Security Providers) on the device to their original factory state. In order to execute the RevertSP method the unique PSID (Physical Secure ID) printed on the drive label must be provided. PSID is not electronically accessible and can only be manually read from the drive label or scanned in using the 2D barcode.

# 11. Installation

Nytro 5350S NVMe SSD installation is a plug-and-play process. There are no jumpers on the drive.

NVMe drives are designed to be used in a host system that provides an PCIe-compatible backplane with bays designed to accommodate the drive. In such systems, the host system typically provides a carrier or tray into which the drive must be mounted. Mount the drive to the carrier or tray provided by the host system using four M3 x 0.5 metric screws. When tightening the screws, use a maximum torque of 4.5 in-lb +/- 0.45 in-lb. Do not over-tighten or force the screws. The drive can be mounted in any orientation.

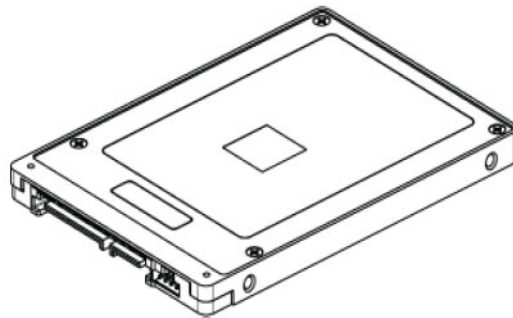
**NOTE** NVMe drives are designed to be attached to the host system without I/O or power cables. If the intent is to use the drive in a non-backplane host system, connecting the drive using high-quality cables is acceptable as long as the I/O cable length does not exceed 1 meter (3.2 feet).

Slide the carrier or tray into the appropriate bay in the host system using the instructions provided by the host system. This connects the drive directly to the system's SFF8639-compatible connector. The connector is normally located on a PCIe-compatible backpanel. See [Section 12.4 Signal characteristics](#) for additional information about these connectors.

Power is supplied through the SFF-8639 connector

The drive is shipped from the factory low-level formatted in 512-byte logical blocks and a single namespace using all logical blocks. Reformatting the drive is only required if the application requires a different logical block size..

**Figure 5 Physical interface**



## 11.1 Drive orientation

The drive may be mounted in any orientation. All drive performance characterizations, however, have been done with the drive in horizontal (level) and vertical (drive on its side) orientations, which are the two preferred mounting orientations.

## 11.2 Cooling

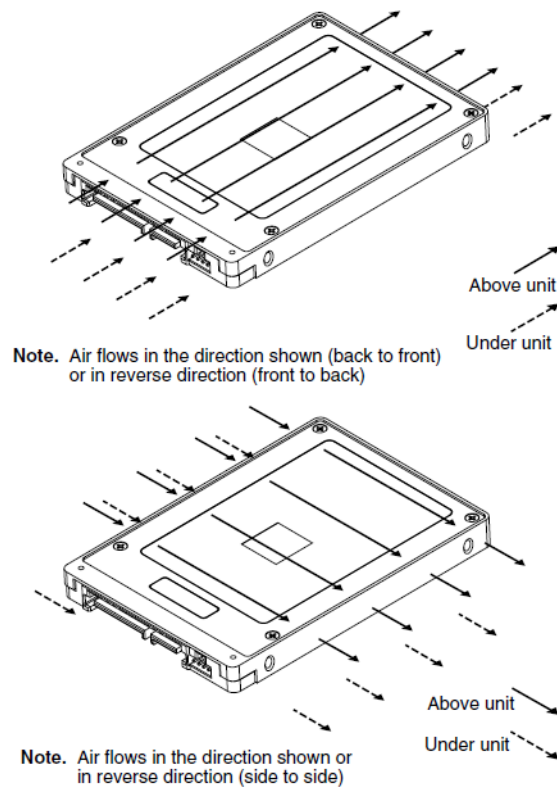
Cabinet cooling must be designed by the customer so that the temperature of the drive will not exceed temperature conditions specified in [Section 9.3.1 Temperature](#).

The rack, cabinet, or drawer environment for the drive must provide heat removal from the assembly. The system designer should confirm that adequate heat removal is provided using the temperature measurement guidelines described in [Section 9.3.1 Temperature](#).

