Seagate® Nytro® 5050 NVMe SSD
Product Manual

Nytro 5550H 15 mm U.2/U.3 Mixed Use (3 DWPD)

Capacity	Standard	SED	FIPS 140-3
12800	XP12800LE70005	XP12800LE70015	XP12800LE70025
6400	XP6400LE70005	XP6400LE70015	XP6400LE70025
3200	XP3200LE70005	XP3200LE70015	XP3200LE70025
1600	XP1600LE70005	XP1600LE70015	XP1600LE70025
800	XP800LE70005	XP800LE70015	XP800LE70025

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

Capacity	Standard	SED	FIPS 140-3
15360	XP15360SE70005	XP15360SE70015	XP15360SE70025
7680	XP7680SE70005	XP7680SE70015	XP7680SE70025
3840	XP3840SE70005	XP3840SE70015	XP3840SE70025
1920	XP1920SE70005	XP1920SE70015	XP1920SE70025

Nytro 5550M 15mm U.2/U.3 Mixed Use (3 DWPD)

Capacity	Standard	SED	FIPS 140-3
12800	XP12800LE70035	XP12800LE70045	XP12800LE70055
6400	XP6400LE70035	XP6400LE70045	XP6400LE70055
3200	XP3200LE70035	XP3200LE70045	XP3200LE70055
1600	XP1600LE70035	XP1600LE70045	XP1600LE70055
800	XP800LE70035	XP800LE70045	XP800LE70055

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

Capacity	Standard	SED	FIPS 140-3
15360	XP15360SE70035	XP15360SE70045	XP15360SE70055
7680	XP7680SE70035	XP7680SE70045	XP7680SE70055
3840	XP3840SE70035	XP3840SE70045	XP3840SE70055
1920	XP1920SE70035	XP1920SE70045	XP1920SE70055

Nytro 5550M 7mm U.2/U.3 Mixed Use (3 DWPD)

Capacity	Standard	SED	FIPS 140-3
6400	XP6400LE10005	XP6400LE10015	XP6400LE10025
3200	XP3200LE10005	XP3200LE10015	XP3200LE10025
1600	XP1600LE10005	XP1600LE10015	XP1600LE10025
800	XP800LE10005	XP800LE10015	XP800LE10025

Nytro 5350M 7mm U.2/U.3 Read Intensive (1 DWPD)

Capacity	Standard	SED	FIPS 140-3
7680	XP7680SE10005	XP7680SE10015	XP7680SE10025
3840	XP3840SE10005	XP3840SE10015	XP3840SE10025
1920	XP1920SE10005	XP1920SE10015	XP1920SE10025

Revision History

Version and Date	Description of Changes
Rev D, September 2024	Updated specifications
Rev C, February 2023	Updated security logistics
Rev B, November 2022	Updated specifications
Rev A, July 2022	First release of the document

Contents

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® 5050 NVM Express (NVMe) SSD series.

The NVMe interface meets next-generation computing demands for performance, scalability, flexibility, and high-density storage requirements. Nytro 5050 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 5050 NVMe SSDs have the following features.   .

Table 1 - SSD Features

Feature	Description	
Capacities (User)	■ See Section 3. *Nytro 5050 Models and Capacities*	
Certifications, Eco-compliance	■ CE, FCC, UKCA, RCM, BSMI, KCC, VCCI, CB, UL, TUV, CMIM, Microsoft WHQL ■ RoHS	
Form Factor	■ 2.5-inch x 15mm (Nytro 5050H) ■ 2.5-inch x 7mm (Nytro 5050H and Nytro 5050M)	
Dimensions	15 mm: ■ Height 14.9 mm/0.587 in ■ Width 70.1 mm/2.760 in ■ Depth 100.4mm/3.953 in 7 mm: ■ Height 7.1 mm/0.280 in ■ Width 70.1 mm/2.760 in ■ Depth 100.4 mm/3.953 in ■ See Section 9.4 *Mechanical specifications*	
Weight	■ 205 g Nytro 5050H 15mm U.2/U.3 ■ 205 g Nytro 5050M 15mm U.2/U.3 ■ 105 g Nytro 5050M 7mm U.2/U.3 ■ See Section 9.4.1 *Nytro 5050 Weights*	
Endurance	■ See Section 8.2 *Endurance*	
Interface Complliance	■ PCI Express Gen4 x4 using SFF-8639 and SFF-TA-1001 (U.2/U.3 auto-detect) ■ NVMe 1.4c	
NAND	■ Enterprise-grade TLC, 3D	
Operating Systems	■ Windows Server 2019, Server 2022, Azure, SDDC ■ Ubuntu Server 18.04, 20.04 ■ CentOS 7	
Performance Random	■ Read: Up to 1,700,000 IOPS ■ Write: Up to 495,000 IOPS	Actual performance can vary depending on use conditions and environment. See Section 7.2.2 *Performance (Throughput)*
Performance Sequential	■ Read: Up to 7400MB/s ■ Write: Up to 7200MB/s	
Power Consumption	■ Active Power, Average: <24 W ■ Idle Power Average: <6 W	See Section 9.2 *Power consumption*
Power Management	■ Supports NVMe Power States ■ Profiles: — Nytro 5050H: 25W, 18W, 14W, 12W, 9W — Nytro 5050M 15mm: 18W, 14W, 12W — Nytro 5050M 7mm: 21W, 12.5W, 9W ■ Supports D3hot	

Table 1 - SSD Features *(continued)*

Security	Self-Encrypting Drive (SED) models comply with the Trusted Computing Group (TCG) Documents: ■ TCG Storage Architecture Core Specification, Version 2.01, Revision 2.0 ■ TCG Storage Security Subsystem Class Opal Specification, Version 2.01, Revision 1.0
Reliability	■ End-to-end data path protection ■ MTBF: 2.5 million hours ■ UBER: 1 error in 10^{17} bits read See Section 8.1 *Read error rates*
Shock	Shock ■ Non-Operating: 1,300 G, at 0.5 ms
Vibration	Vibration ■ Operating: 16.3G$_{RMS}$, (20 to 2000 Hz, Frequency)
Temperature	■ Operating: 0℃ to 70℃ ■ Non-operating: -40℃ to 85℃
Voltage	■ These drives receive DC power +12 V (Max 13.2 V) ■ Operation of SMBus requires application of +3.3Vaux (Max 3.6V)
Warranty	For warranty support details, visit: http://www.seagate.com/support/warranty-and-replacements/ Limited Warranty with Media Usage - based on the shorter of term and endurance use of the drive.

(Shock, Vibration, and Temperature rows share: See Section 9.3 *Environmental limits*)

Additional NVMe Features

Nytro 5050 Standard Drives

■ 264 I/O queue pairs
■ 64,000 maximum entries per queue
■ Up to 128 namespaces supported
■ PRP and SGL data transfer schemes
■ Weighted Command Arbitration scheme support
■ User-selectable logical block size (512, 520, 4096, 4104, or 4160 bytes per logical block)
■ No preventive maintenance or adjustments required
■ Self diagnostics performed when power is applied to the drive
■ ECC and Micro-RAID Error Recovery
■ Vertical, horizontal, or top down mounting
■ Device Self Test (DST)
■ Power loss data protection
■ Authenticated firmware download
■ Sanitize command Block Erase support

Nytro 5050 SED and FIPS 140-3 Drives

All of the above NVMe features and the following additional features
■ Automatic data encryption/decryption
■ Controlled access
■ Random number generator
■ Drive locking
■ Up to 8 independent locking bands plus one global band
■ Sanitize Cryptographic Erase support

3. Nytro 5050 Models and Capacities

The following categories apply to the Nytro 5050 series. Nytro 5350 and Nytro 5550 are families in the Nytro 5050 series. The H configuration is high power, full performance, and M stands for mainstream. M is a power-limited configuration that keeps power under 15 Watts.

Table 2 - Nytro 5050 Models and Capacities

Nytro 5550H 15 mm U.2/U.3 Mixed Use (3 DWPD)			
Capacity	**Standard**	**SED**	**FIPS 140-3**
12800	XP12800LE70005	XP12800LE70015	XP12800LE70025
6400	XP6400LE70005	XP6400LE70015	XP6400LE70025
3200	XP3200LE70005	XP3200LE70015	XP3200LE70025
1600	XP1600LE70005	XP1600LE70015	XP1600LE70025
800	XP800LE70005	XP800LE70015	XP800LE70025
Nytro 5350H 15 mm U.2/U.3 Read Intensive (1 DWPD)			
Capacity	**Standard**	**SED**	**FIPS 140-3**
15360	XP15360SE70005	XP15360SE70015	XP15360SE70025
7680	XP7680SE70005	XP7680SE70015	XP7680SE70025
3840	XP3840SE70005	XP3840SE70015	XP3840SE70025
1920	XP1920SE70005	XP1920SE70015	XP1920SE70025
Nytro 5550M 15mm U.2/U.3 Mixed Use (3 DWPD)			
Capacity	**Standard**	**SED**	**FIPS 140-3**
12800	XP12800LE70035	XP12800LE70045	XP12800LE70055
6400	XP6400LE70035	XP6400LE70045	XP6400LE70055
3200	XP3200LE70035	XP3200LE70045	XP3200LE70055
1600	XP1600LE70035	XP1600LE70045	XP1600LE70055
800	XP800LE70035	XP800LE70045	XP800LE70055
Nytro 5350M 15mm U.2/U.3 Read Intensive (1 DWPD)			
Capacity	**Standard**	**SED**	**FIPS 140-3**
15360	XP15360SE70035	XP15360SE70045	XP15360SE70055
7680	XP7680SE70035	XP7680SE70045	XP7680SE70055
3840	XP3840SE70035	XP3840SE70045	XP3840SE70055
1920	XP1920SE70035	XP1920SE70045	XP1920SE70055

Table 2 - Nytro 5050 Models and Capacities *(continued)*

Nytro 5550M 7mm U.2/U.3 Mixed Use (3 DWPD)			
Capacity	**Standard**	**SED**	**FIPS 140-3**
6400	XP6400LE10005	XP6400LE10015	XP6400LE10025
3200	XP3200LE10005	XP3200LE10015	XP3200LE10025
1600	XP1600LE10005	XP1600LE10015	XP1600LE10025
800	XP800LE10005	XP800LE10015	XP800LE10025
Nytro 5350M 7mm U.2/U.3 Read Intensive (1 DWPD)			
Capacity	**Standard**	**SED**	**FIPS 140-3**
7680	XP7680SE10005	XP7680SE10015	XP7680SE10025
3840	XP3840SE10005	XP3840SE10015	XP3840SE10025
1920	XP1920SE10005	XP1920SE10015	XP1920SE10025

NOTES

- Nytro 5050 SED models provide for "Security of Data at Rest" as defined by the Trusted Computing Group (see http://www.trustedcomputinggroup.org).

