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User Manual

Tektronix

VM5000
Automatic Video Measurement Set

071-1522-02

This document applies to Option SD/HD software version 2.X and above.

This document applies to Option VGA software version 1.X and above.

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Contacting Tektronix

Tektronix, Inc.
14200 SW Karl Braun Drive or P.O. Box 500
Beaverton, OR 97077 USA

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Preface

This is the user manual for the VM5000 Automatic Video Measurement Set. This manual focuses on the automatic video measurement functionality; it does not cover the oscilloscope functionality. Refer to *Related Manuals and Online Documents* to locate information about using the oscilloscope functionality.

About This Manual

This manual is composed of the following chapters:

- *Getting Started* shows you how to configure and install your instrument and provides a functional check procedure.
- *Operating Basics*, using a highly-graphical approach, walks you through the basics of using the instrument user interface.
- *Reference* goes into more detail on the menu functions, understanding the measurements, and interpreting your results.
- *Appendices* provides additional information including instrument specifications, performance verification, cleaning information, and signal source descriptions.

Related Manuals and Online Documents

This manual is part of a document set of manuals and online documentation. See the following list for other documents supporting operation and service:

Manual name	Description
VM5000 *Quick Start User Manual (*printed, and also available on the software CD as a .pdf file*)*	The VM5000 Quick Start User Manual provides information about installation and basic operating concepts to enable you to start using VM5000 as quickly as possible.
VM5000 Automatic Video Measurement Set Online Help	An integrated online help system, which can be accessed from the VM5000 help menu (located in the middle of the screen when the VM5000 application is open).
*VM5000 Programmer Manual (*only in PDF format*)*	Documentation for GPIB commands, with syntax and description, and commands that are specific to the VM5000.
TDS5000B Series Digital Phosphor Oscilloscopes Quick Start User Manual	The Quick Start User Manual provides information about installation and basic operating concepts to enable you to easily use the basic oscilloscope functionality.
TDS5000B Series Digital Phosphor Oscilloscopes Online Help	An integrated online help system, which can be accessed from the oscilloscope platform help menu (located at the top right of the screen).
TDS5000B Series Oscilloscope Online Programmer Guide	A listing of the programming commands and other information related to controlling the oscilloscope functionality over GPIB.
TDS5000B Series Digital Phosphor Oscilloscopes Service Manual	A description of how to service the instrument to the module level. This optional manual must be ordered separately.

General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the Product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do Not Operate Without Covers. Do not operate this product with ***metal*** covers or panels removed.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Symbols and Terms

Terms in this Manual. These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product. These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product. The following symbols may appear on the product:



CAUTION
Refer to Manual



WARNING
High Voltage



Protective Ground
(Earth) Terminal

Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment Recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



The symbol shown to the left indicates that this product complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Mercury Notification. This product uses an LCD backlight lamp that contains mercury. Disposal may be regulated due to environmental considerations. Please contact your local authorities or, within the United States, the Electronics Industries Alliance (www.eiae.org) for disposal or recycling information.

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive. This product is known to contain lead, cadmium, mercury, and hexavalent chromium.

Getting Started

Product Description

This manual supports the VM5000 Automatic Video Measurement Set.

This chapter summarizes and highlights some of the key features of the instrument. Following this description are three sections:

- *Installation* shows you how to configure and install the instrument, as well as how to reinstall the system software included with the product.
- *Incoming Inspection* procedure verifies basic operation and functionality.
- *Accessories* lists the standard and optional accessories for this product.

Key Features

The VM5000 Automatic Video Measurement Set is a high-performance, oscilloscope-based automated video measurement system. Key features include:

- Fast, accurate, and repeatable video measurements
- Comprehensive component analog signal analysis
- Support for SD, HDTV, and RGBHV component analog video formats using options
- Automated testing of PC and DTV consumer video devices
- Automated VESA compliance testing for PC graphics devices
- Picture, Vector, and Waveform Displays
- Integrated Pass-Fail limit testing
- Companion Test Signal Package
- GPIB Remote Control and LAN Connectivity
- Complete Oscilloscope Functionality

Targeted to meet the needs of video professionals developing, testing, and manufacturing the next generation of Digital Television reception and play-out devices, PC and play-out devices, the instrument incorporates the power, features, and functionality needed in R&D, QA, and Production Test applications. It enables manufacturers to ensure that DTV video signal (Option SD/HD), and PC video signal (Option VGA) quality is up to the challenge of high performance displays, as well as enabling clear differentiation between input signal and display device impairments.

You can use the VM5000 Automatic Video Measurement Set for the following purposes:

- R&D
- Compliance and certification testing
- Quality/Audit testing
- Automated production test
- Off-air video systems testing

The VM5000 automates a variety of component analog video measurements which verify the integrity and quality of DTV video signals (Option SD/HD) and PC video signals (Option VGA).

The VM5000 automatically assesses conformance of selected video signal parameters to applicable EIA-770-3, SMPTE -274M, and 296M standards (Option SD/HD), or the VESA version 1 revision 2 standard (Option VGA).

The VM5000 also automates measurement of other industry-standard video parameters that quantify the performance of PCs or other consumer video reception and play-out devices with component analog interfaces.

By integrating automated measurement algorithms and a high-speed, wide bandwidth signal acquisition platform into one instrument, Tektronix offers a reliable means to make fast, objective, and accurate video measurements. Product verification activities that previously took hours or days to complete can now be completed in seconds or minutes. Offering near plug-and-play video measurement capability, even unskilled operators can reliably assess PC video output signal quality.

As a fully integrated video analyzer, the VM5000 offers configuration menu settings that can readily be recalled or copied, eliminating complicated oscilloscope set-ups, tedious manual measurements, and time-consuming results correlation exercises. Product quality is enhanced because test results can be reliably generated, easily replicated with other VM5000 instruments, and readily communicated across a global engineering, supply, or sales organization.

The VM5000 runs the Windows operating system, which provides for easy operation with minimal training time. A 10.4 in (264 mm) color display provides a bright, clear, and crisp display of waveforms and measurement results.

Compatibility of the VM5000 Option HD with the VM5000HD

If you are upgrading an existing VM5000HD, some default settings have changed. The changes are as follows:

- The default trigger channel has changed from CH1 to CH4.
- The Operation menu 'Run Mode' default setting has changed from 'Continuously' to 'Once.'
- The Report Generator Format setting now has two CSV options: 'CSV VM5000' and 'CSV Legacy.'
  - The CSV Legacy format is identical to the VM5000HD CSV format. This is provided for customers who perform data reduction on the CSV file. It does not include any information on new measurements.
  - The CSV VM5000 format includes information on all the new measurements and options; for example, Relative to Reference and Limit Testing results are included in the report.

Firmware Upgrade

Tektronix may offer firmware upgrade kits for the VM5000 instrument. Contact your Tektronix service representative for more information (refer to *Contacting Tektronix* at the beginning of the manual*)*.

Recommended Oscilloscope Probes

Table 1–1 lists the recommended oscilloscope probes to use when using the instrument as an oscilloscope.

Table 1-1: Recommended Probes

Probe type	Tektronix probe
Passive, 10X, 500 MHz	P5050
Passive, 100X, 250 MHz, high voltage	P5100
Passive, 1000K, 100 MHz, high voltage	P6015A
Passive, 15 MHz, 1X	P6101B
Active, DC to 1.0 GHz, FET high speed digital, for CMOS/TTL technology	P6243
Active, DC to 1.5 GHz, FET high speed digital, for all technologies	P6245
Active, DC to 400 MHz, FET, high bandwidth differential	P6246

Table 1-1: Recommended Probes (Cont.)

Probe type	Tektronix probe
Active, DC to 1.0 GHz, FET, high bandwidth differential	P6247
Active, DC to 1.7 GHz, FET, high bandwidth differential	P6248
Active, 100 MHz, high voltage differential	P5205
Active, 50 MHz, high voltage differential	P5210
AC Current	P6021
AC Current	P6022
DC/AC Current	AM5030S
High Speed Current	CT-1/CT-2
Current, 250 KHz to 2 GHz, 50 Ω input, AC Only, for temporary in-circuit installation	CT-6
Current, DC to 50 MHz, 15 A DC	TCP202
Low Capacitance, 20X, 3 GHz	P6158
Current Measurement	TCPA3000
Current Measurement	TCPA4000
Differential Preamp	ADA400A
High Voltage Differential	P5200
Optical/Electrical Converter	P6701B
Optical/Electrical Converter	P6703B

Installation

This section addresses instrument installation:

- *Unpacking* on page 1-5
- *Checking the Environment Requirements* on page 1-6
- *Connecting the Mouse* on page 1-7
- *Powering On the Instrument* on page 1-8
- *Shutting Down the Instrument* on page 1-8
- *Creating an Emergency Startup Disk* on page 1-9
- *Backing Up User Files* on page 1-9
- *Installing Software* on page 1-10
- *Connecting to a Network* on page 1-11
- *Adjusting Display Contrast* on page 1-12



CAUTION. *Be sure to create your emergency startup disk as described on page 1-9. You may need that disk if you ever need to reinstall Windows 2000 on the instrument hard drive.*

Unpacking

Refer to the tables beginning on page 1-23 for a list of the options and accessories shipped with this instrument. Remember to fill out and send in the customer registration card.

Checking the Environment Requirements

Read this section before starting any installation procedures. This section describes site considerations, power requirements, and ground connections for your instrument.

Site Considerations

The instrument is designed to operate on a bench or on a cart in the normal position (on the bottom feet). For proper cooling, make sure that there is at least three inches (76.20 mm) of clearance on the left side of the instrument. See Figure 1–1. If you need to access the instrument CD-RW drive, you will also need at least 5.1 inches (129.54 mm) of clearance on the right side of the instrument.

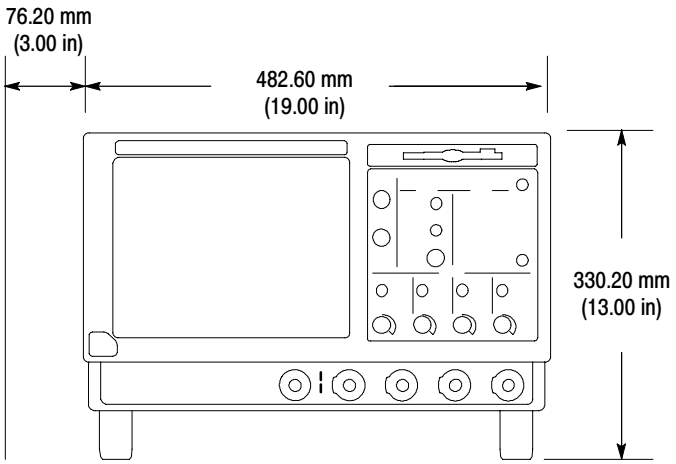


Figure 1-1: Instrument space requirements



CAUTION. *To ensure proper cooling, keep the bottom and left side of the instrument clear of obstructions.*

Operating Requirements

The specifications in *Appendix A* list the power source, temperature, humidity, and altitude operating requirements for the instrument.

Connecting the Mouse

The instrument includes a USB (Universal Serial Bus) mouse. You can plug the mouse into any of the four available USB ports. The USB ports and other PC peripheral connection points are shown in Figure 1–2. Refer to the *TDS5000B Quick Start User Manual* for additional connection information.

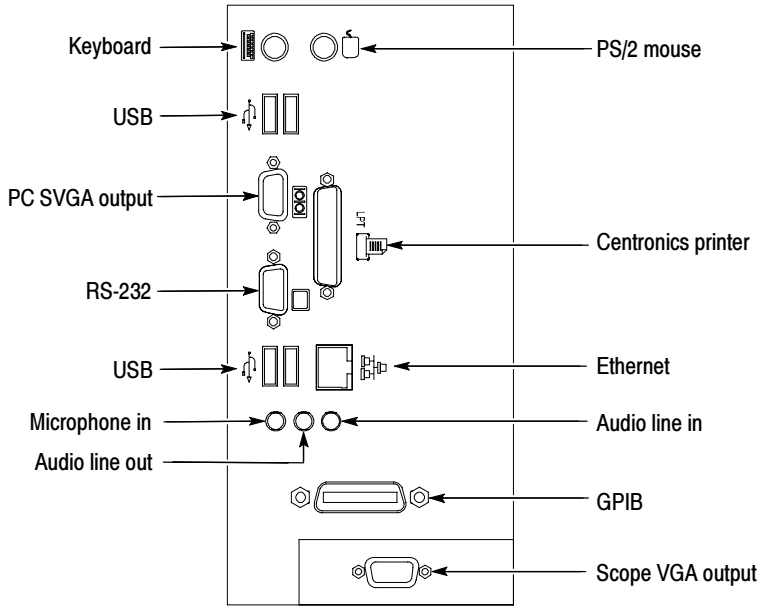


Figure 1-2: Locations of VM5000 Option VGA connectors

***NOTE**. For best performance, plug the USB devices directly into the USB connectors on the instrument chassis, rather than connecting the devices serially.*

You can connect or disconnect a USB mouse, keyboard, or other USB devices with the power on. If your USB mouse locks up, disconnect and reconnect the USB connector to restore normal operation.

***CAUTION.** To avoid product damage, shut down the instrument and disconnect the power cord from the power source before connecting any accessories other than USB devices. If the instrument front panel and/or touch screen does not respond, press the On/Standby switch for at least five seconds to cycle power. See* Shutting Down the Instrument *on page 1–8.*

Powering On the Instrument

Follow these steps to power on the instrument for the first time:

CAUTION. *To ensure proper operation, connect the keyboard, mouse, and other accessories before applying power to the product the first time.*

1. Connect one end of the instrument power cord to the instrument and the other end to a power source.
2. Push the On/Standby switch to power on the instrument (see Figure 1-3 for the switch location).

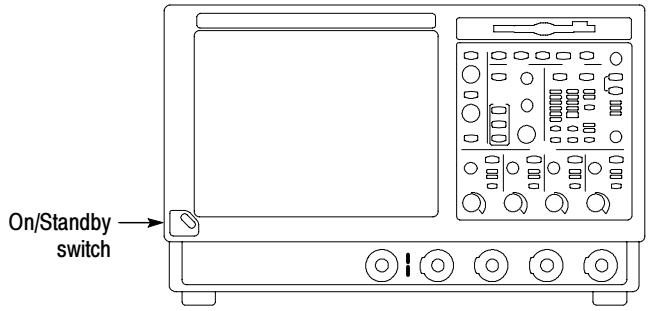


Figure 1-3: On/Standby switch location

Shutting Down the Instrument

To shut down the instrument, push the front-panel On/Standby switch. The instrument preserves settings and then starts a shutdown process (including a Windows shutdown) to put the instrument into standby mode. Avoid disconnecting the power cord or power source to shut down the instrument.

NOTE*. If you remove power instead of using the On/Standby switch to shut down the instrument, the instrument will be in the factory Default Setup when powered on the next time.*

If the shutdown process does not start immediately after pushing the ON/Standby switch, push and hold the On/Standby switch for up to 20 seconds to start the shutdown process.

To completely remove power to the instrument, push the On/Standby switch and then disconnect the power cord from the power source.

Creating an Emergency Startup Disk

Now that you have completed the basic installation process, you should create an emergency startup disk. The emergency startup disk contains basic files to restart your instrument in case of a major hardware or software failure. The disk also contains files that you can use to check and format the hard disk.



CAUTION. *Create this disk and store it in a safe place. It may help you recover your Windows 2000 installation without rebuilding the entire instrument hard disk.*

Follow these steps to create the emergency startup disk for a Windows 2000 instrument:

1. Minimize the instrument application by selecting **Minimize** in the File menu.
2. From the Windows taskbar, select **Start > Programs > Accessories > System Tools > Backup**.
3. In the Welcome display, click **Emergency Repair Disk**.
4. Insert a 3.5 inch disk into the disk drive, and follow the on-screen instructions to create the startup disk.

Backing Up User Files

Always back up your user files on a regular basis. Use the Windows Backup tool to back up files stored on the hard disk. The Backup tool is located in the System Tools folder in the Accessories folder.

Use these steps to back up your files:

1. Quit the instrument application by selecting the File menu **Exit** command.
2. Click the Windows **Start** button.
3. Select **Programs > Accessories > System Tools > Backup**.
4. Use the Backup Wizard to select the items you want to back up and the destination. The destination can be the floppy drive or a third-party storage device over one of the side-panel ports.

Installing Software

The instrument system and application software is preinstalled at the factory. If you have to reinstall the software for any reason, refer to the instructions that accompany the CD-ROMs that are shipped with the instrument.

Software Release Notes

Read the software release notes (README.TXT) on the product software CD-ROM before performing installation procedures. This file contains additional information that supercedes other product documentation.

To view README.TXT, start the Windows Notepad accessory and open the file from the *VM5000 Automatic Video Measurement Set Product Software* CD-ROM.

VM5000 Remote Command Information

The GPIB programmer information is available in the *VM5000 Automatic Video Measurement Set Programmer Manual PDF* located on the VM5000 product software CD–ROM.

Programmer information for the rest of the instrument functions is available as a PDF file on the *TDS5000B Series Product Software* CD-ROM.

Desktop Applications

You can install desktop application software on the instrument. The instrument has been tested with the following software products installed:

- Microsoft Office 98 (Word, Excel, PowerPoint)
- MathCad (Option SD/HD only)
- MATLAB (Option SD/HD only)

Other software products may be compatible but have not been tested by Tektronix. If the instrument malfunctions after you install software, uninstall the software and then reinstall the instrument software (if necessary) to restore proper operation.

Quitting the instrument Application. Before installing other desktop applications, quit the instrument application. To do this, select the **File > Exit** command.

Connecting to a Network

You can connect the instrument to a network to enable printing, file sharing, internet access, and other communications functions. Before you make the connection, do the following steps to enable network access to the instrument:

NOTE*. If you want to disable network access for the instrument, perform the following procedure, except substitute Disabled for the command listed in step 8. The instrument will boot faster with network access disabled.*

1. Begin with the instrument power off.
2. Attach a keyboard and mouse to the instrument.
3. Power on the instrument.
4. As the instrument begins to boot, press the keyboard **F2** key repeatedly until the "Loading SETUP" message appears.
5. In the BIOS Setup Utility, use the keyboard right-arrow key to highlight the **Advanced** menu at the top of the screen.
6. Use the arrow down key to highlight **Peripheral Configuration** in the Advanced screen, and then press **Enter**.
7. Use the arrow down key to highlight **LAN Device** in the Peripheral Configuration screen, and then press **Enter**.
8. Use the arrow up or down key to highlight **Enabled**, and then press **Enter**.

9. Press the **F10** key to save and quit. Confirm Save of the configuration changes when you are prompted on screen.

10. Use the Windows network setup utility to define the instrument as a network client, and configure it for your network. You can find the network setup utility in the Windows **Start** menu if you select **Settings > Control Panel** and then double click **Network**. You should consult your network administrator for specific instructions to make these settings.

Adjusting Display Contrast

If you find that the instrument screen is too bright or too dark, use these steps to adjust the LCD display contrast to your preference. You must have a mouse attached to perform this procedure.

1. Right click the Windows desktop.

2. Select **Properties**.

3. Select the **Settings** tab.

4. Click **Advanced**.

5. Select the **Color** tab.

6. Adjust the slider control for the desired gamma setting. The screen brightness will change as you move the slider control.

7. Click **Apply**.

8. Click **OK**.

Incoming Inspection

This section contains instructions for performing a self test and functional verification of the instrument. These procedures verify that the instrument is operating correctly after shipment, but they do not check product specifications.

If the instrument fails any test within this section, it may need service. To contact Tektronix for service, see *Contacting Tektronix* on the copyright page.

Make sure you have installed the instrument as described in *Installation* starting on page 1–5.

Self Tests

This procedure uses internal routines to verify that the instrument functions and was adjusted properly. No test equipment or hookups are required.

Equipment required	None
Prerequisites	Power on the instrument and allow a 20 minute warm-up.

Perform these substeps to verify internal diagnostics:

1. *Display the system diagnostics menu as follows:*

   a. If the instrument is in the toolbar mode, click **Menu** (far right toolbar button) to switch to menu bar mode.

   b. From the Utilities menu, select **Instrument Diagnostics** to open the Instrument Diagnostics control window.

   c. In the **Subsystem**, **Area**, and **Test** lists, ensure that you select **ALL**.

2. *Run the system diagnostics as follows:*

   a. Disconnect all input signals from all four channels.

   b. Click **Run** in the Instrument Diagnostics control window.

   The internal diagnostics do an exhaustive verification of proper instrument function, taking five to fifteen minutes. When complete, the resulting status appears in the diagnostics control window.

3. *Verify that no failures are found and reported:* The instrument should pass all tests. If any failures occur, record the failure information and contact your local Tektronix service personnel for more information.

4. *Run the signal path compensation routine as follows:*

   a. From the Utilities menu, select **Instrument Calibration** to open the Instrument Calibration control window.

   b. Click **Calibrate** to start the routine.

   c. *Confirm signal path compensation returns passed status:* Signal path compensation may take up to ten minutes to run. Verify that the word ***Pass*** appears in the Status text box.

5. Click **Close** to quit the Instrument Calibration control window.

Functional Test

Option SD/HD

This procedure uses the output from a video signal generator, TG700 or equivalent, to verify the VM5000 SD and HD video application functionality. Two functional tests are described, one for option HD and another for option SD. If you have both options, either test alone will verify functionality adequately.

