

IBM Hard Drive Active Protection System: Effectiveness Test

Test report prepared under contract from IBM Corporation

Executive summary

IBM Corporation commissioned VeriTest, a division of Lionbridge Technologies Inc. to test the effectiveness of IBM's Active Protection System for hard drives. The IBM Active Protection System is an integrated motion sensor configurable by the user that continuously monitors the IBM ThinkPad notebooks on which it is installed and temporarily parks the hard drive heads to prevent them from damage when a disturbance such as a fall or vibration is detected. When repetitive vibration is detected, as might occur when the notebook is riding in a train or automobile, the Active Protection System automatically adjusts sensitivity so hard drive performance is uninterrupted. Active Protection is available on select models of IBM ThinkPad "R" and "T" Series notebooks and on all models of the new ThinkPad X40 notebook.

Our testing consisted of dropping two IBM ThinkPad series notebooks with the Hard Drive Protection System installed and four competitors' notebooks from a height of 29 inches onto a concrete floor covered with industrial carpeting, a flooring commonly found in office settings. VeriTest dropped the notebooks a total of four times; once on the front edge of the notebook, once on the right side, once on the back edge, and once on the left side of the notebook. Before and after each drop test VeriTest tested the notebooks' hard drive for errors or changes in functionality by running Windows' error-checking tool. After each drop test VeriTest also noted any physical damage or changes in functionality to the rest of the notebook.

IBM supplied VeriTest with the following notebooks for use in this test:

- One (1) IBM ThinkPad T41
- One (1) IBM ThinkPad R50
- One (1) Acer TravelMate 800
- One (1) Dell Latitude D500
- One (1) Hewlett-Packard nc6000
- One (1) Toshiba Tecra M1

In our testing, both the IBM ThinkPad T41 and the IBM ThinkPad R50 were the only notebooks to report neither hard drive errors nor physical damage. Four of the six notebooks tested (Acer TravelMate 800, HP nc6000, Toshiba Tecra M1, and the Dell D500) were unable to complete all four of the drop tests successfully because of hard drive errors. The Acer TravelMate 800 encountered physical damage upon completing the third drop test. Please refer to the Test Methodology section of this report for complete details of how we conducted these tests.

Key findings

- ❑ In our drop testing, both the IBM ThinkPad T41 and the IBM ThinkPad R50 were the only notebooks to report neither hard drive errors nor physical damage.
- ❑ Four of the six notebooks tested (Acer TravelMate 800, HP nc6000, Toshiba Tecra M1, and the Dell D500) were unable to complete all four of the drop tests successfully because of hard drive errors.
- ❑ The Acer TravelMate 800 encountered physical damage upon completing the third drop test.

Test methodology

IBM Corporation commissioned VeriTest, a division of Lionbridge Technologies Inc. to test the effectiveness of IBM's Active Protection System for hard drives. The testing consisted of dropping two IBM ThinkPad series notebooks with the Hard Drive Protection System installed and four competitors' notebooks from a height of 29 inches onto a concrete floor covered with industrial carpeting, a flooring commonly found in office settings. Before and after each drop test, VeriTest tested the notebooks' hard drive for errors or changes in functionality by running Windows' error-checking tool. After each drop test VeriTest also noted any physical damage or changes in functionality to the rest of the notebook.

The IBM Active Protection System is an integrated motion sensor configurable by the user that continuously monitors the IBM ThinkPad notebooks on which it is installed and temporarily parks the hard drive heads to prevent them from damage when a disturbance such as a fall or vibration is detected. When repetitive vibration is detected, as might occur when the notebook is riding in a train or automobile, the Active Protection System automatically adjusts sensitivity so hard drive performance is uninterrupted. Active Protection is available on select models of IBM ThinkPad "R" and "T" Series notebooks and on all models of the new ThinkPad X40 notebook.

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- One (1) Dell Latitude D500
- One (1) Hewlett-Packard nc6000
- One (1) Toshiba Tecra M1

IBM also supplied a cable lock for use in this test. The cable lock was used to pull the notebooks off of the 29-inch height surface and onto the carpet-covered concrete floor.

