



Hard disk drive specifications
Ultrastar® DC HC6100
3.5-inch Serial ATA hard disk drive
Model: WSH723634ALE604

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1 General

1.1 Introduction

This document describes the specifications of the Ultrastar® DC HC6100 a Western Digital 3.5-inch 7200-rpm Serial ATA interface hard disk drive with the following model number:

Table 1 Type and Model#

Capacity	Type	Interface	Format	Model#	Description	P3 Power Disable Supported
34TB	US7SAV0	Serial ATA	512 Emulation	WSH723634ALE604	Base(SE)	Yes

*1 One TB equals one trillion bytes. Actual user capacity may be less due to operating environment.

How to Read Model Numbers

WSH723634ALE604 – 34TB SATA 6Gb/s 512e Base (SE) with Power Disable Pin 3 support

W = Western Digital

S = Ultrastar® SMR Technology

H = Helium

72 = 7200 RPM

36 = Capacity Class

34 = Capacity this model

A = Generation code

L = 26.1mm z-height

E6 = Interface (512e SATA 6Gb/s)

** 512e models can be converted to 4Kn format and vice versa

(Note: Changing the block size does not change the HDD Model Number reported by the drive.)

y = Power Disable Pin 3 status

(0 = Power Disable Pin 3 support)

z = Data Security Mode

4 = Base (SE)* : No Encryption, Sanitize Overwrite only

* ATA Security Feature Set comes standard on SATA

1.2 Glossary

ADM	Automatic Drive Maintenance
DFT	Drive Fitness Test
ESD	Electrostatic Discharge
GB	1,000,000,000 bytes
Gbps	1,000,000,000 bits per second
ISE	Instant Secure Erase
KiB	1,024 bytes
Kbpi	1,000 bits per inch
Ktpi	1,000 tracks per inch
MiB	1,048,576 bytes
MB	1,000,000 bytes
MB/s	1,000,000 bytes per second
Mbps	1,000,000 bits per second
MiB/s	1,048,576 bytes per second
PI	Protection Information
PSID	Physical presence Security ID
S.M.A.R.T.	Self-Monitoring Analysis and Reporting Technology
SE	Secure Erase
SED	Self-Encrypting Drive
TB	1,000,000,000,000 bytes
TCG	Trusted Computing Group

1.3 General caution

Do not apply force to the top cover. Handle the drive by its edges or frame only.

Do not touch the interface connector pins or the surface of the print circuit board.

Do not stack drives in storage or during handling operations.

The drive can be damaged by shock, ESD (Electrostatic Discharge) or stacking.

Any damage sustained by the drive after removal from the shipping package and opening the ESD protective bag are the responsibility of the user.

1.4 References

- Serial ATA II: Extensions to Serial ATA 1.0
- Serial ATA International Organization: Serial ATA Revision 3.5
- Zoned Device ATA Command Set -2 (ZAC-2) Revision 14

2 General features

- Host Managed SMR (Shingled Magnetic Recording)
- Spindle speeds of 7200 RPM
- Fluid Dynamic Bearing motor
- Triple Stage Actuator
- Closed-loop actuator servo
- Load/Unload mechanism, non-head disk contact start/stop
- Automatic Actuator lock
- Write Cache
- Power saving modes/Low RPM idle mode (APM)
- S.M.A.R.T. (Self-Monitoring and Analysis Reporting Technology)
- Adaptive zone formatting
- RVS (Rotational Vibration Safeguard)
- 512MiB DDR4 Memory
- 64GB NAND flash drive
- Conventional Zone 0.34TB in case of 99% SMR
- 256MiB zone size (Sequential Write required)
- UnRestricted Sequential Write Required Zone default setting to be 1
- Intelligent Write Verify for SMR Technology
- Segmented buffer implementation
- Automatic Error Recovery procedures for read and write commands
- Automatic defect reallocation
- PSID support
- Data capacities of 34TB
- Sector format of 512 bytes/sector
- Native command queuing support
- Self-Diagnostics at Power on.
- Serial ATA Interface 6/3/1.5Gbps
- CHS and LBA mode
- security feature support
- 48 bit addressing feature
- Full Disk Encryption support (specific model only)
- Supported Zoned Device ATA Command Set - 2 (ZAC-2) (di549r14). Zone Domains feature set and Zone Realms feature set is not supported.

3 Fixed disk subsystem description

3.1 Control Electronics

The drive is electronically controlled by a microprocessor, several logic modules, digital/analog modules, and various drivers and receivers. The control electronics performs the following major functions:

- Controls and interprets all interface signals between the host controller and the drive.
- Controls read write accessing of the disk media, including defect management and error recovery.
- Controls starting, stopping, and monitoring of the spindle.
- Conducts a power-up sequence and calibrates the servo.
- Analyzes servo signals to provide closed loop control. These include position error signal and estimated velocity.
- Monitors the actuator position and determines the target track for a seek operation.
- Controls the voice coil motor driver to align the actuator in a desired position.
- Constantly monitors error conditions of the servo and takes corresponding action if an error occurs.
- Monitors various timers such as head settle and servo failure.
- Performs self-checkout (diagnostics).

3.2 Head disk assembly

The head disk assembly (HDA) is assembled in a clean room environment and contains the disks and actuator assembly. Helium is constantly circulated and filtered when the drive is operational. No venting of the HDA is accomplished, as HDA is hermetically sealed.

The spindle is driven directly by an in-hub, brushless, sensor less DC drive motor. Dynamic braking is used to quickly stop the spindle.

3.3 Actuator

The read/write heads are mounted in the actuator. The actuator is a swing-arm assembly driven by a voice coil motor. A closed-loop positioning servo controls the movement of the actuator. An embedded servo pattern supplies feedback to the positioning servo to keep the read/write heads centered over the desired track.

The actuator assembly is balanced to allow vertical or horizontal mounting without adjustment.

When the drive is powered off, the actuator automatically moves the head to the actuator ramp outside of the disk where it parks.

4 Drive characteristics

This section describes the characteristics of the drive.

4.1 Default logical drive parameters

The default of the logical drive parameters in Identify Device data is as shown below.

Table 2 Formatted capacity

Description	34TB model (512e)
Physical Layout	
Label capacity	34TB
Bytes per Sector	4,096
Number of Heads	22
Number of Disks	11
Logical Layout¹	
Bytes per Sector	512
Number of Sectors	66,406,318,080
Total Logical Data Bytes	34,000,034,856,960

Notes:

¹ Logical layout: Logical layout is an imaginary drive parameter (that is, the number of heads) which is used to access the drive from the system interface. The Logical layout to Physical layout (that is, the actual Head and Sectors) translation is done automatically in the drive. The default setting can be obtained by issuing an IDENTIFY DEVICE command

4.2 Data sheet

Table 3 Data sheet

Description	34TB
Max Data transfer rate (Mbps)	2460 ~ 2520
Max Interface transfer rate (MB/s)	600
Max Sustained transfer rate (MB/s) *1	Up to 267
Max Sustained transfer rate (MiB/s) *1	Up to 255
Memory size (MiB)	512
Rotational speed (RPM)	7,200
Recording density- max (Kbpi)	2091 ~ 2160
Track density (Ktpi)	745 ~ 790
Areal density - max (Gbits/in ²)	1570 ~ 1700

*1 The location of the max Sustained transfer rate is at approximately 10% into the capacity of the HDD.