- For more on FIPS140-3 Level 2 certification see Section 10. *About FIPS*.

- 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, STA029, and STA030

Table 3 - Regulatory Model Numbers by SKU

STA026

XP6400LE70005	XP6400LE70045	XP7680SE70025
XP3200LE70005	XP3200LE70045	XP3840SE70025
XP1600LE70005	XP1600LE70045	XP1920SE70025
XP800LE70005	XP800LE70045	XP7680SE70035
XP6400LE70015	XP6400LE70055	XP3840SE70035
XP3200LE70015	XP3200LE70055	XP1920SE70035
XP1600LE70015	XP1600LE70055	XP7680SE70045
XP800LE70015	XP800LE70055	XP3840SE70045
XP6400LE70025	XP7680SE70005	XP1920SE70045
XP3200LE70025	XP3840SE70005	XP7680SE70055
XP1600LE70025	XP1920SE70005	XP3840SE70055
XP800LE70025	XP7680SE70015	XP1920SE70055
XP6400LE70035	XP3840SE70015	
XP3200LE70035	XP1920SE70015	
XP1600LE70035		
XP800LE70035		

STA029

XP6400LE10005	XP7680SE10005
XP3200LE10005	XP3840SE10005
XP1600LE10005	XP1920SE10005
XP800LE10005	XP7680SE10015
XP6400LE10015	XP3840SE10015
XP3200LE10015	XP1920SE10015
XP1600LE10015	XP7680SE10025

Table 3 - Regulatory Model Numbers by SKU *(continued)*

XP800LE10015	XP3840SE10025
XP6400LE10025	XP1920SE10025
XP3200LE10025	
XP1600LE10025	
XP800LE10025	

STA030

XP12800LE70005	XP15360SE70005
XP12800LE70015	XP15360SE70015
XP12800LE70025	XP15360SE70025
XP12800LE70035	XP15360SE70035
XP12800LE70045	XP15360SE70045
XP12800LE70055	XP15360SE70055

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

Nytro 5050 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. It is possible to obtain different formatted capacities than those listed below. Use equipment that can modify data block sizes before issuing the format command.

Nytro 5050 models follow the SFF-8447 specification.

Table 4 - Formatted Capacity Block Count (15360 GB, 12,800 GB, 7680 GB, and 6400 GB models)

	Last Logical Block Address							
Block	15360 GB		12,800 GB		7680 GB		6400 GB	
Size	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex
512	30005842607	6FC7CD2AF	25004872367	5D26812AF	15,002,931,887	37E3E92AF	12,502,446,767	2E93432AF
520	29,391,585,279	6D7DFFFFF	24,490,541,055	5B3BFFFFF	14,685,538,559	36B5388FF	12,237,948,759	2D9704757
4096	3,750,730,325	DF8F9A55	3,125,609,045	BA4D0255	1,875,366,485	6FC7D255	1,562,805,845	5D268655
4104	3,724,017,663	DDF7FFFF	3,103,260,671	B8F7FFFF	1,854,502,927	6E89780F	1,545,419,103	5C1D395F
4160	3,673,948,159	DAFBFFFF	3,061,317,631	B677FFFF	1,838,769,231	6D99644F	1,532,307,695	5B5528EF

Table 5 - Formatted Capacity Block Count (3840GB, 3200GB, and 1920GB models)

	Last Logical Block Address					
Block	3840 GB		3200 GB		1920 GB	
Size	Decimal	Hex	Decimal	Hex	Decimal	Hex
512	7,501,476,527	1BF1F72AF	6,251,233,967	1749A42AF	3,750,748,847	DF8FE2AF
520	7,342,769,279	1B5A9C47F	6,118,974,383	16CB823AF	3,671,384,639	DAD4E23F
4096	937,684,565	37E3EE55	781,404,245	2E934855	468,843,605	1BF1FC55
4104	927,251,463	3744BC07	772,709,551	2E0E9CAF	463,625,735	1BA25E07
4160	919,384,615	36CCB227	766,153,847	2DAA9477	459,692,311	1B665917

Table 6 - Formatted Capacity Block Count (1600GB, 960GB, and 800GB models)

	Last Logical Block Address			
Block	1600 GB		800 GB	
Size	Decimal	Hex	Decimal	Hex
512	3,125,627,567	BA4D4AAF	1,562,824,367	5D26CEAF
520	3,059,487,191	B65C11D7	1,529,743,599	5B2E08EF
4096	390,703,445	1749A955	195,353,045	BA4D9D5
4104	386,354,774	17074E56	193,177,391	B83A72F
4160	383,076,927	16D54A3F	191,538,463	B6AA51F

7. Performance

This section provides detailed information on performance-related features of Nytro 5050 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 7 - 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)

The values below indicate throughput performance for models in the Nytro 5050 series. Values are listed by product family and configuration.

Table 8 Nytro 5050 Performance

Performance of 5550H 15 mm Mixed Use Models					
Standard	XP12800LE70005	XP6400LE70005	XP3200LE70005	XP1600LE70005	XP800LE70005
SED	XP12800LE70015	XP6400LE70015	XP3200LE70015	XP1600LE70015	XP800LE70015
SED FIPS 140-3	XP12800LE70025	XP6400LE70025	XP3200LE70025	XP1600LE70025	XP800LE70025
Sustained Sequential 128KB Read Transfer Rate (MB/s)	7,400	7,400	7,400	7,400	7,400
Sustained Sequential 128KB Write Transfer Rate (MB/s)	7,200	7,200	6,900	3,700	1,900
Sustained Random 4KB Read Transfer Rate (IOPS)	1,700,000	1,700,000	1,700,000	1,550,000	945,000
Sustained Random 4KB Write Transfer Rate (IOPS)	495,000	445,000	460,000	315,000	140,000
Performance of 5350H 15 mm Read Intensive Models					
Standard	XP15360SE70005	XP7680SE70005	XP3840SE70005	XP1920SE70005	
SED	XP15360SE70015	XP7680SE70015	XP3840SE70015	XP1920SE70015	
SED FIPS 140-3	XP15360SE70025	XP7680SE70025	XP3840SE70025	XP1920SE70025	
Sustained Sequential 128KB Read Transfer Rate (MB/s)	7,400	7,400	7,400	7,400	
Sustained Sequential 128KB Write Transfer Rate (MB/s)	7,200	7,200	6,900	3,700	
Sustained Random 4KB Read Transfer Rate (IOPS)	1,700,000	1,700,000	1,700,000	1,550,000	
Sustained Random 4KB Write Transfer Rate (IOPS)	210,000	195,000	195,000	125,000	
Performance of 5550M 15mm Mixed Use Models					
Standard	XP12800LE70035	XP6400LE70035	XP3200LE70035	XP1600LE70035	XP800LE70035
SED	XP12800LE70045	XP6400LE70045	XP3200LE70045	XP1600LE70045	XP800LE70045
SED FIPS 140-3	XP12800LE70055	XP6400LE70055	XP3200LE70055	XP1600LE70055	XP800LE70055
Sustained Sequential 128KB Read Transfer Rate (MB/s)	7,400	7,400	7,400	7,400	7,200
Sustained Sequential 128KB Write Transfer Rate (MB/s)	4,500	4,500	4,500	3,300	1,900
Sustained Random 4KB Read Transfer Rate (IOPS)	1,250,000	1,250,000	1,250,000	1,250,000	1,000,000
Sustained Random 4KB Write Transfer Rate (IOPS)	290,000	330,000	350,000	240,000	140,000

Table 8 Nytro 5050 Performance *(continued)*

Performance of 5350M 15mm Read Intensive Models					
Standard	XP15360SE70035	XP7680SE70035	XP3840SE70035	XP1920SE70035	
SED	XP15360SE70045	XP7680SE70045	XP3840SE70045	XP1920SE70045	
SED FIPS 140-3	XP15360SE70055	XP7680SE70055	XP3840SE70055	XP1920SE70055	
Sustained Sequential 128KB Read Transfer Rate (MB/s)	7,400	7,400	7,400	7,400	
Sustained Sequential 128KB Write Transfer Rate (MB/s)	4,500	4,500	4,500	3,300	
Sustained Random 4KB Read Transfer Rate (IOPS)	1,250,000	1,250,000	1,250,000	1,250,000	
Sustained Random 4KB Write Transfer Rate (IOPS)	140,000	140,000	140,000	90,000	
Performance of 5550M 7mm Mixed Use Models					
Standard		XP6400LE10005	XP3200LE10005	XP1600LE10005	XP800LE10005
SED		XP6400LE10015	XP3200LE10015	XP1600LE10015	XP800LE10015
SED FIPS 140-3		XP6400LE10025	XP3200LE10025	XP1600LE10025	XP800LE10025
Sustained Sequential 128KB Read Transfer Rate (MB/s)		7,400	7,400	7,400	7,200
Sustained Sequential 128KB Write Transfer Rate (MB/s)		6,000	6,000	3,200	1,900
Sustained Random 4KB Read Transfer Rate (IOPS)		1,250,000	1,250,000	1,250,000	1,000,000
Sustained Random 4KB Write Transfer Rate (IOPS)		360,000	360,000	230,000	140,000
Performance of 5350M 7mm Read Intensive Models					
Standard		XP7680SE10005	XP3840SE10005	XP1920SE10005	
SED		XP7680SE10015	XP3840SE10015	XP1920SE10015	
SED FIPS 140-3		XP7680SE10025	XP3840SE10025	XP1920SE10025	
Sustained Sequential 128KB Read Transfer Rate (MB/s)		7,400	7,400	7,400	
Sustained Sequential 128KB Write Transfer Rate (MB/s)		6,000	6,000	3,200	
Sustained Random 4KB Read Transfer Rate (IOPS)		1,250,000	1,250,000	1,250,000	
Sustained Random 4KB Write Transfer Rate (IOPS)		150,000	160,000	100,000	

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 interfaces, including all interface timings, power supply voltages, environmental requirements, and drive mounting constraints.