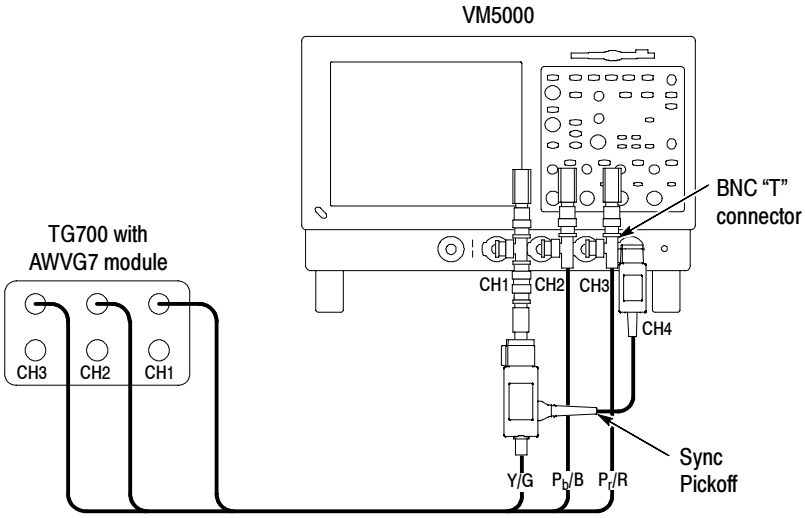
Equipment required	VM5000
	75Ω precision BNC terminations (3)
	BNC "T" connectors (3)
	A TG700 video generator with either a AWVG7 (for HD) or AVG7 (for SD) (or equivalent generator)

NOTE*. These procedures verify that the application features operate. They do not verify that they operate within limits. Therefore, when the instructions in these functional tests call for you to verify that a signal appears on screen "that is about five divisions in amplitude" or "has a period of about six horizontal divisions," and so on, do not interpret the quantities given as limits.*

Do not change the front-panel settings unless directed to by the procedure. If you change front-panel settings, you may obtain invalid results. In this case, redo the procedure from step 1.

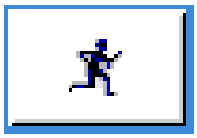
When you are instructed to press a front-panel button or screen button, the button may already be selected (its label is lighted). If this is the case, it is not necessary to press the button.

1. Set the video generator to output 1080i/60 100% (for option HD) color bars, or 480i/60 100% color bars (for option SD).
2. Connect the signal generator to the VM5000 instrument as shown in the following diagram:



3. Power on the VM5000 instrument and wait for it to complete the power-on process.
4. Select **File > Run Application > VM5000 HD and SD video** to display the VM5000 application window.
5. In the application window, select **File > Recall Default** to load the application default settings.
6. In the application window, select **Configuration > Format** to display the Format view.
7. Select the **1080i/60 (HD) or 480i/60 (SD)** button.
8. In the application window, select **Configuration > Operation** to display the Operation view.

9. In the application window, select the **Run** button to start the application measurement process.



The instrument begins taking measurements and displays a Color bars measurement view listing measurement values similar to those as shown.

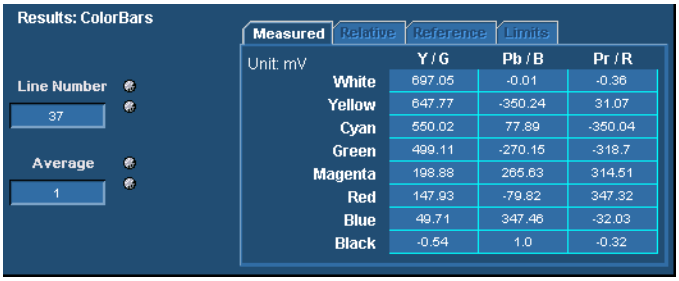


Figure 1-4: Displaying measurement values in color bars measurement

10. Select the Picture button to display the VM5000 Video Monitor Window. Verify that a color bars signal appears.

This completes the functional test. If your VM5000 did not complete the functional test satisfactorily, please contact your local Tektronix Service representative.

Option VGA

This procedure uses the output of a PC Display Card to verify the functionality of the VM5000 Option VGA measurement set (comprising the VM5000 Option VGA, RGBHV Measurement Interface Unit (MIU) and associated cables).

Equipment required	VM5000 Option VGA
	RGBHV Measurement Interface Unit
	VGA to 5 BNC cable, part number 174-5126-XX
	PC with VGA Display Card

***NOTE**. These procedures verify that the application features operate. They do not verify that they operate within limits. Therefore, when the instructions in these functional tests call for you to verify that a signal appears on screen "that is about five divisions in amplitude" or "has a period of about six horizontal divisions", and so on, do not interpret the quantities given as limits.*

Do not change the front-panel settings unless directed to by the procedure. If you change front-panel settings, you may obtain invalid results. In this case, redo the procedure from step 1.

When you are instructed to press a front-panel button or screen button, the button may already be selected (its label is lighted). If this is the case, it is not necessary to press the button.

1. Connect the RGBHV MIU to the VM5000 as described in *Option VGA Setup 1: RGBHV Measurement Interface Unit* on page 2–7.
2. Set the VGA display card under test to any built-in format (such as 800x600@60) supported by Option VGA. This can be done in the PC by using the **Display Properties** menu. Select the corresponding Matrix BMP file (Resolution 800x600-Matrix Signal.bmp) from the PC Bitmap Graphics CD (part number 020–2634–XX) and display the BMP file in full screen mode.
3. Remove the PC monitor connection from the VGA display card and connect the VGA display card output to the input channels on the MIU using the VGA to 5 x BNC adapter cable.
4. Ensure that all four channels of the VM5000 are enabled. All four channel buttons must be glowing.
5. Press the Autoset button on the VM5000. You should see the signals from all four channels on the display with some visible activity.
6. Launch the VM5000 application from the TekScope menu bar by selecting **File > Run Application > VM5000 VGA Video**.
7. In the Format Panel (**Configuration > Format**), select the 800 x 600 resolution and 60 Hz refresh rate. Leave the Timing standard as the default (that is, DMT). If the VGA display card generates signals using a different Timing Standard, change the Timing selection accordingly. Refer to Figure 1–5.

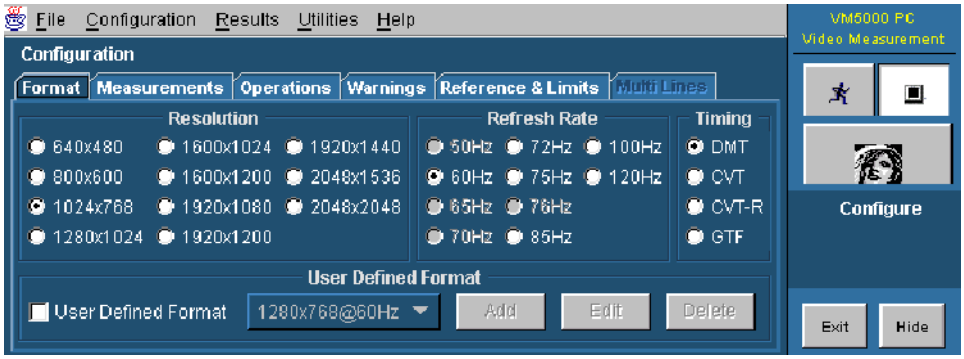


Figure 1-5: Format panel

8. In the Measurements panel (Configuration > Measurements), select the following measurements:

   - Color Bars
   - H Sync
   - V Sync
   - Video Transient

   Leave the settings in other configuration panels at their default values.

9. Press the Run button.

10. If the VM5000 is functioning normally, the four selected measurements will be executed without any warning message(s). The results should be displayed on the corresponding result panels (for example, **Results > H Sync**). Because multiple measurements are selected, the Results Summary panel will appear. Some representative screen shots are shown in the Figures 1-6 through 1-10.

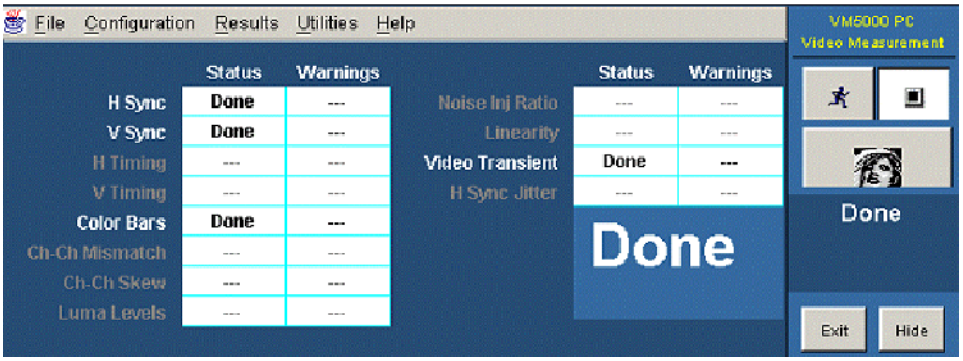


Figure 1-6: Results Summary display

11. To view results for individual measurements, go to their respective screens. For example, to see the results of the color bars measurement, select **Results > Color Bars**.

The results shown in Figure 1–7 through Figure 1–10 are typical results. Your results may vary.

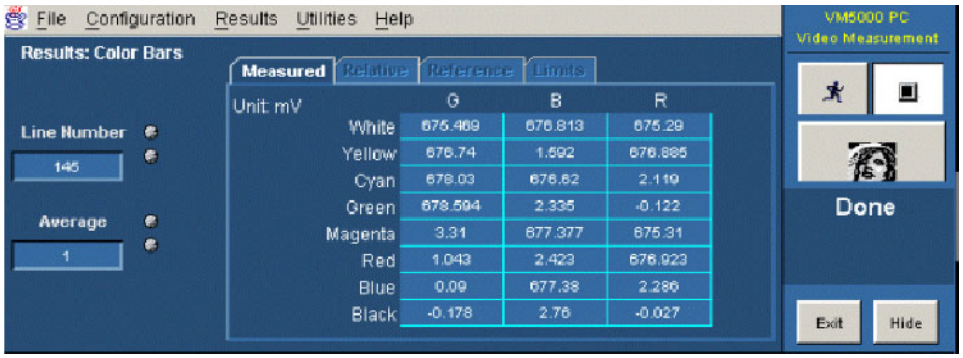


Figure 1-7: Color Bars measurement results display

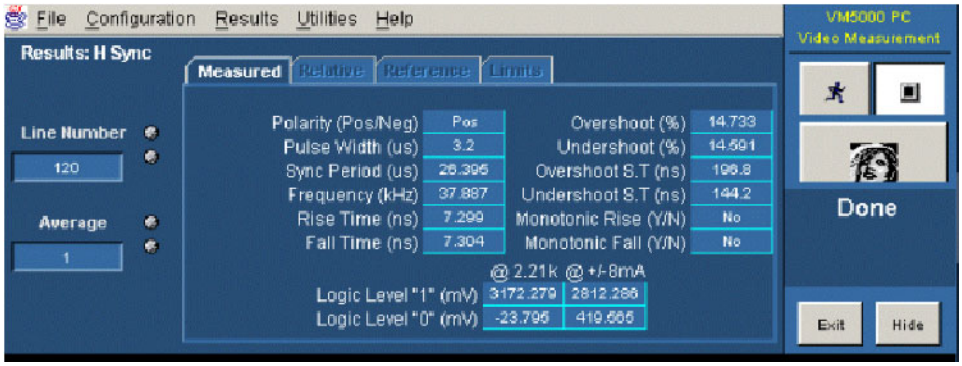


Figure 1-8: H Sync measurement results display

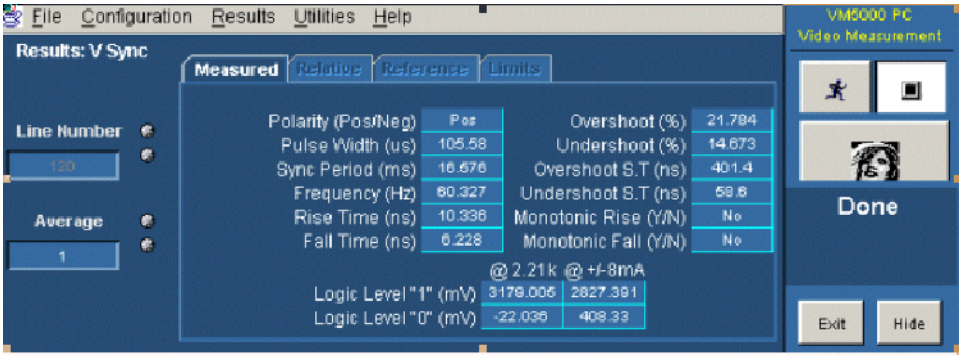


Figure 1-9: V Sync measurement results display

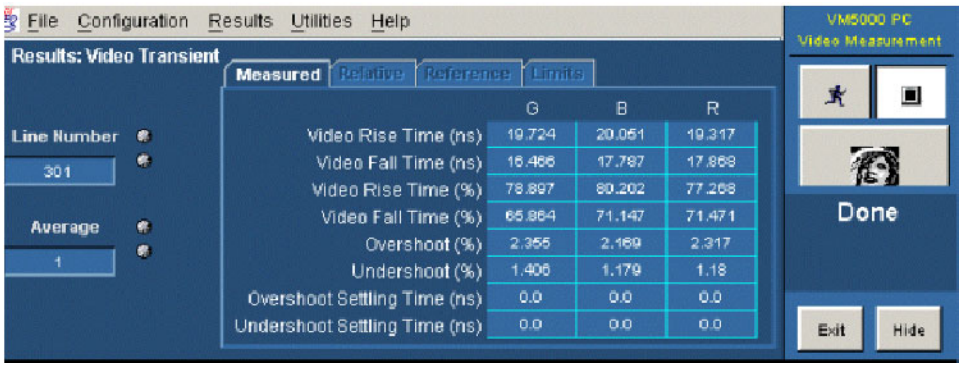


Figure 1-10: Video Transient measurement results display

Possible Errors and Troubleshooting Tips. If there is any problem associated with the MIU or its connections, the following error message appears:

Error occurred in configuring the MIU

Perform the following steps to isolate the problem:

1. To further localize the problem, check the results display. For example, if there is no signal on the G channel, the corresponding results will not be displayed. So, check the G channel cables and their connection at the input side of the MIU. Between the MIU and VM5000 check the Ch 1 cable and its connections.
2. If expected results still do not appear, there might be some internal problem in the MIU.
3. Other warning messages can be due to an incorrect signal or no signal. If the warning is due to no signal, carry out the checks specified in step 1 above. If the warning is due to an incorrect signal, ensure that the VGA card is set to the same resolution, refresh rate, and timing standard as selected in the Format panel of the application and that the appropriate BMP file is used.

This completes the VM5000 functional test for Option VGA. If your VM5000 did not complete the functional test satisfactorily, contact your local Tektronix Service representative.

Options and Accessories

This section lists the product options, standard accessories, and optional accessories that are available for the instrument.

Options

You can order the options shown in Table 1–2 with the instrument. For the current list of accessories, upgrades, and options, including service options, available for your VM5000, visit the Tektronix Web site, www.tektronix.com.

Table 1-2: Instrument options

Hardware	18*1	Touch-screen interface
	1R	Rackmount kit
	FHD	Front panel removable hard drive
	1K	Scope Cart
	655-4920-00	Thermal Printer - 1P
Mounting	016-1946-XX	TDS5000B Series Rackmount Kit - 1R
Software	SM	Series Communications mask testing
	CP2*2	TDSCPM2 - ANSI/ITU telecom pulse compliance testing software (This requires option SM)
	HD*3	HD component analog video measurements & format support, includes test signal package
	SD*3	SD component analog video measurements & format support, excludes test signal package
	VGA*3	RGBHV Video Measurements and VESA Compliance Tests
	DVD	TDSDVD - Optical storage analysis software
	ET3	TDSET3 - Ethernet compliance test software
	J2	TDSDDM2 - Hard disk drive measurements software
	J3E	TDSJIT3E - Jitter and timing analysis software essentials
	JA3	TDSJIT3 V2.0 Advanced- Jitter and timing analysis software
	JT3	TDSJIT3 V2.0 Essentials- Jitter and timing analysis software
	PW3	TDSPWR3 - Power measurements software

Table 1-2: Instrument options (Cont.)

	USB	TDSUSBS; USB 2.0 Compliance test software only
Service	C3	Calibration Service 3 years
	C5	Calibration Service 5 years
	D1	Calibration Data Report
	D3	Calibration Data Report 3 years (with Option C3)
	D5	Calibration Data Report 5 years (with Option C5)
	R3	Repair service 3 years (including warranty)
	R5	Repair service 5 years (including warranty)

*1 No upgrade path for this option, must be ordered at the time of initial purchase.

*2 Requires option SM.

*3 At least one of the Option HD, SD, or VGA is mandatory for each VM5000 Instrument.

Upgrades equivalent to original options can be ordered to extend instrument performance after initial purchase. Users can install upgrades without opening the instrument case or requiring on-site service. To upgrade a VM5000, order a VM5UP with one or more of the options listed above. Factory installation is available by specifying Option IF. For older VM5000HD instrument upgrades, order VM5HDUP with one or more of the following options: 1R, DVD, ET3, J2, J3E, JT 3, PW3, USB.

Accessories

This section lists the standard and optional accessories. The accessories listed in Table 1-3 are shipped standard with the instrument. Please specify the power plug and the manual language option when ordering.

Table 1-3: Standard Accessories

Accessory	Part number
VM5000 Automatic Video Measurement Set Quick Start User Manual in English (and a Korean, German, Spanish, Traditional Chinese, Simplified Chinese, or Japanese translation if a language option was ordered)	071-1573-XX
VM5000 Automatic Video Measurement Set User Manual	071-1522-XX
VM5000 Automatic Video Measurement Set Programmer Manual in PDF format on VM5000 Product Software CD	071-1574-XX
VM5000 Complete Signal Set (Option SD only)	020-2610-XX
VM5000 Signal Set (Option SD/HD Only)	020-2611-XX
VM5000 PC Graphics Test Signal Files (Option VGA only)	020-2634-XX

Table 1-3: Standard Accessories (cont.)

Accessory	Part number
TDS5000B Series Digital Phosphor Oscilloscopes Quick Start User Manual	
English (Option L0)	071-1355-XX
French (Option L1)	071-1352-XX
German (Option L2)	071-1358-XX
Japanese (Option L5)	071-1356-XX
Simplified Chinese (Option L7)	071-1360-XX
Traditional Chinese (Option L8)	071-1361-XX
Korean (Option L9)	071-1359-XX
Russian (Option L10)	071-1401-XX
Oscilloscope Analysis and Connectivity Made Easy manual with software	020-2449-XX
VM5000 Product Software CD-ROM (includes VM5000 product software with online help, VM5000 User Manual PDF, VM5000 Quick Start User Manual PDF, and release notes)	020-2565-XX
TDS5000B Series Product Software CD-ROM that includes TDS5000B product software including online help, TDS5000B Programmer Guide (GPIB online help and PDF), Performance Verification PDF, release notes, VISA information	063-3692-XX
TDS5000B Series Operating System Restore CD-ROM	063-3759-XX
TDS5000B Series Optional Applications Software CD-ROM	020-2450-XX
Getting Started with *OpenChoice*™ book and Software Developer's Kit CD-ROM	020-2513-XX
30-day evaluation copy LabVIEW CD-ROM	020-2476-XX
Calibration Certificate Documenting NIST Traceability, Z540-1 Compliance, and ISO9001 Registration	---
Option HD	
Test signal files (ATSC transport, MPEG ES, TG700 DNL, Bitmap) on CD-ROM	020-2611-XX
Sync pick-off accessory	012-1680-XX
Option SD	
VM5000 DVD Signal Set	020-2610-00
VM5000 MPEG and Baseband Signal Set	020-2611-00
Sync pick-off accessory	012-1680-00

Table 1-3: Standard Accessories (cont.)

Accessory	Part number
Option VGA	
PC graphics bitmap test signal files on CD-ROM	020-2634-XX
VGA to 5X BNC cable (3 foot)	174-5126-XX
VGA to 5X BNC cable (6 in.)	174-5147-XX
RGBHV Measurement Interface Unit	012-1685-XX
Termination accessory kit	
BNC-to-Binding Post Adapters (2)	011-0183-XX
Power Cord	
North America (Option A0)	161-0104-00
Universal Euro (Option A1)	161-0104-06
United Kingdom (Option A2)	161-0104-07
Australia (Option A3)	161-0104-05
240V North America (Option A4)	161-0104-08
Switzerland (Option A5)	161-0167-00
Japan (Option A6)	161-A005-00
China (Option A10)	161-0306-00
No power cord or AC Adapter (Option A99)	
Optional Wheel Mouse	119-6936-XX
Mini-Keyboard	118-9402-XX
Front Cover	200-4651-XX
Accessory Pouch	016-1935-XX
Optional Applications Software for Windows-Based Oscilloscopes CD-ROM and manuals	020-2450-XX
P5050 10X, 500 MHz, Passive Voltage Probe	P5050
Blank CDR / CDRW	020-2434-XX
Click 'N Burn Patch Floppy Disk	063-XXXX-XX
Precision 75 Ω terminations (4)	011-0102-XX
2.21 KΩ and 301 Ω Terminator Kit	020-2633-XX
BNC Female-to-Female connector	103-0028-XX
BNC Male-to-Male connector	103-0029-XX
BNC "T" connectors (4)	103-0030-XX
2.21 kΩ resistor	322-3226-00
301 Ω resistor	322-3143-00

Table 1-3: Standard Accessories (cont.)

Accessory	Part number
VGA to BNC Sync Combiner cable	012-1664-XX

Table 1–4 lists the Recommended Accessories.

Table 1-4: Recommended Accessories

Accessories	Part Number
TDS5000B Series Digital Phosphor Oscilloscopes Service Manual	071-1362-XX
Transit Case	016-1937-XX
Probe Calibration, Compensation, and Deskew Adapter	067-0405-XX
Power Deskew Fixture	067-1478-00
Video Display Clamp	013-0278-XX
P5050 500 MHz 10x passive probe	P5050
GPIB Cable (3.3 ft. or 1m)	012-0991-01
GPIB Cable (6.6 ft. or 2m)	012-0991-00
Centronics (printer) cable	012-1214-00

The accessories in Table 1–5 were orderable for use with the instrument at the time this manual was published. Consult a current Tektronix catalog or the Tektronix Web site for additions, changes, and details.

Table 1-5: Optional Accessories

Accessories	Part Number
Transit Case	016-1937-00
Video Display Clamp	013-0278-XX
Thermal Printer Paper	016-1897-00
Probe Calibration, Compensation and Deskew Adapter Requires a separate pulse generator	067-0405-XX
Power Deskew Fixture	067-1478-00
Extra Front Removable Hard Drive	065-0692-XX
P6101B 15 MHz 1X Passive Probe	P6101B
Extra P5050 500 MHz 10X Passive Probe	P5050

Table 1-5: Optional Accessories (Cont.)