Forced air flow may be required to keep temperatures at or below the temperatures specified in [Section 9.3.1 Temperature](#) in which case the drive should be oriented, or air flow directed, so that the least amount of air flow resistance is created while providing air flow. Also, the shortest possible path between the air inlet and exit should be chosen to minimize the travel length of air heated by the drive and other heat sources within the rack, cabinet, or drawer environment.

If forced air is determined to be necessary, possible air-flow patterns are shown in [Figure 6, Air Flow, on page 44](#). The air-flow patterns are created by one or more fans, either forcing or drawing air as shown in the illustrations. Conduction, convection, or other forced air-flow patterns are acceptable as long as the temperature measurement guidelines of [Section 9.3.1 Temperature](#) are met.

**Figure 6 Air Flow**



**NOTE**

Image may not represent actual product, for reference only.

## 11.3 Drive mounting

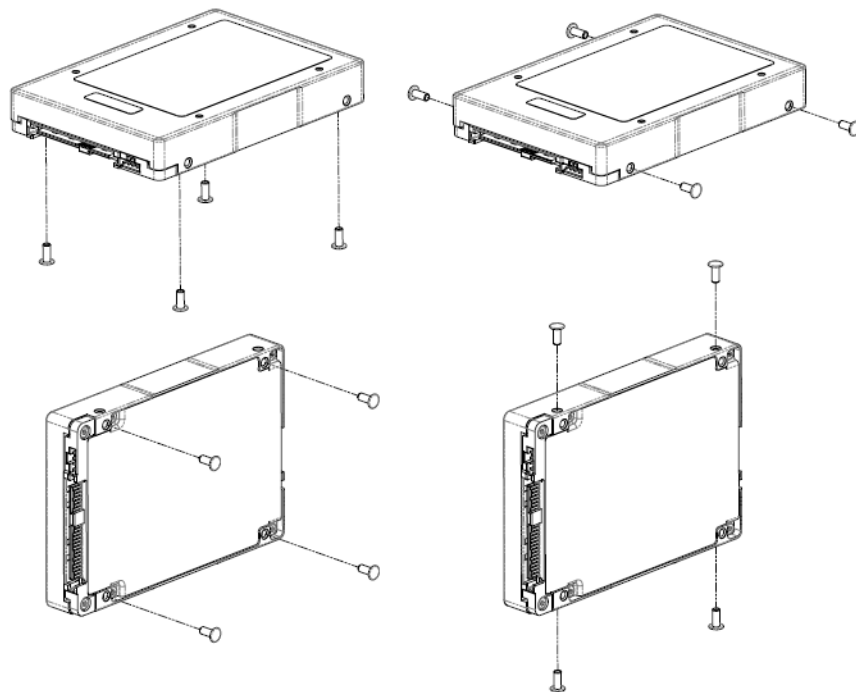
Mount the drive using the bottom or side mounting holes. If mounting the drive using the bottom holes, ensure not to physically distort the drive by attempting to mount it on a stiff, non-flat surface.

The allowable mounting surface stiffness is 80 lb/in (14.0 N/mm). The following equation and paragraph define the allowable mounting surface stiffness:

$$K \times X = F < 15\text{lb} = 67\text{N}$$

where K is the mounting surface stiffness (units in lb/in or N/mm) and X is the out-of-plane surface distortion (units in inches or millimeters). The out-of-plane distortion (X) is determined by defining a plane with three of the four mounting points fixed and evaluating the out-of-plane deflection of the fourth mounting point when a known force (F) is applied to the fourth point.

**Figure 7 Recommended mounting**



**NOTE** Image may not represent actual product, for reference only.

## 11.4 Grounding

Signal ground (PCBA) and case ground are connected together in the drive and cannot be separated by the user. The equipment in which the drive is mounted is connected directly to the drive with no electrically isolating shock mounts. If it is desired for the system chassis to not be connected to the drive ground, the systems integrator or user must provide a nonconductive (electrically isolating) method of mounting the drive in the host equipment.