8.1   Read error rates

Table 9 Read Error Rates

	Error Rates	Notes
Unrecovered Data	Less than 1 LBA in 10^{17} bits transferred	
Miscorrected Data	Less than 1 LBA in 10^{21} bits transferred	
Interface Error Rate	Less than 1 error in 10^{12} bits transferred	
Mean Time Between Failure (MTBF)	2.5M hours	
Annualized Failure Rate (AFR)	0.35%	
Preventive Maintenance	None required	
Typical Data Retention with Power Removed (at 40C up to 90% of write endurance)	3 months	■ 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.
Endurance Rating	Method 2: TBW (per JEDEC JESD218)	■ Endurance rating is the amount of host data that can be written to the drive at the specified workload, operating temperature, and storage temperature for the life of a specific drive. For more information on the specific workload to achieve this level of endurance, see JEDEC Specification JESD218. TBW is defined as 1x10^12 Bytes. ■ 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.

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

8.2   Endurance

See below for Nytro 5050 15 mm and 7 mm Endurance results.

Table 10 - Nytro 5050M 15 mm Endurance

Nytro 5550H 15 mm U.2/U.3 Mixed Use (3 DWPD)					
Endurance Class	**Capacity**	**Standard**	**Seagate Secure SED**	**FIPS 140-3**	**Lifetime PB JEDEC**
MU	128000 GB	XP12800LE70005	XP12800LE70015	XP12800LE70025	70
	6400 GB	XP6400LE70005	XP6400LE70015	XP6400LE70025	35
	3200 GB	XP3200LE70005	XP3200LE70015	XP3200LE70025	17
	1600 GB	XP1600LE70005	XP1600LE70015	XP1600LE70025	8.7
	800 GB	XP800LE70005	XP800LE70015	XP800LE70025	4.3
Nytro 5350H 15 mm U.2/U.3 Read Intensive (1 DWPD)					
Endurance Class	**Capacity**	**Standard**	**Seagate Secure SED**	**FIPS 140-3**	**Lifetime PB JEDEC**
RI	15360 GB	XP15360SE70005	XP15360SE70015	XP15360E70025	28
	7680 GB	XP7680SE70005	XP7680SE70015	XP7680SE70025	14
	3840 GB	XP3840SE70005	XP3840SE70015	XP3840SE70025	7
	1920GB	XP1920SE70005	XP1920SE70015	XP1920SE70025	3.5
Nytro 5550M 15 mm U.2/U.3 Mixed Use (3 DWPD)					
Endurance Class	**Capacity**	**Standard**	**Seagate Secure SED**	**FIPS 140-3**	**Lifetime PB JEDEC**
MU	128000 GB	XP12800LE70035	XP12800LE70045	XP12800LE70055	70
	6400 GB	XP6400LE70035	XP6400LE70045	XP6400LE70055	35
	3200 GB	XP3200LE70035	XP3200LE70045	XP3200LE70055	17
	1600 GB	XP1600LE70035	XP1600LE70045	XP1600LE70055	8.7
	800 GB	XP800LE70035	XP800LE70045	XP800LE70055	4.3
Nytro 5350M 15 mm U.2/U.3 Read Intensive (1 DWPD)					
Endurance Class	**Capacity**	**Standard**	**Seagate Secure SED**	**FIPS 140-3**	**Lifetime PB JEDEC**
RI	15360 GB	XP15360SE70035	XP15360SE70045	XP15360SE70055	28
	7680 GB	XP7680SE70035	XP7680SE70045	XP7680SE70055	14
	3840 GB	XP3840SE70035	XP3840SE70045	XP3840SE70055	7
	1920GB	XP1920SE70035	XP1920SE70045	XP1920SE70055	3.5

For more information on FIPS 140-3 Level 2 certification see Section 10. *About FIPS*.

Table 11 - Nytro 5050M 7 mm Endurance

Nytro 5550M 7 mm U.2/U.3 Mixed Use (3 DWPD)					
Endurance Class	**Capacity**	**Standard**	**Seagate Secure SED**	**FIPS 140-3**	**Lifetime PB JEDEC**
MU	**6400 GB**	XP6400LE10005	XP6400LE10015	XP6400LE10025	35
	3200 GB	XP3200LE10005	XP3200LE10015	XP3200LE10025	17
	1600 GB	XP1600LE10005	XP1600LE10015	XP1600LE10025	8.7
	800 GB	XP800LE10005	XP800LE10015	XP800LE10025	4.3
Nytro 5350M 7mm U.2/U.3 Read Intensive (1 DWPD))					
Endurance Class	**Capacity**	**Standard**	**Seagate Secure SED**	**FIPS 140-3**	**Lifetime PB JEDEC**
RI	7680	XP7680SE10005	XP7680SE10015	XP7680SE10025	14
	3840	XP3840SE10005	XP3840SE10015	XP3840SE10025	7
	1920	XP1920SE10005	XP1920SE10015	XP1920SE10025	3.5

For more information on FIPS 140-3 Level 2 certification see Section 10. *About FIPS*.

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, and 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 5050 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 12.2 *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 12.2 *Cooling* are not exceeded. Temperatures outside the specifications in Section 12.2 *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 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 when the drive does not respond 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 5050 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 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-test's 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 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 the 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 +3.3V 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 12 - +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 µf

Table 13 - +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 µf

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°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 14 - Power consumption by model and capacity

Nytro 5550H 15 mm, 800 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA

Table 14 - Power consumption by model and capacity *(continued)*

	Current (A)	Power (W)
Average Idle Current	0.45	4.9
Maximum Start Current		
Average DC	0.67	8.1
Maximum DC (Peak)	0.80	
Operating Current (Random Read)		
Average DC	0.71	8.5
Maximum DC	0.75	9.0
Maximum DC (peak)	0.93	
Operating Current (Random Write)		
Average DC	0.69	8.3
Maximum DC	0.74	8.9
Maximum DC (peak)	1.01	
Operating Current (Sequential Read)		
Average DC	0.75	9.0
Maximum DC	0.78	9.3
Maximum DC (peak)	0.98	
Operating Current (Sequential Write)		
Average DC	0.68	8.1
Maximum DC	0.70	8.4
Maximum DC (peak)	1.00	
Nytro 5550H 15 mm, 1600 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	Power (W)
Average Idle Current	0.45	5.5
Maximum Start Current		
Average DC	0.99	11.9
Maximum DC (Peak)	1.10	
Operating Current (Random Read)		
Average DC	1.06	12.8
Maximum DC	1.07	12.9
Maximum DC (peak)	1.29	
Operating Current (Random Write)		
Average DC	1.03	12.4
Maximum DC	1.13	13.6
Maximum DC (peak)	1.62	
Operating Current (Sequential Read)		
Average DC	0.86	10.4

Table 14 - Power consumption by model and capacity *(continued)*

	Current (A)	Power (W)
Maximum DC	0.88	10.6
Maximum DC (peak)	1.17	
Operating Current (Sequential Write)		
Average DC	1.10	13.2
Maximum DC	1.12	13.5
Maximum DC (peak)	1.64	
Nytro 5550H 15 mm, 3200 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.48	5.8
Maximum Start Current		
Average DC	1.02	12.3
Maximum DC (Peak)	1.17	
Operating Current (Random Read)		
Average DC	1.14	13.7
Maximum DC	1.15	13.9
Maximum DC (peak)	1.40	
Operating Current (Random Write)		
Average DC	1.36	16.4
Maximum DC	1.54	18.5
Maximum DC (peak)	2.10	
Operating Current (Sequential Read)		
Average DC	0.91	10.9
Maximum DC	0.93	11.2
Maximum DC (peak)	1.22	
Operating Current (Sequential Write)		
Average DC	1.52	18.2
Maximum DC	1.54	18.5
Maximum DC (peak)	2.22	

Table 14 - Power consumption by model and capacity *(continued)*

Nytro 5550H 15 mm, 6400 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.49	5.9
Maximum Start Current		
Average DC	1.06	12.7
Maximum DC (Peak)	1.30	
Operating Current (Random Read)		
Average DC	1.33	15.9
Maximum DC	1.34	16.1
Maximum DC (peak)	1.57	
Operating Current (Random Write)		
Average DC	1.49	17.8
Maximum DC	1.67	20.0
Maximum DC (peak)	2.53	
Operating Current (Sequential Read)		
Average DC	1.14	13.7
Maximum DC	1.22	14.7
Maximum DC (peak)	1.49	
Operating Current (Sequential Write)		
Average DC	1.27	15.3
Maximum DC	1.68	20.1
Maximum DC (peak)	2.52	
Nytro 5550H 15 mm, 12.80 TB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	Power (W)
Average Idle Current	0.61	7.3
Maximum Start Current		
Average DC	1.13	13.6
Maximum DC (Peak)	1.48	
Operating Current (Random Read)		
Average DC	1.36	16.2
Maximum DC	1.38	16.6
Maximum DC (peak)	1.70	
Operating Current (Random Write)		
Average DC	1.67	20.0

Table 14 - Power consumption by model and capacity *(continued)*

Maximum DC	1.81	21.6
Maximum DC (peak)	2.59	
Operating Current (Sequential Read)		
Average DC	1.03	12.4
Maximum DC	1.06	12.8
Maximum DC (peak)	1.39	
Operating Current (Sequential Write)		
Average DC	1.72	20.6
Maximum DC	1.83	21.8
Maximum DC (peak)	2.62	
Nytro 5350H 15 mm, 1920 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.46	5.5
Maximum Start Current		
Average DC	0.93	11.1
Maximum DC (Peak)	1.27	
Operating Current (Random Read)		
Average DC	1.02	12.2
Maximum DC	1.05	12.5
Maximum DC (peak)	1.23	
Operating Current (Random Write)		
Average DC	0.98	11.7
Maximum DC	1.09	13.1
Maximum DC (peak)	1.51	
Operating Current (Sequential Read)		
Average DC	0.83	10.0
Maximum DC	0.86	10.3
Maximum DC (peak)	1.10	
Operating Current (Sequential Write)		
Average DC	1.05	12.6
Maximum DC	1.09	13.1
Maximum DC (peak)	1.57	
Nytro 5350H 15 mm, 3840 GB Power Consumption		
Parameter		

