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ThinkVantage Active Protection System

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ThinkPad®

Contents

Overview

The Active Protection System (APS), available on many ThinkPad® notebooks, employs airbag-like technology to protect the hard drive. The system has an integrated motion sensor that continuously monitors the movement of the notebook, and, if a sudden change in motion is detected, the Active Protection System temporarily stops the hard drive to protect it from a potential crash. This ThinkVantage™ Technology provides up to four times greater impact protection than systems without it and helps reduce down-time and support costs.

Difficulties with hard drives generally result from physical shock. One type of shock, called *operating shock*, occurs when the disk is in operation and the drive head is over the drive platters reading and writing data. If a physical shock to the drive occurs during operation, the head and the platters can come into contact damaging both components. A second type of shock, called *non-operating shock*, occurs when the head is in the unloaded position, or not positioned over the platters, and a physical shock occurs. The head can contact the ramp over which it is positioned and damage its ability to read and write.

With Microsoft® Windows® XP or Windows 2000, the Active Protection System v1.3 can protect the following hard disk drives:

- The primary hard disk drive
- A secondary hard disk drive that is installed in the ThinkPad Ultrabay™ Slim
- A secondary hard disk drive that is installed in the ThinkPad Ultrabay Slim of the ThinkPad X4 UltraBase ™ Dock if the computer is attached to the ThinkPad X4 UltraBase Dock
- A secondary hard disk drive that is installed in the ThinkPad Ultrabay Enhanced of the computer

Highlights

The APS accelerometer senses orientation and movement and APS software interprets its signals and stops the drive when a damaging event is predicted.

With Microsoft Windows XP or Windows 2000, the Active Protection System cannot protect the following drives:

- A secondary drive connected to the USB connector
- A secondary drive installed in the PC card slot
- A secondary drive installed on the ThinkPad Dock II, ThinkPad X# UltraBase, or any older docking station.

Older versions of the Active Protection System prior to v1.3 support only the primary ThinkPad hard drive.

Active Protection System design

The Active Protection System uses a combination of hardware and software components. The hardware component is a motion detector, or accelerometer, that is embedded in the motherboard and continually senses system orientation and movement. The software component receives and interprets signals from the accelerometer, can differentiate between potentially harmful movements and repetitive motion, and signals the hard drive to stop when a potentially damaging event is predicted. The software component also includes a system tray icon and properties window.

There are two types of hard disk drives. The first spins down the motor after unloading the head. The second does not spin down the motor, but does unload the head. The hard disk drive is less vulnerable to damage when it is not in operation. Since the drive cannot be accessed while the head is unloaded, it may seem to the user that the drive has stopped. In reality, the disk access request has been temporarily queued by Active Protection System software while the disk head can remain unloaded until a stable situation is detected. The suspended disk access request is then released and passed to the disk, and the hard disk drive returns to normal operation.

Highlights

There are two rating values for the amount of shock and vibration sufficient to cause damage in each of these situations. For a typical 2.5" hard disk drive, the value for operating shock is 200G/2ms and the value for non-operating shock is 800G/1ms. These numbers suggest that the hard disk drive is four times more durable if the head is unloaded prior to receiving an excessive shock, even during a read or write operation.

Head unloading

In simulated drop tests to a concrete floor from either the knee or a desktop, the internal hard drive is protected by the durable ThinkPad shell so that the shock received typically does not exceed 800G or 800 times the force of gravity. Since 800G is the maximum rating of shock tolerance of the drive with the head unloaded, it can be rescued from most typical accidents if it is unloaded prior to receiving the shock impact.

The Active Protection System constantly checks machine posture or system orientation by monitoring acceleration and using a prediction algorithm to statistically analyze recent typical behavior.

Head unloading can take 300 to 500ms, and the duration between detecting a free-fall situation once it has begun and impact can be as little as 300ms. Therefore, it often would be too late to unload the head if unloading started after the free-fall situation was detected. This makes it necessary to focus on the behavior of the machine prior to a drop. The initial behavior acts as a prediction of the impending accident. The duration of the predicting event often is much longer than the actual free fall. This enables the Active Protection System to respond to the impending accident prior to receiving the shock.