Increased radiated emissions may result if designers do not provide the maximum surface area ground connection between system ground and drive ground. This is the system designer's and integrator's responsibility.

## 12. NVMe Interface requirements

This section lists the NVMe-specific features supported by Nytro 5350S SSDs.

### 12.1 Get/Set Features

The following table lists Get Features and Set Feature Identifiers.

**Table 15 - Nytro 5350S SSDs Support the Following Get/Set Features**

Feature Identifier	M/O	Command	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	Yes
07h	M	Number of Queues	Yes
08h	M	Interrupt Coalescing	Yes
09h	M	Interrupt Vector Configuration	Yes
0Ah	M	Write Atomicity	Yes
0Bh	M	Asynchronous Event Configuration	Yes
0Ch	O	Autonomous Power State Transition	No
0Dh	O	Host Memory Buffer	No
0Eh	O	Timestamp	Yes
0Fh	O	Keep Alive Timer	No
10h	O	Host Controlled Thermal Management	No
11h	O	Non-Operational Power State Config	No
15h	O	LBA Status Information Report Interval	No
16h	O	Host Behavior Support	No
17h	O	Sanitize Config	Yes
18h	O	Endurance Group Event Configuration	No
7Eh	O	Controller Metadata	Yes
7Fh	O	Namespace Metadata	Yes
80h	O	Software Progress Marker	No
81h	O	Host Identifier	Yes
82h	O	Reservation Notification Mask	Yes
83h	O	Reservation Persistence	Yes
84h	O	Namespace Write Protection Config	No

## 12.2 Log Pages

The following table lists the NVMe log pages supported by Nytro 5350S SSDs.

**Table 16 - NVMe Log Pages Supported**

<b>Log Page Identifier</b>	<b>M/O</b>	<b>Command</b>	<b>Supported</b>
01h	M	Error Information	Yes
02h	M	SMART / Health Information	Yes
03h	M	Firmware Slot Information	Yes
04h	O	Changed Namespace List	Yes
05h	O	Commands Supported and Effects Log	Yes
06h	O	Device Self-Test Log	Yes
07h	O	Telemetry Host-Initiated	Yes
08h	O	Telemetry Controlled-Initiated	Yes
0Dh	O	Persistent Event Log	Yes
80h	O	Reservation Notification	Yes
81h	O	Sanitize Status	Yes

## 12.3 NVMe Commands Supported

The following table lists the NVMe commands supported by Nytro 5350S SSD drives. For details about command fields definition and options, refer to the NVMe Express 1.4c specification available at [nvmexpress.org](http://nvmexpress.org).

**Table 17 - NVMe Admin and I/O Commands**

Admin Commands Supported			
Command Identifier	M/O	Command	Supported
00h	M	Delete I/O Submission Queue	Yes
01h	M	Create I/O Submission Queue	Yes
02h	M	Get Log Page	Yes
04h	M	Delete I/O Completion Queue	Yes
05h	M	Create I/O Completion Queue	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	Yes
10h	M	Firmware Commit	Yes
11h	M	Firmware Image Download	Yes
14h	M	Device Self-Test	Yes
15h	O	Namespace Attachment	Yes
1Dh	O	NVMe-MI Send	Yes
1Eh	O	NVMe-MI Receive	Yes
7Ch	O	Doorbell Buffer Config	No
80h	O	Format NVM	Yes
81h	O	Security Send	Yes
82h	O	Security Receive	Yes
84h	O	Sanitize	Yes



**Table 17 - NVMe Admin and I/O Commands (continued)**

I/O commands supported			
Command Identifier	M/O	Command	Supported
00h	M	Flush	Yes
01h	M	Write	Yes
02h	M	Read	Yes
04h	O	Write Uncorrectable	Yes
05h	O	Compare	Yes
08h	O	Write Zeros	Yes
09h	O	Dataset Management - Trim	Yes
		Dataset Management - IDW	Yes
		Dataset Management - IDR	Yes
0Ch	O	Verify	Yes
0Dh	O	Reservation Register	Yes
0Eh	O	Reservation Report	Yes
11h	O	Reservation Acquire	Yes
15h	O	Reservation Release	Yes

### 12.3.1 Identify Controller

The following table lists the Identify Controller data structure (CNS 01h) bytes 63:24 that the drive returns to the host. Bytes 24 through 63 (MN field) reflect the model of drive in ASCII.

