

WITS - The Windows Integrated Test Suite

Welcome to WITS, the Windows Integrated Test Suite. With WITS you can measure the video performance of PC graphics boards using real applications.

The following Help Topics are available:

Overview of WITS

Command menus

Application test descriptions

Presentation of results

When running WITS we strongly suggest you close all other Windows 3.1 programs first.

This serves two purposes: it releases all the memory to WITS and it ensures no other program is performing video operations while WITS is running.

For Help on Help, Press F1

Overview of WITS

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Command menus

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Application test descriptions

Microsoft Word for Windows

Microsoft Excel

CorelDRAW!

PhotoStyler

QuarkXPress

Disclaimer

DISCLAIMER OF WARRANTY AND DAMAGES

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Programs and Documentation Copyright ©1993 Jon Peddie Associates. WITS is released into the public domain and may be freely distributed and copied, subject to the following conditions: at no time may this program be sold, with the exception that it may be included in video display boards by their manufacturer, and the test files, *.SCR, *.DOC, etc., may not be modified in any way.

Objectives

Quantifying the performance of a video display board in a PC is a difficult task. Different application programs place different requirements on a video display board. While a word processor needs a video display board that can scroll text quickly a paint program requires a board that can quickly fill shapes and perform bitBLT operations.

This situation creates a difficult problem. How does one test performance of an application that uses so many different graphics operations? Tests in the past have attempted to simulate how an application interacts with the Windows environment. The prime example of this is the WinMark test from Ziff-Davis publications. This test simulates the API calls an application makes to Windows 3.x. The problem with this is determining the calls a program makes to the Windows 3.1 API and the frequency at which they are made.

Another problem is that certain video board manufacturers have made benchmark aware drivers that return arbitrarily high performance figures when being benchmarked by existing benchmark programs. This is a well known problem in the industry but not in the user community. Purchase decisions are made, in part, based on these results.

Rather than create another method of simulating the application program we at Jon Peddie Associates decided to use the actual application programs themselves and measure the video performance as the programs run. We believe this method is immune to techniques commonly used to fool benchmark programs.

Each application is tested with two files. One file consists of a relatively simple document or graphic image. For example, the first test document for WinWord consists strictly of text that includes several different fonts, reflecting a simple Word document. The second test document consists of a more complex document that contains tables and an imported graphic bitmap.

Along with the time required to execute the given graphic operation the option is available to measure the time taken by the video driver to execute low-level operations including BitBLT and others. Click [here](#) for more detail on video driver testing.

Application program versions supported by WITS

WITS support the following versions of the application software:

- Microsoft Word for Window 1.x and 2.x.
- Microsoft Excel 2.1, 3.0 and 4.0
- CorelDRAW! 3.0
- PhotoStyler 1.x
- QuarkXPress 3.1

For three of the tests sample files provided with the application software are required. For CorelDRAW! the sample file EYE.CDR is required. For PhotoStyler the three files FLORA.TIF, MUSICA.TIF and VIRTUOSO.TIF are required. For QuarkXPress the files BEACHCRZ.QXD and WORLDUCUP.QXD are required. These files MUST be copied to the WITS directory manually after WITS installation.

Method of testing

WITS uses actual applications to measure video board performance in the Windows 3.1 environment. To do this the application programs are fed data by WITS that appears to come from the mouse and keyboard, as if a user was actually interacting with the program. This is done by sending simulated keystrokes and mouse movements to the program. Much of these are to set up the program and load test files. During video-intensive operations scrolling a page of text or drawing a graphic image WITS measures the time taken for these operations. These times are then used for calculating the WITSMark for the display board.

A test based on this method, by its very nature, can not produce exactly repeatable results. Because an application is used, control of the system is sacrificed by WITS. Dependent on other programs that may be loaded, the available disk and memory space, or the influx of neutrinos at any given moment may have an effect on the results. For greatest accuracy we suggest closing all other Windows programs before beginning WITS and to do two or three runs and average the results.

Security of test files

To ensure that no tampering of the test data files takes place great effort has been invested in encrypting them to prevent modification of the file. If the files were modified in any way test results could not be compared with each other.

Reporting of test results

Results grid and chart

Upon completion of the test cycle a screen appears with a chart and grid of the test results displayed. These display the individual test times as compared to the baseline test system.