Accessories	Part Number
TCPA300, TCPA400 Series Current Measurement Systems (requires TCPA300 / TCPA400 style probe)	TCPA300 / TCPA400
AMT75 1 GHz 75 W Adapter	AMT75
AFTDS Differential Signal Adapter	AFTDS
K420 Scope Cart with mouse accessory tray	436-0317-XX
TDS5000 Series, VM5000 Option HD rackmount kit	016-1887-XX
GPIB cable (3.3 frt / 1 m)	012-0991-01
GPIB cable (6.6 ft / 2m)	012-0991-00
Centronics cable	012-1250-00

Operating Basics

Operating Basics

This section provides basic information on how to use VM5000. More detailed measurement information can be found in the *Reference* section.

Input Signal Connection Requirements

Option SD/HD

Use only 75 Ω coaxial cables to connect the video device under test to the VM5000 instrument.

Install the included 75 Ω terminations between the end of the coaxial cables and the instrument input channels, using the included BNC "T" connectors. See Figure 2–1. For accurate frequency response measurements, it is important to attach the "T" connector directly to the VM5000 input channel BNCs.

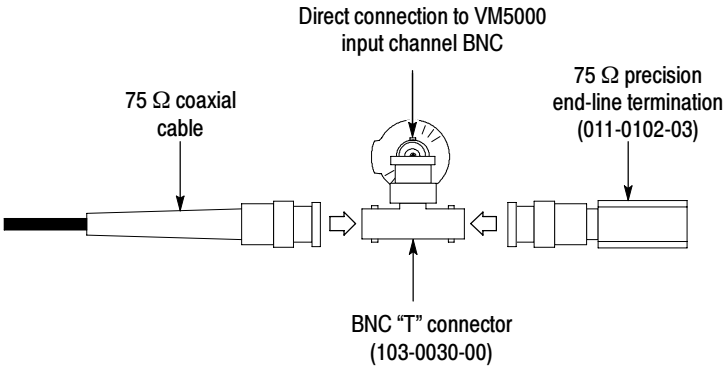


Figure 2- 1: Connecting the T-connector to the VM5000

Option VGA

The preferred method of connecting the video device under test to the VM5000 instrument is to use the RGBHV Measurement Interface Unit. The Measurement Interface Unit contains an impedance-matching circuit to ensure the most accurate measurement results. For some measurements, a low-frequency path is used and for other measurements a wideband path is used.

The VM5000 selects which path is used through an RS-232 connection to the Measurement Interface Unit. See Figure 2–2.

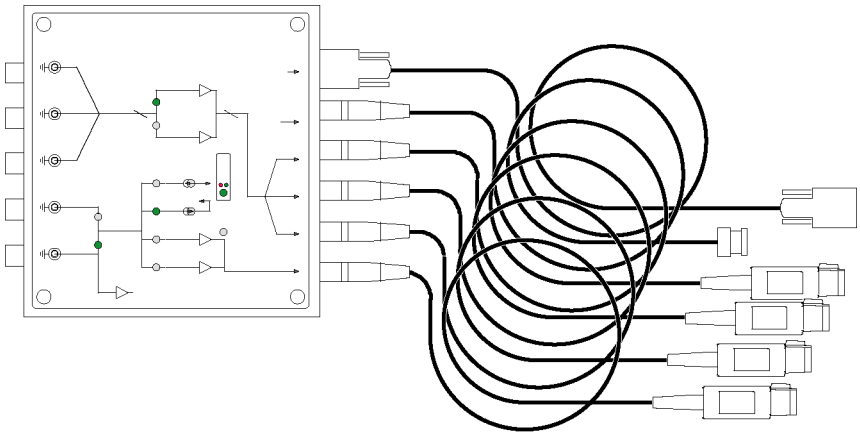


Figure 2-2: RGBHV Measurement Interface Unit

You can also connect the video device under test to the VM5000 by using the supplied VGA Connector to 5X cable. See Figure 2–3. If you use this method, you will need to connect the cable to the VM5000 using the supplied precision terminations. Depending on which measurements you take, you may need to manually change terminations while taking measurements.

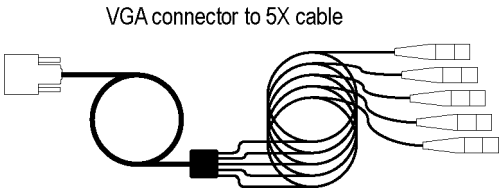


Figure 2-3: VGA connector to 5X cable

Connecting Input Signals

Use the following diagrams to determine the optimum input signal setup for your measurement needs.

3-Wire Analog Video with Composite Sync, Setup 1 (Option SD/HD)

This is the preferred setup for testing 3-wire component analog video signals (Y/G, Pb/B, Pr/R) with the composite sync signal on Y/G. This setup uses the Sync Pickoff accessory to derive the trigger signal from the Y/G signal on CH1. The triggering source is set to Channel 4. This configuration provides more accurate low-level noise measurements (below –60 dB at 30 MHz bandwidth) than setup 2.

Figure 2–4 shows how to connect the Sync Pickoff to the instrument. This method of connecting to the instrument allows you to make more accurate noise measurements on CH 1 while triggering on CH 4, without adding additional cabling from CH1 to CH4. The additional cabling could adversely impact frequency response and multiburst measurements.

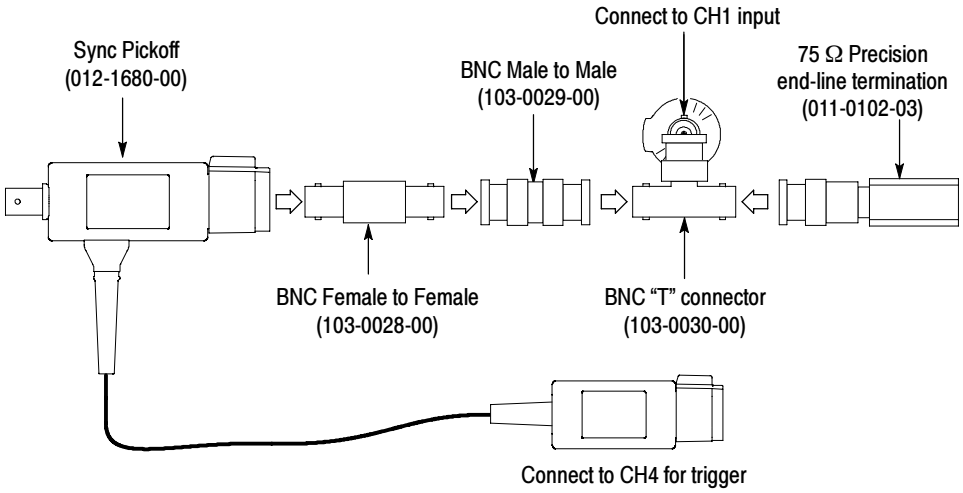


Figure 2- 4: Connecting the Sync Pickoff to the instrument

To achieve the best frequency response and multiburst measurements, connect the 75 Ω terminator as close to the platform's input connector as possible, as shown in the Figure 2–5.

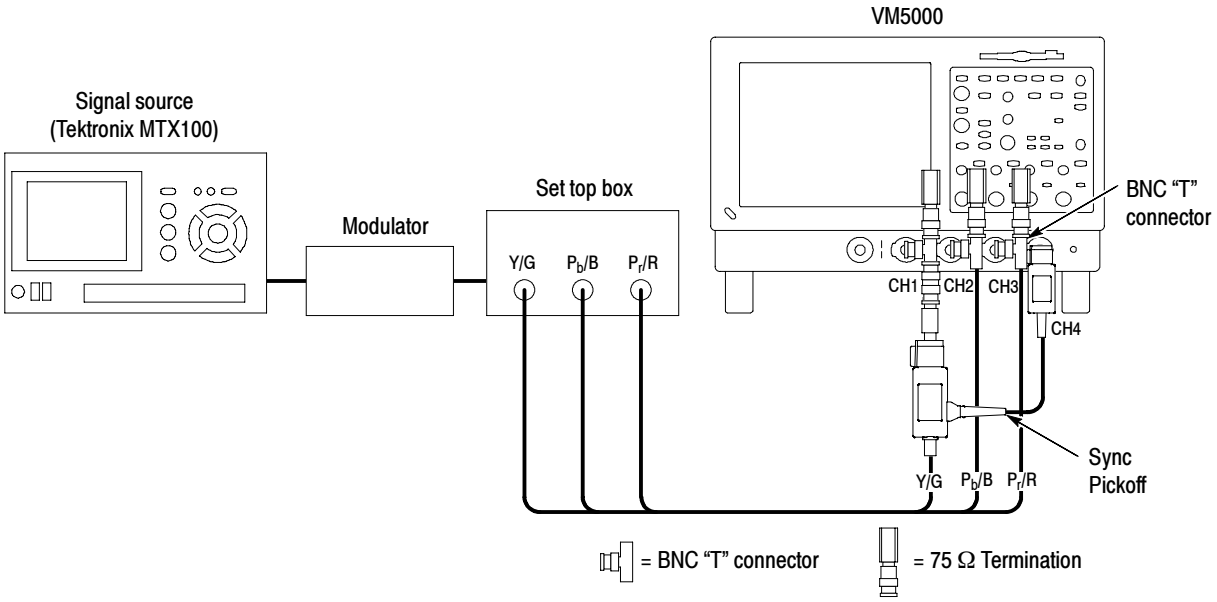


Figure 2- 5: Connection of 3- wire video with composite sync, Setup 1

NOTE*. Verify that the trigger channel is set to channel 4 (the default setting). If the trigger setting (Configuration > Operation) is not set to channel 4, you will see signal warning messages and will be unable to take measurements.*

3-Wire Video with Composite Sync, Setup 2 (Option SD/HD)

Use this setup for testing 3-wire component analog video signals (Y/G, Pb/B, Pr/R) with the composite sync signal on Y/G. See Figure 2–6. Set the triggering on the instrument to channel 1 (the default trigger setting is channel 4). This setup is simpler than the others mentioned in this section, but limits noise measurement on Y/G to –65 dB (30 MHz noise bandwidth).

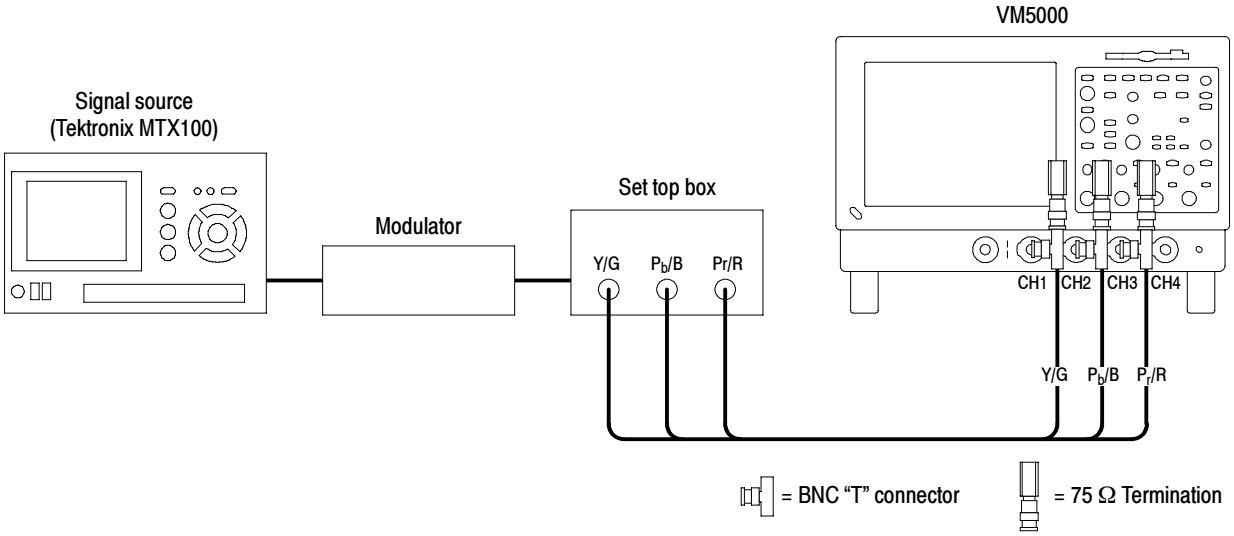


Figure 2-6: Connection of 3-wire video with composite sync, Setup 2

NOTE. *Verify that the trigger channel is set to channel 4 (the default setting). If the trigger setting (Configuration > Operation) is not set to channel 4, you will see signal warning messages and will be unable to take measurements.*

4-Wire Video with Separate Composite Sync (Option SD/HD)

Use this setup for testing 4-wire component analog video signals (Y/G, Pb/B, Pr/R) with the composite sync signal on a separate output line. For CH4, termination is optional. For CH4 only, you can use no termination or a 75 Ω termination of lower accuracy than the 75 Ω terminations that are provided with the instrument. See Figure 2–7.

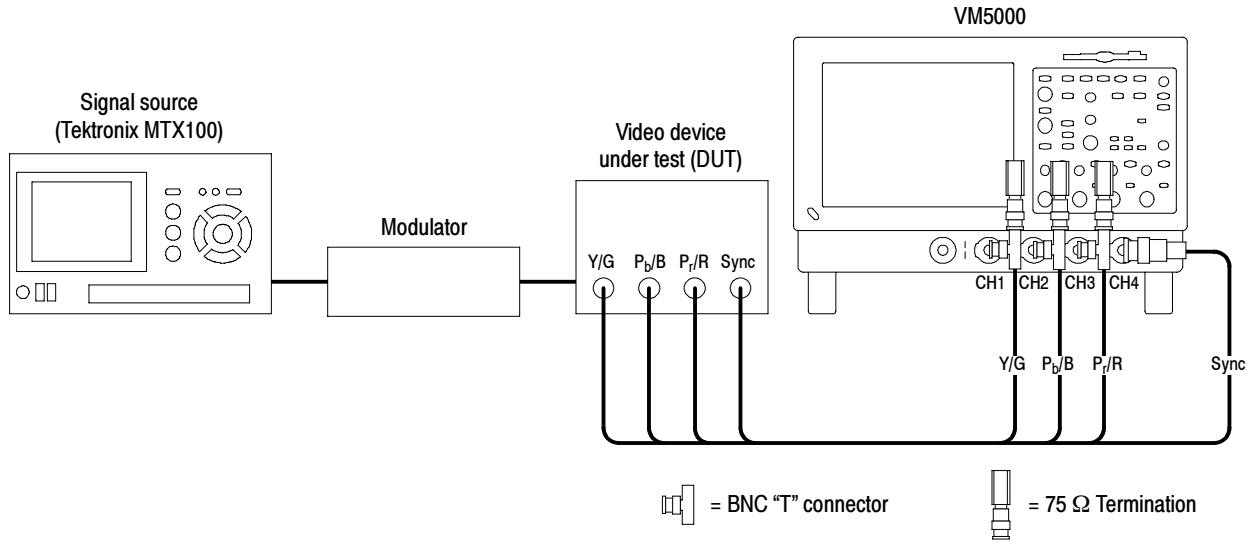


Figure 2-7: Connection of 4-wire video with separate composite sync

NOTE. *Verify that the trigger channel is set to channel 4 (the default setting). If the trigger setting (Configuration > Operation) is not set to channel 4, you will see signal warning messages and will be unable to take measurements.*

Use the following diagrams to determine the optimum input signal setup for your measurement needs.

Option VGA Setup 1: RGBHV Measurement Interface Unit

This is the preferred setup for testing PC and play-out device video. See Figure 2–8. Use the RGBHV Measurement Interface Unit to connect the PC video card to the VM5000. Using the RGBHV MIU provides the most accurate measurement results.

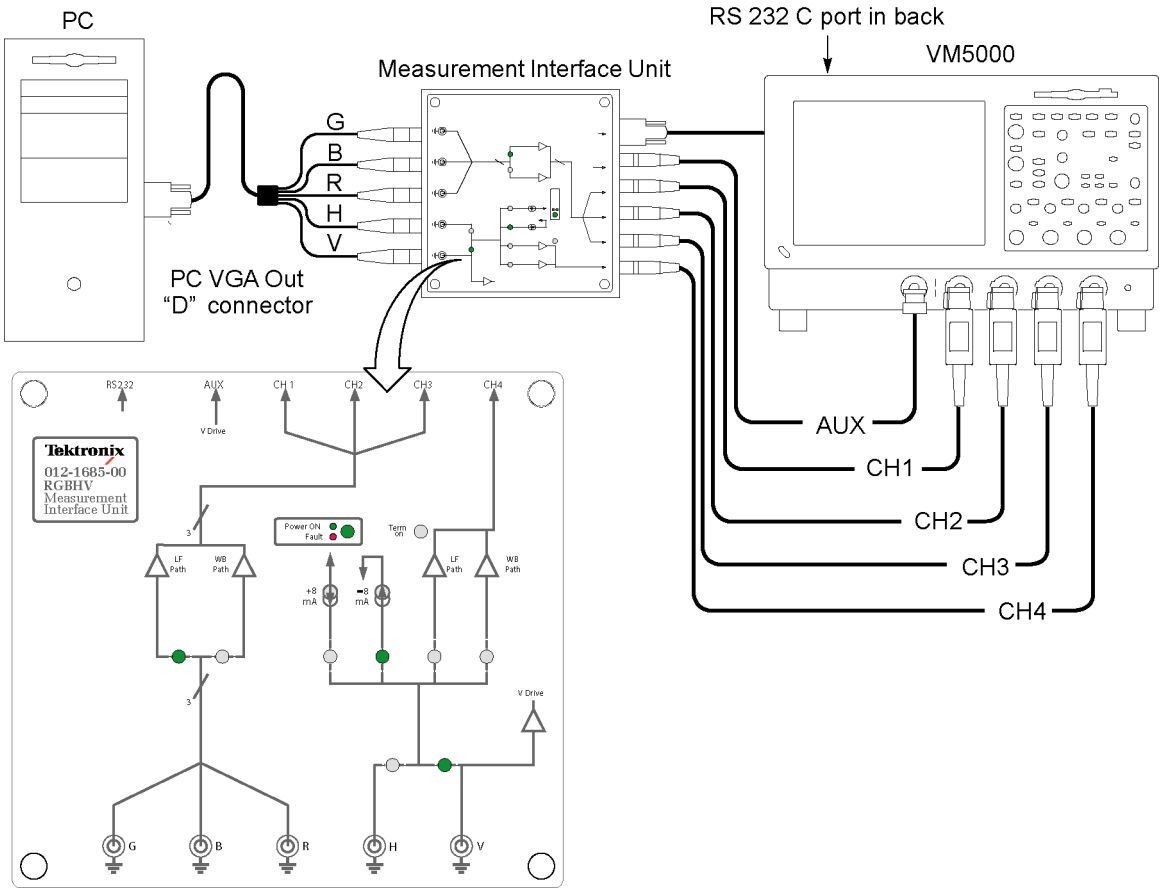


Figure 2- 8: Connection of the PC video card to the VM5000 using RGBHV Measurement Interface Unit

To connect the RGBHV Measurement Interface Unit:

1. Connect the device-under-test (DUT) to the input side of the RGBHV Measurement Interface Unit using one of the VGA-to-BNC adapter cables supplied with your VM5000. See Figure 2–9.

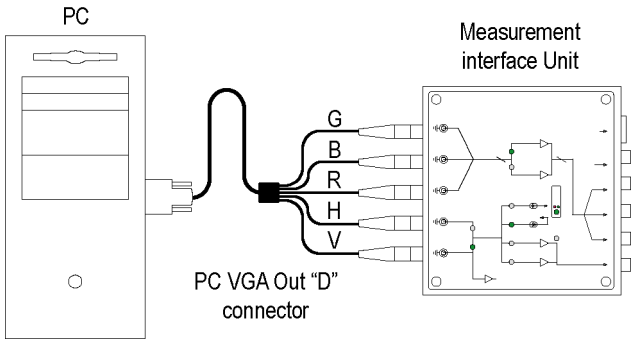


Figure 2-9: Connection of the DUT to the RGBHV Measurement Interface Unit

2. Connect the outputs (Aux, CH1–CH4) of the RGBHV Measurement Interface Unit to same inputs on the VM5000 (that is, connect the CH1 output to the CH1 input). See Figure 2–10.

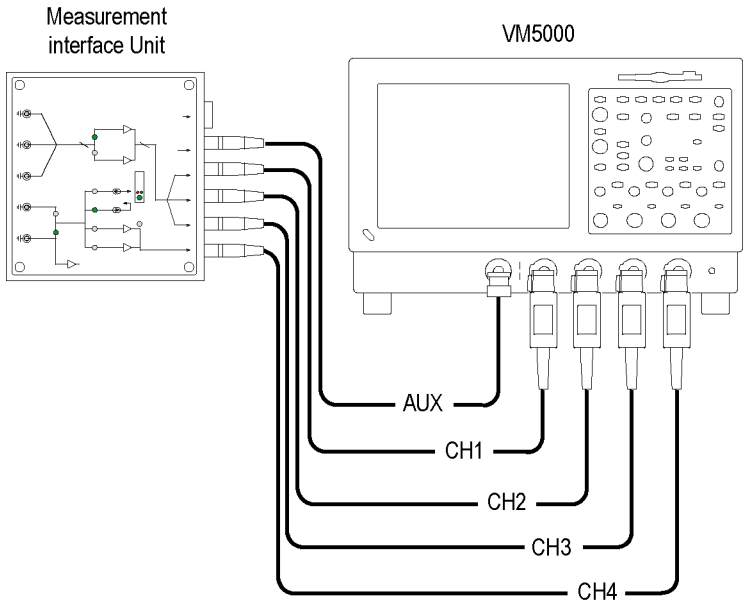


Figure 2-10: Connection of the RGBHV Measurement Interface Unit to the VM5000

3. Connect the RS-232C cable between the RGBHV Measurement Interface Unit and the COM1 port on the VM5000. See Figure 2–11.