Before dropping the notebooks, VeriTest installed and started the WinBench99 High-End Disk benchmark test on the hard drive of each notebook under test. This was done to ensure that there was hard drive activity present before and while the notebooks were being dropped. VeriTest then conducted the drop tests by pushing and pulling the notebooks off of a surface 29 inches high and onto a concrete floor covered with a layer of industrial carpet. This surface is representative of the floor found in many typical office environments. The drops were conducted on all four edges of each notebook as follows:

- Push the notebook off of the surface so it lands on the front edge of the notebook.
- Push the notebook off of the surface so it lands on the right edge of the notebook.
- Using an attached cable lock, pull the notebook off of the surface so it lands on the left-side edge of the notebook.
- Using an attached cable lock, pull the notebook off of the surface so it lands on the back edge of the notebook.

After each drop, VeriTest ran Windows' error-checking tool to determine the presence of any errors or bad sectors on the hard drive of the notebook under test. If errors were detected, or the machine displayed a blue screen and would not start Windows, the drop tests were stopped. After each drop, the VeriTest engineer also noted any physical damage or other atypical behavior from the notebook. Refer to the Test Results section for complete results of all drop tests with each notebook.

Notebook Drop Test Procedure

We used the following procedure to perform the drop tests for each of the notebooks:

I. Push method

1. Install WinBench99 version 2.0.
2. Place the notebook on a surface (i.e. desk or table) exactly 29 inches in height above a carpeted floor.
3. Reboot the notebook and verify it starts with no problems.
4. Run Windows error-checking tool using the following method: Click on the "My Computer" icon on the desktop. Right click the "C:" drive. Click "Properties." Click "Tools." Click "Check now."
 - i. Place a check mark in the box that states "Scan for and attempt recovery of bad sectors."
 - ii. Click "start."
 - iii. If Windows error-checking tool reports no errors, proceed to step iv.
 - iv. Report the results of the Windows error-checking tool.
5. Adjust the lid of the notebook so that it is at a 90-degree angle from its keyboard.
6. Start WinBench99 and select the "High-End Disk" test. Do not to disable any startup programs when starting the test and wait for the test to begin.
7. Swiftly push the notebook off of the edge of the surface so it falls onto the carpeted floor and lands on the front edge of the notebook.
 - i. Power on the notebook and run Windows error-checking tool using the following method: Click on the "My Computer" icon on the desktop. Right click the "C:" drive. Click "Properties." Click "Tools." Click "Check now."
 - ii. Place a check mark in the box that states "Scan for and attempt recovery of bad sectors."
 - iii. Click "start."
 - iv. Report the results of the Windows error-checking tool.
 - v. Repeat steps 1-7, ensuring that the notebook lands on the right-side edge in step 7 instead of the front edge.

II. Pull Method

1. Install WinBench99 version 2.0 (if not previously installed).
2. Place the notebook on a surface (i.e. desk or table) exactly 29 inches in height from a carpeted floor.
3. Reboot the notebook to verify it starts with no problems.
4. Run Windows error-checking tool using the following method: Click on the "My Computer" icon on the desktop. Right click the "C:" drive. Click "Properties." Click "Tools." Click "Check now."
 - i. Place a check mark in the box that states "Scan for and attempt recovery of bad sectors."
 - ii. Click "start."
 - iii. If Windows error-checking tool reports no errors, proceed to step iv.
 - iv. Report the results of the Windows error-checking tool.
5. Adjust the lid of the notebook so that it is at a 90-degree angle from its keyboard.
6. Start WinBench99 and select the "High-End Disk" test. Do not to disable any startup programs when starting the test and wait for the test to begin.
7. Connect a cable lock to the notebook, wherever the cable lock port resides on each specific notebook.
8. Gripping the cable on the cable lock, swiftly pull the notebook off of the edge of the surface so that it falls onto the carpeted floor and lands on the left-side edge of the notebook.
 - i. Power on the notebook and run Windows error-checking tool using the following method: Click on the "My Computer" icon on the desktop. Right click the "C:" drive. Click "Properties." Click "Tools." Click "Check now."
 - ii. Place a check mark in the box that states "Scan for and attempt recovery of bad sectors."
 - iii. Click "start."
 - iv. Report the results of the Windows error-checking tool.
 - v. Repeat steps 1-7, ensuring that the notebook lands on the back edge in step 7 instead of the left-side edge.