The Active Protection System constantly checks machine posture or system orientation by monitoring acceleration and using a prediction algorithm to statistically analyze recent behavior in typical use. Head unloading is initiated by degrees of tilt, acceleration, or shock. The degrees at which head unloading occurs are adjusted and fine-tuned every time a proper prediction is applied for the current motion. The disk drive head remains unloaded until detecting a stable environment for approximately one to four seconds depending upon the amount of excessive acceleration at the beginning of the current shock or posture change.

Highlights

A Shock Manager analyzes the variations in acceleration, collects system orientation data into a Shock History Database, and uses that to tune sensitivity and predict excessive shocks.

Prediction algorithm

The Active Protection System employs a heuristic learning algorithm to track system orientation. The Shock Manager, a system thread created by the Shockprf.sys of a kernel mode device driver, analyzes variations in acceleration and collects system orientation data into the Shock History Database. The collected data is then used to tune sensitivity and predict excessive shocks. This tuning is important in minimizing the disk performance penalty caused by predicted failures. Once the Shock Manager detects a variation that may be equivalent to one usually seen just before receiving an excessive shock, it stops the hard drive.

Sensitivity to predict a shock varies depending on how the notebook is used. In general, the more stable the ThinkPad notebook remains, the more sensitively the Shock Manager behaves. The Shock Manager focuses its attention on the current acceleration variation and the weighted average in the recent past. The log is used to minimize intrusive operation during normal use. If the drive head is unloaded after detecting a potentially harmful situation, the user can shorten the current head-unloading period up to one second on the condition that a calm state, stable enough to remove the risk of a drop, continues for at least one second and at the same time mouse movement activity for more than 200ms is detected thereby informing the Active Protection System that this is not a drop situation.

The design of the Active Protection System allows for certain shocks and vibrations that fall within a span of accepted or normal motion and does not repeatedly stop the hard drive when this level of motion is detected. You can select a checkbox in the properties window to temporarily disable the

Highlights

The Active Protection System allows for certain shocks, a feature particularly valuable when the computer is used on a train or plane.

Active Protection System while repetitive motion or vibration is detected. This feature is particularly useful when ThinkPad notebooks are used on a plane or train and repetitive vibration is expected.