Test summaries

The main WITS screen displays the WITSMark numbers for the currently tested boards.

For additional information click [here](#).

WITS sponsors and tools used

Development of WITS was sponsored by VideoLogic in England and IBM, Boca Raton, FL. The program was developed with Microsoft Visual Basic 2.0 and the Professional Features software package. Help files were developed with RoboHelp 1.0 from Blue Sky Software (619.459.6365). Driver timing software was provided by Ingenious Solutions (510.531.5681), developers of Perform for profiling video driver performance. Invaluable help came from the multitudes of subscribers and Microsoft support personnel on CompuServe who shared tips and hints to overcome some difficult programming issues, especially Robert Eineigl and Ed Dore from Microsoft.

About Jon Peddie Associates

Jon Peddie Associates is a technical and management consulting firm in the San Francisco area. We have many man-years of experience in testing and working with PC graphic display boards. We consult with manufacturers of display boards, chips, and software to advise them regarding technical and market related issues. We can be reached by phone at 415.435.1775 or by FAX at 415.435.1599 and via Compuserve at 71250,2146.

File

Batch print...

Once a test has been completed the test results can be printed immediately via the Print function of the **WITS Results** screen. Batch print allows multiple test results to be printed automatically. Select this function and mark the test results to be printed then click the Print button.

Printer Setup...

Use this function to select and setup up the printer to print the test results. Be sure the paper orientation is set to Portrait.

Update program locations...

WITS must be informed of where the application programs are located on the local or network system disk(s). If a new application is added after the initial WITS program installation or the location of a program changes use this function to update the information WITS uses to locate the files. Do NOT enter the program name, just the directory path.

Preferences...

Three preferences can be set:

Hide the introduction screen,
Sound a beep when finished testing, and
Automatically save the test results

Hide introductory screen brings up the main WITS screen and bypasses the initial screen that displays the program name, screen resolution and number of colors. Bypassing this screen does not affect overall program operation in any way.

Beep when finished testing sounds a series of beeps when the test cycle is over.

Autosave test results saves the test results automatically at the end of a test cycle. The file name is the name of the driver file with a .DTA suffix. If the file already exists WITS will ask whether to overwrite this file or save it with a new name.

About...

Displays a screen with information about WITS and the test system.

Exit

Ends the WITS program.

Test

Application programs

Five programs were chosen as the test applications. These five programs represent each major category of application software:

- Wordprocessing
- Spreadsheet
- Paint and graphics arts
- Image processing
- Desktop publishing

A checkmark next to the program name indicates the program is selected for test. This is also indicated by a checkmark in the button next to the program name on the main screen.

Driver timing...

WITS can measure the time spent in the video driver performing the following functions:

- BitBLT
- Text drawing
- Polygon fills
- Line drawing
- Total time spent in the driver

These functions are provided for sophisticated users who desire more detailed information about the behavior of the video driver. This is an excellent measurement of a boards performance as no other operations occur while the driver is executing the API calls.

Changes are made to the SYSTEM.INI file for this function. Your current SYSTEM.INI file will be saved in the WINDOWS\SYSTEM directory with the name SYSTEM.ORG. If this file already exists you will be prompted to replace it. Once this is done WITS will attempt to restart Windows. When Windows restarts WITS will automatically be run.

If for any reason Windows can not be automatically restarted for example if you have a DOS session open you will need to do it manually. Simply quit Windows and restart it.

Reset test results...

After a series of tests have been run you may wish to run the tests again. Before re-running the tests select this menu item to reset the internal counters and variables in WITS. **This will erase all test results** so be sure to save or print results before choosing this menu item.

Measure refresh rate...

WITS has the ability to measure the refresh rate of VGA boards only. Selecting this

menu item will begin the process. Total time to measure the refresh rate can be up to 30 seconds.

System information

This menu item shows a screen that displays information about the system, video board and video driver.

Demo mode

This is provided for users who wish to have WITS run continuously, for example at a trade show. When this is selected WITS will run the selected programs continuously and display a window on the screen offering information about the test being run and the test results.

During the test a dialog box will be displayed on the screen noting the operations being executed and the WITSMark of the test board.

To end demo mode click on the applications right-hand restore arrows to shrink it down from the full screen, but not to minimize it to an icon. At the upper left-hand corner of the screen there is a dialog box with the single command button labeled "Halt the demo." Click on the button to end the demo. WITS must be restarted to perform additional tests.