Table 14 - Power consumption by model and capacity *(continued)*

	Current (A)	Power (W)
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 5350H 15 mm, 7680 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	
Operating Current (Random Write)		
Average DC	1.42	16.7
Maximum DC	1.65	19.3
Maximum DC (peak)	2.41	

Table 14 - Power consumption by model and capacity *(continued)*

Operating Current (Sequential Read)		
Average DC	0.96	11.4
Maximum DC	1.00	11.9
Maximum DC (peak)	1.30	
Operating Current (Sequential Write)		
Average DC	1.54	18.1
Maximum DC	1.69	19.8
Maximum DC (peak)	2.40	
Nytro 5350H 15 mm, 15.36 TB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.59	7.1
Maximum Start Current		
Average DC	1.15	13.8
Maximum DC (Peak)	1.44	
Operating Current (Random Read)		
Average DC	1.34	16.0
Maximum DC	1.37	16.3
Maximum DC (peak)	1.62	
Operating Current (Random Write)		
Average DC	1.62	19.3
Maximum DC	1.77	21.1
Maximum DC (peak)	2.58	
Operating Current (Sequential Read)		
Average DC	1.01	12.1
Maximum DC	1.04	12.5
Maximum DC (peak)	1.31	
Operating Current (Sequential Write)		
Average DC	1.67	19.9
Maximum DC	1.75	20.9
Maximum DC (peak)	2.62	
Nytro 5550M 15 mm, 800 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA

Table 14 - Power consumption by model and capacity *(continued)*

	Current (A)	Power (W)
Average Idle Current	0.47	5.7
Maximum Start Current		
Average DC	0.64	7.6
Maximum DC (Peak)	0.82	
Operating Current (Random Read)		
Average DC	0.74	9.0
Maximum DC	0.80	9.6
Maximum DC (peak)	0.92	
Operating Current (Random Write)		
Average DC	0.73	8.8
Maximum DC	0.76	9.2
Maximum DC (peak)	0.97	
Operating Current (Sequential Read)		
Average DC	0.77	9.3
Maximum DC	0.80	9.6
Maximum DC (peak)	0.99	
Operating Current (Sequential Write)		
Average DC	0.73	8.8
Maximum DC	0.76	9.2
Maximum DC (peak)	1.01	
Nytro 5550M 15 mm, 1600 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	Power (W)
Average Idle Current	0.48	5.8
Maximum Start Current		
Average DC	0.99	11.7
Maximum DC (Peak)	1.12	
Operating Current (Random Read)		
Average DC	0.85	10.2
Maximum DC	0.91	11.0
Maximum DC (peak)	1.30	
Operating Current (Random Write)		
Average DC	0.96	11.6
Maximum DC	1.01	12.3
Maximum DC (peak)	1.44	
Operating Current (Sequential Read)		

Table 14 - Power consumption by model and capacity *(continued)*

Average DC	0.85	10.3
Maximum DC	0.87	10.5
Maximum DC (peak)	1.27	
Operating Current (Sequential Write)		
Average DC	0.94	11.4
Maximum DC	1.01	12.2
Maximum DC (peak)	1.41	
Nytro 5550M 15 mm, 3200 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.55	6.6
Maximum Start Current		
Average DC	1.04	12.3
Maximum DC (Peak)	1.18	
Operating Current (Random Read)		
Average DC	0.95	11.5
Maximum DC	1.03	12.5
Maximum DC (peak)	1.42	
Operating Current (Random Write)		
Average DC	1.13	13.6
Maximum DC	1.24	14.9
Maximum DC (peak)	2.80	
Operating Current (Sequential Read)		
Average DC	0.93	11.2
Maximum DC	0.96	11.7
Maximum DC (peak)	1.54	
Operating Current (Sequential Write)		
Average DC	1.18	14.3
Maximum DC	1.27	15.3
Maximum DC (peak)	2.14	
Nytro 5550M 15 mm, 6400 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**

Table 14 - Power consumption by model and capacity *(continued)*

Average Idle Current	0.60	7.2
Maximum Start Current		
Average DC	1.09	12.8
Maximum DC (Peak)	1.22	
Operating Current (Random Read)		
Average DC	1.04	12.5
Maximum DC	1.06	12.8
Maximum DC (peak)	1.59	
Operating Current (Random Write)		
Average DC	1.21	14.6
Maximum DC	1.33	16.1
Maximum DC (peak)	2.08	
Operating Current (Sequential Read)		
Average DC	0.97	11.8
Maximum DC	1.04	12.6
Maximum DC (peak)	1.54	
Operating Current (Sequential Write)		
Average DC	1.24	15.0
Maximum DC	1.35	16.3
Maximum DC (peak)	2.23	
Nytro 5550M 15 mm, 12.80 TB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.68	8.3
Maximum Start Current		
Average DC	1.17	13.8
Maximum DC (Peak)	1.35	
Operating Current (Random Read)		
Average DC	1.13	13.6
Maximum DC	1.22	14.7
Maximum DC (peak)	1.62	
Operating Current (Random Write)		
Average DC	1.30	15.7
Maximum DC	1.42	17.1
Maximum DC (peak)	2.24	
Operating Current (Sequential Read)		
Average DC	1.02	12.4

Table 14 - Power consumption by model and capacity *(continued)*

	Current (A)	Power (W)
Maximum DC	1.05	12.7
Maximum DC (peak)	1.39	
Operating Current (Sequential Write)		
Average DC	1.35	16.3
Maximum DC	1.46	17.5
Maximum DC (peak)	2.23	
Nytro 5350M 15 mm, 1920 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.49	5.9
Maximum Start Current		
Average DC	1.07	12.5
Maximum DC (Peak)	1.21	
Operating Current (Random Read)		
Average DC	0.90	10.9
Maximum DC	0.93	11.2
Maximum DC (peak)	1.32	
Operating Current (Random Write)		
Average DC	1.08	13.0
Maximum DC	1.17	14.2
Maximum DC (peak)	1.79	
Operating Current (Sequential Read)		
Average DC	0.85	10.2
Maximum DC	0.88	10.7
Maximum DC (peak)	1.26	
Operating Current (Sequential Write)		
Average DC	1.12	13.5
Maximum DC	1.20	14.4
Maximum DC (peak)	1.77	
Nytro 5350M 15 mm, 3840 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.49	5.9

Table 14 - Power consumption by model and capacity *(continued)*

Maximum Start Current		
Average DC	1.07	12.5
Maximum DC (Peak)	1.21	
Operating Current (Random Read)		
Average DC	0.90	10.9
Maximum DC	0.93	11.2
Maximum DC (peak)	1.32	
Operating Current (Random Write)		
Average DC	1.08	10.2
Maximum DC	1.17	14.2
Maximum DC (peak)	1.79	
Operating Current (Sequential Read)		
Average DC	0.85	10.2
Maximum DC	0.88	10.7
Maximum DC (peak)	1.26	
Operating Current (Sequential Write)		
Average DC	1.12	13.5
Maximum DC	1.20	14.4
Maximum DC (peak)	1.77	
Nytro 5350M 15 mm, 7680 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.56	6.8
Maximum Start Current		
Average DC	1.11	13.1
Maximum DC (Peak)	1.26	
Operating Current (Random Read)		
Average DC	1.00	12.1
Maximum DC	1.06	12.9
Maximum DC (peak)	1.50	
Operating Current (Random Write)		
Average DC	1.20	14.5
Maximum DC	1.31	15.8
Maximum DC (peak)	1.97	
Operating Current (Sequential Read)		
Average DC	0.95	11.5
Maximum DC	1.00	12.1

Table 14 - Power consumption by model and capacity *(continued)*

Maximum DC (peak)	1.35	
Operating Current (Sequential Write)		
Average DC	1.23	14.8
Maximum DC	1.37	16.6
Maximum DC (peak)	1.97	
Nytro 5350M 15 mm, 15.36 TB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.69	8.4
Maximum Start Current		
Average DC	1.20	14.1
Maximum DC (Peak)	1.38	
Operating Current (Random Read)		
Average DC	1.12	13.6
Maximum DC	1.19	14.4
Maximum DC (peak)	1.50	
Operating Current (Random Write)		
Average DC	1.33	16.0
Maximum DC	1.42	17.1
Maximum DC (peak)	1.97	
Operating Current (Sequential Read)		
Average DC	1.03	12.4
Maximum DC	1.07	12.9
Maximum DC (peak)	1.35	
Operating Current (Sequential Write)		
Average DC	1.36	16.4
Maximum DC	1.47	17.7
Maximum DC (peak)	1.97	
Nytro 5550M 7 mm, 800 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.42	5.1

Table 14 - Power consumption by model and capacity *(continued)*

Maximum Start Current		
Average DC	0.61	7.2
Maximum DC (Peak)	0.74	
Operating Current (Random Read)		
Average DC	0.68	8.3
Maximum DC	0.74	9.0
Maximum DC (peak)	1.02	
Operating Current (Random Write)		
Average DC	0.68	8.3
Maximum DC	0.73	8.9
Maximum DC (peak)	1.05	
Operating Current (Sequential Read)		
Average DC	0.71	8.6
Maximum DC	0.75	9.1
Maximum DC (peak)ax	1.07	
Operating Current (Sequential Write)		
Average DC	0.68	8.2
Maximum DC	0.72	8.8
Maximum DC (peak)	1.09	
Nytro 5550M 7 mm, 1600 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.49	5.9
Maximum Start Current		
Average DC	0.90	10.7
Maximum DC (Peak)	0.99	
Operating Current (Random Read)		
Average DC	0.85	10.3
Maximum DC	0.90	10.9
Maximum DC (peak)	1.12	
Operating Current (Random Write)		
Average DC	0.94	11.4
Maximum DC	1.00	12.1
Maximum DC (peak)	1.35	
Operating Current (Sequential Read)		
Average DC	0.80	9.7
Maximum DC	0.87	10.5