Test results

This section describes the results of the drop tests. Please refer to the Test Methodology section of this report for complete details on how we conducted these tests.

In our testing, both the IBM ThinkPad T41 and the IBM ThinkPad R50 were the only notebooks to report neither hard drive errors nor physical damage. Four of the six notebooks tested (Acer TravelMate 800, HP nc6000, Toshiba Tecra M1, and the Dell D500) were unable to complete all four of the drop tests successfully because of hard drive errors. Additionally, the Acer TravelMate 800 encountered physical damage upon completing the third drop test.

Figure 1 below shows the results of the drop test for the IBM ThinkPad T41 notebook. In our testing, Windows' error-checking tool reported no hard drive errors following any of the four drops. In addition, the IBM ThinkPad T41 notebook incurred no physical damage following any of the four drops.

Does the notebook Boot Before the Drop?	Windows Error Check Results Before Drop	Drop Test Number	Drop Method	Side of Impact	Does the Notebook Boot After the Drop?	Windows Error Check Results After Drop	Physical Damage
Yes	OK	1	Push	Front	Yes	OK	None
Yes	OK	2	Push	Right	Yes	OK	None
Yes	OK	3	Pull	Left	Yes	OK	None
Yes	OK	4	Pull	Back	Yes	OK	None

Figure 1: Drop Test Results for the IBM ThinkPad T41.

Figure 2 below shows the results of the drop test for the IBM ThinkPad R50 notebook. In our testing, Windows' error-checking tool reported no hard drive errors following any of the four drops. In addition, the IBM ThinkPad R50 notebook incurred no physical damage following any of the four drops.

Does the Notebook Boot Before the Drop?	Windows Error Check Results Before Drop	Drop Test Number	Drop Method	Side of Impact	Does the Notebook Boot After the Drop?	Windows Error Check Results After Drop	Physical Damage
Yes	OK	1	Push	Front	Yes	OK	None
Yes	OK	2	Push	Right	Yes	OK	None
Yes	OK	3	Pull	Left	Yes	OK	None
Yes	OK	4	Pull	Back	Yes	OK	None

Figure 2: Drop Test Results for the IBM ThinkPad R50.

Figure 3 below shows the results of the drop tests for the Acer TravelMate 800 notebook. Windows' error-checking tool was unable to run following the fourth and final drop due to the fact that the machine displayed only a continuous blue screen and would not boot into Windows. Also, while no physical damage was visible following the first drop, the wireless device was "rediscovered" by Windows when the machine restarted (implying that it was "lost" temporarily at some point during the test). During the third drop, a small piece of plastic broke off the rear of the machine. Please note that explanations for certain test results appear below this figure.

Does the Notebook Boot Before the Drop?	Windows Error Check Results Before Drop	Drop Test Number	Drop Method	Side of Impact	Does the Notebook Boot After the Drop?	Windows Error Check Results After Drop	Physical Damage
Yes	OK	1	Push	Front	Yes	OK	None
Yes	OK	2	Push	Right	Yes	OK	None
Yes	OK	3	Pull	Left	Yes	OK	* Note 1
Yes	OK	4	Pull	Back	No	* Note 2	* Note 3

Figure 3: Drop Test Results for the Acer TravelMate 800.

* **Note 1:** A plastic part broke where the key lock is inserted.

* **Note 2:** Machine would not start Windows. Machine continues to display a blue screen during boot phase.

* **Note 3:** Machine would still not start Windows, even in safe mode. Machine's battery ejected.

Figure 4 below shows the results of the drop tests for the Dell Latitude D500 notebook. The Dell D500 successfully completed only the first drop test. Although it was able to successfully scan the hard drive after the first drop, the WinBench 99 High End Disk Benchmark Test was unable to restart. An error was displayed stating that the user was unable to work around this. We attempted to uninstall and reinstall the WinBench99 application but the same error was reported. Because of the error we could not continue drops two through four. Please note that explanations for certain test results appear below this figure.