4.3 Worldwide Name Assignment

Table 4 World Wide Name Assignment

Description	WWN
Organizationally Unique Identifier (OUI)	000CCAh (for Western Digital)
SHBU Block Assignment	436h, 43Ah (Thailand)

4.4 Drive organization

4.4.1 Drive Format

Upon shipment from Western Digital manufacturing the drive satisfies the sector continuity in the physical format by means of the defect flagging strategy described in Section 5 on page 16 to provide the maximum performance to users.

4.4.2 Cylinder allocation

Physical cylinder is calculated from the starting data track of 0. It is not relevant to logical CHS. Depending on the capacity some of the inner zone cylinders are not allocated.

Data cylinder

This cylinder contains the user data which can be sent and retrieved via read/write commands and a spare area for reassigned data.

Spare cylinder

The spare cylinder is used by Western Digital manufacturing and includes data sent from a defect location.

4.4.3 Zone Layout

The LBAs are divided into ranges called zones.

The entire capacity of a zoned block device is organized into a set of contiguous, non-overlapping zones.

4.4.3.1 Zone size 256MiB (99% SMR)

Sequential write required zone 100% of Total Capacity

Table 5 Zone Layout 256MiB (99% SMR)

Description	34TB (512e)
Logical Layout	
Bytes per Sector	512
Number of Conventional Zone	1,267
Start LBA	0
End LBA	664,272,895
Number of Sequential write required zone	125,393
Start LBA	664,272,896
End LBA	66,406,318,079
Number of Sectors	66,406,318,080

Conventional zone

↓ LBA 0					LBA 664,272,895 ↓
Zone 0	Zone 1	Zone 2	...	Zone 1,266	

Sequential write required/ zone

↓ LBA 664,272,896					LBA 66,406,318,079 ↓
Zone 1,267	Zone 1,120	Zone 1,121	...	Zone 126,659	

Figure 1 Logical Layout example: 34TB, Zone size 256MiB(99%SMR), Number of Block per Sector 512

4.5 Performance characteristics

Drive performance is characterized by the following parameters:

- Command overhead
- Mechanical positioning
- Latency
- Data transfer speed
- Buffering operation (Look ahead/Write cache)

All the above parameters contribute to drive performance. There are other parameters that contribute to the performance of the actual system. This specification defines the characteristics of the drive, not the characteristics of the system throughput which depends on the system and the application.

The terms “Typical” and “Max” are used throughout this specification with the following meanings: Typical. The average of the drive population tested at nominal environmental and voltage conditions. Max. The maximum value measured on any one drive over the full range of the environmental and voltage conditions. (See Section 6.2, “Environment” and Section 6.3, “DC Power Requirements”)

4.5.1 Mechanical positioning

4.5.1.1 Average latency

Table 6 Latency Time

Rotational speed	Time for a revolution (ms)	Average latency (ms)
7200 RPM	8.3	4.16

4.5.2 Drive ready time

Table 7 Drive ready time

Power on to ready	POR Condition	Typical (sec)	Maximum (sec)
11 Disk model	Controlled POR without Deferred FW Activation	25	30
	Controlled POR with Deferred FW Activation	N/A	60
	Uncontrolled POR (EPO) with destage to media cache and possible Deferred FW Activation	N/A	75

Ready The condition in which the drive can perform a media access command (such as read, write) immediately

Power on This includes the time required for the internal self-diagnostics.

Notes: The typical and maximum drive ready times in the table are for proper power shutdown using the required power-off sequence. The actual time may vary depending on the drive pre-condition before the EPO event.

4.5.3 Operating modes

4.5.3.1 Operating mode descriptions

Operating mode	Description
Spin up	Period of time from 0 rpm to full rpm
Start up	Period of time from power on to drive ready.
Seek	Seek operation mode
Write	Write operation mode
Read	Read operation mode
Active	Drive is able to perform a media access command (such as read, write) immediately
Idle_0	Drive Ready, but not performing IO, drive may power down selected electronics to reduce power without increasing response time
Idle_A	Drive Ready, but not performing IO, drive may power down selected electronics to reduce power without increasing response time
Idle_B	Spindle rotation at 7200 RPM with heads unloaded
Idle_C/Standby_Y	Spindle rotation at Low RPM with heads unloaded
Standby_Z	Actuator is unloaded and spindle motor is stopped. Commands can be received immediately
Sleep (SATA)	Actuator is unloaded and spindle motor is stopped. Only soft reset or hard reset can change the mode to standby_z

Note: Upon power down or spindle stop a head locking mechanism will secure the heads in the OD parking position.

4.5.3.2 Mode transition times

Mode transition times are shown below

Table 8 Mode transition times

From	To	RPM	Typical (sec)
Idle_B	Active	7200	1.5
Idle_C	Active	6300 -> 7200	4
Standby_Y	Active	6300 -> 7200	4
Standby_Z	Active	0 > 7200	15

Note: Maximum transition time of 30 Seconds based on drive timeout value

5 Defect flagging strategy

Media defects are remapped to the next available sector during the Format Process in manufacturing. The mapping from LBA to the physical locations is calculated by an internally maintained table.

5.1 Shipped format

- Data areas are optimally used.
 - No extra sector is wasted as a spare throughout user data areas.
 - All pushes generated by defects are absorbed by the spare tracks of the inner zone.
-

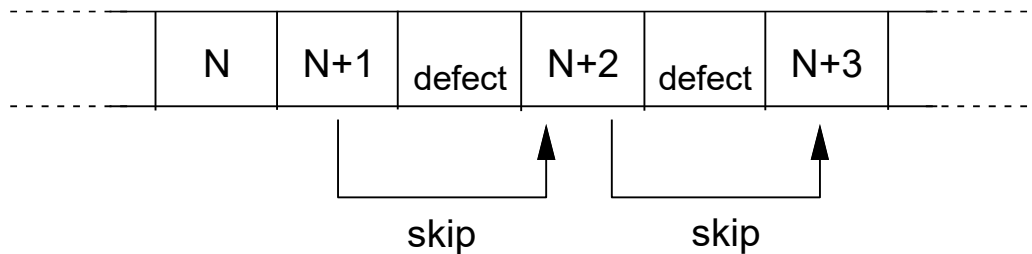


Figure 2 PList physical format

Defects are skipped without any constraint, such as track or cylinder boundary. The calculation from LBA to physical is done automatically by internal table.

6 Specification

6.1 Electrical interface

6.1.1 Connector location

Refer to the following illustration to see the location of the connectors.