Go!

This is equivalent to clicking on the Start button of the main WITS screen. This will begin the test process.

Help

Help

Obviously you know what Help does or you wouldn't be here. Context sensitive help is provided on many of the WITS screens.

Uninstall...

As users we find it quite irritating that software vendors typically do not offer a method of removing the myriad files copied to the hard disk during a Windows 3.1 program installation. To aid you in removing WITS from your hard disk this option can be chosen to Uninstall, or remove, most of the files. The reason that it is most is, that in some cases, a single file may be accessed by several different programs. This is true for WITS because of its development environment, Visual Basic 2.0. There is a file, VBRUN200.DLL, that is used by any Visual Basic 2.0 program. If you have other Visual Basic 2.0 programs you MUST keep this file on your disk. There is no, though, easy to determine if other programs you have are written using Visual Basic 2.0. The method we suggest is, after uninstalling WITS, rename VBRUN200.DLL to VBRUN200.XXX and run your programs. If you do not get an error message from the other programs you can safely delete the file.

What is WITS?

The Windows Integrated Test Suite, or WITS, is a series of tests to measure the performance of IBM PC-compatible computers and video display boards when running Microsoft Windows 3.1 applications. WITS currently uses five application programs for the tests:

Microsoft Word for Windows,
Microsoft Excel,
CorelDRAW!,
Aldus PhotoStyler, and
QuarkXPress.

Additional applications in these classes will be added over time.

Video performance is indicated by the **WITSMark** score of the board.

You must have the software package to perform the test(s). If you don't have the software you probably don't care how well your video board performs.

For additional information read the Objectives portion of Help.

Microsoft Word for Windows

Four major functions of Word for Windows are tested:

Page scroll

Line scroll

Print preview

Graphics rendering speed

Two test documents are used for this test. The first document, WORDTST1.DOC, is a text-only file that contains a number of different fonts and point sizes as well as left-, center- and right-justified text. The different fonts require WinWord to read the new fonts into its cache. Caching occurs as WinWord requires the fonts. This can be seen as WinWord scrolls a document immediately after opening it. There is a slight pause as the fonts are read from disk into the cache. Scroll times while fonts are being cached are not a component of the total test time reported back by WITS.

The second document, WORDTST2.DOC, is similar to the first with the inclusion of tables and an imported image. In WinWord tables are treated as graphics and take advantage of a fast video board.

When the document is first loaded into WinWord a macro is executed to set up WinWord for WITS. If the ruler or ribbon are turned on they are turned off and Page Preview mode is set to a single page if it was previously set to two page.

The times taken in the scrolling operations are identified in the test results as xxx - cached, where xxx is the specific test being executed.

Microsoft Excel

Two major functions in Excel are tested by WITS:

Scrolling speed, and
Graphics rendering speed.

A single file is used for the test, WITSEXCL.XLS. When the spreadsheet is first loaded into Excel it is replicated to ensure it is large enough for scrolling on high resolution displays.

Once the spreadsheet has been replicated it is scrolled up and down a number of times. Next, it is scrolled in page preview mode.

Once this has been completed a 3-D bar chart is created. To measure the redraw time it is maximized to the full screen and Excel toggles between the maximized spreadsheet window and chart window.

CorelDRAW!

Since CorelDRAW! is a graphics creation and presentation product WITS focuses on those functions. Two different documents are used for the test - EYE.CDR and FONTTEST.CDR. EYE.CDR is a sample file shipped with CorelDRAW!. This file MUST be copied into the WITS home directory for the test to function properly.

The test is very straightforward. First, EYE.CDR is loaded into CorelDRAW. It is then redrawn 10 times by CorelDRAW!. After finishing the redraws one object is selected and then dragged left. The time for the cycle of redraws and drags is measured by WITS. Next, FONT.CDR is loaded and redrawn 10 times.

PhotoStyler

PhotoStyler, being an image manipulation application, is very dependent on the power of the CPU in the PC. Another factor in PhotoStyler performance is how quickly the video driver can place the image in its memory.

PhotoStyler normally works with images that are 8-, 15/16- or 24-bits per pixel. Since the bus of a PC is 16-bits wide it may be the limiting factor in sending the pixels from the CPU to the video board.

