Enhanced Adaptive Battery Life Extender

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Introduction

In mobile computing and other power sensitive applications, especially notebooks and handheld consumer electronics products, battery life is a critical concern. Since the disk drive is one of the main power consuming components, Hitachi sought to devise methods to enhance the power efficiency of its products. Research in this area resulted in the invention of Adaptive Battery Life Extender, (ABLE)™ in 1995. ABLE is a power efficiency tool which maps the power consumption by the drive to specified drive usage parameters based on options input by the host system integrator. ABLE allows the system integrator to simply select the desired usage parameters, and the Hitachi drive does the rest.

Enhancements over time

Throughout the years, Hitachi has continued to optimize power utilization of its disk drives. This work resulted in Enhanced ABLE, an extension of its ABLE predecessor which broadens the power management options previously available. Today, Enhanced ABLE is supported by most small form factor disk drives in Hitachi's extensive product line.

Enhanced ABLE features include:

- Performance Idle
- Active Idle
- Low Power Idle
- Adaptive Standby Mode

In addition to the original ABLE modes of:

- Sleep Mode
- Standby Mode
- Idle Mode
- Active Mode

Enhanced ABLE allows the host system to select the desired advanced power management level of the disk drive when the drive is in Idle Mode.

Enabling optimum power utilization

Hitachi's ABLE technology permits the host to modify the behavior of the Hitachi drive to reduce the power required by the hard drive to operate. ABLE is configurable through Advanced Power Management, a set of commands specifically designed to interact with the ABLE power control modes and a timing device. By monitoring the transition across power modes according to access patterns of the host to the hard drive, the Hitachi drive dynamically selects which mode is most suitable for the host system's actual usage parameters. This results in the lowest power consumption solution for the drive in the host and the applications being run by the end user.

The power modes used in Hitachi Enhanced ABLE drives are:

- Active Mode: The drive is actively completing a Read or Write Command.
- Idle Mode: The drive is not actively working on a Read or Write Command but the heads are still "loaded" (flying over the disk) and the disk is spinning. Hitachi supports five variations of Idle mode which are Standby Mode, Sleep Mode, Performance Idle, Active Idle, and Low Power Idle. (Exception: Idle Mode, as per this definition is not supported in the Hitachi Microdrive®, since the following three variations of Idle are supported.)
- Performance Idle: The drive is spinning and the heads are "loaded" near the center of the disk. The drive is ready to accept and execute commands immediately.
- Active Idle: The drive is spinning, the heads are "loaded" but some electronics may be turned off (e.g. servo control of head arm). Time to become active is approximately 10ms.
- Low Power Idle: The drive is spinning and the heads are "unloaded," or parked on the ramp. Time to become active is approximately 300ms.
- Standby Mode: The drive is not spinning but the electronic interface is active and the drive will accept commands.
- Sleep Mode: The drive is not spinning and in all cases, the drive interface requires a RESET to become active. (Exception: Sleep Mode is not implemented in the Hitachi Microdrive®, where Sleep and Standby Mode are configured to function in the same manner.)

ABLE in Hitachi hard disk drives

All Hitachi disk drives are equipped with the latest ABLE technology. The power on default setting is always with ABLE enabled, and is usually set to support the highest performance parameters. However, various degrees of aggressiveness in the application of the ABLE power reduction algorithm can be selected by the host though the Set Features command set. The APM (Advanced Power Management) Value refers to the numerical value of the Sector Count register. This can be accessed by issuing a Set Features command with the APM subcommand (05h) in the Features register. Details on the ABLE options supported are provided in the Product Specifications corresponding to the Hitachi drive model number; Product Specifications are available through the Hitachi Global Storage Technologies web site.

Summary

Hitachi shipped its first 2.5-inch mobile hard drive market in 1991, and has been dedicated to the small form factor drive market ever since. Hitachi understands the challenges its customers face in maximizing battery life in their products, and engineered the ABLE power management technology in response.

ABLE enables the host system to realize the optimum power utilization from the drive, and customize power consumption at the drive level to suite the particular drive access patterns of the specific application. Today, Enhanced ABLE is supported by Hitachi's extensive line of small hard drive products including the Travelstar® 2.5- and 1.8-inch series, as well as the 1.0-inch Microdrive. ABLE makes high capacity data storage on even the most power sensitive application possible, providing YOU the freedom to innovate.

Additional recommended reading

Hitachi Hard Drive Power Modes and Maximizing Battery Life, a White Paper by Dr. William C. Heybruck and Matt Latter, Hitachi Global Storage Technologies.

	Microdrive 3K6 (1" HDD)	Travelstar C4K60 (1.8"HDD)	Travelstar 7K60 (2.5" HDD)
APM Value	Deepest automatic power saving mode		
C0h – FEh	Active Idle	Low Power Idle	Active Idle
A0h – BFh	Low Power Idle	Low Power Idle	Low Power Idle
80h – 9Fh	Low Power Idle	Low Power Idle	Low Power Idle
20h – 7Fh	Standby	Standby	Standby
01h – 1Fh	Standby	Standby	Standby

Table 1: ABLE Features in Various Hitachi Hard Drives

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