Table 14 - Power consumption by model and capacity *(continued)*

	Current (A)	Power (W)
Maximum DC (peak)ax	1.09	
Operating Current (Sequential Write)		
Average DC	0.94	11.4
Maximum DC	0.99	12.0
Maximum DC (peak)	1.36	
Nytro 5550M 7 mm, 3200 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.49	6.0
Maximum Start Current		
Average DC	0.97	11.6
Maximum DC (Peak)	1.05	
Operating Current (Random Read)		
Average DC	0.91	11.0
Maximum DC	0.96	11.6
Maximum DC (peak)	1.20	
Operating Current (Random Write)		
Average DC	1.07	12.9
Maximum DC	1.25	15.1
Maximum DC (peak)	1.91	
Operating Current (Sequential Read)		
Average DC	0.82	9.9
Maximum DC	0.89	10.7
Maximum DC (peak)ax	1.12	
Operating Current (Sequential Write)		
Average DC	1.37	16.5
Maximum DC	1.52	18.3
Maximum DC (peak)	1.93	
Nytro 5550M 7 mm, 6400 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.56	6.8
Maximum Start Current		

Table 14 - Power consumption by model and capacity *(continued)*

Average DC	1.02	12.2
Maximum DC (Peak)	1.12	
Operating Current (Random Read)		
Average DC	1.01	12.2
Maximum DC	1.04	12.6
Maximum DC (peak)	1.29	
Operating Current (Random Write)		
Average DC	1.18	14.2
Maximum DC	1.32	15.9
Maximum DC (peak)	2.08	
Operating Current (Sequential Read)		
Average DC	0.90	10.9
Maximum DC	0.95	11.4
Maximum DC (peak)ax	1.23	
Operating Current (Sequential Write)		
Average DC	1.46	17.6
Maximum DC	1.62	19.4
Maximum DC (peak)	2.08	
Nytro 5350M 7 mm, 1920 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	**Power (W)**
Average Idle Current	0.48	5.8
Maximum Start Current		
Average DC	0.92	10.9
Maximum DC (Peak)	1.01	
Operating Current (Random Read)		
Average DC	0.85	10.3
Maximum DC	0.90	10.9
Maximum DC (peak)	1.15	
Operating Current (Random Write)		
Average DC	0.94	11.4
Maximum DC	1.04	12.6
Maximum DC (peak)	1.39	
Operating Current (Sequential Read)		
Average DC	0.81	9.8
Maximum DC	0.88	10.7
Maximum DC (peak)ax	1.10	

Table 14 - Power consumption by model and capacity *(continued)*

Operating Current (Sequential Write)		
Average DC	0.94	11.3
Maximum DC	0.99	11.9
Maximum DC (peak)	1.38	
Nytro 5350M 7 mm, 3840 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	Power (W)
Average Idle Current	0.50	6.0
Maximum Start Current		
Average DC	0.95	11.3
Maximum DC (Peak)	1.11	
Operating Current (Random Read)		
Average DC	0.92	11.1
Maximum DC	0.95	11.5
Maximum DC (peak)	1.18	
Operating Current (Random Write)		
Average DC	1.10	13.3
Maximum DC	1.20	14.5
Maximum DC (peak)	1.85	
Operating Current (Sequential Read)		
Average DC	0.83	10.1
Maximum DC	0.86	10.4
Maximum DC (peak)ax	1.12	
Operating Current (Sequential Write)		
Average DC	1.36	16.4
Maximum DC	1.52	18.3
Maximum DC (peak)	1.92	
Nytro 5350M 7 mm, 7680 GB Power Consumption		
Parameter		
Voltage	+12V	NA
Regulation	+/-5%	NA
	Current (A)	Power (W)
Average Idle Current	0.56	6.8
Maximum Start Current		
Average DC	1.04	12.3

Table 14 - Power consumption by model and capacity *(continued)*

Maximum DC (Peak)	1.20	
Operating Current (Random Read)		
Average DC	1.01	12.2
Maximum DC	1.11	13.4
Maximum DC (peak)	1.32	
Operating Current (Random Write)		
Average DC	1.20	14.5
Maximum DC	1.29	15.5
Maximum DC (peak)	2.05	
Operating Current (Sequential Read)		
Average DC	0.91	10.9
Maximum DC	1.01	12.2
Maximum DC (peak)ax	1.26	
Operating Current (Sequential Write)		
Average DC	1.47	17.7
Maximum DC	1.62	19.5
Maximum DC (peak)	2.05	

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 68°F (20°C) per hour.

> **NOTE**   Internal temperature swings greater than 55°C over a three-day time period may cause elevated read error rates.

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 an excessive 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. Writing large transfers sequentially will consume the most current. After the temperatures stabilize, read the internal temperature of the drive using Seagate SeaChest or SeaTools utilities available at https://www.seagate.com/support/downloads.

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 the 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 9, *Recommended mounting, on page 67*, and in accordance with the restrictions the Section 12.3 *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 as 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 S71.04-2013 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　Mechanical specifications

See the below figures for detailed mounting configuration dimensions. See Section 12.3 *Drive mounting*.

NOTE　All (AXX) NVMes (except where noted by [3]) are from SFF-8201 Specification For 2.5" Form Factor Drives Dimension Rev 3.3, AUGUST 30 2014, or from SFF-8223 Specification Rev 2.7, AUGUST 30, 2014. You can find these documents here:
https://www.snia.org/technology-communities/sff/specifications

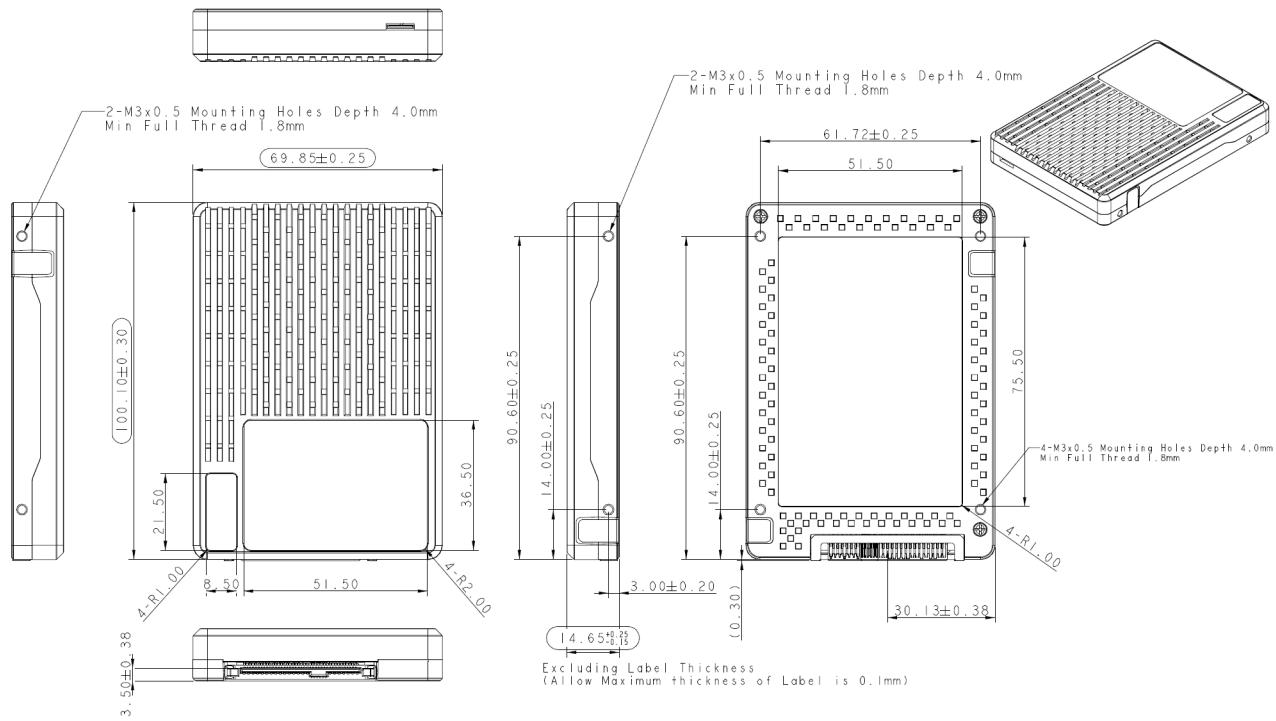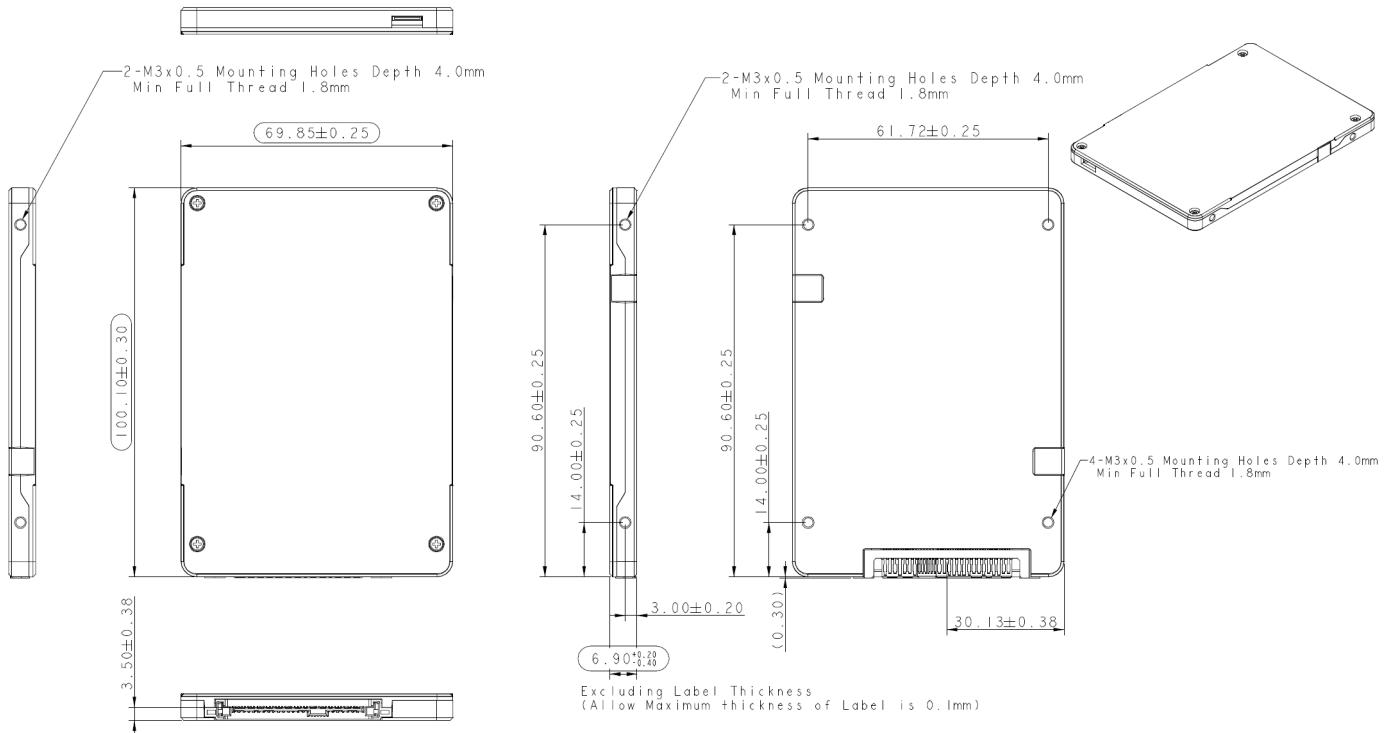**Figure 1 Mounting configuration (U.3 - 15mm models)**