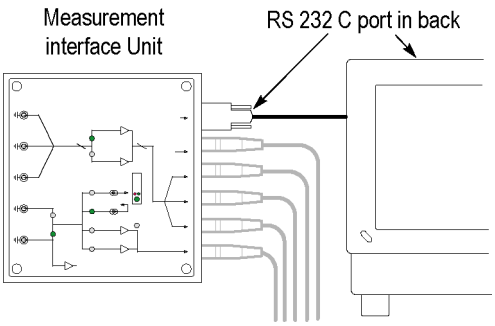


Figure 2-11: Connecting the RS-232C cable between the Measurement Interface Unit and the VM5000

4. Verify that the **Use MIU** checkbox on the Configuration > Operation tab is selected. See Figure 2–12.

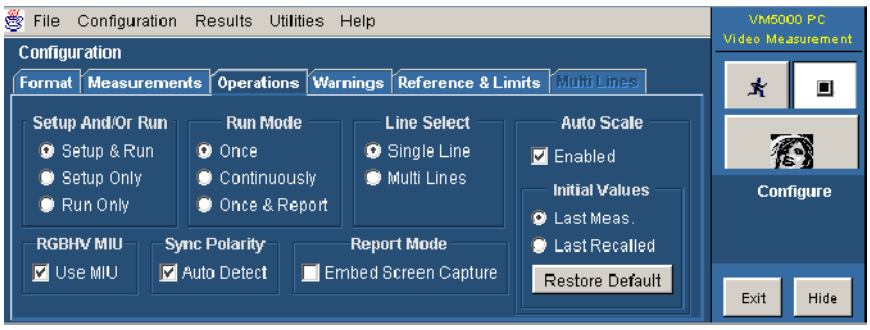


Figure 2-12: Selection of the Use MIU option on the Configuration > Operation tab

Option VGA Setup 2: VGA Connector to 5X Cable

Use this setup for testing PC and play-out device video when it is not convenient to use the RGBHV Measurement Interface Unit. To ensure accurate measurements, connect the signals to the VM5000 using the “T” connectors and precision terminations on CH1–CH4. You must use 75 ohm terminations on CH1–CH3 (used for GBR) and 2.21 kΩ and 301 Ω terminations on CH4 (used for H Sync and V Sync measurements). This method requires you to change the signal and termination connections on CH4 for certain horizontal and vertical measurements. The VM5000 displays a dialog box prompting you to make these changes when necessary (the RGBHV Measurement Interface Unit performs these connection and termination changes internally).

To connect the DUT to the VM5000 using a 5X cable:

1. Install the included 75 Ω terminations between the end of the BNC cables and the instrument input channels 1 through 3, using the included BNC T-connectors. See Figure 2–13. To achieve accurate measurements, it is important to attach the T-connectors directly to the input channel BNCs.

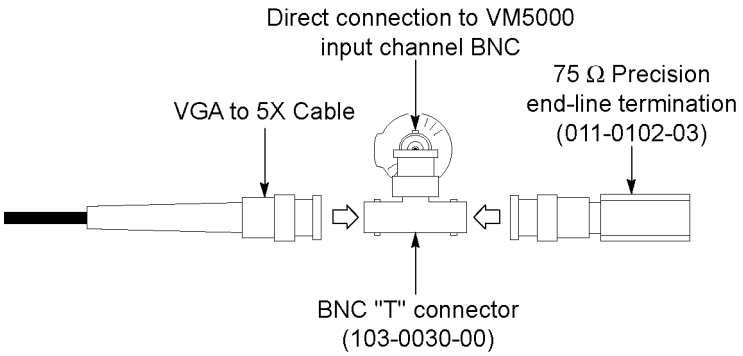


Figure 2-13: Connecting the VGA to 5X cable to the input channel

2. If you will be making H Sync, V Sync, or V Timing measurements, you will need to make 2.21 kΩ and 301 Ω terminations using the BNC-to-Binding Post adapters and resistors supplied as standard accessories.

Attach each resistor to an adapter. See Figure 2–14.

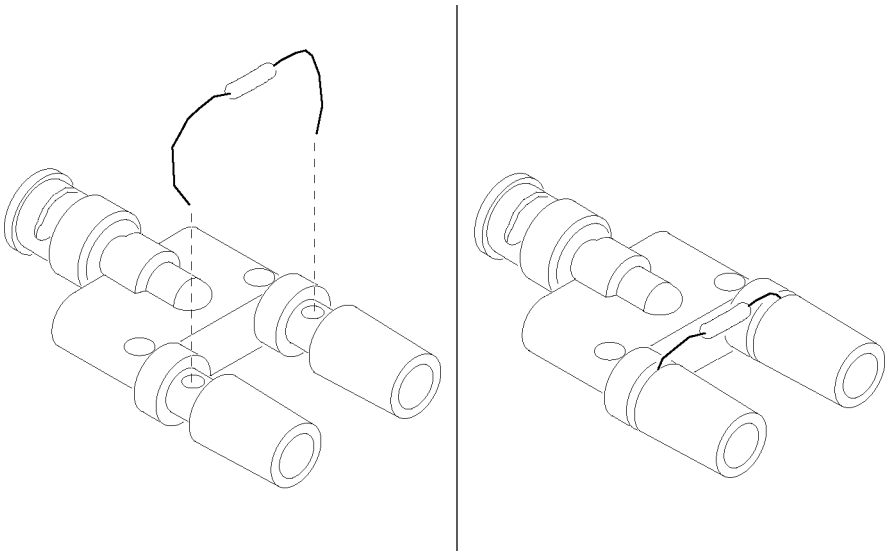


Figure 2-14: Building the 2.21 kΩ and 301 Ω terminations

3. Connect the PC video output signals to the VM5000. See Figure 2–15. Connect the H Sync signal using the 2.21 kΩ adapter to begin with. The VM5000 will prompt you to change it to the 301 Ω adapter if necessary.

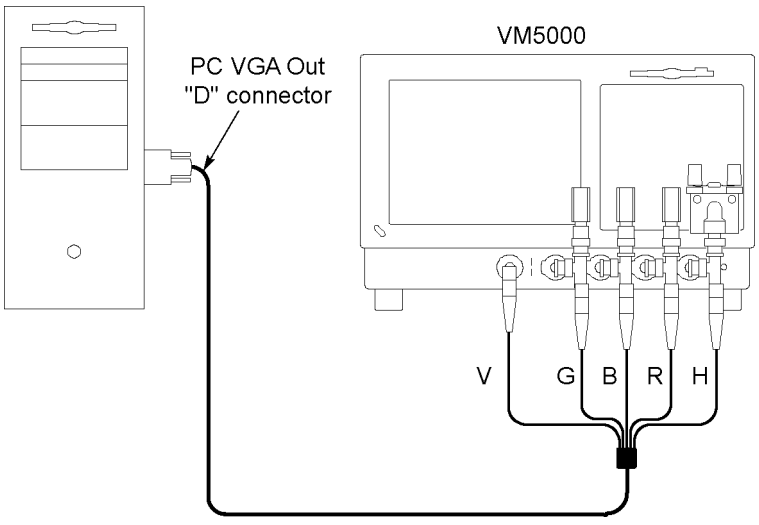


Figure 2-15: Connecting the PC video output signals to the VM5000

A pop-up warning appears to prompt you to change signal termination on CH4 when making a H Sync measurement. See Figure 2–16.

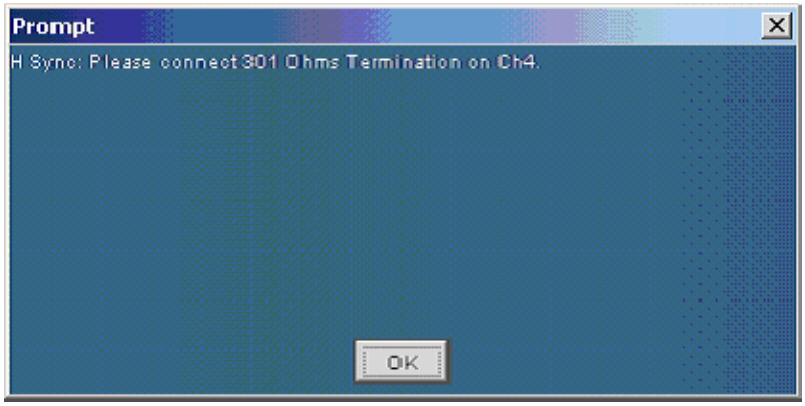


Figure 2-16: Appearance of the pop-up warning when making H Sync measurement

Table 2–1 identifies which signal from the Device-Under-Test (DUT) should be connected to which input connector on the VM5000 and the terminator that should be used for each signal.

Table 2-1: Required connections of the VGA signal, VM5000, and the terminator

VGA signal (Device Under Test)	VM5000 Input Connector	Terminator
Green	CH 1	75 Ω
Blue	CH 2	75 Ω
Red	CH 3	75 Ω
H Sync	CH 4*1	2.21 kΩ and 301 Ω
V Sync	AUX	None

*1 V Sync signal is connected to this channel only when making a V Timing or V Sync measurement. The VM5000 will prompt you for this connection change if necessary.

Signal Path Compensation

Use this procedure if the temperature has changed more than 55°C since the last signal path compensation. Perform the signal path compensation once a week. Failure to do so may result in the instrument not meeting warranted performance levels at those volts/div. settings.

1. Prerequisites: Instrument powered on for 20 minutes, and all input signals removed.

2. Select **Instrument Calibration**.

3. If the status is Warm-up, wait until the status changes to Temp. Click **Calibrate** to start the calibration. Calibration may take 10 to 15 minutes. See Figure 2–17.

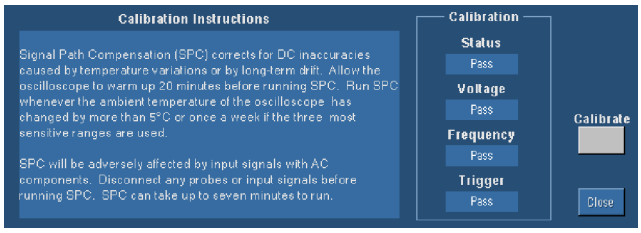


Figure 2-17: Calibration instruction

4. If after calibration the status indicator does not display Pass, recalibrate the instrument, or have the instrument serviced by qualified service personnel.

***NOTE**. Signal Path Compensation is the only calibration that is accessible to you.*

Sync Pickoff Compensation for Option SD/HD

To properly compensate the sync pickoff, follow these steps:

1. Prerequisites: instrument powered on for 20 minutes, and all input signals removed.
2. Connect the Sync Pickoff cable to CH1 and CH4 as shown. See Figure 2–18.

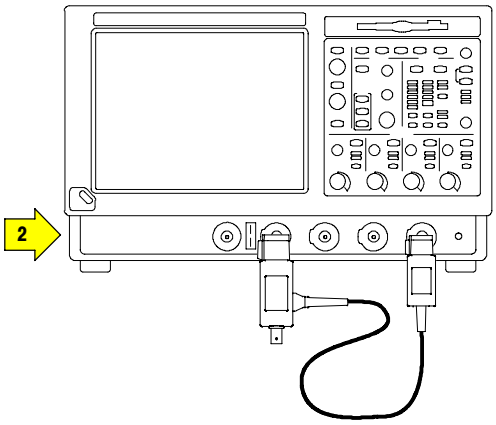


Figure 2- 18: Attaching Sync Pickoff for compensation adjustment

3. Attach the Sync Pickoff BNC connector to the BNC-to-minigrabbers connector (Pomona Electronics model number 3789). See Figure 2–19.

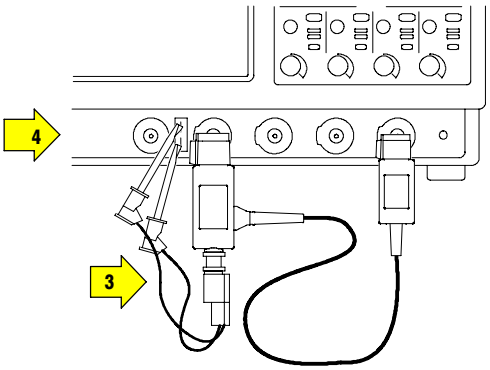


Figure 2- 19: Connecting to the probe compensation connector

4. Connect the minigrabbers to the Probe Compensation connector.

5. Push **AUTOSET**. See Figure 2–20.

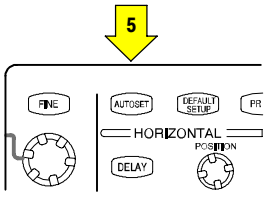


Figure 2-20: Location of AUTOSET button

6. Check the shape of the displayed waveform to determine if the sync pickoff is compensated correctly. See Figure 2–21.



Figure 2-21: Display of waveform to determine sync pickoff compensation

7. If necessary, adjust the sync pickoff. Repeat as needed. See Figure 2–22.

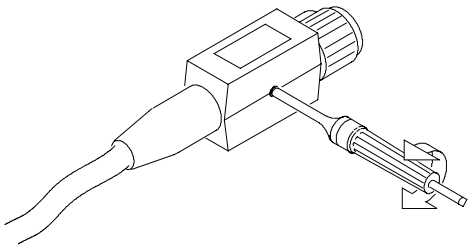


Figure 2-22: Adjusting the compensation

The Matrix Test Signal

The Matrix test signal incorporates all the analog video signal requirements within one file (different files are used for Option SD/HD and Option VGA). Using this single test file eliminates the need to change test signals when running different measurements. The Matrix test signal is provided with the Signal Source Disks accessory. You can select the setup file (.vmset) that matches the format of the Matrix test signal. The default line number setting is provided for each measurement type. You can change the line number as needed. See Appendix E, *Signal Source Set* for a full description of the files in the Signal Source Set.

Figure 2–23 shows the Option SD/HD Matrix test signal. Table 2–2 shows the signal elements.

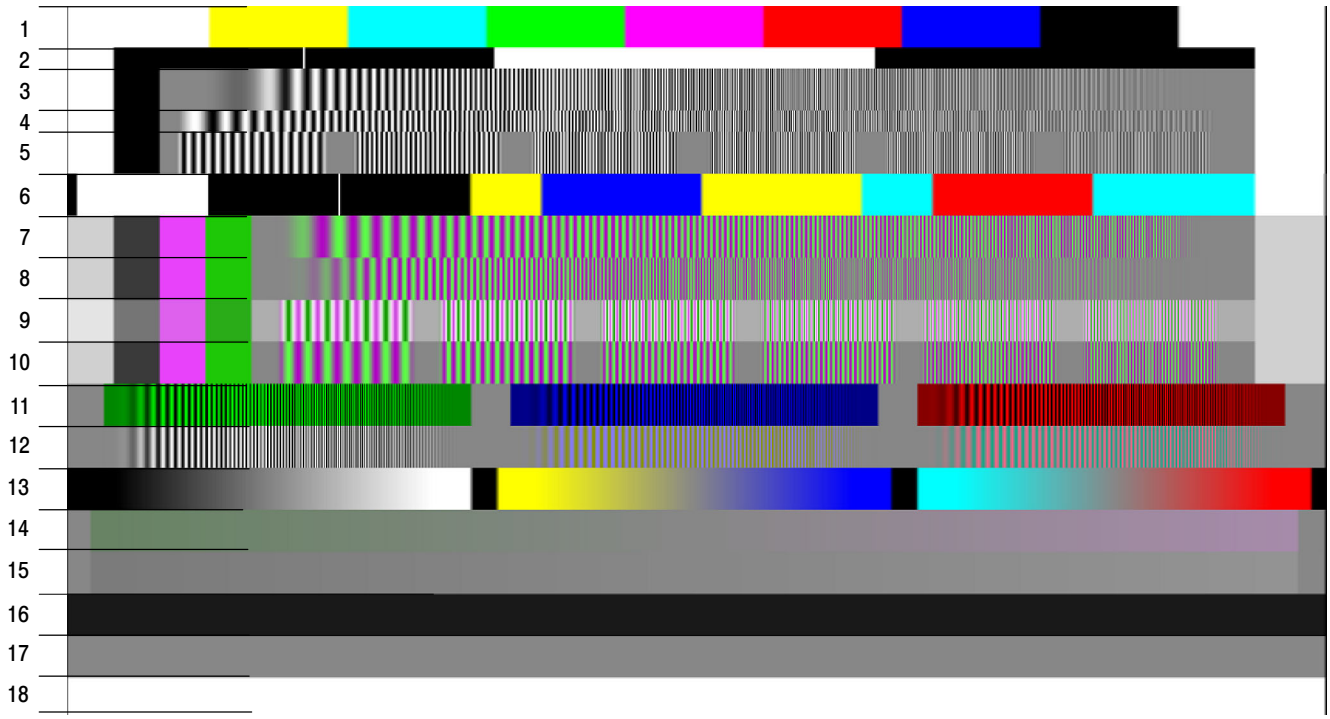


Figure 2-23: Option SD/HD Matrix signal

Table 2-2: Option SD/HD Matrix signal elements

Signal Name	Format	Signal Name	Format	Signal Name	Format
1. Color bars	All	**7.** YPbPr Sweep Time	YPbPr	**13.** Valid Ramp	All
2. RGB Pulse Bars	RGB	**8.** YPbPr Multiburst	YPbPr	**14.** YPbPr Shallow Ramp	YPbPr
3. RGB Frequency Sweep	RGB	**9.** YPbPr Multiburst	YPbPr	**15.** RGB Shallow Ramp	YPbPr
4. RGB Time Sweep	RGB	**10.** YPbPr Multiburst	YPbPr	**16.** Flat Field 7.5%	YPbPr
5. RGB Multiburst	RGB	**11.** RGB Crosstalk	YPbPr	**17.** Flat Field 50%	YPbPr
6. RGB Pulse Bars	RGB	**12.** YPbPr Crosstalk	YPbPr	**18.** Flat Field 100%	YPbPr

Figure 2–24 shows the Option VGA Matrix test signal. Table 2–3 shows the signal elements.

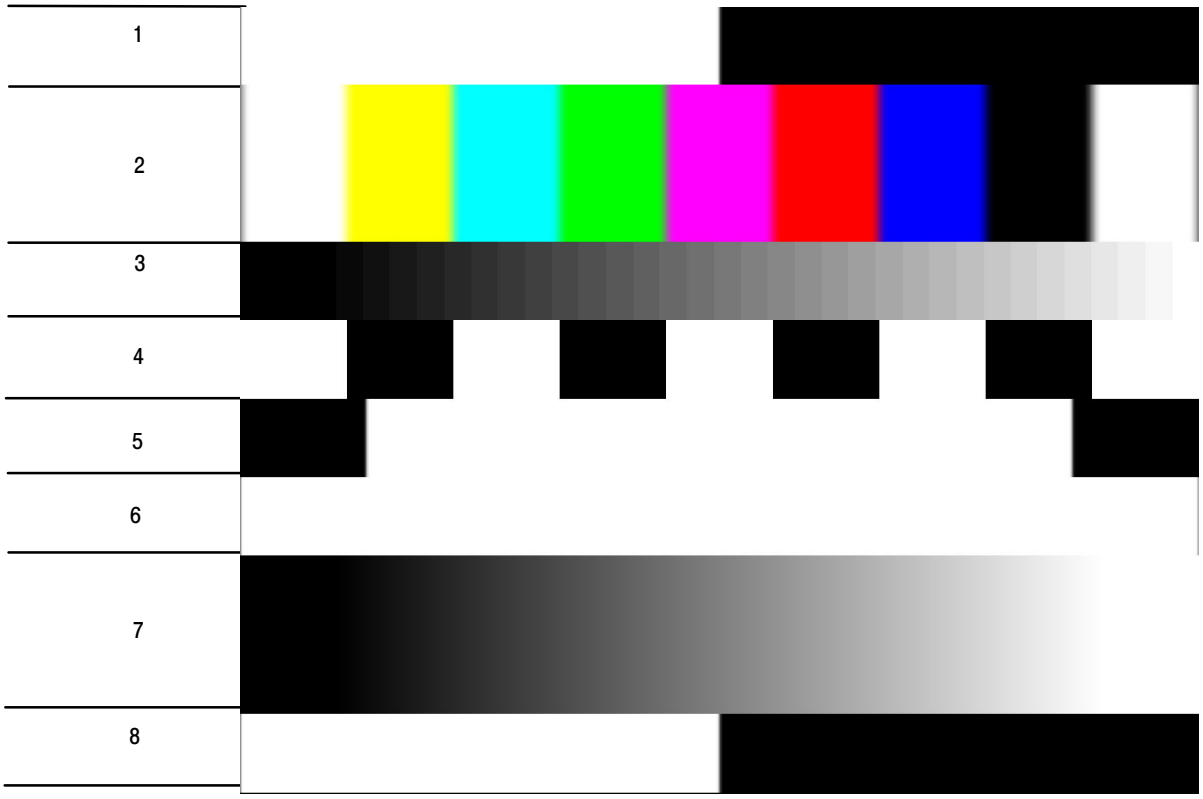


Figure 2-24: Option VGA Matrix test signal

Table 2-3: Elements of Option VGA Matrix Signal

Signal Name	Signal Name
1. Half White and Half Black	5. Black White Black
2. Nine Colorbars	6. Full White
3. 32 Steps	7. Ramp
4. Alternate White and Black	8. Half White and Half Black

The addressable line number pattern of the matrix signal is based on the following equations:

Half White and Half Black Bars (1–9.5%)
Nine Color Bars (10.5–29.5%)

32 Steps (30.5-39.5%)
Alternate White and Black Bars(40.5-49.5%)
Black-White-Black Bars (50.5-59.5%)
Full White (60.5-69.5%)
Staircase (70.5-89.5%)
Half White and Half Black Bars(90.5-100%)

The actual line number which user enters in the application is calculated based on the following equation:

Active Line Number = Vertical Sync Time + Back Porch + Addressable Line Number according percentage

For 1280x1024 resolution, 85 Hz refresh rate, and DMT timing standard the Vertical Sync Line is 3, Vertical Back Porch is 44.

For Half White and Half Black pattern,
The Start Active Line Number = 3 + 44 + 1 = 48
The End Active Line Number = 3 + 44 + 97 = 144
The line range for Half White and Half Black for 1280x1024 at 85 Hz would be 48 - 144.

Table 2-4 shows an example of the resolutions and the corresponding line number ranges the DMT timing standard supports at 60 Hz refresh rate for Option VGA matrix signal.