Does the Notebook Boot Before the Drop?	Windows Error Check Results Before Drop	Drop Test Number	Drop Method	Side of Impact	Does the Notebook Boot After the Drop?	Windows Error Check Results After Drop	Physical Damage
Yes	OK	1	Push	Front	Yes	OK	None
Yes	OK (Note 1)	2	Push	Right	N/A	N/A	N/A
N/A	N/A	3	Pull	Left	N/A	N/A	N/A
N/A	N/A	4	Pull	Back	N/A	N/A	N/A

Figure 4: Drop Test Results for the Dell Latitude D500.

* **Note 1:** WinBench99 High End Disk benchmark could not start. An error was reported that stated: "Cannot create a file when a file already exists." Testing was discontinued because the benchmark test could not be restarted, even after uninstalling/reinstalling the WinBench99 application.

Figure 5 below shows the results of the drop tests for the Hewlett-Packard nc6000 notebook. The Hewlett-Packard nc6000 successfully completed only the first drop test. Although it was able to successfully scan the hard drive after the first drop, the WinBench 99 High End Disk Benchmark Test was unable to restart. An error was displayed stating that the user was unable to work around this. We attempted to uninstall and reinstall the WinBench99 application but the same error was reported. Because of the error we could not continue drops two through four. Please note that explanations for certain test results appear below this figure.

Does the Notebook Boot Before the Drop?	Windows Error Check Results Before Drop	Drop Test Number	Drop Method	Side of Impact	Does the Notebook Boot After the Drop?	Windows Error Check Results After Drop	Physical Damage
Yes	OK	1	Push	Front	Yes	OK	None
Yes	OK (Note 1)	2	Push	Right	NA	NA	NA
NA	NA	3	Pull	Left	NA	NA	NA
NA	NA	4	Pull	Back	NA	NA	NA

Figure 5: Drop Test results for the Hewlett-Packard nc6000.

* **Note 1:** WinBench99 High End Disk benchmark could not start. An error was reported that stated: "Cannot create a file when a file already exists." Testing was discontinued because the benchmark test could not be restarted, even after uninstalling/reinstalling the WinBench99 application.

Figure 6 below shows the results of the drop tests for the Toshiba Tecra M1 notebook. The Toshiba Tecra M1 was able to successfully complete only one drop test. While the machine did not show any physical damage after the first drop test, the wireless device was rediscovered by Windows when the machine was rebooted (implying that the device was "lost" temporarily at some point during the drop test). Testing stopped after the second drop test because the machine displayed a continuous blue screen and would not boot into Windows. The Toshiba Tecra M1 hard drive also made an unusually loud clicking noise after the second drop. Please note that explanations for certain test results in the figure below appear beneath it.

Does the Notebook Boot Before the Drop?	Windows Error Check Results Before Drop	Drop Test Number	Drop Method	Side of Impact	Does the Notebook Boot After the Drop?	Windows Error Check Results After Drop	Physical Damage
Yes	OK	1	Push	Front	Yes	OK	None
Yes	OK	2	Push	Right	NO	* Note 1	* Note 2
NA	NA	3	Pull	Left	NA	NA	NA
NA	NA	4	Pull	Back	NA	NA	NA

Figure 6: Drop Test results for the Toshiba Tecra M1.

* **Note 1:** Machine displays a blue screen and states: "the registry cannot load the hive (file):/systemRoot/System32/Config/Security. It is corrupt, absent, or not writable." Testing was discontinued because the machine could not be restarted past the blue screen.

* **Note 2:** Hard drive produced an atypical clicking noise.