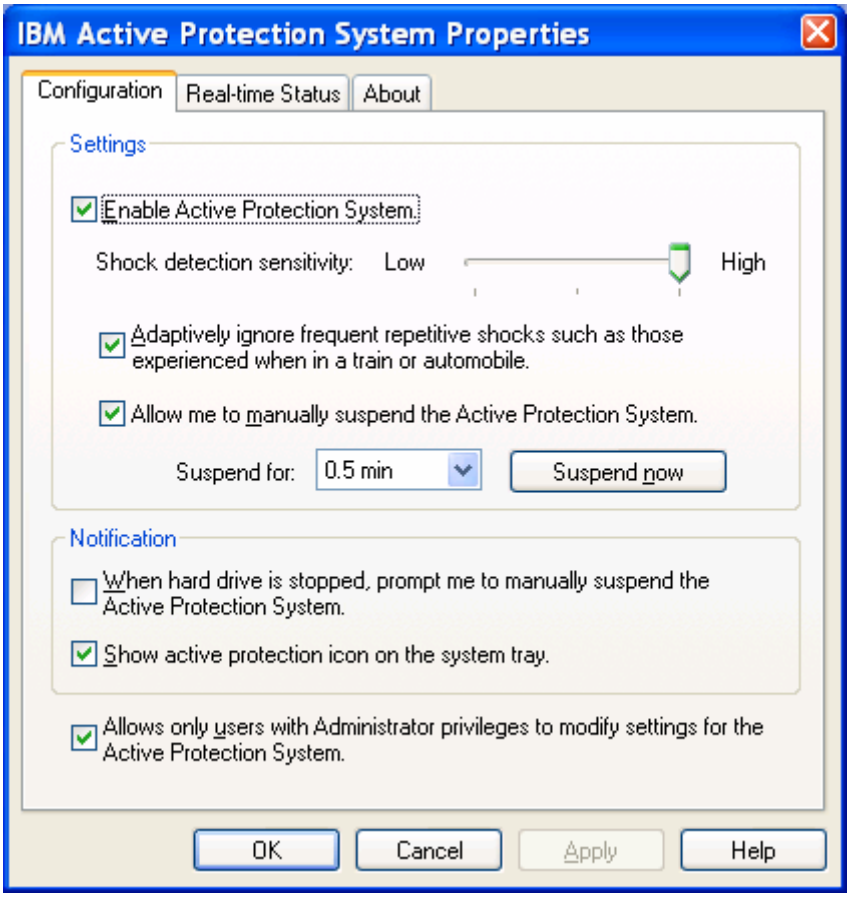

Figure 1. Hard drive Active Protection Systems properties window

Highlights

The Active Protection System has five states that are illustrated with icons on the system tray.

Application function overview

The Active Protection System software monitors the accelerometer sensor information and displays the sensor status in the system task tray. The following five status states are illustrated using their system tray icons.

The Active Protection System is disabled. In this state, shock sensor monitoring is disabled and the Active Protection System is not activated.

The Active Protection System is enabled, but no shock is detected. In this state, shock sensing is enabled and monitoring the shock condition. The Active Protection System does not detect any shock condition and any protected drive is operating normally.

The Active Protection System is enabled and the head of the hard disk drive is unloaded due to shock condition. In this state, the computer has detected a shock, and the head of any protected drive is unloaded to protect it from physical damage.

The Active Protection System is enabled, and a repetitive vibration has been detected that does not cause the head in the hard drive to be unloaded.

The Active Protection System is enabled but has been manually suspended. Low-level shocks will be ignored for a specified time. If severe shocks are detected while the system is in this state, the drive is stopped.

User interface and task tray applet

The Active Protection System application program is installed as part of a driver package on Micrososft Windows 2000 and Windows XP platforms using the InstallShield Wizard for the following components:

- Shockmgr.sys: kernel mode driver for miscellaneous operation
- Sensor.dll: application interface dll
- TpShCPL.cpl: control applet
- TpShocks.exe: task tray application
- TpShCPL.dll: bitmap resource file for this application program
- TpShPrm.hta: promotion pop-up window
- TpShPrm.gif: animation for promotion pop-up window
- TpShPrm.jpg: banner picture for promotion pop-up window

Once these components are installed, the user can access the APS Properties from Windows by clicking:
Start --> Programs --> Access IBM --> Active Protection System,
or by opening the Control Panel and double-clicking on Active Protection.
Either way, the Active Protection System Properties window is displayed.