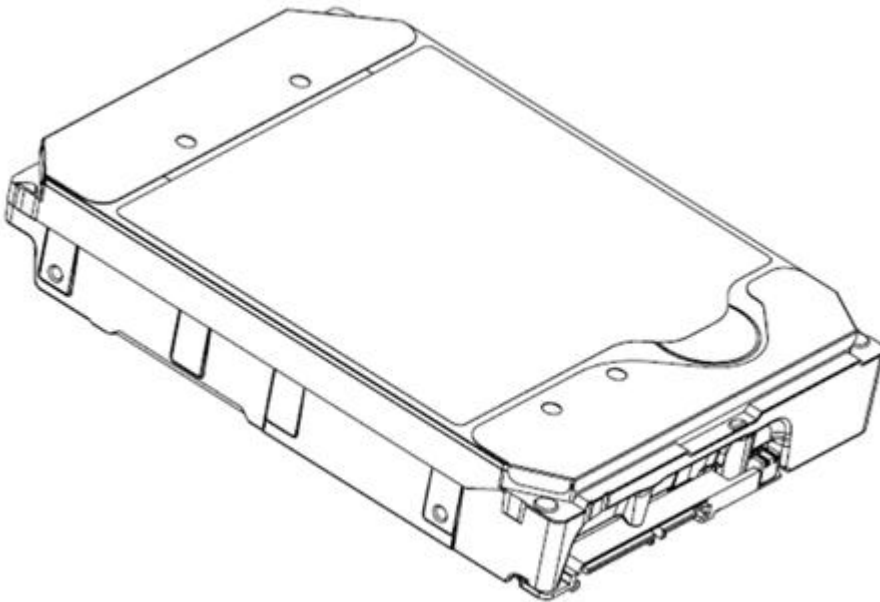


Figure 3 Connector location

6.1.1.1 Signal connector

A Serial ATA device may be either directly connected to a host or connected to a host through a cable.

For direct connection, the device plug connector is inserted directly into a backplane connector. The device plug connector and the backplane connector incorporate features that enable the direct connection to be hot pluggable and blind mate able.

For connection via cable, the device signal plug connector mates with the signal cable receptacle connector on one end of the cable. The signal cable receptacle connector on the other end of the cable is inserted into a host signal plug connector. The signal cable wire consists of two twinax sections in a common outer sheath.

Besides the signal cable, there is also a separate power cable for the cabled connection. A Serial ATA power cable includes a power cable receptacle connector on one end and may be directly connected to the host power supply on the other end or may include a power cable receptacle on the other end. The power cable receptacle connector on one end of the power cable mates with the device power plug connector. The other end of the power cable is attached to the host as necessary.

6.1.2 Signal definition

SATA has receivers and drivers to be connected to Tx+/- and Rx +/- Serial data signal. Defines the signal names of I/O connector pin and signal name.

Table 9 Interface connector pins and I/O signals

	No.	Plug Connector pin definition		Signal	I/O
Signal	S1	GND	2nd mate	Gnd	
	S2	A+	Differential signal A from Phy	RX+	Input
	S3	A-		RX-	Input
	S4	Gnd	2nd mate	Gnd	
	S5	B-	Differential signal B from Phy	TX-	Output
	S6	B+		TX+	Output
	S7	Gnd	2nd mate	Gnd	
	Key and spacing separate signal and power segments				
Power	P1	Reserved*	NOT USED (P1 and P2 tied internally)	Reserve	
	P2	Reserved*	Not USED (P1 and P2 tied internally)	Reserve	
	P3	Reserved* or PWDIS* (option)	Not USED (P1, P2 and P3 tied internally) or Enter/Exit Power Disable (option)	Reserve or PWDIS	
	P4	Gnd	1st mate	Gnd	
	P5	Gnd	2nd mate	Gnd	
	P6	Gnd	2nd mate	Gnd	
	P7	V5	5V power,pre-charge,2nd mate	5V	
	P8	V5	5V power	5V	
	P9	V5	5V power	5V	
	P10	Gnd	2nd mate	Gnd	
	P11	Reserved	Support staggered spin-up and LED activity VDih max=2.1V	Reserve	
	P12	Gnd	1st mate	Gnd	
	P13	V12	12V power,pre-charge,2nd mate	V12	
	P14	V12	12V power	V12	
	P15	V12	12V power	V12	

* SATA Specification Revision 3.1 and prior revisions assigned 3.3V to pins P1, P2 and P3. In addition, device plug pins P1, P2, and P3 were required to be bused together. In the standard configuration of this product,

P3 is connected with P1 and P2 and this product behaves as SATA 3.1 or prior version product in a system designed to SATA 3.2 system that does not support the 3.3 feature. For product with the optional SATA 3.3 Power Disable Feature supported, P3 is now assigned as the POWER DISABLE CONTROL PIN. If P3 is driven HIGH (2.1V-3.6V max), power to the drive circuitry will be disabled. Drives with this optional feature WILL NOT POWER UP in systems designed to SATA Spec Revision 3.1 or earlier because P3 driven HIGH will prevent the drive from powering up.

6.1.2.1 TX+ / TX-

These signals are the outbound high-speed differential signals that are connected to the serial ATA cable.

6.1.2.2 RX+ / RX-

These signals are the inbound high-speed differential signals that are connected to the serial ATA cable.

6.1.2.3 5V PRECHARGE

+5 Vdc that is available on the extended pins. It is used for PRECHARGE when connected to backplane incorporated feature.

6.1.2.4 12V PRECHARGE

+12 Vdc that is available on the extended pins. It is used for PRECHARGE when connected to backplane incorporated feature.

6.1.3 Out of band signaling

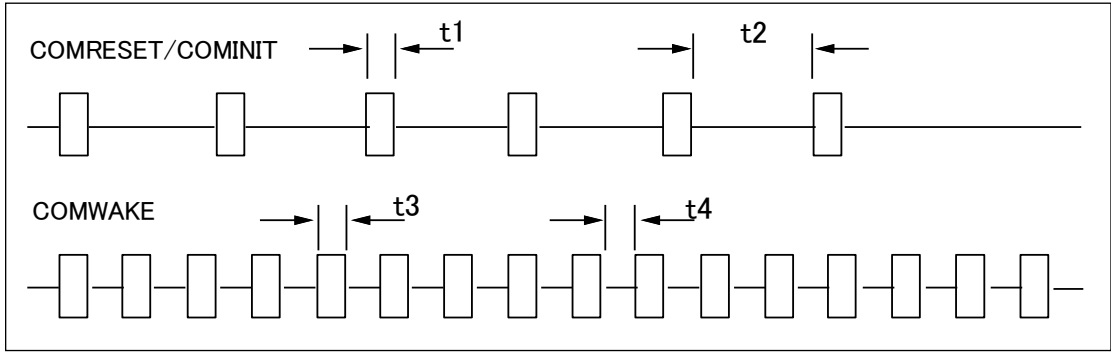


Figure 4 The timing of COMRESET, COMINIT and COMWAKE

Table 10 Parameter descriptions

	PARAMETER DESCRIPTION	Nominal (ns)
t1	ALIGN primitives	106.7
t2	Spacing	320
t3	ALIGN primitives	106.7
t4	Spacing	106.7

6.2 Environment

6.2.1 Temperature and humidity

Table 11 Temperature and humidity

System Responsibility	
The system is responsible for maintaining a drive sensor temperature below 60°C. Drive sensor temperature is as reported using SMART SCT.	
Operating conditions	
Temperature	Ambient 5°C to Drive Reported 60°C
Relative humidity	5 to 90% non-condensing (*1)
Maximum wet bulb temperature	29.4°C non-condensing (*1)
Maximum temperature gradient	20°C/Hour
Altitude	-300 to 3,048 m
Non-Operating conditions	
Temperature	-40 to 70°C
Relative humidity	5 to 95% non-condensing (*1)
Maximum wet bulb temperature	35°C non-condensing (*1)
Maximum temperature gradient	20°C/Hour
Altitude	-300 to 12,000 m (Inside dashed-dotted line of Figure 6)

Notes:

1. Noncondensing conditions should be maintained at any time.

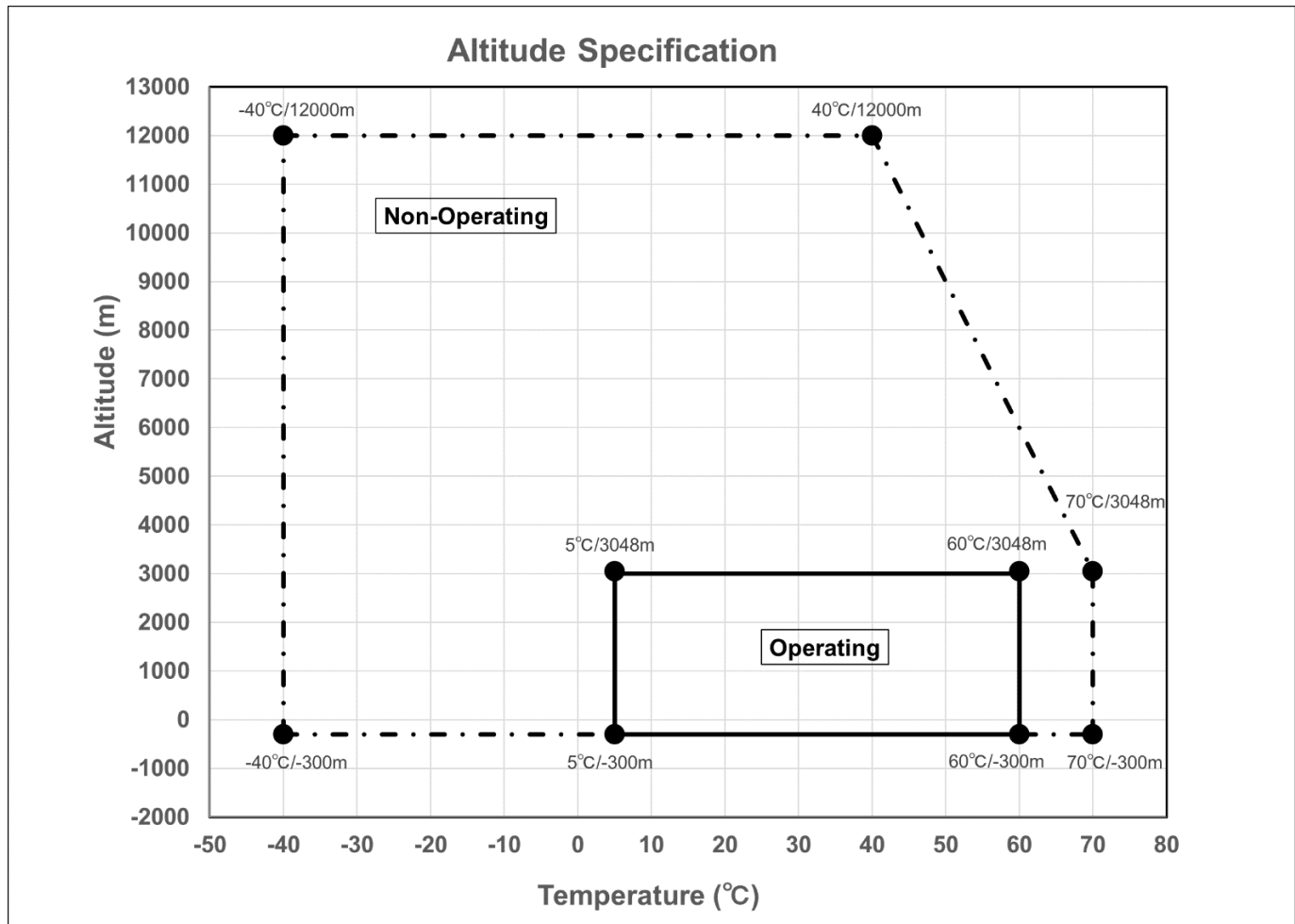


Figure 5 Limits of temperature and altitude

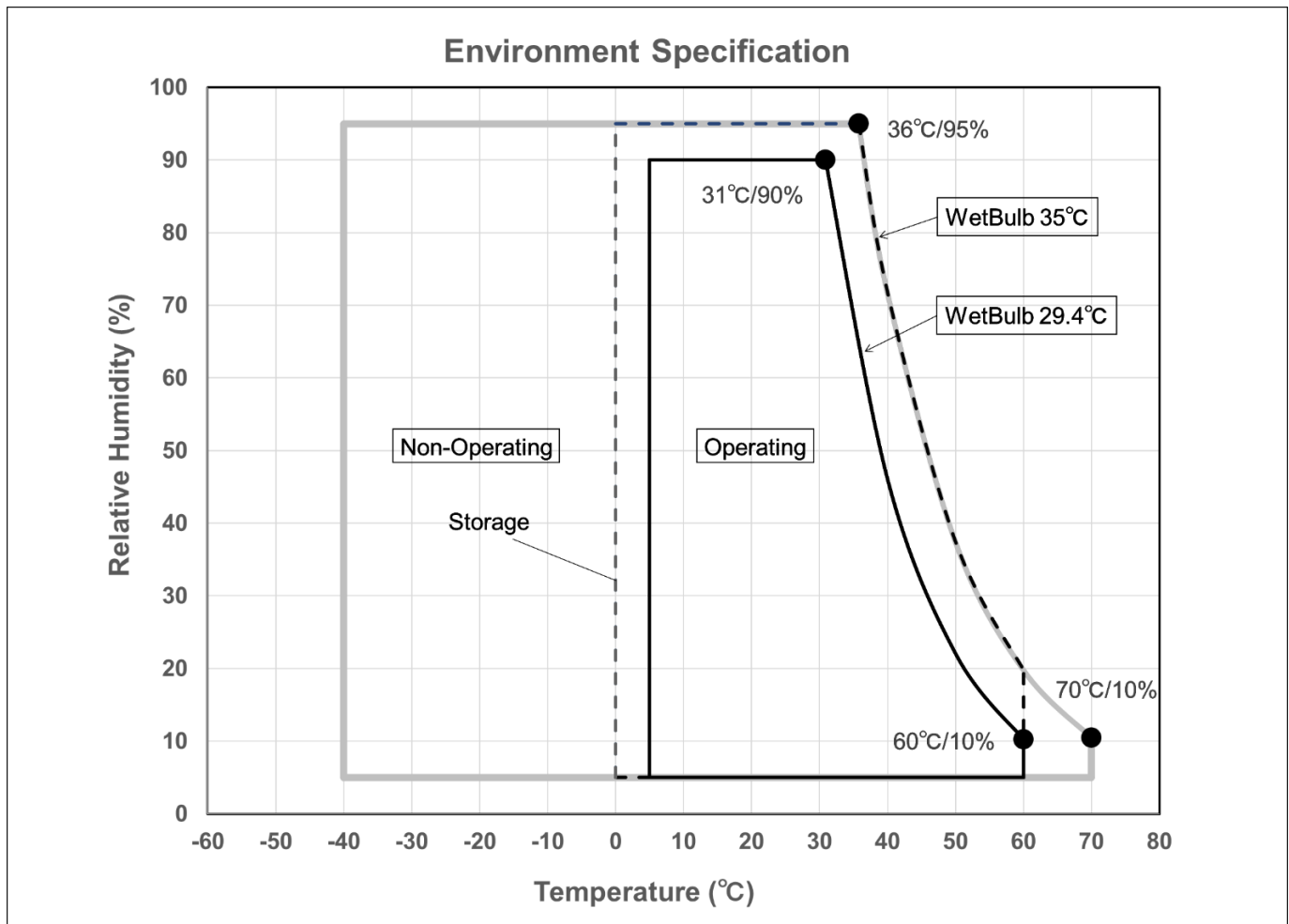


Figure 6 Limits of temperature and humidity

6.2.2 Storage Requirements

6.2.2.1 Packaging

The drive or option kit must be heat-sealed in a moisture barrier bag with bag supplied by Western Digital.

