

## High capacity 16TB HDD CMR HDD with two-dimensional magnetic recording (TDMR)

The growth and prevalence of cloud services has set the stage for the increasing dissemination of different types of storage services for different types of data storage needs. In addition to data protection and archival storage services, wider use of surveillance camera systems, a rise in the use of artificial intelligence (AI) and machine learning (ML), and the next wave of edge computing using a 5G networks, will all spur exponential growth in the volume of data generated and data under management. To meet these varied and expanding storage needs, demand for high-capacity nearline-class 3.5-inch hard disk drives (HDDs), for cloud- and core- data centers is increasing.

### 1. Releasing the Gen-8 MG08 Nearline HDD series

Toshiba Enterprise HDDs have been divided into three categories: “Enterprise Performance HDDs” for traditional mission critical servers and storage systems, “Enterprise Capacity HDDs” for entry servers and storage system for business critical workload, and the most recently created category - “Cloud-Scale Capacity HDDs” for Hyperscale data centers. The very large scale of storage deployments used in Hyperscale data centers have created demand for a new class of very-high capacity HDDs. Where data transfer rates and Tier-1 workload reliability have historically been important factors for the selection of traditional Enterprise Performance HDDs, Cloud-scale infrastructure may benefit most from improvements in storage density and operating power profile to deliver better overall TCO. As a result, today’s Enterprise Capacity and Cloud-Scale Capacity HDD categories both provide nearline-class performance and reliability, with Cloud-Scale Capacity models providing the added TCO benefits of increased storage capacity and lower operating power achieved by a Helium-sealed mechanical design.

In January 2019, Toshiba Electronic Devices & Storage Corporation released the MG08 nearline HDD series with a capacity of 16 TB<sup>1</sup>, delivered using conventional magnetic recording (CMR) for very broad compatibility with the various operating and file systems in use today. Building on the success of the 14TB MG07 9-disk helium-sealed mechanical HDD design, the MG08 series incorporates TDMR technology to achieve as class-leading 16TB storage capacity.

### 2. Helium sealing

Being smaller than air molecules, the helium molecule

produces a lower aerodynamic drag resulting in less turbulence or buffeting of the rotating disks and head suspension assemblies. The reduced turbulence helps reduce the vibration of head suspension assemblies and the wobbling of disk platters at high RPM. This, in turn, helps improve the positioning precision of the actuator arms and therefore increase the areal density that can be achieved. The reduced turbulence also makes it possible to shrink the distance between platters, making it possible to utilize 9-disks to increase the storage capacity that can be achieved within the industry-standard 1-inch form-factor.

In addition, since helium has a viscosity close to that of air, existing technologies can be used to “fly” the recording head “slider” above the platter surface in a controlled manner so as to maintain an optimum “fly height”. Furthermore, because helium has less drag force acting on the spinning platters than air, it is possible to significantly reduce the power consumption of the spindle motor. As a result, the MG08 series consumes roughly 50% less power per gigabyte (W/GB)<sup>2</sup> than conventional air-filled HDDs. The reduction in power consumption will greatly benefit the overall cost of operating a Cloud-scale data center utilizing many thousand HDDs.

### 3. Industry-leading high-density assembly design to squeeze in nine platters

With the Gen-7 MG07ACA series, Toshiba achieved the first nine platter mechanical design for the industry-standard 3.5-inch enclosure with a height of 26.1 mm<sup>3</sup>. This was made possible by Toshiba’s expertise in high-density mechanical design and precision assembly cultivated through its experience with 2.5-inch and smaller HDDs. To fit more platters into an enclosure of a fixed size, various modifications and innovations were necessary. We reduced the platter thickness, shrank the distance between platters, and modified the actuator design

and printed circuit board assembly (PCBA).

We also created an enclosure design that requires the minimum space to hermetically seal helium gas in the HDD while leaving a greater amount of space for the assembly of platters than in prior conventional HDD models.

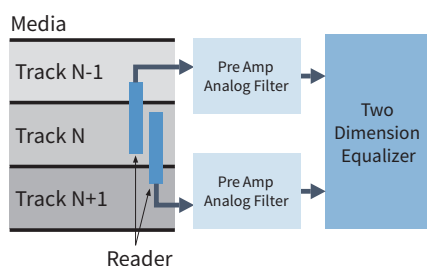
The platter thickness was also reduced. The nine-platter MG07 series uses a platter with a thickness of 0.635 mm, down from the 0.8-mm platters in Toshiba's previous-generation seven-platter Enterprise Capacity (nearline-class) HDDs. The MG07 series also reduced the distance between platters.

High-density assembly and manufacturing technologies were required for the actuator assembly, which has 18 heads to support the nine platter design. We leveraged our expertise for the design and manufacturing of 2.5-inch and smaller HDDs to assemble parts thinner than those in conventional Enterprise Capacity HDD models with high precision. The same assembly design has been adopted for the 16-TB MG08 series to ensure these Cloud Capacity nearline-class HDDs are able to be manufactured in high volume with processes that are highly-consistent to ensure the delivery of the required high quality.

#### 4. TDMR with improved read signal integrity

To further increase storage capacity, the MG08 Series employs TDMR (two-dimensional magnetic recording) technologies. As areal density increases, the read signal detection becomes more challenging. In addition, as the track widths become smaller, magnetic tracks will tend to interfere or "fringe" on adjacent tracks, adversely affecting the read signal accuracy. TDMR helps solve this problem. Conventional HDDs use one writer and one reader per head, whereas TDMR HDDs use two readers per head.

The two readers improve the read accuracy by enhancing the



TDMR

Nearline HDDs



signal detection and canceling noise due to inter-track interference. As a result, TDMR makes it possible to reduce the track width and thereby increase the areal density of HDD platters.

#### 5. Toshiba's Precision Laser Welding and quality discipline provide advantages

As described above, the small helium molecule helps increase the HDD storage capacity. To prevent the helium from leaking out, a high-quality welding technology is required to seal the top cover of the HDD enclosure. To achieve the welding quality and precision required, Toshiba is able to adopt laser welding technology developed by the Corporate Manufacturing Engineering Center of Toshiba Corporation. Toshiba has a proven track record in the deployment of precision laser welding technologies for such products as lithium-ion batteries and other industrial applications.

Furthermore, we improved the yields for heads, media, and other parts, drawing on our advanced technologies and extensive expertise in the field of semiconductor fabrication. We continuously offer technical assistance to parts suppliers in order to ensure a stable supply of high-quality components for all our HDD products.

With a line-up of conventional Enterprise Capacity CMR HDDs ranging from 1 TB to 10TB, Toshiba has expanded the model line-up with innovative Cloud-Scale helium HDD models, including 12-TB, 14-TB and 16-TB HDDs, offering new levels of storage value and efficiency for Cloud-scale use cases.

Toshiba Electronic Devices & Storage Corporation will continue to collaborate with Toshiba Group companies and external suppliers in order to develop products that meet customers' needs and contribute to the enhancement of the infrastructure that underpins today's information society.

\*1 Definition of capacity: A terabyte (TB) is  $10^{12}$  (1 000 000 000 000) bytes. A computer operating system, however, indicates storage capacity using powers of 2 for the definition of 1 TB =  $2^{40}$  = 1 099 511 627 776 bytes and therefore shows less storage capacity. Available storage capacity will vary based on file size, formatting, settings, software and operating system and/or pre-installed software applications.

\*2 Power efficiency is calculated by dividing active idle power consumption by capacity.

\*3 As of December 2017 (as surveyed by Toshiba Electronic Devices & Storage Corporation)

## Toshiba Electronic Devices & Storage Corporation

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