Appendix A - Disclosure for the systems used in this test

IBM ThinkPad T41 Type 2373-7FU	
Processor / Speed / # of CPUs	P4M 1.6 GHz
System RAM / Type / # of Slots	512MB
Motherboard Manufacturer	Intel
Motherboard Chipset	Intel 82855PM
BIOS / Version / Date	IBM / 2.00(1RET68WW) / 7-24-2003
HD Make / Model / Size	IC25N040ATCS05-0 / 40GB
HD Controller	Intel 82801DBM Ultra ATA Storage Controller – 24CA
Graphics Adapter	ATI Mobility Radeon 7500
Graphics Memory	32MB
Graphics Chip Type	ATI
Video Resolution Assigned	1024 X 768
Color Depth Assigned	16 bit
Refresh Rate Assigned	60Hz
DAC Type	Internal
Sound Board	Soundmax Integrated Audio
NIC / Driver	Intel/Pro 1000 MT / e1000325.sys / 6.4.16.36 Intel/Pro Wireless 2100 / w70n51.sys / 1.2.0.56
Modem	Agere Systems AC97 Modem
DVD Make / Model	Matshita UJDA745 DVD/CDRW
OEM OS	Windows XP Professional
USB Chipset / Version	Intel 82801DB/DBM USB 2.0

Figure 7: Full disclosure for the IBM T41 test system

IBM ThinkPad R50 Type 1836-2UU	
Processor / Speed / # of CPUs	Pentium 4M / 1.5 GHZ / 1
System RAM / Type / # of Slots	256 MB
Motherboard Manufacturer	Intel
Motherboard Chipset	82855PM
BIOS / Version / Date	1RET84WW (2.11) / 10-30-2003
HD Make / Model / Size	Hitachi / IC25N060ATMR04-0 / 60GB
HD Controller	Intel 82801DBM ultra ATA storage controller -24CA
Graphics Adapter	ATI Mobility Radeon 7500
Graphics Memory	32 MB
Graphics Chip Type	ATI
Video Resolution Assigned	1024X768
Color Depth Assigned	16 bit
Refresh Rate Assigned	60 HZ
DAC Type	Internal
Sound Board	Soundmax Integrated Audio
NIC / Driver	Philips 11a/b/g Wireless LAN Adapter / ar5211.sys / v2.4.1.7 / 9-12-2003 Intel Pro/1000MT e1000325.sys / v6.4.16.36 / 6-13-2003
Modem	Agere AC97
DVD Make / Model	TEAC DW-225
OEM OS	Windows XP Professional service pack 1
USB Chipset / Version	Intel 82801DB/DBM USB 2.0

Figure 8: Full disclosure for the IBM R50 test system

Acer TravelMate 800	
Processor / Speed / # of CPUs	Pentium 4M / 1.3 GHZ / 1
System RAM / Type / # of Slots	256 MB
Motherboard Manufacturer	Intel
Motherboard Chipset	82855PM
BIOS / Version / Date	Phoenix Bios 3A15 / 03/01/2003
HD Make / Model / Size	Hitachi DK23EA-30 / 30 GB
HD Controller	Intel 82801DBM ultra ATA storage controller -24C
Graphics Adapter	ATI mobility Radeon 9000
Graphics Memory	32 MB
Graphics Chip Type	Mobility Radeon 9000 AGP (0X4C66)
Video Resolution Assigned	1024X768
Color Depth Assigned	32 bit
Refresh Rate Assigned	60 HZ
DAC Type	Internal
Sound Board	Intel AC'97
NIC / Driver	Broadcom 440x 10/100 Intel/Pro Wireless 2100 / w70n51.sys / 1.2.0.56
Modem	Intel
DVD Make / Model	QSI CD-RW/DVD-ROM SBW-242
OEM OS	Windows XP Professional service pack 1
USB Chipset / Version	Intel 82801DB/DBM USB 2.0