6.2.2.2 Storage

Maximum storage periods are 180 days within original, unopened Western Digital shipping bag or 60 days in an opened bag or outside the bag, while maintaining a temperature range of 0°C - 60°C and the specified humidity and altitude limits in the environmental section of this manual.

Storage can be extended to 1 year packaged or unpackaged under optimal environmental conditions (<25°C, <40% relative humidity non-condensing, and non-corrosive environment).

During any storage period, the drive shock, vibration, magnetic and electrical field specifications should be followed

6.2.3 Atmospheric condition

Environments that contain elevated levels of corrosives (e.g., hydrogen sulfide, sulfur oxides, or hydrochloric acid) should be avoided. Care must be taken to avoid using any compound/material in a way that creates an elevated level of corrosive materials in the atmosphere surrounding the disk drive. Care must also be taken to avoid use of any organometallic (e.g., organosilicon, or organotin) compound/material in a way that creates elevated vapor levels of these compounds/materials in the atmosphere surrounding the disk drive.

6.3 DC power requirements

Damage to the drive electronics may result if the power supply cable is connected or disconnected to the legacy Power connector while power is being applied to the drive (no hot plug/unplug is allowed). If SATA power supply cable is connected or disconnected to the SATA power connector, hot plug/unplug is allowed.

6.3.1 Input voltage

Table 12 Input voltage

Input voltage	During run and spin up	Absolute max spike voltage	Supply rise time
+5 Volts Supply	5V $\pm$ 5%	–0.3 to 5.5V	0 to 200ms
+12 Volts Supply	12V $\pm$ 5%	–0.3 to 15.0V	0 to 400ms

Caution: To avoid damage to the drive electronics, power supply voltage spikes must not exceed specifications.

6.3.2 Power supply current

Table 13 Power supply current (typical)

Serial ATA @ 6Gb/sec

	IO/Sec	34TB SMR Model (11-Disk)		Power (Watts)
		+5V Current (Amp)	+12V Current (Amp)	
Max Peak Operational [1]		0.91	2.00	
Start up Peak DC [2]		0.56	1.39	
Start up Peak AC [3]		0.72	2.00	
Idle_0 Ave.		0.28	0.33	5.4
Idle Ripple		0.04	0.06	
Random Read 4KB Qd=1 Peak [1]		0.72	1.71	
Random Read 4KB Qd=1 Ave.	81	0.32	0.49	7.5
Random Read 4KB Qd=4 Peak [1]		0.73	1.79	
Random Read 4KB Qd=4 Ave.	114	0.32	0.52	7.9
Max Power Workload				
Random Read 4KB Qd=8 Peak [1]		0.73	1.81	
Random Read 4KB Qd=8 Ave.	138	0.33	0.54	8.1
Random SMR Zone Workload				
Random SMR Zone Write 128z 64KB Qd=1 WCE=1 Peak [1]		0.88	1.66	
Random SMR Zone Write 128z 64KB Qd=1 WCE=1 Ave.	1219	0.49	0.35	6.6
Sequential Read 64KB Qd=1 Peak [1]	MiB/s	0.77		
Sequential Read 64KB Qd=1 Ave. [4]	250/254	0.60	0.31	6.7
Sequential Write 64KB Qd=1 WCE=1 Peak [1]	MiB/s	0.91		
Sequential Write 64KB Qd=1 WCE=1 Ave. [4]	250/254	0.68	0.31	7.2
Power Save Mode				
Idle_A		+5V Current (Amp)	+12V Current (Amp)	Power (Watts)
Idle_B		0.28	0.33	5.4
Idle_C		0.22	0.21	3.6
Standby_Y		0.22	0.16	3.1
Standby_Z		0.22	0.16	3.1
Sleep		0.21	0.008	1.2
		0.21	0.008	1.2
PHY power condition				
Partial		Port A Power Saved (Watts)		
Slumber		0.08		
		0.17		

Notes

Sample size
Temperature
Sampling rate
PHY

3 HDDs per model
HDD reported temperature = 40degC (25degC for Start up)
62.5K measurements/sec
Single port, 6Gb/s

[1] Peak current is established via the average current in a 16 usec moving window. The peak values of the HDDs in the population are then averaged and reported.

[2] Start up DC (average) current is measured within a 200ms sliding window. The peak DC values of the HDDs in the population are then averaged and reported.

[3] Start up AC current is sampled at 62.5kHz. The peak sample values of the HDDs in the population are then averaged and reported.

[4] Average measured at sustained sequential streaming rate.

[5] Power saved compared to Idle_0

6.3.3 Power line noise limits

Table 14 Allowable power supply noise limits at drive power connector

	Noise Voltage (mV pp)	Frequency Range
+5V DC	250	100Hz-20MHz
+12V DC	800	100Hz-8KHz
	450	8KHz-100KHz
	250	100KHz-20MHz

During drive operation, both 5 and 12-volt ripple are generated by the drive due to dynamic loading of the power supply. This voltage ripple will add to existing power supply voltage ripple. The sum is the power line noise.

To prevent significant performance loss, the power line noise level when measured at the drive power connector should be kept below the limits in the above table.

6.3.4 Power Consumption Efficiency

Table 15 Power consumption efficiency

Power Consumption Efficiency at Idle	
W/TB	0.159
W/GB	0.000159

6.4 Workload

6.4.1 Workload

The maximum rated workload is <550TB/YR. The workload can be comprised of reads and/or writes.

The maximum rated workload is specified for operating at typical temperatures.

Occasional* excursions in operating conditions between the “typical AFR specification conditions” and the “maximum drive operating conditions” may occur without significant impact to reliability.

*Occasional excursions shall not exceed 2% of total run time.

6.5 Reliability

6.5.1 Annualized failure rate

This product has a 0.35% AFR specification rating based on typical workload and temperatures. The AFR specification is based on a sample population and is estimated by statistical measurements and acceleration algorithms under typical operating conditions at 40°C device reported temperature. Derating of AFR will occur above these parameters, up to 550TB/YR workload and 60°C (device reported temp). AFR ratings do not predict an individual drive's reliability and do not constitute a warranty.

6.5.2 Data integrity

OptiNAND™'s Enhance Data Safety feature allows up to full DRAM write cache of user data protection in event of Emergency Power Off event. Data is power-loss safe in both Write Cache Enabled and Write Cache Disabled modes.

No customer data is lost during power loss. As write cache is by nature power-loss safe, no further action will be performed as part of a FLUSH CACHE (E7h) or FLUSH CACHE EXT (EAh) command. This feature can be disabled to cause FLUSH CACHE commands to flush data to media instead of NAND if desired.

6.5.3 Cable noise interference

To avoid any degradation of performance throughput or error rate when the interface cable is routed on top or comes in contact with the HDA assembly, the drive must be grounded electrically to the system frame by four screws. The common mode noise or voltage level difference between the system frame and power cable ground or AT interface cable ground should be in the allowable level specified in the power requirement section.