Table 2-4: Resolutions and line number ranges supported at 60 Hz (DMT standard) for Option VGA

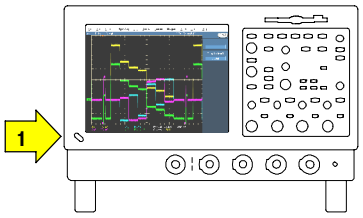
Pattern	640x480	800x600	1024x768	1280x 1024	1600x 1200	1920x 1200	1920x 1440
1. Half White and Half Black	28-73	28-84	36-108	42-138	50-163	43-156	60-196
2. Nine Colorbar	77-169	90-204	116-262	149-343	175-403	168-396	210-484
3. 32 Steps	173-217	210-264	269-338	353-445	415-523	408-516	498-628
4. Alternate White and Black	221-265	270-324	346-415	456-548	535-643	528-636	642-772
5. BlackWhite-Black	269-313	330-384	423-492	558-650	655-763	648-756	786-916
6. Full White	317-361	390-444	500-569	661-753	775-883	768-876	930-1060
7. Ramp	365-457	450-564	576-722	763-957	895-1123	888-1116	1074-1348
8. Half White and Half Black	461-507	570-627	730-803	968-1065	1135-1249	1128-1242	1362-1499

For other refresh rates, the actual starting line number can be noticeably different than the 60 Hz refresh rate. To view the active video line number location for a specific pattern at another refresh rate, locate the Microsoft Excel file, Matrix-Signals-LineNumbers.xls located on the VM5000 software CD. This file lists the Actual Video line numbers for all supported refresh rates.

Starting the Application

Ensure that you have set up the input signal sources before running the measurements (See page 2-23).

1. Power on the instrument. The instrument displays the default main screen.

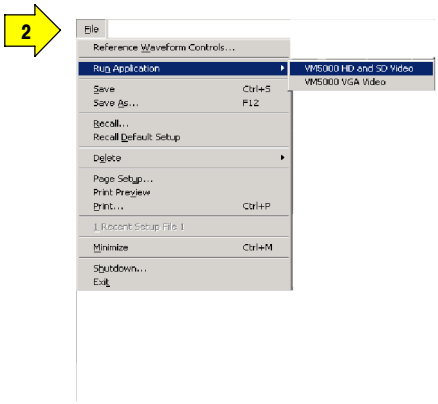


2. On the menu bar, click **File > Run Application > VM5000 HD and SD Video**.

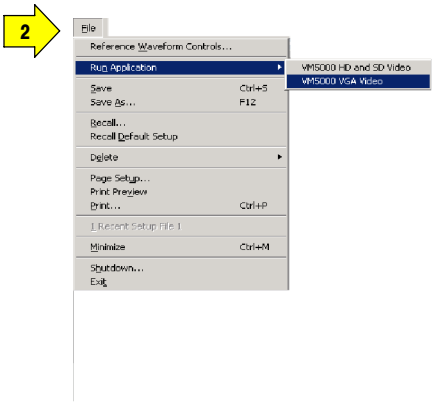
   or

   File > Run Application > VM5000 VGA Video.

Option SD/HD

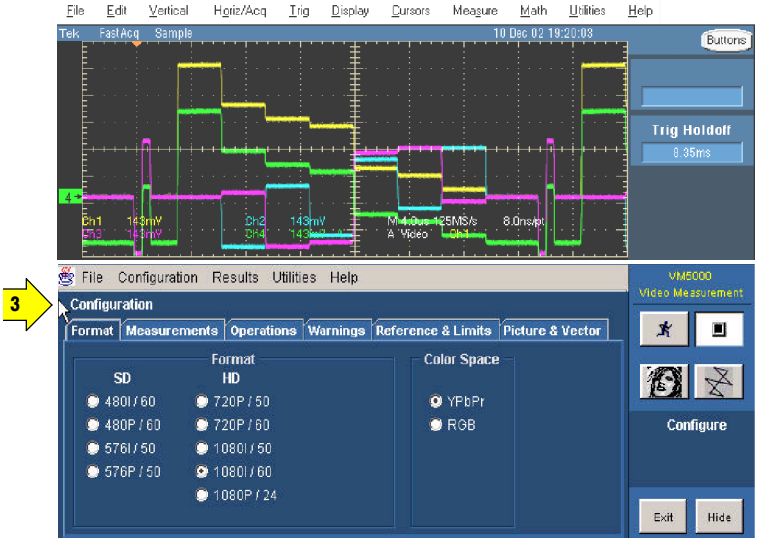


Option VGA



3. The instrument reduces the waveform area to the upper part of the screen, and opens the VM5000 application in the lower part of the screen.

Option SD/HD



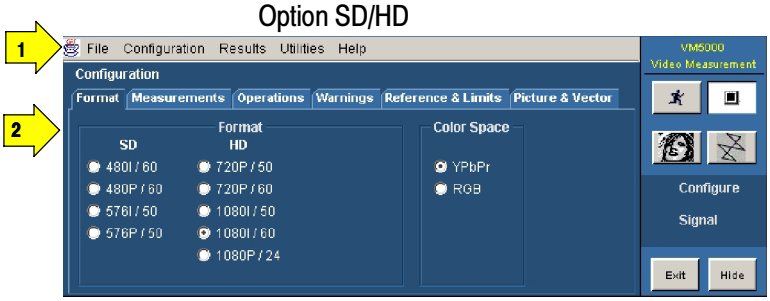
Option VGA



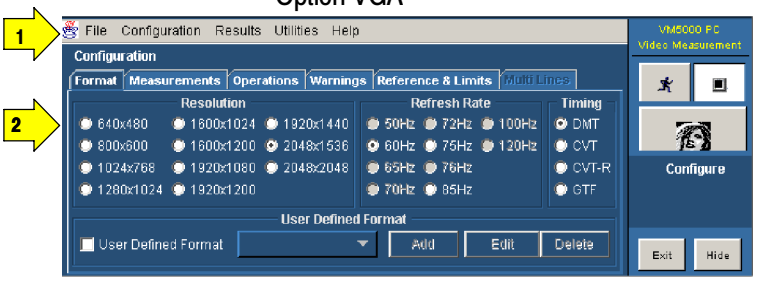
The VM5000 Application User Interface

1. Menu bar: The menu bar allows you to configure the different parameters of the application. Use the menu bar to display the results information in the Results window.
2. Application view: The main application window displays the configuration controls and the measurement results.

Option SD/HD

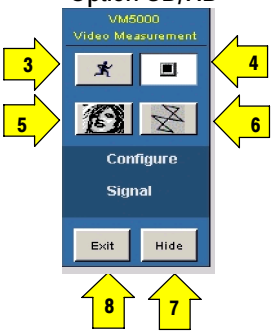


Option VGA



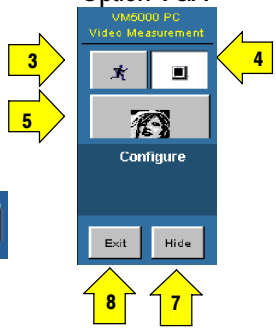
3. Run Button: Click **Run** to run the selected measurements and to display the results.
4. Stop button: Click **Stop** to stop running the selected measurements.

Option SD/HD





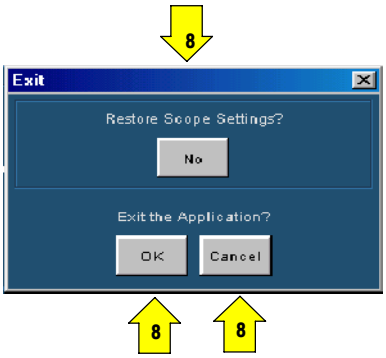
Option VGA



5. Picture button: Click the **Picture** button to display the picture of the signal.
6. Vectorscope button (Option SD/HD): Displays the signal in vectorscope format.
7. Hide button: Click **Hide** to restore the main screen to full-screen and hide the application window behind the main screen.
   To restore the application window after hiding it, click **App** on the main screen.
   To access the Windows desktop, for example, to view reports, click **Hide**. In the main screen, click **File > Minimize**, and then click **Hide** again.

8. Exit button: Click **Exit** to quit the application. From the Exit dialog box you can choose whether to retain the settings. The default setting for **Restore Scope Setting?** is **No**. Click the button to change the option to **Yes.**

   To quit the application, click **OK**. If you don't want to quit the application, click **Cancel**.



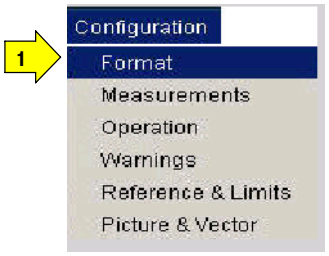
Measurement Steps Overview

1. Use the **Configuration > Format** menu to set the input signal format standard (such as 1080i/60) and refresh rate (page 2–24).
2. Use the **Configuration > Measurements** menu to select one or more measurements to run (page 2–27).
3. Use the **Configuration > Operations** menu to set the measurement run operations, such as run mode and trigger channel (page 2–28).
4. Click **Run** to run the selected measurements and view the measurement results (page 2–41).
5. Use the **Utilities > Generate Report** menu to save the measurement results to a file (page 2–51).

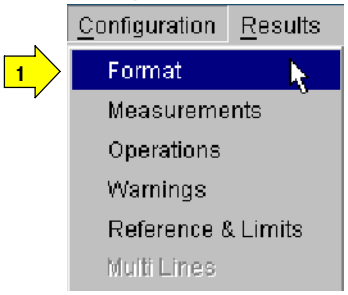
Setting the Input Signal Format

1. On the menu bar, click **Configuration > Format**.

Option SD/HD

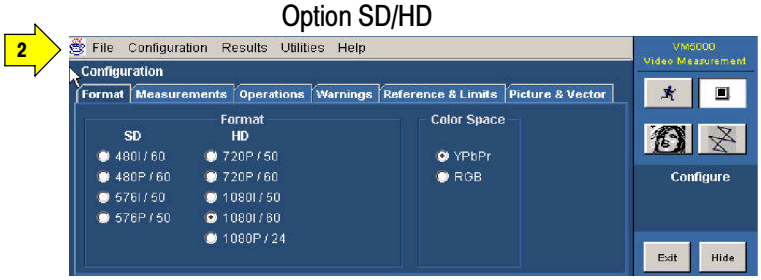


Option VGA

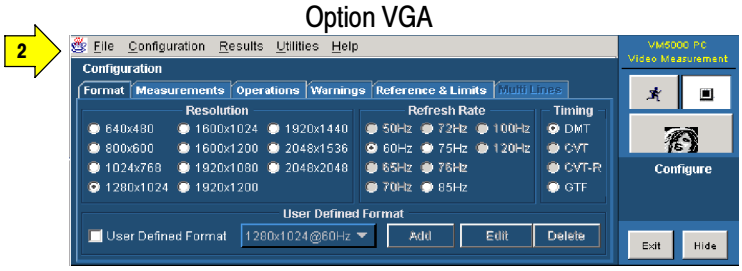


2. The Format panel appears.

Option SD/HD

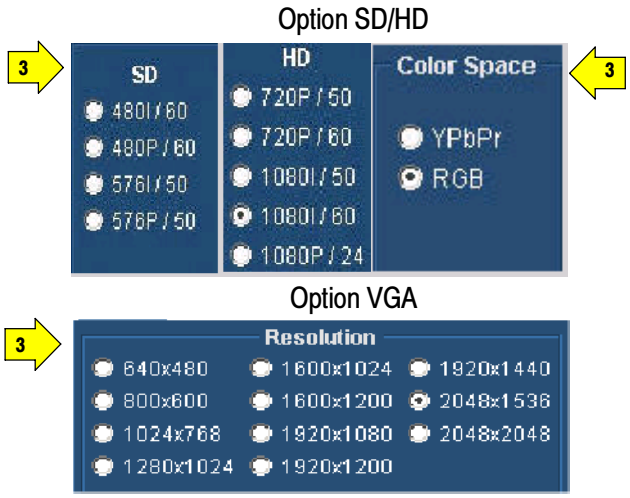


Option VGA



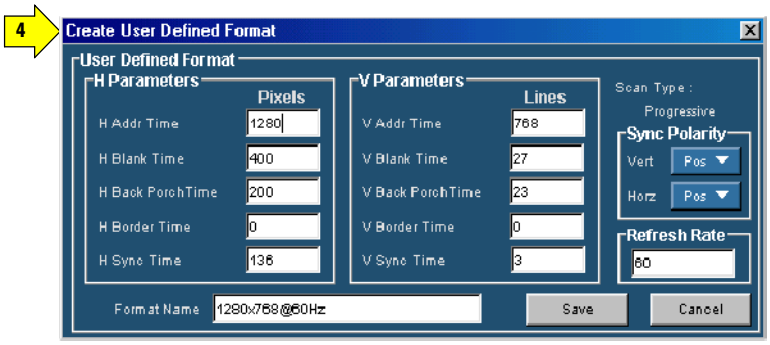
3. Select one of the standard video formats or define your own format using the User Defined Format option function (Option VGA)

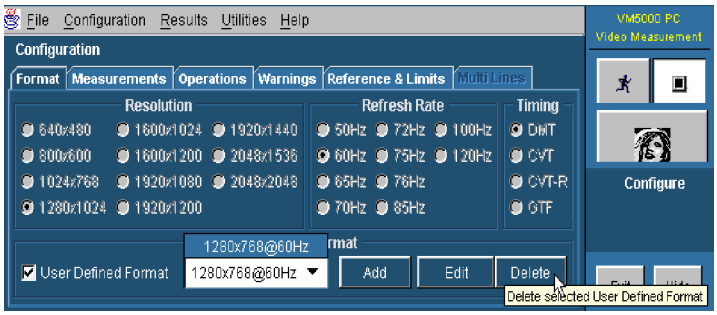
   All the resolutions are selectable regardless of theselected timing standard or refresh rate.



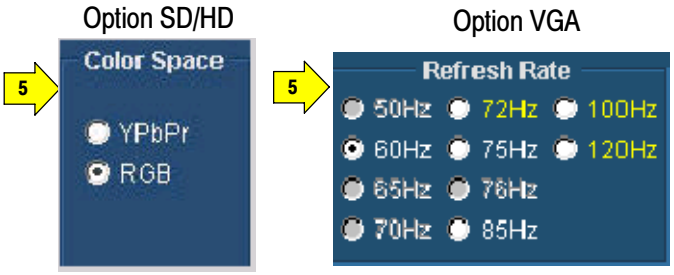
4. (Option VGA)
   To add a new user-defined format, select **User Defined Format** and click **Add**. To edit a user-defined formatselect **User Defined Format** and click **Edit**. The User Defined Format window appears. Enter the appropriate values for the horizontal and vertical parameters. To save your new format, enter a name in the Format Name field and click **Save**.

   To delete a user defined format, select the User Defined format and click **Delete**.

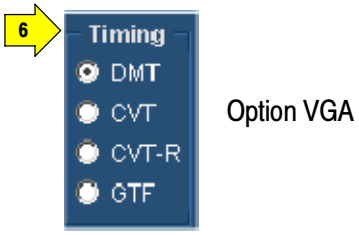




5. Select the appropriate Color Space (Option SD/HD) or Refresh Rate (Option VGA).



6. Select the appropriate timing standard for the signal (Option VGA).

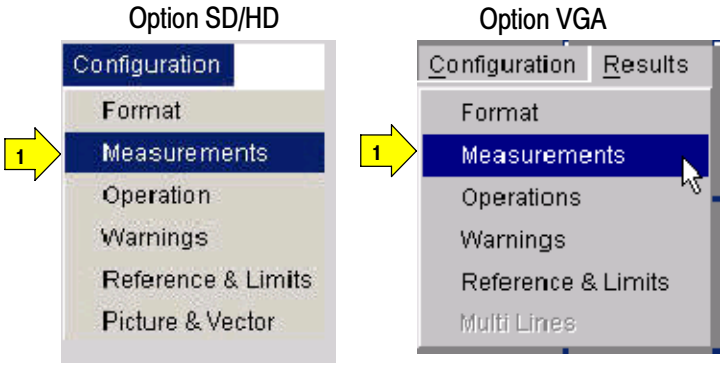


- **DMT:** The Display Monitor Timing standards and guidelines are used for lower resolutions or refresh rates that are in common industry use in lower performance systems.
- **CVT:** The Coordinated Video Timing standard is a method for generating a consistent and coordinated set of standard format formats, display refresh rates, and timing specifications for computer display products, both those employing CRTs and those using other display technologies. CVT addresses problems found in GTF.
- **CVT-R:** The Coordinated Video Timing Reduced Blanking standard is designed for use with non-CRT displays that can accept reduced horizontal blanking times.
- **GTF:** The Generalized Timing Formula standard is a method for generating general purpose display timings and new formats. This allows much greater flexibility in the choice of refresh rates and pixel formats than currently available with discrete monitor timings. GTF enables new formats and refresh rates to be developed, but is based on some set parameters to improve the likelihood of interchange.

If a timing standard or refresh rate is not available for the selected resolution, then the timing standard or refresh rate is grayed out. Select the resolution, refresh rate, and the timing standard for the signal you are measuring. If a resolution is selected and the currently selected refresh rate is not available in the selected resolution, the refresh rate will automatically change to the default value of 60 Hz. A message informs of the change. If a resolution is selected and the currently selected timing standard is not available for the selected resolution, the timing standard will automatically change to a supported timing standard in the order of CVT, DMT, and GTF. A message informs you of the change.

Selecting the Measurements

1. On the menu bar, click **Configuration > Measurements**.

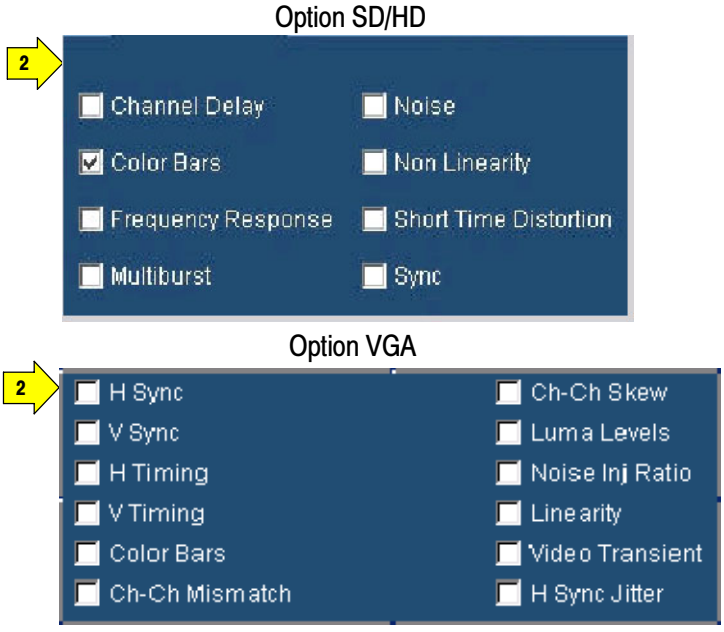


2. Select from one to eight measurements (Option SD/HD)

   OR

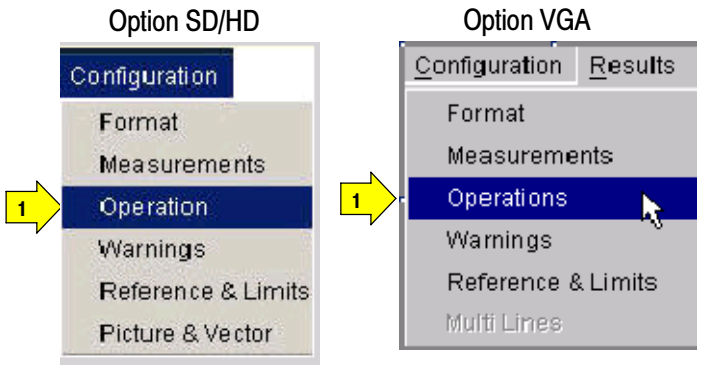
   one to twelve measurements (Option VGA),

   in any combination.

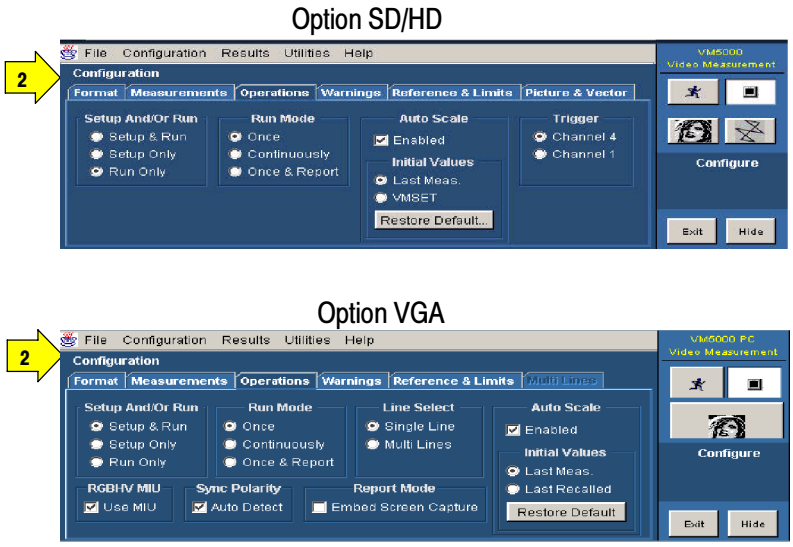


Setting the Measurement Run Operations

1. Select **Configuration > Operation**.



2. The instrument displays the Operations window. These settings control how the instrument sets up and acquires measurements when you click **Run**.

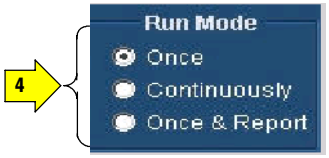


3. Select how the instrument sets up and runs the measurements.



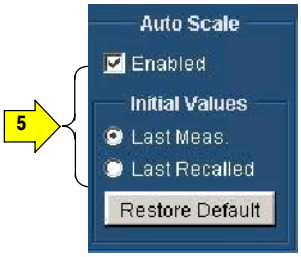
- **Setup & Run:** Configures the instrument setting and takes a measurement, for each selected measurement, and for each measurement acquisition. Use this when taking multiple measurements that require different instrument setups.
- **Setup Only:** Configures the instrument for a measurement but does not take the measurement. Use this to set up customized settings. Try out your settings by pressing the Run button, make adjustments as needed (for example, change the horizontal scale), and then select the Run button again. Once you are satisfied with your customizations, use the Run Only setting to collect results. Setup Only is not selectable for certain measurements like H Sync, V Sync, Noise Inj Ratio, V Timing, and Video Transient as they need multiple settings for the oscilloscope and MIU.
- **Run Only:** Takes a measurement using the existing instrument configuration. Designed for taking measurements with custom settings (see *Setup Only* description above).