**Table 18 Identify Controller Data**

Bytes	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	...	63
XP1920SE70065	58	50	31	39	32	30	53	45	37	30	30	36	35	20	20	20	...	20
XP3840SE70065	58	50	33	38	34	30	53	45	37	30	30	36	35	20	20	20	...	20
XP7680SE70065	58	50	37	36	38	30	53	45	37	30	30	36	35	20	20	20	...	20
XP15360SE70065	58	50	31	35	33	36	30	53	45	37	30	30	36	35	20	20	...	20
XP1920SE70075	58	50	31	39	32	30	53	45	37	30	30	37	35	20	20	20	...	20
XP3840SE70075	58	50	33	38	34	30	53	45	37	30	30	37	35	20	20	20	...	20
XP7680SE70075	58	50	37	36	38	30	53	45	37	30	30	37	35	20	20	20	...	20
XP15360SE70075	58	50	31	35	33	36	30	53	45	37	30	30	37	35	20	20	...	20

### 12.3.2 Set Features Data

The Get Features command provides a way for the drive to report its operating parameters to the host. The drive maintains four sets of feature attributes:

#### 1. Current values

Current values are volatile values being used by the drive to control its operation. A Set Features command can be used to change the values identified as changeable values. Originally, current values are installed from saved or default values after a reset.

#### 2. Default values

Default values are hard-coded in the drive firmware stored in flash E-PROM (nonvolatile memory) on the drive's PCB. These default values can be changed only by downloading a complete set of new firmware into the flash E-PROM. A host can request and receive from the drive a list of default values and use those in a Set Features command to set up new current and saved values, where the values are changeable.

#### 3. Saved values

Saved values are stored on the drive media using a Set Features command. Only attribute values that are allowed to be changed can be changed by this method. Attributes in the saved values list that are not changeable by the Set Features command get their values from default values storage.

When power is applied to the drive, it takes saved values from the media and stores them as current values in volatile memory. It is not possible to change the current values (or the saved values) with a Set Features command before the drive is "ready." An attempt to do so results in a "Check Condition" status.

On drives requiring unique saved values, the required unique saved values are stored into the saved values storage location on the media prior to shipping the drive. Some drives may have unique firmware with unique default values also.

On standard OEM drives, the saved values are taken from the default values list and stored into the saved values storage location on the media prior to shipping.

#### 4. Supported Capabilities

Supported Capabilities returns the capabilities supported for this Feature Identifier. The capabilities supported are returned in Dword 0 of the completion entry of the Get Features command.

## 12.4 Signal characteristics

This section describes the electrical signal characteristics of the drive's input and output signals. See [Table 14, SFF-8639 connector pin descriptions](#) for signal type and signal name information.

### 12.4.1 ACTIVITY# signal

The ACTIVITY# signal is driven by the drive as indicated in the table below.

**Table 19 - ACTIVITY LED Out conditions**

Normal command activity	LED status
Drive stopped, not ready, and no activity	Off
Drive stopped, not ready, and activity (command executing)	Blinks (50ms on, 50ms off)
Drive started, ready, and no activity	Off
Drive started, ready, and activity (command executing)	On
FORMAT UNIT in progress	Slower blinks (0.5 seconds on, 0.5 seconds off)

The ACTIVITY# signal is designed to pull down the cathode of an LED. The anode is attached to the proper +3.3 volt supply through an appropriate current limiting resistor. The LED and the current limiting resistor are external to the drive.

See [Table 20, LED drive signal](#) for the output characteristics of the LED drive signals.

**Table 20 - LED drive signal**

State	Test condition	Output voltage
■ LED off, high	$0.3\text{ V} \leq V_{OH} \leq 3.6\text{ V}$	$-100\ \mu\text{A} < I_{OH} < 100\ \mu\text{A}$
■ LED on, low	$I_{OL} = 15\text{ mA}$	$0 \leq V_{OL} \leq 0.225\text{ V}$



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