6.5.4 Load/Unload

The product supports a minimum of 600,000 normal load/unloads in a 40° C environment. Load/unload is invoked by transition of the HDD's power mode. (Chapter 4.5.3 Operating modes)

- Idle (Idle_A) <-> unload idle (Idle_B)
- Idle (Idle_A) <-> Low rpm idle (Idle_C)

6.5.5 Start/stop cycles

The drive withstands a minimum of 50,000 start/stop cycles in a 40° C environment and a minimum of 10,000 start/stop cycles in extreme temperature or humidity within the operating range.

6.5.6 Preventive maintenance

None

6.5.7 Data reliability

Probability of not recovering data is 1 in 10¹⁵ bits read.
LDPC on the fly/ offline data correction

- 4608-bit LDPC
- This implementation recovers maximum 2500 bits single burst error by on-the-fly correction and maximum 3500 bits single burst error by offline correction

6.5.8 Required Power-Off Sequence

The required sequence for removing power from the drive is as follows:

Step 1: Issue a STOP UNIT Command

Standby

Standby immediate

Sleep

Note: Do not use the Flush Cache command for the power off sequence because this command does not invoke Unload.

Step 2: Wait until the Command Complete status is returned. However, the time out value needs to be 60 seconds considering error recovery time.

Step 3: Terminate power to HDD.

6.6 Mechanical specifications

6.6.1 Physical dimensions

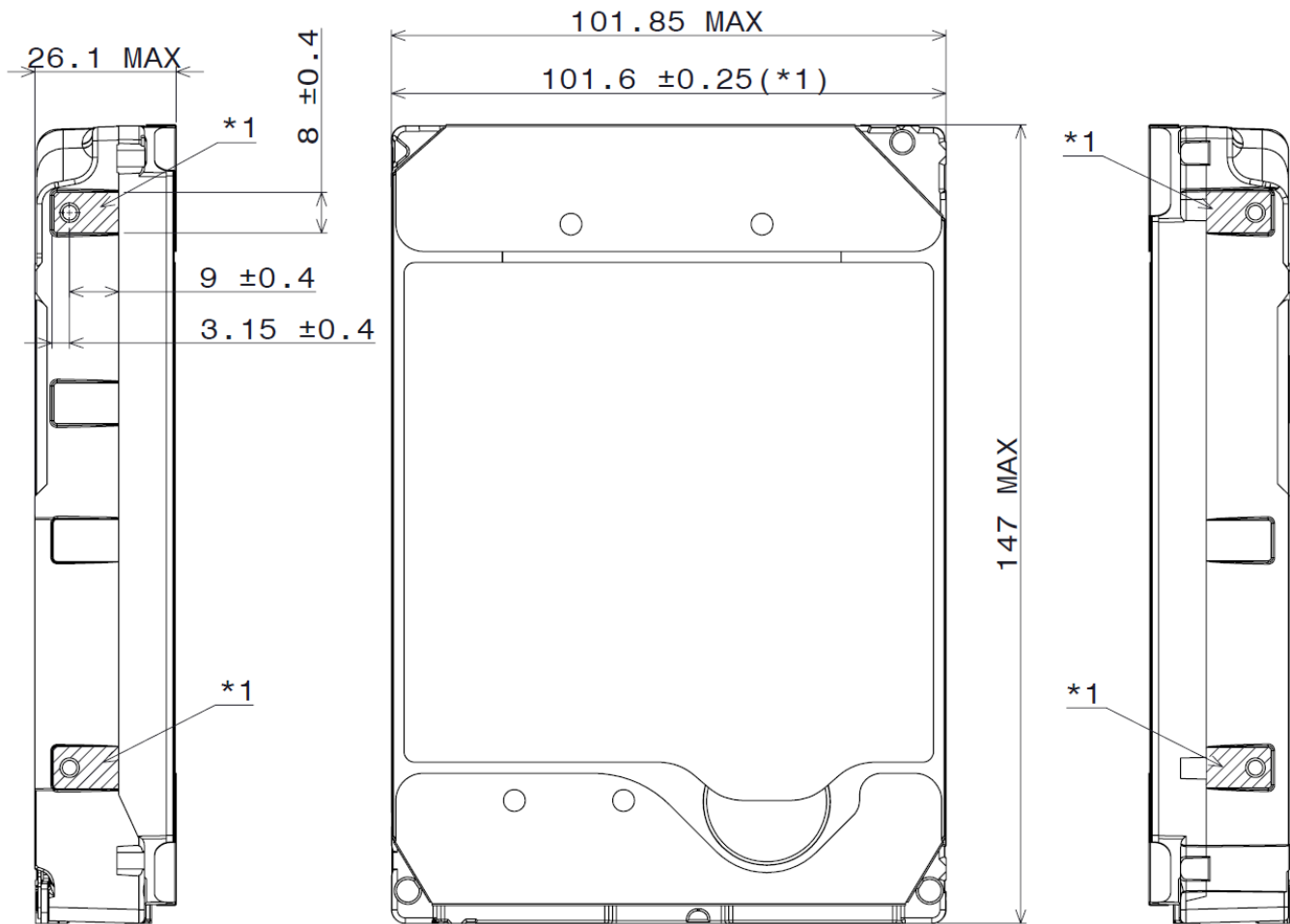


Figure 7 Top and side views and mechanical dimensions

All dimensions are in millimeters.