To test PhotoStyler performance WITS loads three images into it and then cascades them so they overlap. WITS then brings one of the obscured images to the front, causing the pixel data to be redrawn in the video memory. Three images that are supplied with PhotoStyler are used: FLORA.TIF, MUSICA.TIF and VIRTUOSO.TIF. These files must be moved from the PhotoStyler directory to the WITS home directory.

At the beginning of the test you may hear a series of beeps coming from your computer. Apparently PhotoStyler's keyboard buffer can be over run, causing the beeps. This situation does not affect the test results.

QuarkXPress

The test for QuarkXPress uses two documents: BEACHCRZ.CDR and WORLDDCUP.CDR. The BEACHCRZ document is mainly text with a graphic image at the top of the page while WORLDDCUP is mainly graphics with little text. These two images test the font and graphics redraw capability of the video board.

The test process is the same for each document file. Once it is loaded into QuarkXPress it is minimized to an icon and then maximized. This cycle is repeated 10 times. The results give an indication of the text and graphics redraw capability of the video board.

The two files must be copied to the WITS home directory after WITS is installed.

Presentation of results

Once the tests have concluded the results are displayed in both graphic and tabular form via a bar chart and spreadsheet. The bar chart displays the results of the currently tested video board compared with the base-level 386SX/25 configured with 4 Mbytes of memory, a 512KB Tseng 4000 VGA board set to 640 x 480 display resolution. Below the bar chart is a spreadsheet display with the WITSMark for each test displayed in the first column, the time taken, in seconds, for each individual test of the board under test and finally the time taken by the base-level system for the same test.

Mainscreen

Choose the test(s) to run with the mouse or Tab Key/Spacebar by clicking on the "X" or checkmark. An "X" indicates the test for that program will not be run.

To disable a program test, even though you have the application on your system, select "File/Update program locations..." and delete the path for that program. For example, if you do not want the Word for Windows test to be enabled every time you run WITS simply delete the path from the appropriate "Update program locations" line.

Click on **Start** or select the menu **Test/Go** to begin the tests. Program names that are grayed out are not available to test. If you want to add one of these programs run the WITSETUP program in the WITS home directory.

To view results of completed tests click on **Display results**.

Test/Demo mode runs the tests continuously and **Driver timing** measures driver performance. Results are measured against 386SX/25 with ET4000 VGA board. The WITSMARK is this ratio.

Once the tests have been run the WITSMARK data will be displayed in the center column. The WITSMARK from the either of the two tests or the overall WITSMARK can be displayed by selecting the appropriate radio button in the right hand column.

The center and right columns are blanked out until a test has been completed. Only test data from the application program(s) run will be available for display.

Clicking on the "Driver timing enabled" option will measure key video driver parameters. These are:

- BitBLT time
- ExtTextOut time
- Polygon fill time
- Line draw time
- Total driver time

ExtTextOut time reports back the time taken for drawing text. Polygon and Line draw times reflect how much time the driver spent drawing and filling polygons as well as drawing lines, respectively. The final number shows how much total time was spent in the video driver. This time will always be less than the total time taken for the entire test.

Test Results Screen

Test results are presented in both graphic and tabular form. Only test results which contribute to the total time are displayed. For example, the WinWord scroll times while the fonts were being cached are not included in the total. Refer to the specific application program discussion for more detail.

Results of the board currently under test are shown in yellow on the chart. Times of the 386SX/25 system used for the baseline tests are shown in blue and the **currently tested board in yellow**. The blue bars are all a value of 1, against which are shown the WITSMARK, in yellow, of the system being tested.

The five program names are listed across the top of the form. Test results from the last test cycle are shown in black while test results not available are in gray. To select one of the two tests for a given program or the overall test results click on its name and select the test results to display. A checkmark next to the name shows the currently displayed test results.

The grid in the lower part of the window displays the test name, the WITSMARK, the time taken for the board you are testing, and the time taken for the 386SX/25 base system.

Select Print to print the test results, Save to save them in a file or OK to return to the main screen. Be advised printing is a somewhat slow process requiring a 250KB+ print file to be generated. If you are interested in the numerical results you can "Save" them and then load the values into a spreadsheet for analysis.

Note: If you want printed results they must be printed before running another test cycle. Saved test results can not be read into WITS for printing at a later time.