Figure 2 Mounting configuration (U.3 - 7mm models)

9.4.1 Nytro 5050 Weights

Table 15 Nytro 5050 Weights

Nytro 5050H 15mm U.2/U.3 weight by model					
Endurance Class	Capacity (GB)	Standard	SED	FIPS 140-3	Weight (g)
MU	12800	XP12800LE70005	XP12800LE70015	XP12800LE70025	170
MU	6400	XP6400LE70005	XP6400LE70015	XP6400LE70025	205
MU	3200	XP3200LE70005	XP3200LE70015	XP3200LE70025	205
MU	1600	XP1600LE70005	XP1600LE70015	XP1600LE70025	205
MU	800	XP800LE70005	XP800LE70015	XP800LE70025	205
RI	15360	XP15360SE70005	XP15360SE70015	XP15360SE70025	170
RI	7680	XP7680SE70005	XP7680SE70015	XP7680SE70025	205
RI	3840	XP3840SE70005	XP3840SE70015	XP3840SE70025	205
RI	1920	XP1920SE70005	XP1920SE70015	XP1920SE70025	205
Nytro 5050M 15mm U.2/U.3 weight by model					
Endurance Class	Capacity in GB	Standard	SED	FIPS 140-3	Weight (g)
MU	12800	XP12800LE70035	XP12800LE70045	XP12800LE70055	170
MU	6400	XP6400LE70035	XP6400LE70045	XP6400LE70055	205
MU	3200	XP3200LE70035	XP3200LE70045	XP3200LE70055	205
MU	1600	XP1600LE70035	XP1600LE70045	XP1600LE70055	205
MU	800	XP800LE70035	XP800LE70045	XP800LE70055	205
RI	15360	XP15360SE70035	XP15360SE70045	XP15360SE70055	170
RI	7680	XP7680SE70035	XP7680SE70045	XP7680SE70055	205
RI	3840	XP3840SE70035	XP3840SE70045	XP3840SE70055	205
RI	1920	XP1920SE70035	XP1920SE70045	XP1920SE70055	205
Nytro 5050M 7mm U.2/U.3 weight by model					
Endurance Class	Capacity in GB	Standard	SED	FIPS 140-3	Weight (g)
MU	6400	XP6400LE10005	XP6400LE10015	XP6400LE10025	105
MU	3200	XP3200LE10005	XP3200LE10015	XP3200LE10025	105
MU	1600	XP1600LE10005	XP1600LE10015	XP1600LE10025	105
MU	800	XP800LE10005	XP800LE10015	XP800LE10025	105
RI	7680	XP7680SE10005	XP7680SE10015	XP7680SE10025	105
RI	3840	XP3840SE10005	XP3840SE10015	XP3840SE10025	105
RI	1920	XP1920SE10005	XP1920SE10015	XP1920SE10025	105

9.5　Connector specification

9.5.1　Connector specification

Figure 3, *Physical Interface, on page 53* shows the location of the SFF-8639 (U2) connector. Figure 4, *NVMe device plug dimensions, on page 54* and Figure 5, *NVMe device plug dimensions (detail), on page 55* provide the dimensions of the NVMe connector. Details of the physical, electrical, and logical characteristics are provided within this section.

Figure 3　Physical Interface
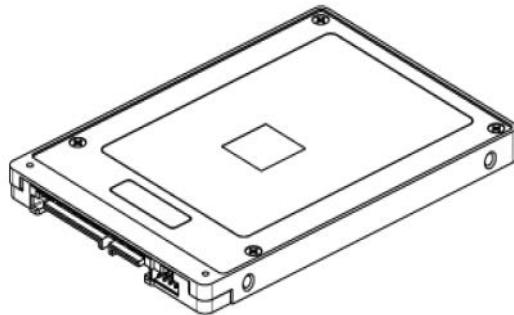
Figure 4 NVMe device plug dimensions
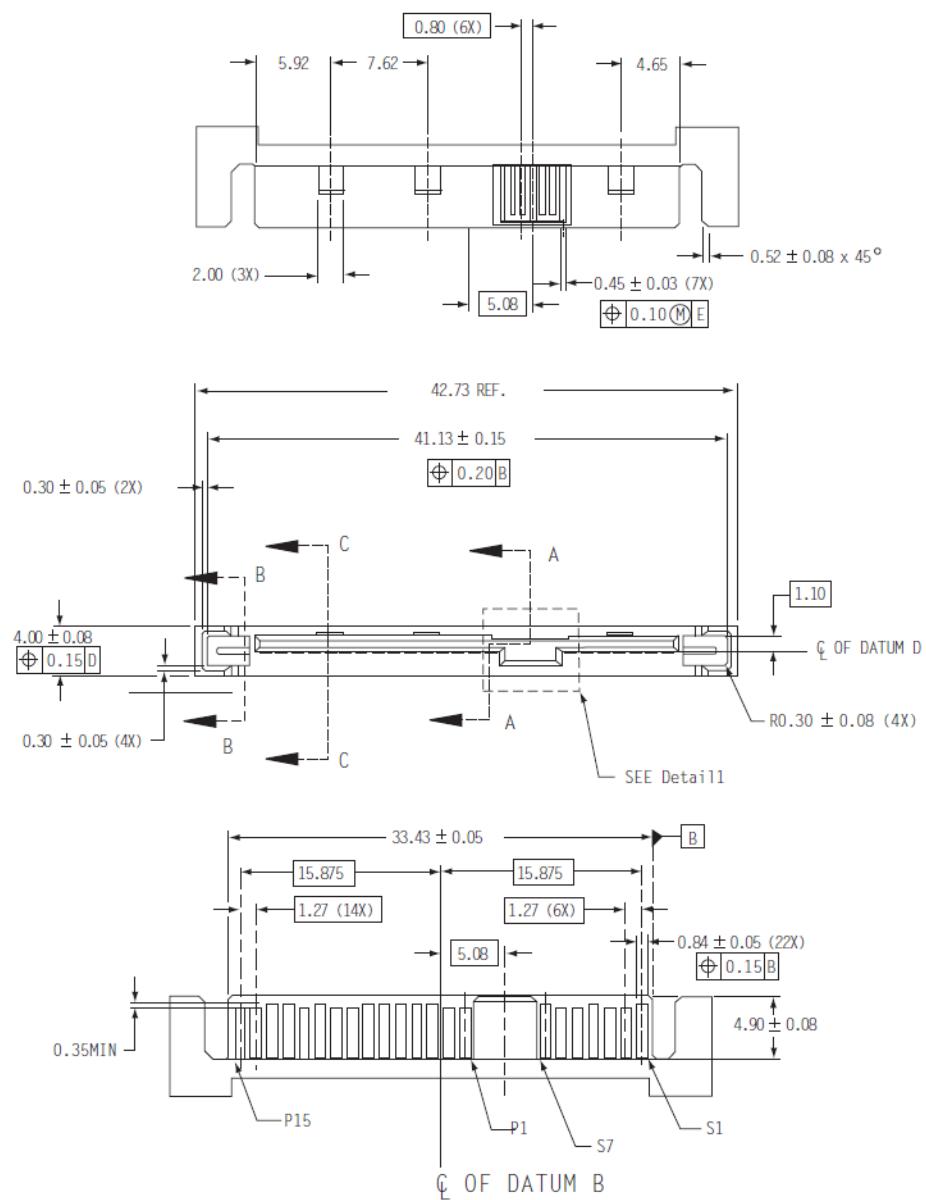
Figure 5 NVMe device plug dimensions (detail)
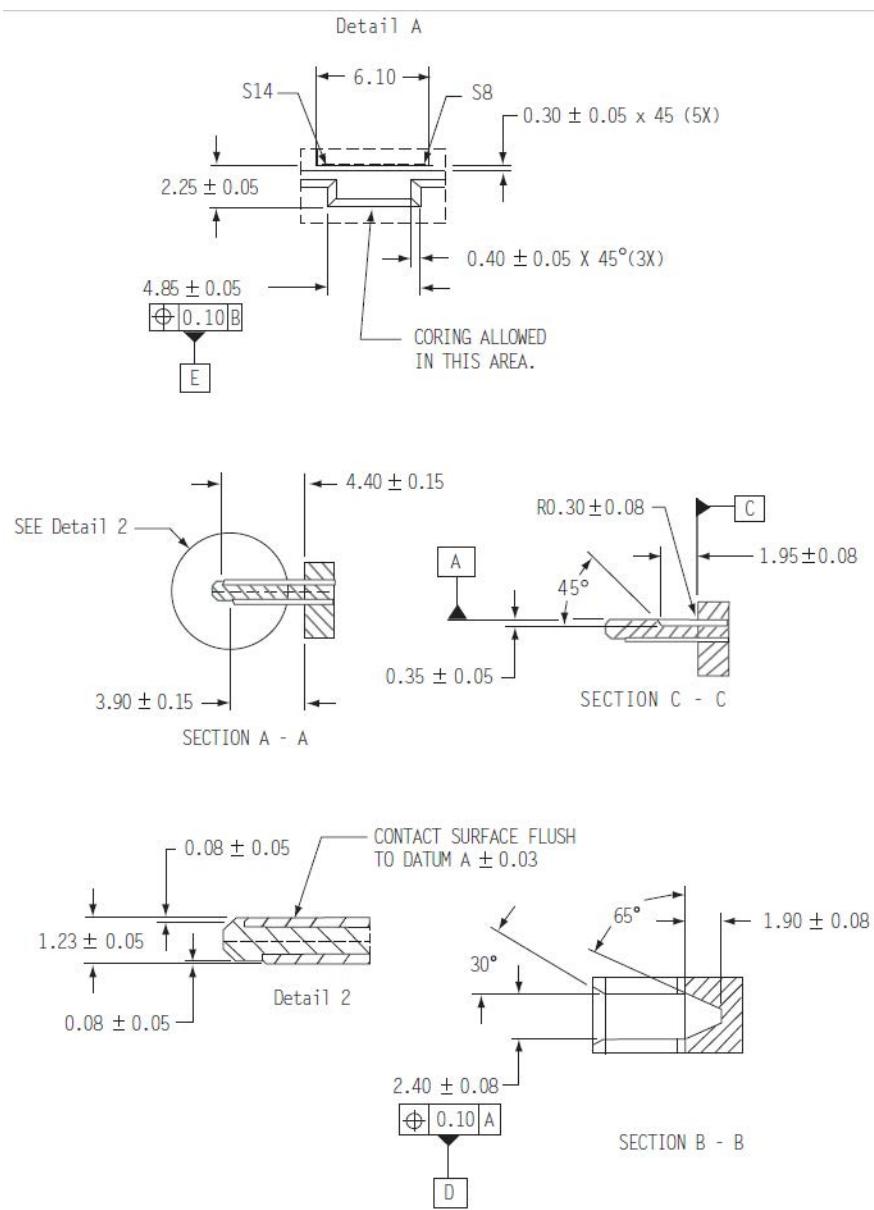
9.5.2 Physical characteristics

This section defines physical interface connector.