4. Select how the application acquires measurements (run mode).



- **Once** takes each selected measurement the number of times determined by the averaging setting, then stops taking measurements.
- **Continuously** continually takes measurements. You must select the Stop button to stop measurements.
- **Once & Report** takes each selected measurement the number of times determined by the averaging setting, presents the report, and stops taking measurements.

5. Auto Scale fits the signal within the available vertical scale. Auto Scaling adjusts the vertical scale units so that the input signals fill the graticule as much as possible. Auto Scaling occurs once for each selected measurement. Select the Enabled checkbox to enable waveform Auto Scale. Clear the **Enabled** check box to disable waveform autoscaling.

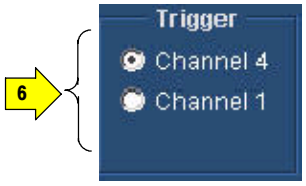


In the initial values pane, there are three settings: **Last Meas**, **Last Recalled**, and **Restore Default**.

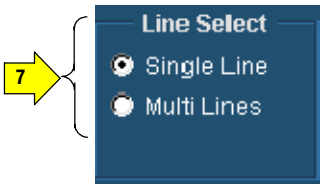
- **Last Meas.:** is the default. When selected, the values from the last measurement will be used at the start of the next Auto Scale step.
- **Last Recalled:** when selected, the values recalled with the last recalled setup will be used at the start of the next Auto Scale step. If a setup (File > Recall Setup) has not been recalled since the program was started, it will load the Auto Scale settings from the last power up.
- **Restore Default:** when selected, the Factory Default Auto Scale starting points will be used at the start of the next Auto Scale step. See page 3–7 for details.

6. (Option SD/HD) Select which instrument channel has the sync signal for triggering.

   If you use the wrong trigger channel (and Signal Warnings is on), you will get a signal warning. See the setup diagrams and trigger requirements on page 2–3.



7. (Option VGA) Choose the Line Select setting as appropriate. In Single Line mode, each measurement is made on a single line (for example, line 153). In Multi Lines mode, measurements are made across a range of lines (for example, lines 153–185).



   - **Single Line** takes each selected measurement on the line specified in the Line Number field of the Results window.
   - **Multi Lines** takes each selected measurement across a range of lines. You acquire measurements across multiple lines by specifying the starting and the ending line numbers. When Multi Lines is selected, the Generate Report button in the Utilities > Generate Report panel is not selectable. Also when Multi Lines is selected, in the Run Mode operation settings only Once & Report is selectable and report is generated based on the configuration set in the Utilities > Generate Report. The Results Summary panel is not accessible when Multi Lines is selected. For more information, see *Taking Measurements Across Multi Lines*, on page 2–44.

8. (Option VGA) Select Use MIU to automatically route H and V signals to the CH 4 output depending on the selected measurements.



9. (Option VGA) The specified polarities for the H Sync and V Sync signals vary between the timing standards. In the absence of the MIU and with Auto Detect selected, the VM5000 will prompt you to connect the H and V Sync signals to determine the polarities. If you use the MIU, the VM5000 will automatically determine the H and V Sync polarities.
Once the sync signal polarities are determined, the measurement cycle begins. This "polarity test" is performed at the beginning of every measurement cycle. To prevent this test from running at the beginning of every measurement cycle, take any measurement once with Auto Detect selected. Once a measurement cycle has been completed with Auto Detect selected, you can deselect Auto Detect. The VM5000 remembers the polarity of the sync signals. Any time you change the format set-up for the device-under-test, you should complete a measurement with Auto Detect selected.

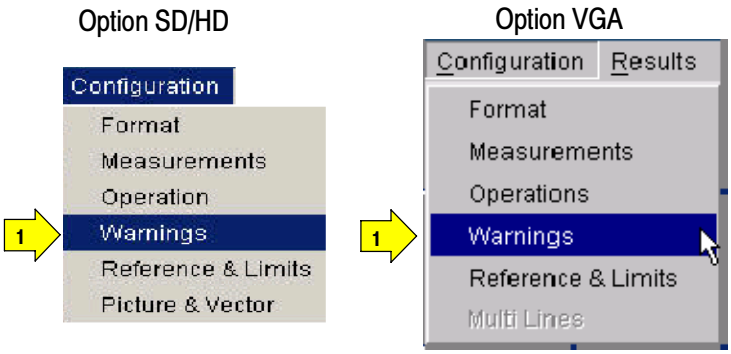


10. In the Report Mode pane, select Embed Screen Capture to include a snapshot of the waveform display in the results report in RTF format only.



Setting the Measurement Warnings

1. On the menu bar, click **Configuration > Warnings**.



2. The instrument displays the Warnings view. These settings control how the instrument sets up the Warning Types Reported and the Control Options when you select the Run button.

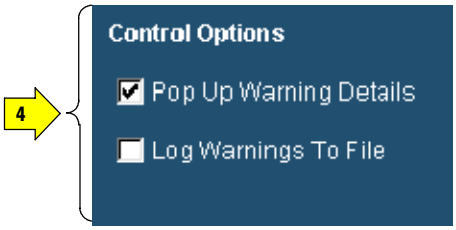


3. Select the warning messages to report when a warning occurs.

   See page 3–7 for more information.



4. Select how to report warning messages by selecting the check boxes in the control options pane. Messages can be displayed in a window or logged to a file.



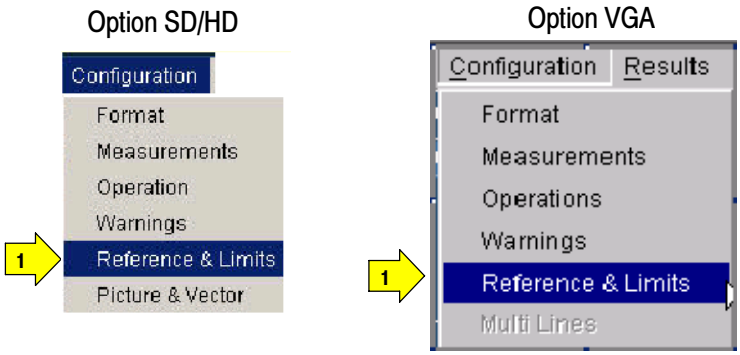
If **Log Warnings To File** is selected, the warnings are written to the Log.txt file (Option SD/HD at C:\VM5000TV or Option VGA at C:\VM5000PC). Warnings are appended to the Log.txt file until it reaches 1 MB in size. At that point, it is renamed LogOld.txt and a new Log.txt file is created. If the new file reaches 1 MB in size, it will be renamed LogOld.txt and will be written over the existing LogOld.txt file. If you wish to save the data in the LogOld.txt file, you must save the file under a different name before it is overwritten.

Setting Reference and Limits Options

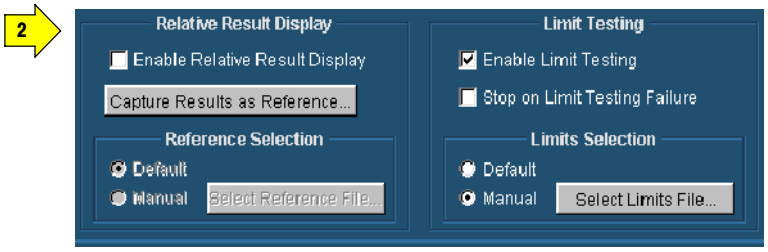
When you run a measurement relative to a reference, the VM5000 (Option SD/HD) or VM5000PC (Option VGA) runs the measurements and displays the difference between the measurement and the reference value. The reference values are stored in a reference file. Limit Testing provides a Pass/Fail indication by comparing the measured value to limit values. The limit values are maximum and minimum values that are stored in limit files.

NOTE. *The default reference file (or default limits file) is provided as is without warranty of any kind, and is intended to be used as a template only. WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXPLICITLY DISCLAIMED.*

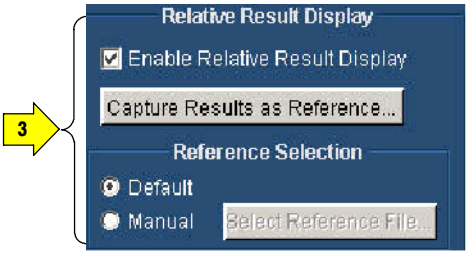
1. Select **Configuration > Reference & Limits**.



2. The instrument displays: the **Relative Result Display** and the **Limit Testing** in the Configuration display view.



3. When you select **Enable Relative Result Display,** the VM5000 enables **Reference Selection** to select a reference file. For more details, see page 3-60.



   Capture Result as Reference saves measurements to a reference file using the actual measured values as the reference values. For more details, see page 3-64.

4. Select Enable Limit Testing to enable pass/fail testing. When limit testing is enabled, the choices under Limits Selection are used to specify the limits file used. By default, the VM5000 application automatically selects a limits file, from a set of supplied templates, matched to the selected signal format. For more details, see page 3-64.



   When you select the **Stop on Limit Testing Failure** option, the test stops when the limit testing fails.

Displaying the Input Signal as a Picture

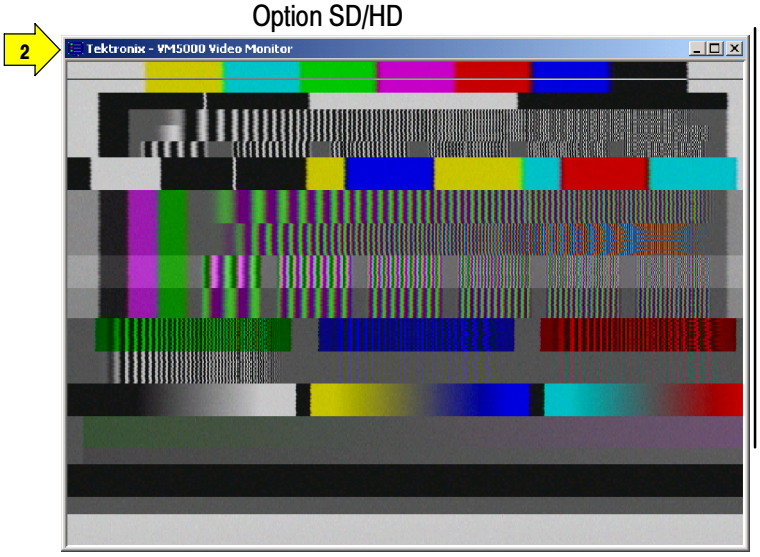
The VM5000 will display a picture of the input signal for Options SD, HD, and VGA.

1. Click the picture button.

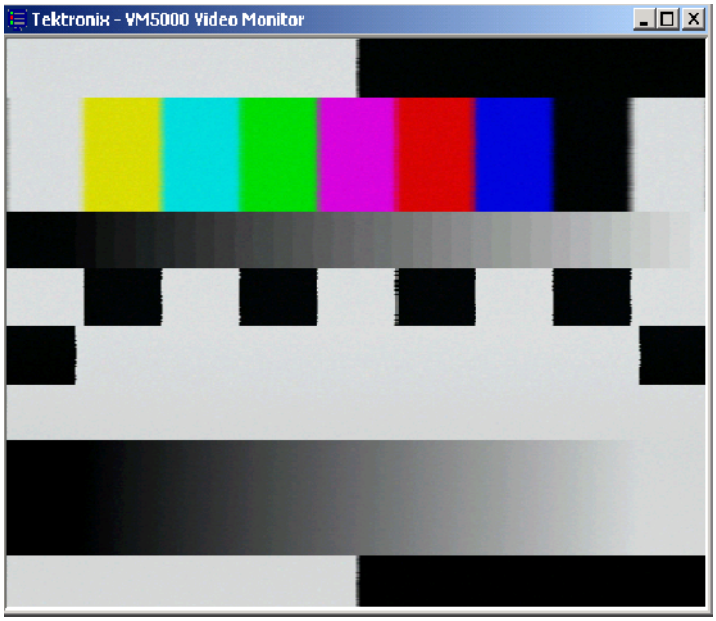


2. This launches the video monitor window. The instrument displays the picture. Click the maximize button to expand the picture to full screen.

Option SD/HD



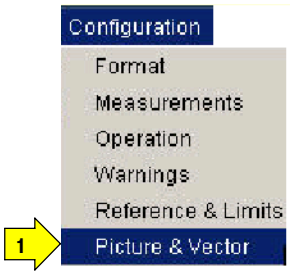
Option VGA



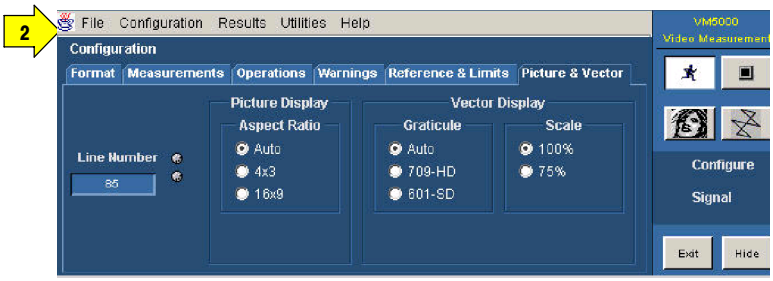
Changing Picture Display Settings

Option SD/HD You can change the settings for the Picture and Vector displays as follows:

1. Select **Configuration > Picture & Vector**.



2. The instrument displays the Picture & Vector panel. These settings control the display parameters of the picture and vectorscope displays.



3. Line Number sets the video line number that is displayed in the vectorscope display or highlighted in the picture display.

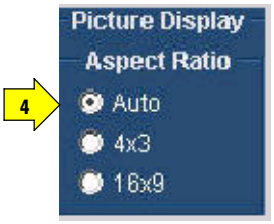


   Use the line number to identify features in the picture. To remove the line, set the line number to a line outside the active video. Note that the line number on the Picture & Vector tab is not used to specify where measurements are taken.

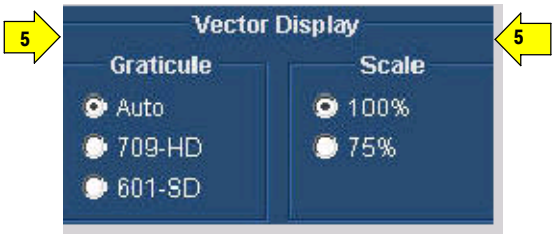
4. Sets the width to height ratio of the picture display based on the format.

   Auto is the default. Auto determines the aspect ratio of the video signal and sets the picture display accordingly

   The **4x3** setting is for SD format and **16x9** is for HD format.



5. Sets the Graticule and the Scale of the Vector Display.



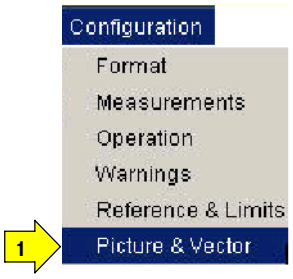
Displaying the Input Signal in a Vectorscope Window for Option SD/HD

The VM5000 can display the input signal in a vectorscope window so that you can quickly see the color range of the signal.

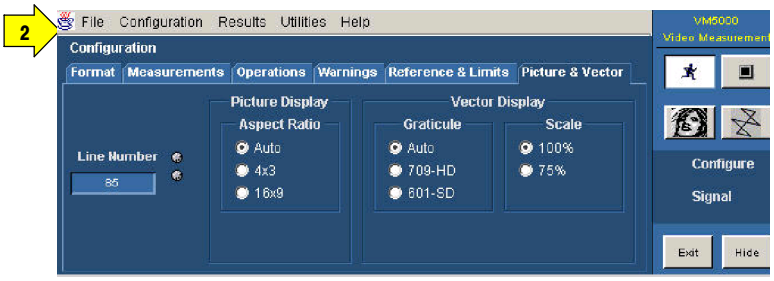
The vectorscope displays the chrominance (coloring) portion of the video signal. The amplitude and the phase are the two important parameters of the chrominance signal that lead to noticeable picture problems. The phase is relationship between the chrominance signal and the reference burst on the video. The processing within a vectorscope and the display of the processed signals is designed to detect and evaluate both phase and gain distortions of the chrominance. Each bar of the video signal creates a dot on the vectorscope's display. The position of these dots relative to the targets, on the graticule and phase of the burst vector are the indicators of the chrominance signal's health.

The vectorscope's display is created by decoding the chrominance portion of the video signal into its two components, B-Y and R-Y. These two signals are then plotted against each other in an X-Y fashion, with B-Y on the horizontal axis and R-Y on the vertical axis. Three color bars signals are used with vectorscopes 75% and 100% full field color bars and the SMPTE color bars. The 100% and 75% labels refer to the amplitude of the signal.

1. Select **Configuration > Picture & Vector**.



2. The instrument displays the Picture & Vector tab which provides access to the picture and vectorscope settings.



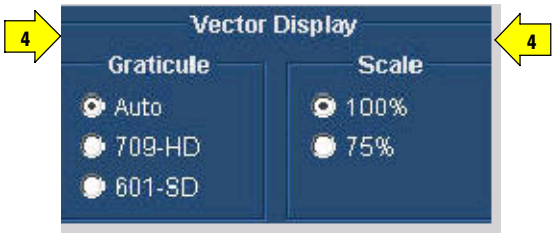
3. Sets the video line number that is displayed in the vectorscope display.

   Note that the line number on the Picture & Vector tab is not used to specify where measurements are taken.



4. Sets the Graticule and the Scale according the video signal format.

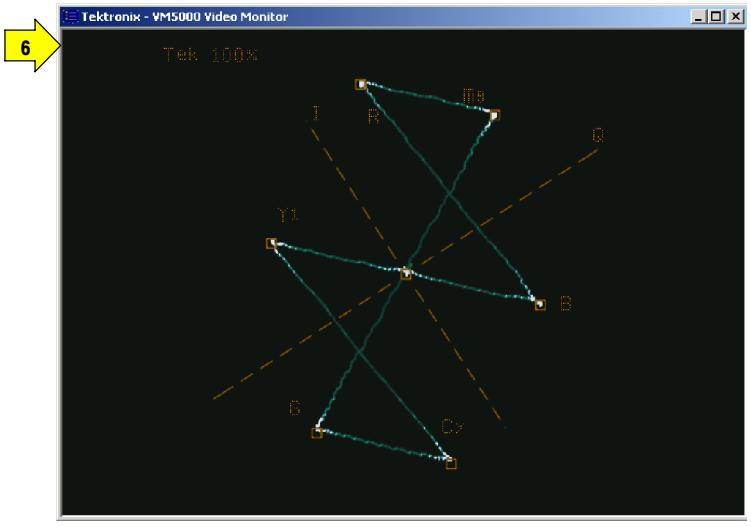
   Auto is the default setting in Graticule. This setting can be either HD or SD depending on the format selected.



5. Click the vector button.



6. This launches the video monitor display window. Click the maximize button to expand the vectorscope display to full screen.



Taking and Viewing the Measurement Results

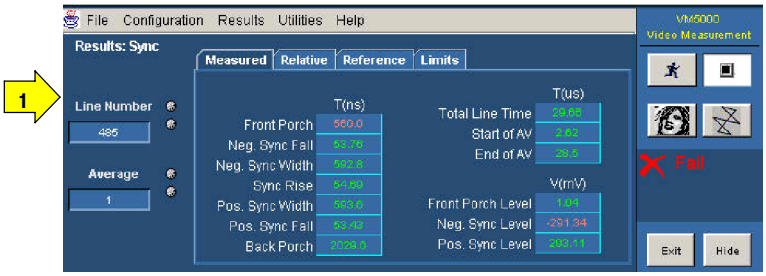
Ensure that you select a signal format, select one or more measurements, and configure the run options before you run a measurement.

1. Select the Run button.

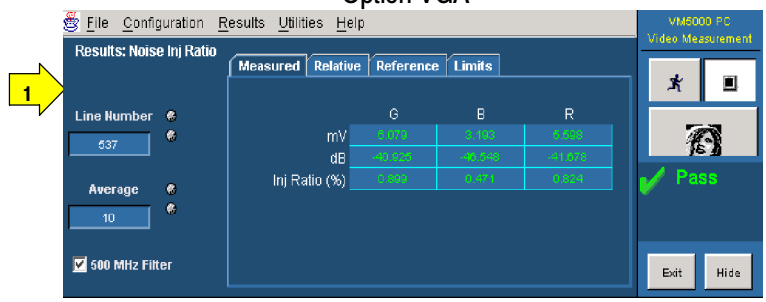


The instrument begins taking measurements and displays the measurement results for the recently taken measurement.

Option SD/HD

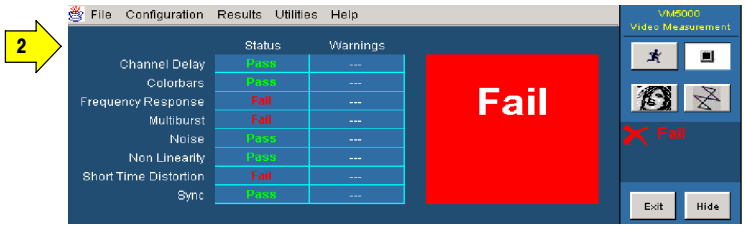


Option VGA

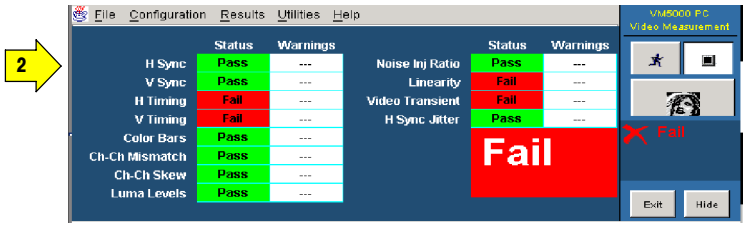


2. The instrument displays the Results Summary window when two or more measurements are selected. The results are displayed as Pass or Fail if Limit Testing is enabled.