If the labels of the graph are difficult to read it can be enlarged by selecting the arrows at the upper right hand corner of the graph. The same holds true for the grid.

If the "Driver timing enabled" option was selected the following times will be reported:

- BitBlt time
- ExtTextOut time
- Polygon fill time
- Line draw time
- Total driver time

ExtTextOut time reports back the time taken for drawing text. Polygon and Line draw times reflect how much time the driver spent drawing and filling polygons as well as drawing lines. The final number shows how much total time was spent in the video driver. You may notice that the times shown for the operations above do not add up to the total driver time. That is because there are dozens of other API calls that are executed that WITS does not keep track of. The items above are the majority of API calls used in graphic operations.

Save test data file

The left-hand column indicates the PC system the video board was tested on. To record the speed you must select the appropriate clock rate. Also, enter the board name and any comments you may have. Also, indicate the refresh rate if you know it. This information is not required to save the file it is for information only.

Update program locations

Enter the path for each program. For example, C:\WINWORD or C:\EXCEL. Do not add a trailing '\'. Also, do not enter the program name itself. If you add a program to WITS after initial installation or change the directory of the WITS program files use this function to inform WITS of the path to the program.

Uninstall

This dialog box allows you to delete WITS from your system. If you desire to retain any of the files indicated click on the checkbox to remove the check. 'OK' will delete the files.

The files WITS installs are:

WINDOWS directory:

SETUPKIT.DLL - Needed for initial program installation

WITSHELP.HLP - The context-sensitive Help file

WITS.INI - Information for WITS for program locations and preferences

WINDOWS/SYSTEM directory:

GSWDDL.DLL - For drawing the test results chart

VBRUN200.DLL - DLL necessary for Visual Basic 2.0

ESTIMER.DRV - For measuring driver performance

CMDIALOG.VBX - For managing common dialog boxes

GSW.EXE - For drawing the test results chart

GRAPH.VBX - For drawing the test results chart

GRID.VBX - For display of the test results grid

SPIN.VBX - For spinner box on Save Results screen

THREED.VBX - To give it the screens their bitchin' 3D look.

WITS home directory :

WITS.EXE - The test program itself

WITSETUP.EXE - The WITS setup program

***.DOC** - Microsoft Word for Windows test files

***.XLS** - Microsoft Excel test file

***.SCR** - Encrypted files with test sequences

README.TXT - Directions about installation and WITS quirks

Test files - Sample files from CorelDRAW!, PhotoStyler and QuarkXPress

***.DTA** - Saved test results files

The data files (*.DTA) will NOT be erased. If you do not want to save these files simply delete them from the directory.

Note: Some of these files specifically VBRUN200.DLL may be required by other Visual Basic programs you have. Please consult the documentation for them before deleting these files.

System information

This screen shows key system information. The 'Driver Name' is the driver file name while 'Driver Description' is the string returned from SYSTEM.INI.

The other information listed gives details on the PC, Windows mode, driver file date, the current screen resolution, the number of bit planes and the number of simultaneous colors the display board supports at the indicated resolution.

Batch print

Choose the test result(s) to print. One or more tests can be selected. Click the Print button to begin printing.

Be sure the printer is set to portrait mode before beginning to print.

Preferences

This dialog box allows you to set three preferences for WITS operation:

Hide the Introductory screen

This option will prevent the initial introductory screen from being displayed when WITS is started. Hiding the screen does not change the operation of WITS in any way. An "X" in the box indicates the introductory screen will not be displayed.

Beep when finished testing

You can choose to have the system beep at the conclusion of testing. For unattended operation this option will advise you the test cycle is finished. An "X" in the box indicates that the beep will be sounded.

Autosave test results

To ensure the test results are saved you can enable this option. If it is enabled, shown by an "X" in the box, the test results from all tests will be automatically saved in a file in the WITS home directory. The file name will be the video driver file name with a .DTA extension. If a file with the same name is already in the directory you will be prompted to overwrite it. An "X" in the box indicates that Autosave is enabled.

BitBLT

Short for *bit-block-move*. In this operation an area of pixels, the block, is moved to another location on the screen. This happens, for example, as you drag an icon across the screen. The pixels that make up the icon are erased in one location and bitBLT'd to the destination. The speed of *BitBLT* operations greatly affect the performance of Windows.