9.5.3 Connector requirements

Contact a preferred connector manufacturer for mating part information.

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 16 SFF-8639 connector pin descriptions

Pin	Name	Description	Pin	Name	Description
S1	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
S4	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
S7	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	REFCLKB+	Reference clock for second B-Side port	S8	GND	Ground
E2	REFCLKB-	Reference clock for second B-Side port	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#/PERSTB#	Clock request (if Dual Port mode not enabled) / Fundamental reset port 1	S11	GN	Ground
E5	PERST#	Fundamental reset port 0	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
P3	PWRDIS	Power Disable	S17	PETp1 (U.2) / PETp2 (U.3)	Transmitter differential pair, Lane 1 Positive
P4	IfDet#	Interface Detect (drive type)	S18	PETn1 (U.2) / PETn2 (U.3)	Transmitter differential pair, Lane 1 Negative
P5	GND	Ground	S19	GND	Ground
P6	GND	Ground	S20	PERn1 (U.2) / PERn2 (U.3)	Receiver differential pair, Lane 1 Negative
P7	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

Table 16 SFF-8639 connector pin descriptions *(continued)*

P10	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
P12	Hot-Plug	Ground	S26	PERn2 (U.2) / PERn3 (U.3)	Receiver differential pair, Lane 2 Negative
P13	+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 +12V pins provide power to the drive, 2 short and 1 long.

The current return for the +12V 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 FIPS

The Federal Information Processing Standard (FIPS) Publication 140-3 is a U.S. Government Computer Security Standard used to accredit cryptographic modules. It is titled 'Security Requirements for Cryptographic Modules (FIPS PUB 140-3)' and is issued by the National Institute of Standards and Technology (NIST).

10.1   Purpose

This standard specifies the security requirements that will be satisfied by a cryptographic module utilized within a security system protecting sensitive but unclassified information. The standard provides four increasing, qualitative levels of security: Level 1, Level 2, Level 3, and Level 4. These levels are intended to cover the wide range of potential applications and environments in which cryptographic modules may be employed.

10.2   Validation Program

Products that claim conformance to this standard are validated by the Cryptographic Module Validation Program (CMVP) which is a joint effort between National Institute of Standards and Technology (NIST) and the Communications Security Establishment (CSE) of the Government of Canada. Products validated as conforming to FIPS 140-3 are accepted by the Federal agencies of both countries for the protection of sensitive information (United States) or Designated Information (Canada).

In the CMVP, vendors of cryptographic modules use independent, accredited testing laboratories to have their modules tested. National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratories perform cryptographic module compliance/conformance testing.

10.3   Seagate Enterprise SED

The SEDs described in this Product Manual are in the process of being validated by CMVP and thoroughly tested by a NVLAP accredited lab to satisfy FIPS 140-3 Level 2 requirements. In order to operate in FIPS Approved Mode of Operation, these SEDs require security initialization. For more information, refer to *Security Rules* section in the *Security Policy* document uploaded on the NIST website. For product certification status visit
https://csrc.nist.gov/projects/cryptographic-module-validation-program/validated-modules/search.

10.4 Security Level 2

Security Level 2 enhances the physical security mechanisms of a Security Level 1 cryptographic module by adding the requirement for tamper-evidence, which includes the use of tamper-evident coatings or seals on removable covers of the module.

Tamper evident coatings or seals are placed on a cryptographic module so that the coating or seal must be broken to attain physical access to the critical security parameters (CSP) within the module.

Tamper-evident seals (example shown in Figure 6, *Example of FIPS tamper evidence labels, on page 60*) are placed on covers to protect against unauthorized physical access.

In addition Security Level 2 requires, at a minimum, role-based authentication in which a cryptographic module authenticates the authorization of an operator to assume a specific role and perform a corresponding set of services.

Figure 6 Example of FIPS tamper evidence labels

NOTE   Image is for reference only, does not represent actual drive.

11. 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 this 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.

11.1 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 11.5 *Data bands*).

11.2 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.

11.2.1 Admin SP

The Admin SP allows the drive's owner to enable or disable firmware download operations (see Section 11.4 *Drive locking*). Access to the Admin SP is available using the SID (Secure ID) password or the MSID (Manufacturers Secure ID) password.

11.2.2 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).

11.2.3   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.

11.3   Random number generator (RNG)

The drive has a 32-byte hardware RNG that it is 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.

11.4   Drive locking

In addition to changing the passwords, as described in Section 11.2.3 *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.

11.5   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.

11.6   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.

11.7   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.

11.8   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.

11.9   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 19, *NVMe Admin and I/O Commands*.

■   Security Send

■   Security Receive

11.10   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.).

11.11   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.

12. Installation

Nytro 5050 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 a 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 13.5 *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 7 Physical interface
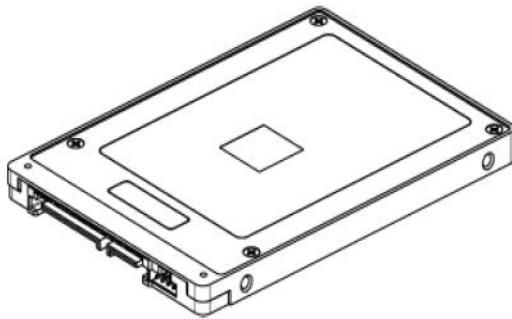
12.1   Drive orientation

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.

12.2   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 8, *Air Flow, on page 66*. 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 8 Air Flow

Note. Air flows in the direction shown (back to front) or in reverse direction (front to back)

Above unit

Under unit

Note. Air flows in the direction shown or in reverse direction (side to side)

Above unit

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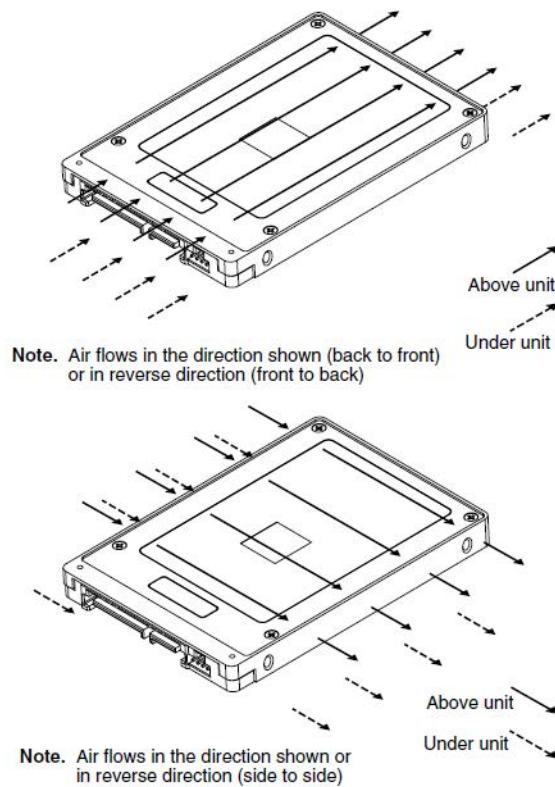
NOTE   Image may not represent actual product, for reference only.

12.3 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:

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

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 9 Recommended mounting
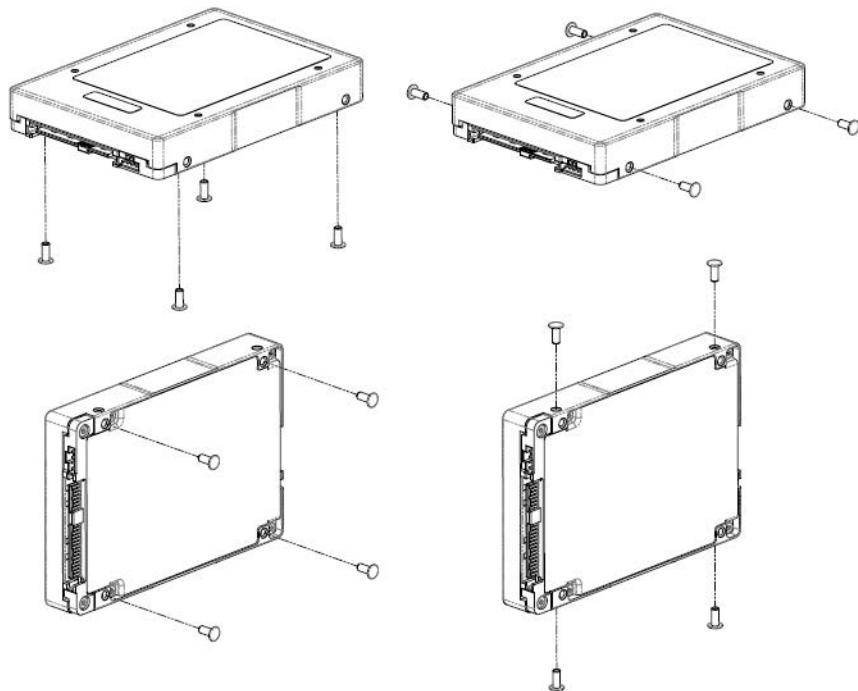
NOTE   Image may not represent actual product, for reference only.