Option SD/HD

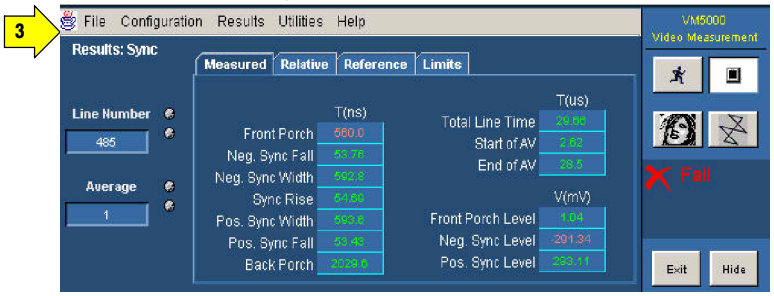


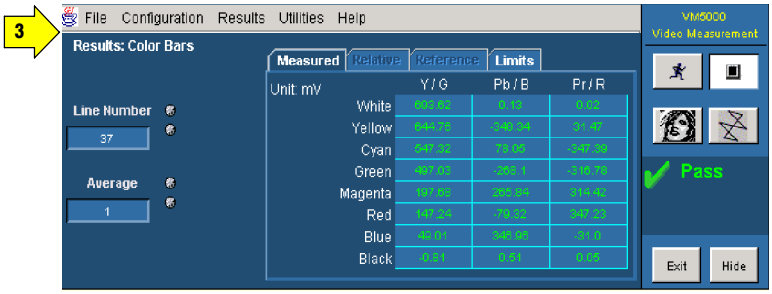
Option VGA



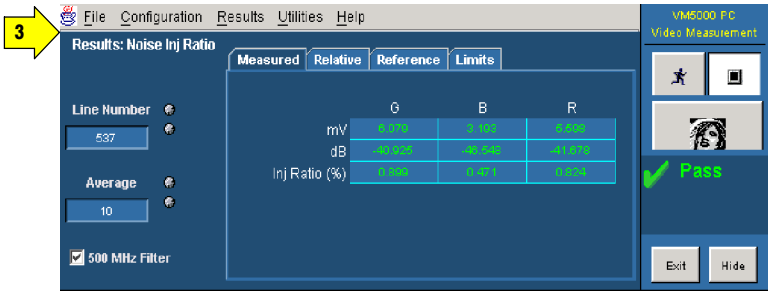
3. To view the detailed results for the measurements, select the Results menu and any one of the selected measurements.

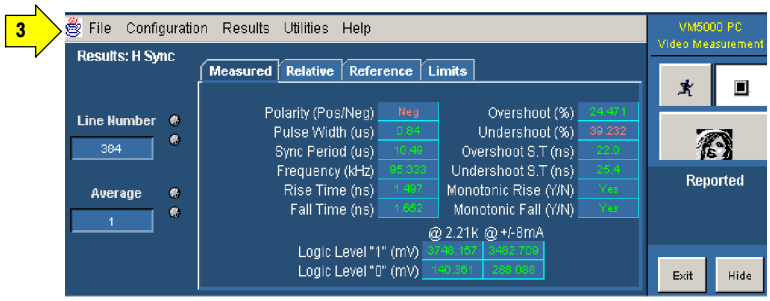
Option SD/HD



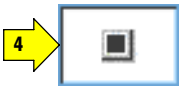


Option VGA





4. If you set the run operation to **Continuously**, press the **Stop** button to stop taking measurements.



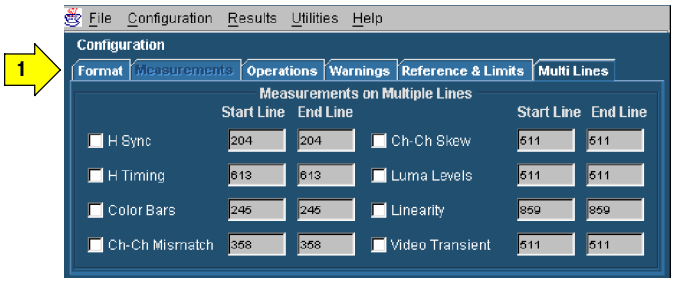
Taking Measurements Across Multiple Lines

Option VGA To take measurements across multiple lines, you must set the Line Select mode to Multiple Lines. When the Multiple Lines mode is enabled, you select the measurements and the lines on which the measurements are taken from the Multi Lines tab.

When Line Select is set to Multiple Lines, measurement results are automatically saved to a file. To view the results of multiple line measurements, you must use an external application. The Results Summary panel is not accessible when Multi Lines is selected.

1. After setting Line Select to Multiple Lines in the Operations panel, select **Configuration > Multi Lines**

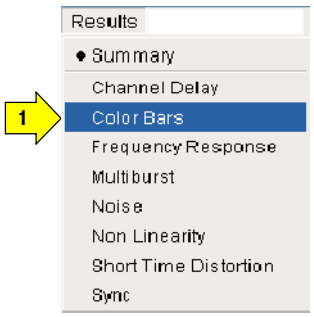
   Select the measurements you want to take. Enter the Start Line and End Line values for each measurement.



Changing Line Number or Averaging on the Results Screen

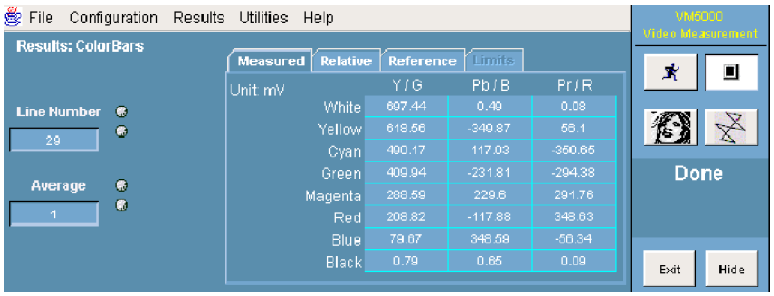
You can change the video signal line number and the number of measurement to average before displaying the results. The instrument stops measuring, changes the results to dashes, and uses the new settings at the start of its next measurement cycle. See page 3–17 for information on line numbers and averaging.

1. Select a measurement from the Results menu. For example, click **Results > Color Bars**

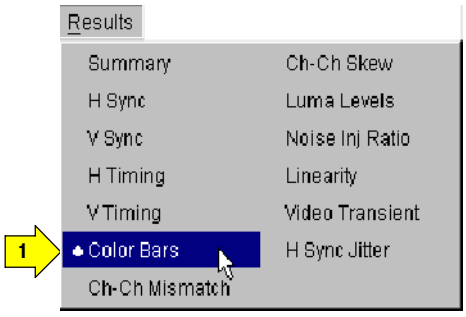


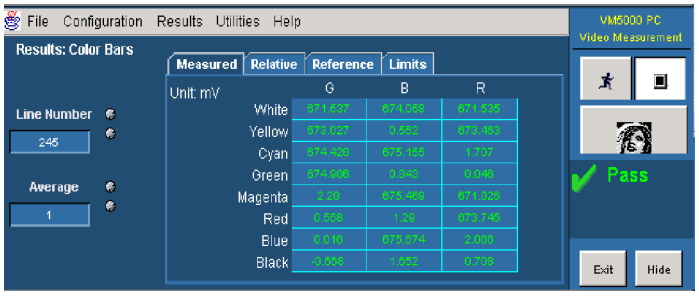
Option SD/HD

The instrument displays the Color Bars measurement results.

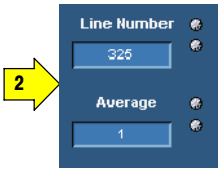


Option VGA

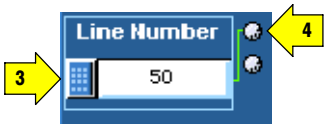


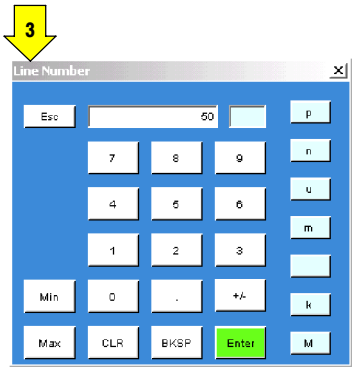


2. To change a value, select the field and enter a value by keyboard. You can also change values using one of the methods outlined in step 3 and step 4.



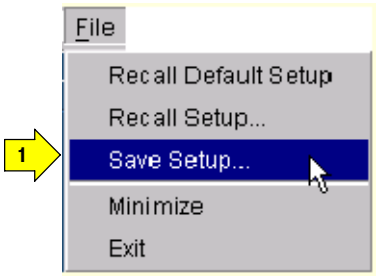
3. Select the keypad icon to the left of the field to display a virtual keyboard to enter values using the touch screen.
4. Use the indicated general purpose knob to change the values.





Saving Measurement Setups

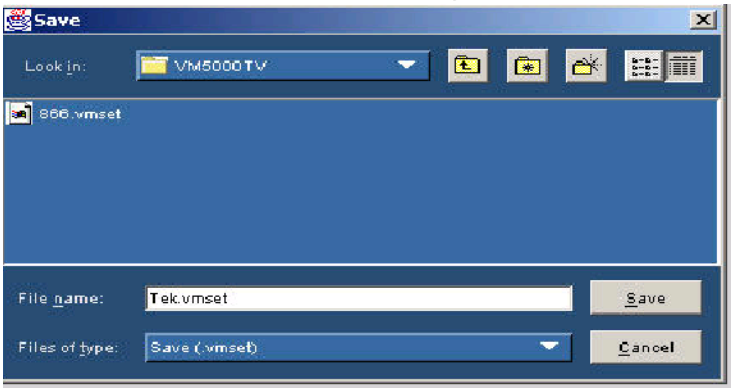
1. Select **File > Save Setup**.



The application displays the Save dialog box.

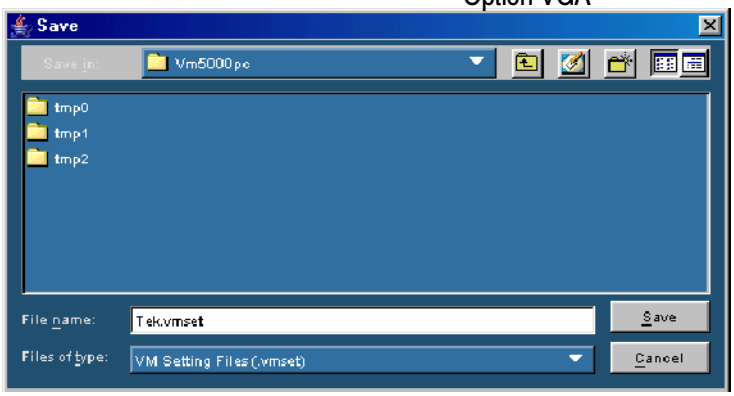
The default save location for Option SD/HD is C:\VM5000TV.

Option SD/HD

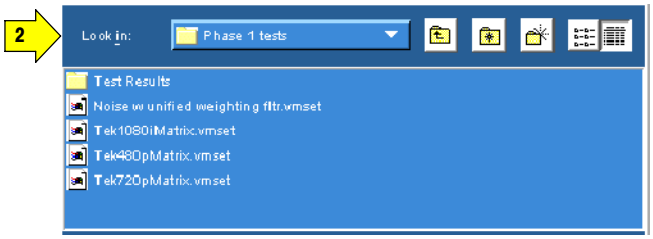


The default save location for Option VGA is C:\VM5000PC.

Option VGA



2. Select the **Look in** list to navigate to a different directory other than the default save location.

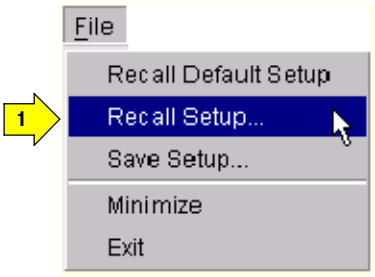


3. Enter a file name in the File Name box. The instrument offers an available file name (or you can choose your own). It automatically appends .vmset to the file name of measurement setup files.
4. Select **Save** to save the measurement settings.



Recalling Measurement Settings

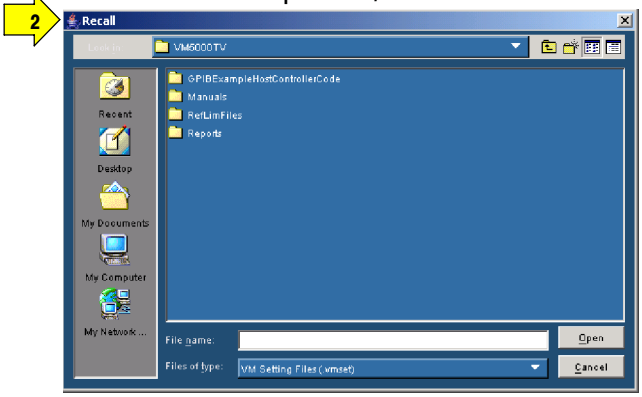
1. Select **File > Recall**.



2. The application displays the Recall dialog box and lists all the instrument setting files present in the default directory

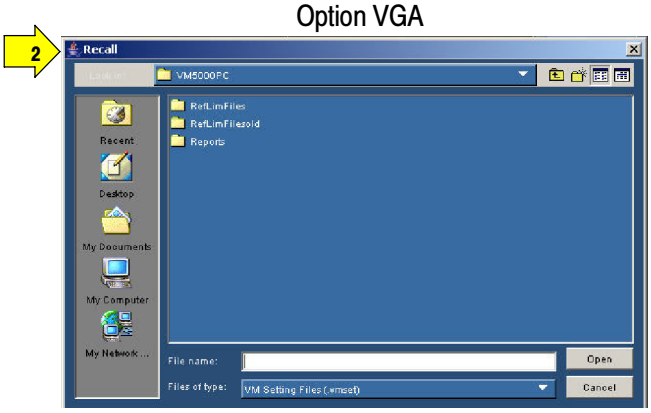
   Option SD/HD default directory:
   C:\VM5000TV

Option SD/HD

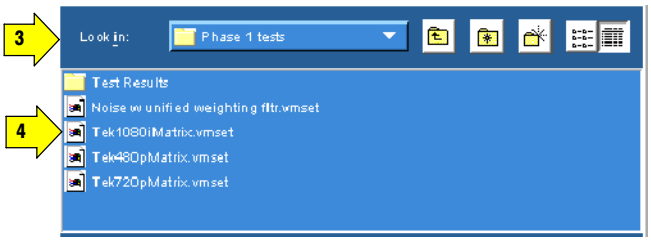


   Option VGA default directory:
   C:\VM5000PC.

Option VGA



3. Select the **Look in:** drop-down list to navigate to a different directory other than the default location.
4. Select a file from those listed.



5. Enter a file name in the **File name** box or select a file from the list.
6. Select **Open** to load the settings file and configure the instrument.



Saving Measurement Results (Reports)

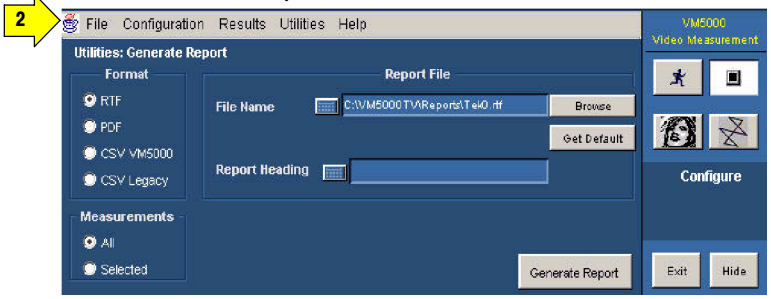
You can use the Generate Report feature to save your measurement results.

1. Select **Utilities > Generate Report.**

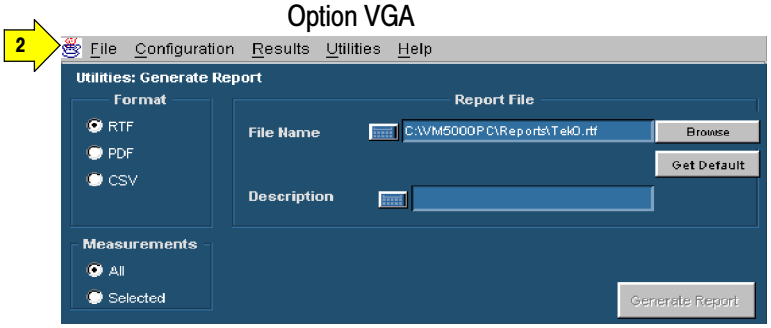


2. The instrument displays the Utilities: Generate Report view.

Option SD/HD

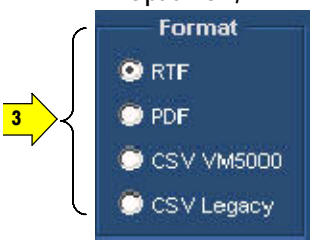


Option VGA

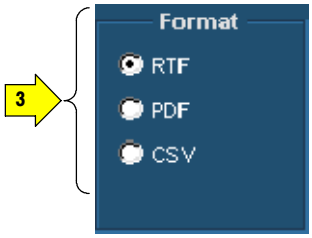


3. Select a report format. Which format you to select depends on what you want to do with the measurement results.

Option SD/HD

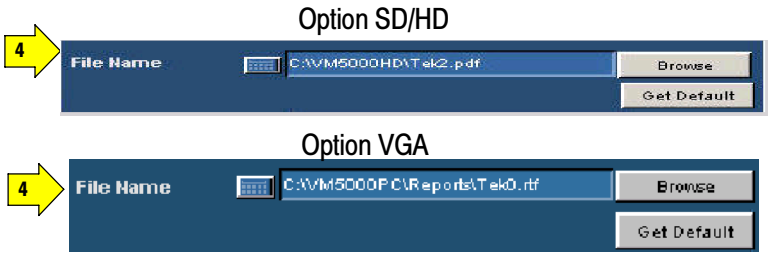


Option VGA



- **RTF**: Use RTF (Rich Text Format) to create results data that you can incorporate into documents.
- **PDF**: Use PDF (Portable Document Format) to create files of the measurement data for distribution and viewing.
- **CSV VM5000 (Option SD/HD) or CSV (Option VGA)**: Use CSV VM5000 (Comma-Separated Values), to save results in a format that contains information on all the new measurements and options. For example, Relative to Reference and Limit Testing results are included in the report.
- **CSV Legacy** (Option SD/HD) – Original format for Version 1 of the software. It is provided for compatibility for customers who use a Microsoft Excel spreadsheet macro to process the file.

4. Use the File Name box to specify where you want to save the report. Use the Browse button to navigate to a specific location. Use the Get Default button to reset the file name to the default location and name for the selected format.



5. Use the Description field to add notes into the report file. You can enter up to 46 characters. For example:
"Serial Number 123456789012 tested by Joe P."



6. Use the Measurements option button to select which measurements to save to a report.



- **All**: Creates a report with all the measurements you have run since starting the application which have valid results in the results panels.
- **Selected**: Creates a report with only the measurements that are currently selected in the Configuration> Measurements screen and that have valid results in the results panels.

7. Select Generate Report to save the measurement results to the specified format and location. All selected measurements are saved together in a single file; each measurement has its own area in the report.

   When Multi Lines is selected, the Generate Report button in the Utilities > Generate Report is not selectable.



Reference

Reference Overview

This chapter provides a detailed description of the VM5000 instrument menus and measurements.

- Menu descriptions. Table 3–1 below lists the top level menus of the instrument and the corresponding sections in this chapter that document those menus. The menu descriptions include high-level descriptions of the measurements.
- Measurement details. In-depth descriptions of each measurement begin page 3–27.

Table 3-1: Overview of menu descriptions

Menu	Submenu	Function	Page
File	Recall Default Setup	Restores default settings of the application.	3-3
	Recall Setup...	Recalls (load) application settings that have been previously saved on the hard disk.	
	Save Setup...	Saves (write) current application setting to hard disk.	
	Minimize	Minimizes the application to the Windows task bar.	
	Exit	Opens the application Exit dialog box.	
Configuration	Format	Sets the input signal format.	3-5
	Measurements	Selects the measurements.	
	Operations	Sets the measurement runtime options.	
	Warnings	Sets the type of warning reported.	
	Reference & Limits	Sets the Reference and the Limit Testing related options.	
	Picture and Vectorscope (Option SD/HD)	Sets the settings related to the Picture and vectorscope display of the video signal.	
	Multi Lines (Option VGA)	Takes each selected measurement on a range of line numbers.	

Table 3-1: Overview of menu descriptions (Cont.)

Overview of menu descriptions			
Menu	**Submenu**	**Function**	**Page**
Results	Summary	Displays the result summary for all the measurements.	3-16
	Channel Delay, Color Bars, Frequency Response, Multiburst, Noise, Non Linearity, Short Time Distortion, and Sync (Option SD/HD)	Adjusts the individual measurement settings and display the results..	
	Ch-Ch Mismatch, Ch-Ch Skew, Color Bars, H Sync, H Sync Jitter, H Timing, Linearity, Luma Levels, Noise Inj Ratio, V Sync, V Timing, and Video Transient (Option VGA)	Adjusts the measurement specific settings and display the results.	
Utilities	Generate Report	Configures the report generation related setting and manually generate reports to a specified file format.	3-25
Help	Help Topics	Opens the VM5000 online help system.	3-26
	About VM5000...	Displays the application version number.	

Menu Descriptions

The following tables list each menu item and its functions. Items in **bold face** are the default application settings when you first start the application or after you do a Recall Default or Recall Setup... operation.

File Menu

Recalling a setup file changes the configuration; current measurements will stop execution and the results appear as dashes.