Figure 9: Full disclosure for the Acer TravelMate 800 test system

Dell Latitude D500	
Processor / Speed / # of CPUs	Pentium 4M / 1.3 GHZ / 1
System RAM / Type / # of Slots	256 MB
Motherboard Manufacturer	Intel
Motherboard Chipset	82852/82855 GM/GME
BIOS / Version / Date	Dell / A06
HD Make / Model / Size	Hitachi / IC25N030ATMR04-0 / 30GB
HD Controller	Intel 82801DBM ultra ATA storage controller -24CA
Graphics Adapter	Intel 82852/82855 GM/GME
Graphics Memory	64 MB
Graphics Chip Type	Intel
Video Resolution Assigned	1024X768
Color Depth Assigned	32 bit
Refresh Rate Assigned	60 HZ
DAC Type	Internal
Sound Board	SigmaTel C-Major Audio
NIC / Driver	Intel/Pro 100 VE / e100b325.sys / 6.04.14.0071 Intel/Pro Wireless 2100 / w70n51.sys / 1.2.0.56
Modem	PCTEL 2304WT
DVD Make / Model	QSI CDRW/DVD SBW-242
OEM OS	Windows XP Professional service pack 1
USB Chipset / Version	Intel 82801DB/DBM USB 2.0

Figure 10: Full disclosure for the Dell Latitude D500 test system

Hewlett-Packard nc6000	
Processor / Speed / # of CPUs	Pentium 4M / 1.4 GHZ / 1
System RAM / Type / # of Slots	256 MB
Motherboard Manufacturer	Intel
Motherboard Chipset	82855PM
BIOS / Version / Date	HP 68BDD ver. F.05 / 09/16/2003
HD Make / Model / Size	Fujitsu MHT2030AT / 30 GB
HD Controller	Intel 82801DBM ultra ATA storage controller -24C
Graphics Adapter	ATI mobility Radeon 9600
Graphics Memory	32 MB
Graphics Chip Type	Mobility Radeon 9600 AGP (0X4C66)
Video Resolution Assigned	1024X768
Color Depth Assigned	32 bit
Refresh Rate Assigned	60 HZ
DAC Type	Internal
Sound Board	SoundMax Integrated Audio
NIC / Driver	Broadcom NetXtreme Gigabit Ethernet / b57xp32.sys / 6.34.0.0
Modem	Agere Systems AC'97 Modem
DVD Make / Model	HL-DT-ST DVD-ROM GDR8082N
OEM OS	Windows XP Professional service pack 1
USB Chipset / Version	Intel 82801DB/DBM USB 2.0

Figure 11: Full disclosure for the Hewlett-Packard nc6000 test system

Toshiba Tecra M1	
Processor / Speed / # of CPUs	Pentium 4M / 1.4 GHZ / 1
System RAM / Type / # of Slots	256 MB
Motherboard Manufacturer	Intel
Motherboard Chipset	82855PM
BIOS / Version / Date	Intel / 06/13/2003
HD Make / Model / Size	Toshiba MK4019GAX / 40 GB
HD Controller	Intel 82801DBM ultra ATA storage controller -24C
Graphics Adapter	Trident Cyber 2100
Graphics Memory	32 MB
Graphics Chip Type	Trident Cyber 2100
Video Resolution Assigned	1024X768
Color Depth Assigned	32 bit
Refresh Rate Assigned	60 HZ
DAC Type	Internal
Sound Board	Intel AC'97
NIC / Driver	Broadcom 570x Gigabit Integrated / b57xp32.sys / 6.64.0.0 Intel/Pro Wireless 2100 / w70n51.sys / 1.2.0.56
Modem	Intel
DVD Make / Model	Toshiba DVD-ROM SD-C2612
OEM OS	Windows XP Professional service pack 1
USB Chipset / Version	Intel 82801DB/DBM USB 2.0

Figure 12: Full disclosure for the Toshiba Tecra M1 test system

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VeriTest created the suite of industry-standard benchmark software that includes WebBench, NetBench, Winstone, and WinBench. We've distributed over 20 million copies of these tools, which are in use at every one of the 2001 Fortune 100 companies. Our Internet BenchMark service provides the definitive ratings for Internet Service Providers in the US, Canada, and the UK.

Under our former names of ZD Labs and eTesting Labs, and as part of VeriTest since July of 2002, we have delivered rigorous, objective, independent testing and analysis for over a decade. With the most knowledgeable staff in the business, testing facilities around the world, and almost 1,600 dedicated network PCs, VeriTest offers our clients the expertise and equipment necessary to meet all their testing needs.

For more information email us at info@veritest.com or call us at 919-380-2800.

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