API calls

Programs communicate with Windows 3.x via an *Application Program Interface*, or *API*. If a program needs to display a character on the screen it calls an API function to display text at a given point on the screen.

Pixel

Short for *picture element*. A pixel is the smallest addressable element of the screen.

Resolution

Described as how many pixels in the horizontal and vertical measurements of the display screen. A VGA display is typically 640 x 480, or 640 pixels horizontally by 480 pixels vertically.

Test cycle

The time taken running an application (or applications) and measuring the video performance.

Video driver

Software supplied with the video display board that controls its operation in Windows 3.1.

WinMark

A metric of video performance developed by Ziff-Davis publications, publisher of PC Magazine among others.

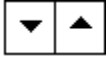
WITS

This program, the *Windows Integrated Test Suite*.

WITSMark

The performance of the test system relative to a 386SX/25 system with a Tseng Labs ET4000 VGA board operating at 640 x 480 resolution and the standard Windows 3.1 VGA driver.

Restore arrows



The two arrows at the upper right corner of a window. They appear as shown above. The right hand arrow enlarges its window to fill the entire screen. The left-hand arrow shrinks the window to an icon.



A double arrow in the right-hand arrow indicates the window is enlarged to its maximum size.

WinWord

An abbreviation for Microsoft *Word for Windows*.

Cache

A cache is an area of memory where data is stored for the quickest access. For example, fonts are read from disk into WinWords cache for quick display.

Bit planes

Hardware used as a storage medium for a bitmap. When a window is thought of as a stack of bitmaps, each bitmap is called a *bit plane*.

CPU

The chip in the PC that performs the processing functions. Since all PCs use an Intel or Intel-compatible chip the part number will be 80386 or similar.

Home directory

This is the directory the WITS.EXE program is located in. The default directory is C:\WITS. To find the *home directory* run WITS and select the "Update program locations..." menu item in the File menu. The top directory shown is the home directory.

Refresh rate

The number of times per second the picture is displayed on the screen. Normal television operates at 60 Hz interlaced . Most computer video displays are non-interlaced. The faster a displays *refresh rate* the less observable flicker there is. Typical rates are 60 and 70 Hz non-interlaced while newer display boards offer up to 90 Hz non-interlaced.

Interlaced

A mode of display in which odd scan lines are displayed during one vertical scan of the picture and the even scan lines on the next vertical scan. This method of refresh can cause flicker on horizontal lines. It is abbreviated as I so that a board that ran at 60 Hz interlaced would be shown as 60 I.

Non-interlaced

A mode of display in which all scan lines are displayed during one vertical scan of the picture. This method of refresh eliminates flicker. It is abbreviated as NI so that a board that ran at 60 Hz non-interlaced would be shown as 60 NI.

Scan lines

The line of pixels that makes up one horizontal line of the screen image.

Coprocessor

An integrated-circuit chip that generates graphics but is not VGA -compatible.

VGA

An abbreviation for Video Graphics Array, the successor to the IBM CGA and EGA video display adapters.

Radio button

☒ A pushbutton in which only one in a group can be active at any one time. Select the appropriate *radio button* to display the WITSMark for the desired test.

Measure the refresh rate

With this function you can measure the refresh rate of a VGA display board. This function works ONLY with VGA boards. Other boards based on TI340x0 or other coprocessors will not work with this routine. Most boards from company's such as ATI, Diamond, Paradise, etc, will work well as they are VGA boards.

To measure the refresh rate click on the "Measure" button. It may take up to one minute to determine the refresh rate. Once it has finished and displayed the refresh rate click the "Return" button.

To return immediately without measuring the refresh rate click the "Return" button.

This function will measure the refresh rate of a VGA display board. While it can measure the vertical refresh rate it can not determine if the display is interlaced or non-interlaced. Most modern displays are non-interlaced and WITS makes that assumption. Refer to the documentation supplied with your display board to determine if it supports an interlaced mode. A non-interlaced refresh is more stable and flicker-free than an interlaced refresh.

The reason for measuring refresh rate is that the higher the refresh rate the slower the board will run. This is due to the contention for memory locations when the computer attempts to write a pixel at the same location the video output section is attempting to read the same pixel. The video output section has priority to access pixels (if it missed pixels there would be "snow" on the screen). The difference can be as great as 10-20%.

The refresh rate will be saved or printed with other data from the test(s).