12.4 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.

13. NVMe Interface requirements

This section lists the NVMe-specific features supported by Nytro 5050 SSDs.

13.1   Get/Set Features

The following table lists Get Features and Set Feature Identifiers.

Table 17 - Nytro 5050 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

13.2   Log Pages

The following table lists the NVMe log pages supported by Nytro 5050 SSDs.

Table 18 - NVMe Log Pages Supported

Log Page Identifier	M/O	Command	Supported
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

13.3   Dual port support

Nytro 5050 SSDs support operation in dual port mode. In this mode, the PCIe interface is bifurcated into two ports with two PCIe lanes each. Each port can perform independent port clocking, and can run at any supported link rate. The supported link rates are 16, 8, 5, or 2.5GT/s.

13.4   NVMe Commands Supported

The following table lists the NVMe commands supported by Nytro 5050 SSD drives. For details about command fields definition and options, refer to the NVM Express 1.4c specification available at nvmexpress.org.

Table 19 - 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 19 - 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 Dataset Management - IDW Dataset Management - IDR	Yes Yes 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

13.4.1　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 20 Identify Controller Data

Bytes	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	...	63
XP1920SE70005	58	50	31	39	32	30	53	45	37	30	30	30	35	20	20	20	...	20
XP3840SE70005	58	50	33	38	34	30	53	45	37	30	30	30	35	20	20	20	...	20
XP7680SE70005	58	50	37	36	38	30	53	45	37	30	30	30	35	20	20	20	...	20
XP15360SE70005	58	50	31	35	33	36	30	53	45	37	30	30	30	35	20	20	...	20
XP1920SE70015	58	50	31	39	32	30	53	45	37	30	30	31	35	20	20	20	...	20
XP3840SE70015	58	50	33	38	34	30	53	45	37	30	30	31	35	20	20	20	...	20
XP7680SE70015	58	50	37	36	38	30	53	45	37	30	30	31	35	20	20	20	...	20
XP15360SE70015	58	50	31	35	33	36	30	53	45	37	30	30	31	35	20	20	...	20
XP1920SE70025	58	50	31	39	32	30	53	45	37	30	30	32	35	20	20	20	...	20
XP3840SE70025	58	50	33	38	34	30	53	45	37	30	30	32	35	20	20	20	...	20
XP7680SE70025	58	50	37	36	38	30	53	45	37	30	30	32	35	20	20	20	...	20
XP15360SE70025	58	50	31	35	33	36	30	53	45	37	30	30	32	35	20	20	...	20
XP800LE70005	58	50	38	30	30	4C	45	37	30	30	30	35	20	20	20	20	...	20
XP1600LE70005	58	50	31	36	30	30	4C	45	37	30	30	30	35	20	20	20	...	20
XP3200LE70005	58	50	33	32	30	30	4C	45	37	30	30	30	35	20	20	20	...	20
XP6400LE70005	58	50	36	34	30	30	4C	45	37	30	30	30	35	20	20	20	...	20
XP12800LE70005	58	50	31	32	38	30	30	4C	45	37	30	30	30	35	20	20	...	20
XP800LE70015	58	50	38	30	30	4C	45	37	30	30	31	35	20	20	20	20	...	20
XP1600LE70015	58	50	31	36	30	30	4C	45	37	30	30	31	35	20	20	20	...	20
XP3200LE70015	58	50	33	32	30	30	4C	45	37	30	30	31	35	20	20	20	...	20
XP6400LE70015	58	50	36	34	30	30	4C	45	37	30	30	31	35	20	20	20	...	20
XP12800LE70015	58	50	31	32	38	30	30	4C	45	37	30	30	31	35	20	20	...	20
XP800LE70025	58	50	38	30	30	4C	45	37	30	30	32	35	20	20	20	20	...	20
XP1600LE70025	58	50	31	36	30	30	4C	45	37	30	30	32	35	20	20	20	...	20
XP3200LE70025	58	50	33	32	30	30	4C	45	37	30	30	32	35	20	20	20	...	20
XP6400LE70025	58	50	36	34	30	30	4C	45	37	30	30	32	35	20	20	20	...	20
XP12800LE70025	58	50	31	32	38	30	30	4C	45	37	30	30	32	35	20	20	...	20
XP1920SE70035	58	50	31	39	32	30	53	45	37	30	30	33	35	20	20	20	...	20
XP3840SE70035	58	50	33	38	34	30	53	45	37	30	30	33	35	20	20	20	...	20
XP7680SE70035	58	50	37	36	38	30	53	45	37	30	30	33	35	20	20	20	...	20
XP15360SE70035	58	50	31	35	33	36	30	53	45	37	30	30	33	35	20	20	...	20
XP1920SE70045	58	50	31	39	32	30	53	45	37	30	30	34	35	20	20	20	...	20
XP3840SE70045	58	50	33	38	34	30	53	45	37	30	30	34	35	20	20	20	...	20
XP7680SE70045	58	50	37	36	38	30	53	45	37	30	30	34	35	20	20	20	...	20
XP15360SE70045	58	50	31	35	33	36	30	53	45	37	30	30	34	35	20	20	...	20
XP1920SE70055	58	50	31	39	32	30	53	45	37	30	30	35	35	20	20	20	...	20

Table 20 Identify Controller Data *(continued)*

XP3840SE70055	58	50	33	38	34	30	53	45	37	30	30	35	35	20	20	20	...	20
XP7680SE70055	58	50	37	36	38	30	53	45	37	30	30	35	35	20	20	20	...	20
XP15360SE70055	58	50	31	35	33	36	30	53	45	37	30	30	35	35	20	20	...	20
XP1920SE10005	58	50	31	39	32	30	53	45	31	30	30	30	35	20	20	20	...	20
XP3840SE10005	58	50	33	38	34	30	53	45	31	30	30	30	35	20	20	20	...	20
XP7680SE10005	58	50	37	36	38	30	53	45	31	30	30	30	35	20	20	20	...	20
XP1920SE10015	58	50	31	39	32	30	53	45	31	30	30	31	35	20	20	20	...	20
XP3840SE10015	58	50	33	38	34	30	53	45	31	30	30	31	35	20	20	20	...	20
XP7680SE10015	58	50	37	36	38	30	53	45	31	30	30	31	35	20	20	20	...	20
XP1920SE10025	58	50	31	39	32	30	53	45	31	30	30	32	35	20	20	20	...	20
XP3840SE10025	58	50	33	38	34	30	53	45	31	30	30	32	35	20	20	20	...	20
XP7680SE10025	58	50	37	36	38	30	53	45	31	30	30	32	35	20	20	20	...	20
XP800LE70035	58	50	38	30	30	4C	45	37	30	30	33	35	20	20	20	20	...	20
XP1600LE70035	58	50	31	36	30	30	4C	45	37	30	30	33	35	20	20	20	...	20
XP3200LE70035	58	50	33	32	30	30	4C	45	37	30	30	33	35	20	20	20	...	20
XP6400LE70035	58	50	36	34	30	30	4C	45	37	30	30	33	35	20	20	20	...	20
XP12800LE70035	58	50	31	32	38	30	30	4C	45	37	30	30	33	35	20	20	...	20
XP800LE70045	58	50	38	30	30	4C	45	37	30	30	34	35	20	20	20	20	...	20
XP1600LE70045	58	50	31	36	30	30	4C	45	37	30	30	34	35	20	20	20	...	20
XP3200LE70045	58	50	33	32	30	30	4C	45	37	30	30	34	35	20	20	20	...	20
XP6400LE70045	58	50	36	34	30	30	4C	45	37	30	30	34	35	20	20	20	...	20
XP12800LE70045	58	50	31	32	38	30	30	4C	45	37	30	30	34	35	20	20	...	20
XP800LE70055	58	50	38	30	30	4C	45	37	30	30	35	35	20	20	20	20	...	20
XP1600LE70055	58	50	31	36	30	30	4C	45	37	30	30	35	35	20	20	20	...	20
XP3200LE70055	58	50	33	32	30	30	4C	45	37	30	30	35	35	20	20	20	...	20
XP6400LE70055	58	50	36	34	30	30	4C	45	37	30	30	35	35	20	20	20	...	20
XP12800LE70055	58	50	31	32	38	30	30	4C	45	37	30	30	35	35	20	20	...	20
XP800LE10005	58	50	38	30	30	4C	45	31	30	30	30	35	20	20	20	20	...	20
XP1600LE10005	58	50	31	36	30	30	4C	45	31	30	30	30	35	20	20	20	...	20
XP3200LE10005	58	50	33	32	30	30	4C	45	31	30	30	30	35	20	20	20	...	20
XP6400LE10005	58	50	36	34	30	30	4C	45	31	30	30	30	35	20	20	20	...	20
XP800LE10015	58	50	38	30	30	4C	45	31	30	30	31	35	20	20	20	20	...	20
XP1600LE10015	58	50	31	36	30	30	4C	45	31	30	30	31	35	20	20	20	...	20
XP3200LE10015	58	50	33	32	30	30	4C	45	31	30	30	31	35	20	20	20	...	20
XP6400LE10015	58	50	36	34	30	30	4C	45	31	30	30	31	35	20	20	20	...	20
XP800LE10025	58	50	38	30	30	4C	45	31	30	30	32	35	20	20	20	20	...	20
XP1600LE10025	58	50	31	36	30	30	4C	45	31	30	30	32	35	20	20	20	...	20
XP3200LE10025	58	50	33	32	30	30	4C	45	31	30	30	32	35	20	20	20	...	20
XP6400LE10025	58	50	36	34	30	30	4C	45	31	30	30	32	35	20	20	20	...	20

13.4.2   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.

13.5   Signal characteristics

This section describes the electrical signal characteristics of the drive's input and output signals. See Table 16, SFF-8639 connector pin descriptions for signal type and signal name information.

13.5.1   ACTIVITY# signal

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

Table 21 - 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)

Table 21 - ACTIVITY LED Out conditions

Normal command activity	LED status
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 +3.3V supply through an appropriate current limiting resistor. The LED and the current limiting resistor are external to the drive.

See Table 22, *LED drive signal* for the output characteristics of the LED drive signals.

Table 22 - LED drive signal

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