CE Features of the Second Generation CinemaStar Hard Disk Drives

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Introduction

The ever increasing appetite for on-demand entertainment drives the rapid adoption of hard disk drives into a growing number of consumer electronic applications. Not only is there a desire to increase the storage capacity of devices such as personal video recorders or set top boxes in order to hold more programs, but higher video resolutions are also pushing data rates and the resulting file sizes continuously upwards.

These trends are also driving the need for improved handling of such high quality video streams, to which HGST is responding with a new set of features implemented in its second generation 3.5-inch and (in some cases) 2.5-inch CinemaStar hard disk drives (HDD).
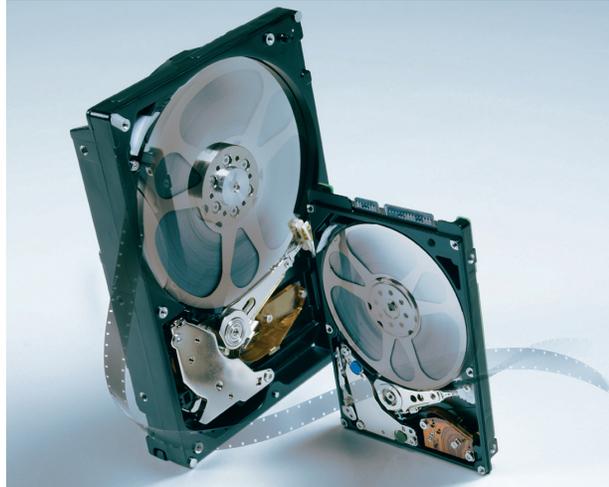
Background

While the actual read error rate of hard disk drives is far superior to the drop out rate known from analog tape recorders, these correctable read errors can not be entirely ignored. When the use of high capacity HDDs in video applications was first considered, the industry agreed on an elaborate set of so-called streaming commands. These new commands such as HGST's SmoothStream™ implementation were eventually released under the ATA-7 standard. Unfortunately the implementation of command-based video stream management on the host side has proven more complex than many device makers preferred.

First generation CinemaStar drives provided for device-based configurations, allowing the manufacturers to tailor the behavior of those drives according to their needs in terms of allowable command turn-around times and depth of error recovery, as well as the resulting level of media maintenance and health monitoring, acoustic levels and power saving modes.

As digital video recorders became more complex in terms of actual functionality and new levels of services, eventually adopting IP-based content delivery mechanisms for stream data and critical data, the need for more differentiated behavior of storage devices arose.

AV-Zoning for 3.5-inch CinemaStar

Instead of setting a global command turn-around time limit for the whole HDD, AV-Zoning allows individual limits to be set for predefined ranges of data blocks by specifying the start and the end address of each zone (LBA-range). When the time limit for a particular zone has been reached, the drive must either respond with the requested data, an error or with a best data estimate* for the movie to continue smoothly, depending on other configuration parameters. The HDD will automatically select the defined error recovery procedure for the data range that a particular data command is addressing.

In order to minimize the number of commands to be implemented on the host side, AV-Zoning is based on the existing S.M.A.R.T. Command Transport (SCT) operating code and has been standardized as SCT Zoned Error Recovery Control. Up to eight different data zones can be defined on a single HDD, which provides for a number of applications and data types.

* see 'Read Continuous'

Critical data, like file system related information, license data, and potential content data bases – all meta-data – ought to reside in a zone with full error recovery procedures (ERP).

Audio data, which is rather sensitive to so called glitches, ought to be treated with medium error recovery, still guaranteeing the fairly low data rates typically involved.

Standard definition video content might be best served by applying short ERP before the HDD needs to respond, while high definition content might require even tighter limits to be set.

Read Continuous for 3.5-inch CinemaStar

'Read Continuous' mode is controlled by a configuration flag, which determines the HDD's error recovery behavior. In 'Read Continuous' mode (flag = 1) the drive will attempt to read exact data from all sectors addressed by a particular command within the defined time limit. Should individual sectors require excessive time to recover exact data, a best effort will be made to recover all stable data bits while applying only ECC-based correction to the remaining bits. ECC stands for Error Correction Codes generated by the hard disk drive for every data sector upon the original write operation for later use in read operation. If no time limit has been set, the 'Read Continuous' flag triggers the drive to deliver ECC corrected data without delay.

In the standard operating mode (flag = 0), the drive will apply the defined command turn around time limit only. Should the full recovery of all sectors not be possible within the limit, the associated command is aborted and an error flag is set by the drive, leaving it to the host to determine whether to retry the last command or to skip to the next frames in the case of a video sequence.

The AV-Zoning and Read Continuous features are not yet implemented in the 2.5-inch CinemaStar C5K320.

Media Maintenance for 2.5- & 3.5-inch CinemaStar

HDD design was originally driven by IT-type applications and associated data access patterns to be executed. In order to make these drives suitable for continuous streaming operations, potentially working around the clock, HGST has developed a number of functions to ensure that individual components don't wear out prematurely.

One critical area is the protective lubrication layer on the media surface that could get displaced if a data head was flying over the same tracks continuously, as a result of repeated or low data rate playback, for instance. CinemaStar drives will therefore utilize the time between access commands to actively reposition their data heads.

Over an extended period, frequent AV content re-fresh operations, as we find in Set Top Boxes (STB) operating 24x7 can have a negative impact on static data residing right next to those tracks recording movie after movie. HGST studied this phenomenon carefully before engaging with the world's set top box makers and has implemented protective measures, keeping static data safe beyond hundreds of thousands of recordings.

For maximum protection during transport and idle modes, HGST equips all drives with a load/unload mechanism, moving the heads away from the data carrying medium. This prevents mechanical contact and avoids the associated damage to the media. CinemaStar drives employ the same mechanism with modified operating algorithms to prevent excessive sound generation and potential wear-out from unnecessary head unload operations, which could otherwise be triggered by low activity tasks, e.g, a low bandwidth audio down-load.

HiVERT™ Lean Power Design for 2.5- & 3.5-inch CinemaStar

Originally developed for the HGST mobile HDD product line as battery run-time extending technology, these high efficiency voltage regulators now help minimize power consumption on both CinemaStar families, 3.5-inch and the compact 2.5-inch models.

The total power consumption of existing CE devices is not only a source of unwanted heat, detrimental to the life expectancy of such devices, but increasingly it is also seen as a growing contributor to general energy consumption with all it's negative impacts on the environment.

CE devices tend to remain in standby mode after use, while set top boxes in particular continue to record incoming programs around the clock, adding to the relevance of HGST's power reduction initiative.

The debut of HiVERT in the 3.5-inch form factor, 7200 RPM CinemaStar SATA models resulted in a very power-efficient product at just 4.1W in unload idle mode. With the recent introduction of the CoolSpin™ motor and driver design, unload idle mode power consumption is improved by 34%, to only 2.7W.

The latest 2.5-inch model, CinemaStar C5K320, maintains the industry-leading 1.7W performance idle power consumption of it's predecessor.

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