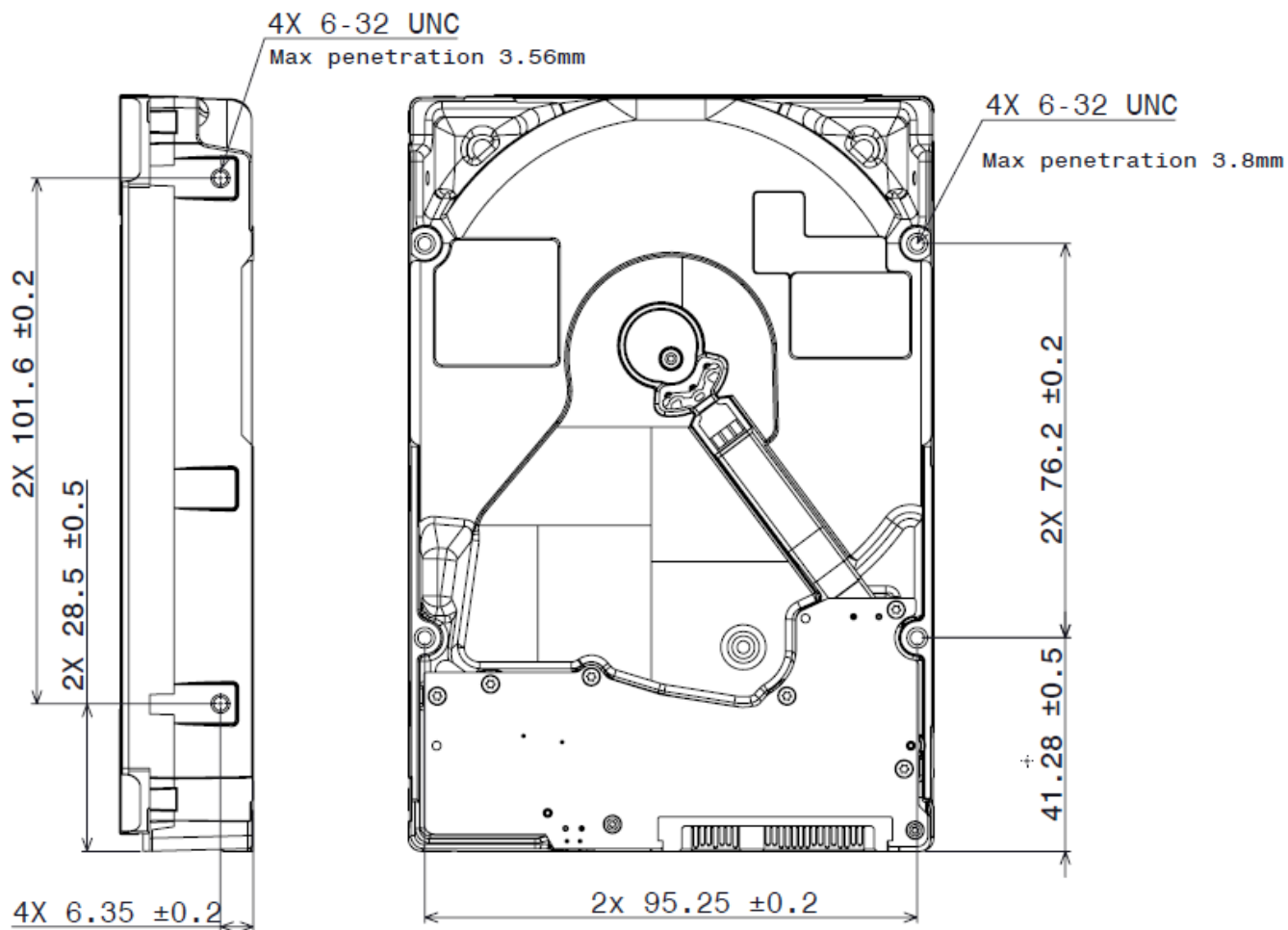


Figure 8 Bottom and side views with mounting hole locations

All dimensions in the above figure are in millimeters.

The following table shows the physical dimensions of the drive.

Table 16 Physical Dimensions

Height (mm)	Width (mm)	Length (mm)	Weight (grams)
26.1 MAX	101.6 ± 0.25	147 MAX	670 MAX

6.6.2 Connector locations

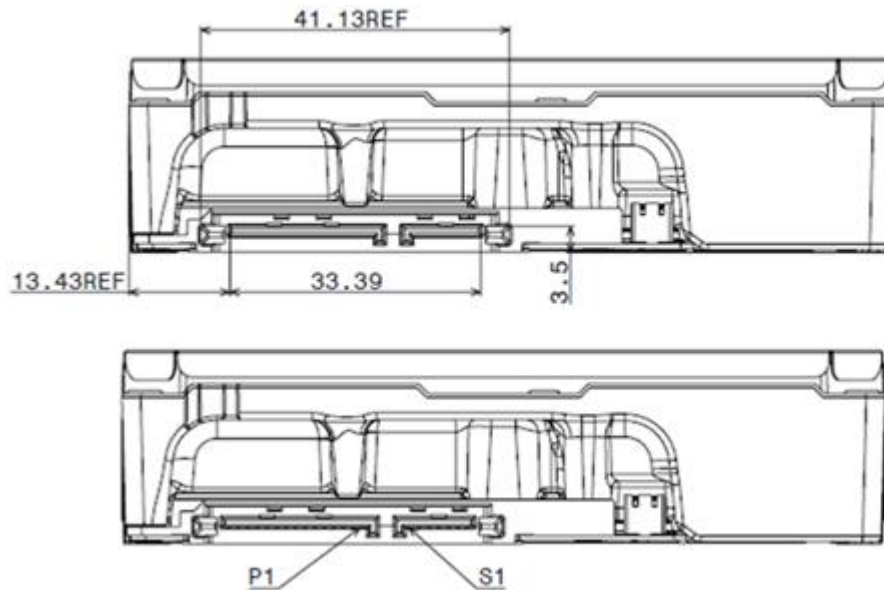


Figure 9 Connector locations

6.6.3 Drive mounting

The drive will operate in all axes (6 directions). Performance and error rate will stay within specification limits if the drive is operated in other orientations than that in which it was formatted.

For reliable operation, the drive must be mounted in the system securely enough to prevent excessive motion or vibration of the drive during seek operation or spindle rotation, using appropriate screws or equivalent mounting hardware.

The recommended mounting screw torque is 0.6 - 1.0 Nm (6-10 Kgf.cm).

The recommended mounting screw depth is 3.8 mm maximum for bottom and 3.56 mm maximum for horizontal mounting.

6.6.4 Heads unload and actuator lock

Heads are moved out from disks (unload) to protect the disk data during shipping, moving, or storage. Upon power down, the heads are automatically unloaded from disk area and the locking mechanism of the head actuator will secure the heads in unload position.

6.7 Vibration and shock

All vibration and shock measurements recorded in this section are made with a drive that has no mounting attachments for the systems. The input power for the measurements is applied to the normal drive mounting points.

6.7.1 Operating vibration

6.7.1.1 Random vibration (Linear)

The test is 30 minutes of random vibration using the power spectral density (PSD) levels shown below in each of three mutually perpendicular axes. The disk drive will operate without a hard error when subjected to the below random vibration levels.

Table 17 Random vibration PSD profile break points (operating)

Frequency	5 Hz	17 Hz	45 Hz	48 Hz	62 Hz	65 Hz	150 Hz	200 Hz	500 Hz	RMS (m/sec ²)
[(m/sec ²) ² /Hz]	2.1 x 10E-3	1.2 x 10E-1	1.2 x 10E-1	8.4 x 10E-1	8.4 x 10E-1	1.0 x 10E-1	1.0 x 10E-1	5.2x 10E-2	5.2 x 10E-2	6.86

The overall RMS (root mean square) level is 6.86 m/sec² (0.7 G).

6.7.1.2 Swept sine vibration (Linear)

The drive will meet the criteria shown below while operating in the specified conditions:

- No hard error occurs with 4.9 m/sec² (0.5 G) 0 to peak, 5 to 300 to 5 Hz sine wave, 0.5 oct/min sweep rate with 3-minute dwells at two major resonances
- No hard error occurs with 9.8 m/sec² (1 G) 0 to peak, 5 to 300 to 5 Hz sine wave, 0.5 oct/min sweep rate with 3-minute dwells at two major resonances

6.7.1.3 Random vibration (Rotational)

The drive will meet the criteria shown below while operating in the specified conditions:

- Less than 10% Performance degradation
- The overall RMS (Root Mean Square) level of vibration is 12.5Rad/sec². PSD profile is shown below.

Table 18 Random vibration (Rotational) PSD profile break points

Frequency	20 Hz	100 Hz	200 Hz	800 Hz	1000 Hz	1500 Hz	1700 Hz	2000 Hz	RMS (Rad/s ²)
[(Rad/s ²) ² /Hz]	1.90E -02	1.90E -02	1.87E -01	1.87E -01	5.33E -02	7.70E -03	4.00E -03	4.00E -03	12.5

6.7.2 Nonoperating vibration

The drive does not sustain permanent damage or loss of previously recorded data after being subjected to the environment described below

6.7.2.1 Random vibration

The test consists of a random vibration applied for each of three mutually perpendicular axes with the time duration of 10 minutes per axis. The PSD levels for the test simulate the shipping and relocation environment shown below. The overall RMS (Root Mean Square) level of vibration is 10.2 m/sec² (1.04 G).