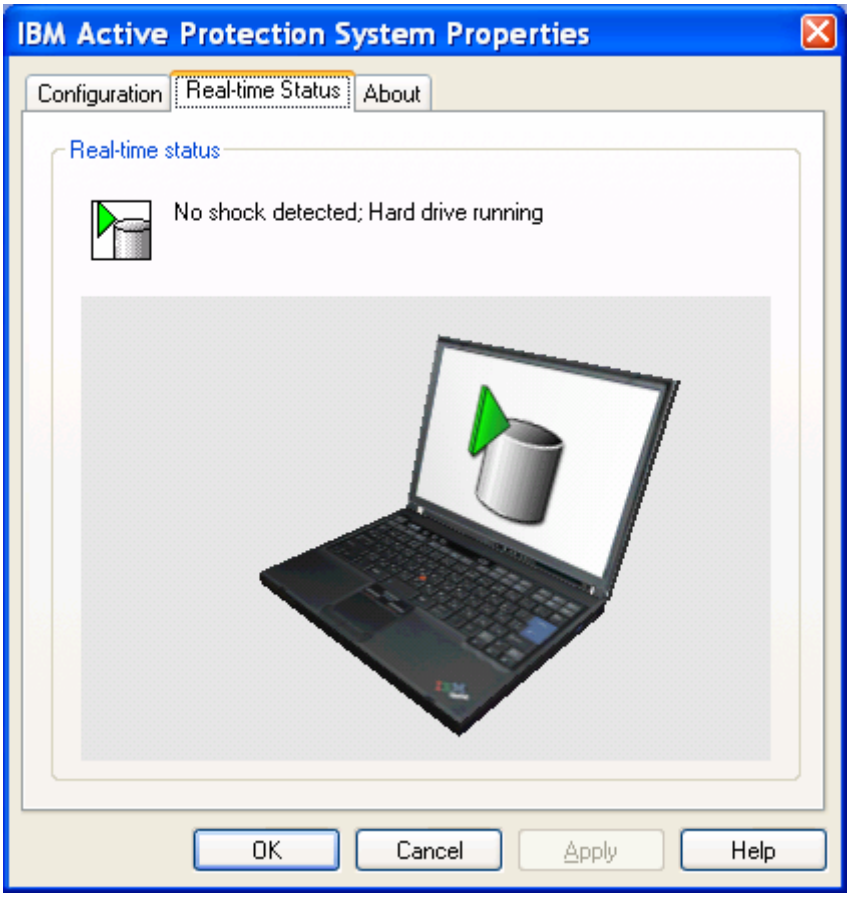

Figure 2. Active Protection System Properties, Real-time Status window

As indicated in Figure 2, there are three tabs associated with the Active Protection System user interface. The Configuration tab allows the user to customize APS settings. The second tab, Real-time Status, visually demonstrates how the shock sensor measures movement as the notebook is tilted from side to side or front to back. The third tab provides version information and allows the user to select language.

Highlights

The Active Protection System can be customized with regard to:

- ***Enablement***
- ***Sensitivity***
- ***Repetitive shocks***
- ***Manual suspension***
- ***Administrative control***

Active Protection System options

The configuration tab shown in Figure 2 allows the user to customize the APS according to the following settings:

Enable Active Protection System checkbox: If a shock is detected, the computer stops the drive to protect it from physical damage. The default setting is "Enabled." APS is enabled by default whenever the computer is operating, but it is automatically disabled while the computer is:

- Loading the operating system
- Entering standby or hibernation mode
- Resuming normal operation after being in standby or hibernation mode
- Being shut down
- Turned off

Shock detection sensitivity slide bar: Slide this indicator from low to high to set the degree of movement required to unload the head of the drive.

Adaptively ignore frequent repetitive shocks checkbox: Select this option to avoid frequent stops of the hard drive when you use the computer in an environment where the shock sensor is likely to detect repetitive, low-level shocks, such as those experienced when riding on a train or airplane. If enabled, this option functions when the ratio of the duration of stopping the hard disk drive caused by APS responding to low-level shocks exceeds a specific percentage within a certain amount of time. Once the shock sensor detects a stable environment for an extended amount of time, this option resets so that the sensitivity for received shocks returns to normal. In all cases, APS stops the hard disk when heavy shocks are detected.

Allow the user to manually suspend the Active Protection System: This enables the user to temporarily suspend APS monitoring for shock conditions. Users can select the amount of time they want to suspend monitoring and then click on the Suspend Now button to initiate the suspension. They can also initiate APS suspension by left clicking on the APS icon in the task tray.

- *Checkbox for displaying a message for suspending the Active Protection System.* Select this box if you want to see a pop-up message for manually suspending APS when low-level shocks or repetitive vibrations are detected. The pop-up message will be displayed above the APS icon on the system tray.
- *Show Active Protection System icon on the system tray checkbox:* If the checkbox is selected, the icon showing the status of the shock sensor is displayed in the system tray.

Allow only users with administrator privileges to enable or disable the Active Protection System checkbox: If this checkbox is selected, you must have administrator privileges to enable or disable the active protection system.

Summary

The Active Protection System can greatly improve overall ThinkPad notebook reliability by providing hard drive protection from shock. With leading technology that constantly monitors the movement of the ThinkPad notebook, users can feel confident that their data will receive greater protection in the event of a drop or similar potentially damaging event.

ThinkPad®

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