Table 19 Random vibration PSD profile break points (nonoperating)

Frequency	2 Hz	4 Hz	8 Hz	40 Hz	55 Hz	70 Hz	200 Hz
[(m/sec ²) ² /Hz]	0.096	2.89	2.89	0.289	0.962	0.962	0.096

6.7.2.2 Swept sine vibration

- 19.6 m/sec² (2 G) (Zero to peak), 5 to 500 to 5 Hz sine wave
- 0.5 oct/min sweep rate
- 3 minutes dwell at two major resonances

6.7.3 Operating shock

The drive meets the following criteria while operating in the conditions described below. Shock is applied in each axis and direction. There must be a delay between shock pulses long enough to allow the drive to complete all necessary error recovery procedures.

- No hard error occurs with a 98.1 m/sec² (10 G) half-sine shock pulse of 11 ms duration
- No hard error occurs with a 294 m/sec² (30 G) half-sine shock pulse of 4 ms duration.
- No hard error occurs with a 294 m/sec² (30 G) in vertical axis, 392 m/sec² (40 G) in horizontal axis half-sine shock pulse of 2 ms duration.

6.7.4 Nonoperating shock

The drive will operate without non-recoverable errors after being subjected to shock pulses with the following characteristics.

6.7.4.1 Sinusoidal shock wave

The shape is approximately half-sine pulse. The figure below shows the maximum acceleration level and duration.

Table 20 Sinusoidal shock wave

Acceleration level (m/sec ²)	Duration (ms)
1960(200G)	2
1470(150G)	11

6.7.5 Nonoperating Rotational shock

All shock inputs shall be applied around the actuator pivot axis.

Table 21 Rotational Shock

Duration	Rad/sec ²
1 ms	30,000
2 ms	20,000

6.8 Acoustics

The upper limit criteria of the octave sound power levels are given in Bels relative to one picowatt and are shown in the following table. The sound power emission levels are measured in accordance with ISO 7779.

Table 22 Sound power levels

Mode	7200rpm (Typical / Max)
Idle	2.5 / 2.8
Operating	3.2 / 3.4

Mode definition:

Idle mode. The drive is powered on, disks spinning, track following, unit ready to receive and respond to interface commands.

Operating mode. Continuous random cylinder selection and seek operation of the actuator with a dwell time at each cylinder. The seek rate for the drive is to be calculated as shown below:

- Dwell time = $0.5 \times 60/\text{RPM}$
- Seek rate = $0.4 / (\text{Average seek time} + \text{Dwell time})$

6.9 Identification labels

The following labels are affixed to every drive shipped from the drive manufacturing location in accordance with the appropriate hard disk drive assembly drawing

- A label containing the Western Digital logo and the part number
- A label containing the drive model number, the manufacturing date code, the formatted capacity, the place of manufacture, certification logos from various safety agencies (e.g., UL/CSA/CE/RCM, etc.)
- A bar code label containing the drive serial number
- A user designed label per agreement

The above labels may be integrated with other labels.

6.10 Regulatory Compliance – Product Safety

6.10.1 North America (US and CA) safety standard conformity

This product is qualified to the following standards:

- UL 62368-1 (4th Edition), published July 31, 2025 — Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements.
- CAN/CSA C22.2 No. 62368-1:25 (4th Edition), binational with UL 62368-1.

UR and cUR Recognition certification marks (where applied) are maintained throughout the product lifecycle (PLC).

6.10.2 European (EU) and United Kingdom (UK) Safety Standard Conformity

The product is CB-Certified to IEC 62368-1, 4th Edition, and complies with the following laws in EU and UK:

- EU: EMC Directive 2014/30/EU
- UK: UKCA S.I. 2016/1101.

6.10.3 Flammability

Printed wiring boards (PWBs) use materials rated UL 94 V-1 or better. Rating information is marked on the board where applicable.

All non-electrical parts not evaluated as electrical components are constructed from materials with a minimum UL 94 V-2 flammability rating.

6.10.4 Safe handling

The product is designed and finished to minimize hazards from sharp edges and corners during normal handling.

6.10.5 Material substance restriction requirements

The product complies with the following material and chemical restriction regulations:

- RoHS Directive 2011/65/EU, including Delegated Directive (EU) 2015/863 (four phthalates: DEHP, BBP, DBP, DIBP).
- UKCA S.I. 2012/3032.
- REACH Regulation (EC) No 1907/2006; suppliers are monitored for SVHCs and applicable restrictions/exemptions.
- China RoHS, Taiwan BSMI, and halogen free requirements per electronics industry standard IEC 61249 21.

6.10.6 Secondary circuit protection

Over-current protection is provided on both the 5 V and 12 V secondary power rails.

6.11 Regulatory Compliance – Electromagnetic Compatibility/Interference (EMC/EMI)

When installed in a suitable enclosure and operated using a random-access routine at maximum data rate, the product meets the following global EMC/EMI requirements:

- United States:
 - FCC 47 CFR Part 15, Subpart B, Class B - Unintentional Radiators (Digital Devices).
- Canada:
 - ISED ICES Gen, Issue 2 and ICES 003, Issue 7, Class B.
- United Kingdom (UK):
 - EMC Regulation UKCA S.I. 2016/1091.
- European Union (EU):
 - EMC Directive 2014/30/EU. Tested to:
 - EN 55032:2015 + A1:2020 (emission) – Multimedia equipment emission requirements (Class B)
 - EN 55035:2017 + A11:2020 (immunity) – Multimedia equipment immunity requirements
 - (or EN 55035:2022, where used)
 - Note: EN 55032 and EN 55035 replace legacy EN 55022, EN 55024, and EN 55103 series for ITE/AV/MME products.
- Australia/New Zealand (ANZ):
 - AS/NZS CISPR 32:2015 (including Amendment 1:2020), Class B
- Taiwan (TW):
 - CNS 15936 – Electromagnetic compatibility of multimedia equipment – Emission requirements (Class B)
- Korea (KR):
 - KS C 9832 (2024) – Electromagnetic interference prevention test for multimedia equipment (Emissions) (Class B)
 - KS C 9835 (2024) – Electromagnetic wave immunity test for multimedia devices (Immunity)

6.11.1 RCM Mark for Australia/New Zealand (ANZ)

The product meets AS/NZS CISPR 32:2015 (including Amendment 1:2020) Class B emission requirements for multimedia equipment to support RCM labeling. (Immunity is generally not mandated by ACMA for non-radio EMC.)

6.11.2 BSMI Mark for Taiwan

The product complies with Taiwan BSMI EMC requirements for multimedia equipment per CNS 15936 (Class B).

6.11.3 KC Mark for Korea

The product complies with Korea KC EMC standards for multimedia equipment:

- KS C 9832 (2024) – Emission (Class B)
- KS C 9835 (2024) – Immunity

6.11.4 FCC Class B Information

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications to this product not authorized by Western Digital could void the electromagnetic compatibility (EMC) and negate your authority to operate the product.

6.11.5 CE Mark for European Union (EU)

The product is declared in conformity with the following EU legislation:

- EMC Directive 2014/30/EU
- RoHS Directive 2011/65/EU, as amended by (EU) 2015/863

Applicable harmonized EMC standards used for assessment include EN 55032 and EN 55035, as listed above.

6.12 Third Party Open-Source Licenses

This product does not contain any open-source software.