CAUTION. *To avoid losing unsaved measurement results, generate a report before you recall the default setup or another .vmset setup file.*

Menu Item	Function	Setting or field	Description
Recall Default Setup	VM5000 recalls (loads) and applies the default settings of the application.		
Recall Setup...			Recalls (loads) and applies application settings that have been previously saved on the hard disk.
	Look in	Drop-down menu	Specifies the directory listed in the File list area. (Option SD/HD) **default location** is **C:\VM5000TV** (Option VGA) **default location is C:\VM5000PC**
	File list area	Filename list field	Lists directories (folders) and setup files that are in the current directory (as set by Look in).
	File name	Text entry field	Field in which to enter an application setup file to load and apply. You can also double-click on a file name in the File list area to enter the name in the File Name field.
	Files of type	Drop-down list box	Lists the valid setup file types. The only valid entry is .vmset. To get valid test results, be sure to choose the appropriate setup file for the signal source you are using. Option SD/HD: For example, for the Matrix signal source file Tek1080iMatrix.trp, be sure to use the Tek1080iMatrix.vmset setup file. The correct .vmset setup file will have the correct line numbers for each measurement as the default Option VGA: For example, for the Matrix signal source file Matrix.bmp, be sure to use the Matrix.vmset setup file. The correct .vmset setup file will have the correct line numbers for each measurement as the default..

Menu Item	Function	Setting or field	Description
	Open		Loads and applies the specified instrument setting file.
	Cancel		Closes (exits) the Recall dialog and does not load or apply any settings.
Save Setup...	Saves (writes) the current application measurement settings to the specified file name and directory. All of the Save dialog functions are the same as those for the Recall dialog except for the Save button.		
	Save		Saves the application measurement settings to the specified file directory (as set by Look in) and file name (as entered in the File name field) as file type .vmset.
Minimize	Minimizes the application to the Windows task bar.		
Exit	Opens the application Exit dialog box.		

Configuration Menu

Option SD/HD

In the configuration menu you can set the format of the input signal, select one or more measurements, set the setup mode, run mode, set the warning options, enable reference and limit testing, and set Picture and Vector display parameters.

All the selected measurement results will appear as dashes any time you change any of the following configurations:

- Format
- Color Space
- Trigger

If you change a configuration while running a measurement or a setup, the measurement or setup will stop.

Recalling a setup file changes the configuration; current measurements will stop and results appear as dashes.



CAUTION. *To avoid losing unsaved measurement results, generate a report before changing any configuration parameters other than selecting measurements or turning warnings on or off.*

Bold values in the *Setting or field* column in the following tables indicate the default value.

Menu Item	Function	Setting or field	Description
Format	Set the video input signal format. The Format setting also affects other measurement settings, such as the video signal line number to use when taking measurements.		
	Format	SD option 480I / 60 480P / 60 576I / 50 576P / 50 HD option 720P / 50 720P / 60 1080P / 24 1080I / 60 1080I / 50	Set the input signal format.
	Color Space	YPbPr **RGB**	Set the input signal color space type.

Menu Item	Function	Setting or field	Description
Measurements	Select the video signal measurements to take. You can select from one to eight measurements, in any combination.		
	Measurements	Channel Delay **Color Bars** Frequency Response Multiburst Noise Non Linearity Short Time Distortion Sync.	Select from one to eight measurements, in any combination. When you click Run, the selected measurements will be taken. The result of the selected measurements will be included in any report that you generate. Click Utilities > Generate Report and set Measurements to Selected. For more information see *Detailed Measurement Information* on page 3-27. For a high-level overview of measurements, see *Results Menu* on page 3-16.
Operation	Set the measurement runtime options, including test run mode, input trigger channel, and warning message display.		
	Setup And/Or Run	**Setup & Run**	For each selected measurement, and for each measurement acquisition, this setting automatically configures the instrument settings and takes a measurement. Use this when taking multiple measurements that require different instrument setups.
		Setup Only	The application configures the instrument for a measurement but does not take the measurement. Use this to set up customized settings. Customized settings might include changes to the instrument Horizontal or Vertical front panel controls to display and measure a non-supported video signal standard. Click Run to try out the settings, make adjustments as needed (for example, change the horizontal scale), and then click Run again. Once you are satisfied with the customizations, use the Run Only setting to collect results.
		Run Only	This setting uses the current instrument and application settings to take a measurement. Use this for taking measurements after you setup the instrument by using Setup Only to create custom settings.
	Run Mode	**Once**	The application takes each selected measurement the number of times required for the average you have selected, and then stops taking measurements.
	Run Mode	Continuously	This setting continually takes measurements, in the order the measurements are listed in the Configuration > Measurements view. Select Stop to stop measurements.
		Once & Report	The application takes each selected measurement the number of times determined by the averaging setting, then stops taking measurements and generates a report.

Menu Item	Function	Setting or field	Description
	Auto Scale	**Enabled** Initial Values—**Last Meas,** Last Recalled, Restore Default	Select the **Enabled** check box to enable waveform autoscaling. Deselect the Enabled check box to disable waveform autoscaling. In the selection **Initial Values**, there are three settings: **Last Meas.**, Last Recalled, and Restore Default. **Last Meas.** is the default. When selected the values from the last measurement will be used at the start of the next Auto Scale step. Last Recalled when selected, the values recalled with the last recalled setup will be used at the start of the next Auto Scale step. If a setup (File > Recall Setup) has not been recalled since the program was started, it will load the Auto Scale settings from the last power up. Restore Default when selected, the Factory Default Auto Scaling adjusts the vertical scale units so that the input signals fill the entire graticule as much as possible without going out of range. Auto Scaling occurs once for each selected measurement. If you are using custom instrument settings (for example, changes to Vertical or Horizontal settings made from the instrument front panel or from remote GPIB commands), you should turn Auto Scaling Off. If you are sure your signal is set up correctly and you want to make further measurements in a high speed production line, set Auto Scale to Off.
	Trigger	**Channel 4** Channel 1	This setting sets the input channel on which to trigger the instrument. Refer to the setup illustrations starting on page 2-2 for appropriate trigger channel settings.
	Warning Types Reported	**Measurement Warnings** **Signal Warnings** **Results Warnings**	Set the warning messages to pop up dialog boxes on the instrument screen while taking measurements. All warning messages are selected by default. Clear them to disable warning messages. Measurement warnings include the most general information about potential problems in taking the measurement. Signal warnings appear if signals either change or are absent. If there are some valid results, Results Warnings lets you know that some of the displayed results may not be valid. Results Warnings also shows you the types of test results that are included in the report you have just generated. If warnings are selected, message boxes may appear on screen, requiring you to click OK. To avoid interruptions to your testing, clear all the Warning reporting.

Menu Item	Function	Setting or field	Description
	Control Options	**Pop Up Warning Details** Log Warnings to File	Control Options determines whether warnings are displayed or logged to a file. When any one of the Warning Types Reported is selected, Control Options is enabled. If Log Warnings to File is checked, the warnings are written to a file named Log.txt. Warnings are appended to the Log.txt file until it reaches 1 MB in size. At that point, it is renamed LogOld.txt and a new Log.txt file is created. If the new file reaches 1 MB in size, it will be renamed LogOld.txt and be written over the existing LogOld.txt file. If you wish to save the data in the LogOld.txt file, you must save the file under a different name before it is overwritten. If Pop Up Warning Details is selected, then a message box appears on the screen. To avoid interruptions to your testing, clear all the Warning reporting.
Reference & Limits	Sets the measurement or measurements options to Relative Result Display, and Limit Testing.		
	Relative Result Display	Enable Relative Result Display	Selecting Enable Relative Result Display enables the Relative to Reference testing.
		Capture Results as Reference	This is a fast and easy way to create a reference file.
	Reference Selection	Default	Select Default to automatically load the Tektronix reference file. The only valid entry is .csv. The actual file can be a text file if it is formatted as a comma-separated-value file. To get valid test results, be sure to choose the appropriate reference file. The correct .csv reference file will have the appropriate values for each of the measurements.
		Manual	Select Manual to enable the user defined Select Reference File.
		Select Reference File...	Click Select Reference File to open the file chooser to browse and select the file. Without selecting the reference file, the measurement will run without producing valid relative results. A reference file can still be loaded after a measurement completes to produce relative results for the latest measured values.
Reference & Limits	Limit Testing	Enable Limits Testing	Selecting Enable Limit Testing enables Pass/Fail testing.
		Stop on Limit Testing Error	Check the Stop on Limit Testing Error option to cause the software to stop testing when a measured value falls outside the defined limits.
	Limit Selection	Default	Select Default to automatically load the Tektronix limit file.

Menu Item	Function	Setting or field	Description
		Manual	Select Manual to enable user-defined select limit File.
		Select Limits File...	Click Select Limit File to open the file chooser to browse and select file. Without selecting the limit file, the measurement will run producing valid relative results during continuous mode. A limit file can still be loaded after a measurement completes to produce valid results for the latest measured values.

NOTE. *The Default Reference file (or Default Limit file) is provided AS IS without warranty of any kind, and is intended to be used as a template only. WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXPLICITLY DISCLAIMED.*

Menu Item	Function	Setting or field	Description
Picture & Vector	Select the display type to either Picture, Vector, or Noise spectrum. The Picture and Vector displays will stop measurements when they are displayed. The measurement continue to run only when Spectrum is displayed.		
	Aspect ratio	Auto	Set the width to height ratio of the picture frame to auto mode. **Auto** is the default. This setting can be either HD or SD depending on the input format selected.
		4X3	Set the width to height ratio of the picture frame to 4:3.
		16X9	Set the width to height ratio of the picture frame to 16:9.
	Graticule	Auto	Set the graticule of the vector display to auto mode. Auto is the default setting in Graticule. This setting can be either HD or SD depending on the input format selected.
		SD	Set the graticule of the vector display to SD colorimetry.
		HD	Set the graticule of the vector display to HD colorimetry.
	Scale	Auto	Set the scale of the vector display to auto mode.
		75%	Set the scale of the vector display to 75% bars.
		100%	Set the scale of the vector display to 100% bars.
	Line Number		Set the Line Number for the line select in the Picture display or the one line displayed in the Vectorscope display.

Option VGA All the selected measurement results will appear as dashes any time you change any of the following configurations:

- Resolution
- Refresh Rate
- Timing Standard

If you change a configuration while running a measurement or a setup, the measurement or setup will stop.

Recalling a default setup or recalling setup using setup file changes the configuration; current measurements will stop execution and results appear as dashes in the Results window.



CAUTION. *To avoid losing unsaved measurement results, generate a report before you change any configuration parameters other than selecting measurements or turning warnings on or off.*

Bold values in the *Setting or field* column in the following tables indicate the default value.

Command	Function	Setting or field	Description
Format	Set the video input signal format. The Format setting also affects other measurement specific settings, such as the video signal line number to use when taking measurements.		
	Resolution	640x480 800x600 **1024x768** 1280x1024 1600x1024 1600x1200 1920x1080 1920x1200 1920x1440 2048x1536 2048x2048	Sets the video signal resolution for the input signal you intend to measure.
	Refresh Rate	50 Hz **60 Hz** 65 Hz 70 Hz 72 Hz 75 Hz 76 Hz 85 Hz 100 Hz 120 Hz	Sets the refresh rate for the signal that you intend to measure. Note that all refresh rates are not available at all times; the selectable refresh rate depends on the currently selected resolution.
	Timing	**DMT** CVT CVT-R GTF	Sets the timing standard available for the input signal that you intend to measure.
	User Defined Format	User Defined Format	Sets the user defined formats available for the input signal that you intend to measure.
		List box	Lists the User Defined Formats available.
		Add	Creates a new User Defined Format.

Command	Function	Setting or field	Description
		Edit	Modifies the selected User Defined Format.
		Delete	Deletes the selected User Defined Format.
Measurements	Select the video signal measurements to take. You can select from one to twelve measurements, in any combination.		
	Measurements	Ch–Ch Mismatch Ch–Ch Skew **Color Bars** H Sync H Sync Jitter H Timing Linearity Luma Levels Noise Inj Ratio V Sync V Timing Video Transient	Select from one to twelve measurements, in any combination. When you click Run, the selected measurements will be taken. For more information see *Detailed Measurement Information* on page 3-27. For a high-level overview of measurements, refer to *Results Menu* on page 3-16.
Operations	Set the measurement runtime options, including test run mode, waveform autoscaling, line select setting, using RGBHV Measurement Interface Unit accessory, sync polarity, and embed screen captures in report mode.		
	Setup And/Or Run	**Setup & Run**	For each selected measurement, and for each measurement acquisition, this setting automatically configures the instrument settings and takes a measurement. Use this when taking multiple measurements that require different instrument setups.
		Setup Only	The application configures the instrument for a measurement but does not take the measurement. Use this to set up customized settings. Customized settings might include changes to the instrument Horizontal or Vertical front panel controls to display and measure a non-supported video signal standard.Click Run to try out the settings, make adjustments as needed (for example, change the horizontal scale), and then click Run again. Once you are satisfied with the customizations, use the Run Only setting to collect results.
		Run Only	This setting uses the current instrument and application settings to take a measurement. Use this for taking measurements after you setup the instrument by using Setup Only to create custom settings.
	Run Mode	**Once**	The application takes each selected measurement the number of times required for the average you have selected, and then stops taking measurements.
		Continuously	This setting continually takes measurements, in the order the measurements are listed in the Configuration > Measurements view. Select Stop to stop measurements.
		Once & Report	The application takes each selected measurement the number of times determined by the averaging setting, then stops taking measurements and generates a report.

Command	Function	Setting or field	Description
	Auto Scale	**Enabled** **Initial Values**— Last Meas, Last Recalled, Restore Default	Select the **Enabled** check box to enable waveform autoscaling. Deselect the Enabled check box to disable waveform autoscaling.
	Initial Values	**Last Meas**	Last Meas. is the default. When selected the values from the last measurement will be used at the start of the next Auto Scale step.
		Last Recalled	Last Recalled when selected, the values recalled with the last recalled setup will be used at the start of the next Auto Scale step. If a setup (File > Recall Setup) has not been recalled since the program was started, it will load the Auto Scale settings from the last power up.
		Restore Default	Restore Default when selected, the Factory Default Auto Scaling adjusts the vertical scale units so that the input signals fill the entire graticule as much as possible without going out of range. Auto Scaling occurs once for each selected measurement. Auto Scaling occurs once for each selected measurement.
	Line Select	**Single Line**	Sets measurements to be taken on a single line.
		Multi Lines	Sets measurements to be taken across a range of lines.
	RGBHV MIU	Use MIU	Uses the RGBHV Measurement Interface Unit accessory.
	Sync Polarity	Auto Detect	Automatically detects the V Sync polarity.
	Report Mode	Embed Screen Capture	Embeds a screen shot of the waveform display into generated reports.
Warnings	Specifies whether or not warning messages are displayed or logged to a file.		
	Warning Types Reported	**Measurement Warnings** **Signal Warnings** **Results Warnings**	Specifies the type of warnings to be reported. All warnings are selected by default. Clear them to disable warnings. Measurement warnings include general information about potential problems in taking the measurement. Signal warnings appear if signals either change or are absent. If there are some invalid results, Results Warnings lets you know that some of the displayed results may not be valid. Results Warnings also shows you the types of test results that are included in the report you have just generated. If warnings are selected, message boxes may appear on screen, requiring you to click OK. To avoid interruptions to your testing, clear all the Warning reporting.

Command	Function	Setting or field	Description
	Control Options	**Pop Up Warning Details** Log Warnings to File	Control Options determines whether warnings are displayed or logged to a file. When any one of the Warning Types Reported is selected, Control Options is enabled. If Log Warnings to File is checked, the warnings are written to a file named Log.txt. Warnings are appended to the Log.txt file until it reaches 1 MB in size. At that point, it is renamed LogOld.txt and a new Log.txt file is created. If the new file reaches 1 MB in size, it will be renamed LogOld.txt and be written over the existing LogOld.txt file. If you wish to save the data in the LogOld.txt file, you must save the file under a different name before it is overwritten. If Pop Up Warning Details is selected, then a message box appears on the screen. To avoid interruptions to your testing, clear all the Warning reporting.
Reference & Limits	Sets the measurement or measurements options to Relative Result Display, and Limit Testing.		
	Relative Result Display	Enable Relative Result Display	Selecting Enable Relative Result Display enables the Relative to Reference testing.
		Capture Results as Reference	This is a fast and easy way to create a reference file. Uses current results as the basis for a new reference file.
	Reference Selection	Default	Select Default to automatically load the Tektronix reference file. The only valid entry is .csv. The actual file can be a text file if it is formatted as a comma-separated-value file. To get valid test results, be sure to choose the appropriate reference file. The correct .csv reference file will have the appropriate values for each of the measurements**.**
		Manual	Select Manual to enable the user defined Select Reference File.
		Select Reference File	Click Select Reference File to open the file chooser to browse and select the file. Without selecting the reference file, the measurement will run without producing valid relative results. A reference file can still be loaded after a measurement completes to produce relative results for the latest measured values.
Reference & Limits	Limit Testing	Enable Limits Testing	Selecting Enable Limit Testing enables Pass/Fail testing.
		Stop on Limit Testing Failure	Check the Stop on Limit Testing Failure option to cause the software to stop testing when a measured value falls outside the defined limits.

Command	Function	Setting or field	Description
	Limits Selection	Default	Select Default to automatically load the Tektronix limits file.
		Manual	Select Manual to enable user-defined select limits File.
		Select Limits File	Click Select Limits File to open the file chooser to browse and select file. Without selecting the limit file, the measurement will run producing valid relative results during continuous mode. A limit file can still be loaded after a measurement completes to produce valid results for the latest measured values.
		Select Reference File	Click Select Reference File to open the file chooser to browse and select the file. Without selecting the reference file, the measurement will run without producing valid relative results. A reference file can still be loaded after a measurement completes to produce relative results for the latest measured values.
		NOTE: *The Default Reference file (or Default Limit file) is provided AS IS without warranty of any kind, and is intended to be used as a template only. WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXPLICITLY DISCLAIMED.*	
Multi Lines	Sets, runs, and writes the result report to a file across a range of lines for each of the selected measurement.		
	Measurements on Multi Lines tab		
	Ch-Ch Mismatch	Start Line	Sets the start line number for the Ch-Ch Mismatch measurement. Note the start line number should be less than or equal to the end line number.
		End Line	Sets the end line number for the Ch-Ch Mismatch measurement. Note the end line number should be greater than or equal to the start line number.
	Ch-Ch Skew	Start Line	Sets the start line number for the Ch-Ch Skew measurement. Note the start line number should be less than or equal to the end line number.
		End Line	Sets the end line number for the Ch-Ch Skew measurement. Note the end line number should be greater than or equal to the start line number.
	Color Bars	Start Line	Sets the start line number for the Color Bars measurement. Note the start line number should be less than or equal to the end line number.
		End Line	Sets the end line number for the Color Bars measurement. Note the end line number should be greater than or equal to the start line number.
	H. Sync	Start Line	Sets the start line number for the H Sync measurement. Note the start line number should be less than or equal to the end line number.
		End Line	Sets the end line number for the H Sync measurement. Note the end line number should be greater than or equal to the start line number.

Command	Function	Setting or field	Description
	H. Timing	Start Line	Sets the start line number for the H Timing measurement. Note the start line number should be less than or equal to the end line number.
		End Line	Sets the end line number for the H Timing measurement. Note the end line number should be greater than or equal to the start line number.
	Linearity	Start Line	Sets the start line number for the Linearity measurement. Note the start line number should be less than or equal to the end line number.
		End Line	Sets the end line number for the Linearity measurement. Note the end line number should be greater than or equal to the start line number.
	Luma Levels	Start Line	Sets the end line number for the Luma Levels measurement. Note the end line number should be greater than or equal to the start line number.
		End Line	Sets the end line number for the Luma Levels measurement. Note the end line number should be greater than or equal to the start line number.
	Video Transient	Start Line	Sets the end line number for the Video Transient measurement. Note the end line number should be greater than or equal to the start line number.
		End Line	Sets the end line number for the Video Transient measurement. Note the end line number should be greater than or equal to the start line number.

Results Menu

Option SD/HD

The Results menu enables you to display a summary of measurement results or display detailed results for a specific measurement.

If you change the Line Number or Average values for any measurement, or if you change the Filter configuration in the Noise measurement, then the changed measurement will stop running and its results will change to dashes.

All the selected measurement results will be invalidated any time you change any of the following configurations:

- Format
- Color Space
- Trigger

If you change a configuration while running a measurement or a setup, the measurement or setup will stop. The Average setting interacts with your choices for the Run Mode. For example, if you select Once for the Run Mode and you set the averages to 2, then when you select the Run button, each selected measurement will run twice and then stop. On the other hand, if you select Continuously for the Run Mode and 2 averages, then when you select the Run button, each selected measurement will run twice, display results, and then continue running and updating the results for every two measurements.

For a detailed discussion of measurements, refer to page 3–27.

The following table lists the measurements that appear in the Results menu and details the values that appear on the Results page for each measurement. Bold values in the *Setting or Field* column in the following tables indicate default values.

Menu item	Function	Setting or Field	Description
Summary	Shows the status during and after the selected measurements are measured in the summary panel. This is useful when multiple measurements are selected to run.		
Channel Delay	Measures the time variation between the three video channels. The instrument measures the crossings of all three channels.		
	Channel Delay Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average: **1**	Sets the number of acquisitions over which to calculate an average measurement value.

Menu item	Function	Setting or Field	Description
	Results (ns)		Displays the time variation, in nanoseconds, from channel 1 to channel 2, from channel 2 to channel 3, and from channel 3 to channel 1.
Color Bars	Measures all eight color levels of the three video channels. The instrument locates and measures the back porch signal of each channel, and then measures each channel's color values relative to that channel's back porch level.		
	Color Bar Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average: **1**	Sets the number of measurements acquisitions over which to calculate an average measurement value.
	Results (mV)		Displays eight color values, in mV, for each channel (24 measurements total).
Frequency Response	Measures the amplitude at selected time or frequency location of the input signal.		
	Frequency Response Setup	Line Number	Sets the input signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average: **1**	Sets the number of measurements acquisitions over which to calculate an average measurement value.
		Dist BW(MHz)	Sets the distortion bandwidth frequency.
	Meas Location	Freq 4:4:4	When Meas Location is set to Freq 4:4:4, the measurement uses the same frequency for the measurement location on all three signals (CH1 (Y/G), CH2(Pb/B), and CH3(Pr/R)). This setting is the best option for RGB (GBR) signals.
		Freq 4:2:2	When Meas Location is set to Freq 4:2:2, the measurement uses the full frequency for CH1 and half that frequency for CH2 and CH3. This setting is the best option for YPbPr signals.
		Time	When the Meas location is set to Time, the measurement reports the waveform frequency at that specified time.
		Freq (MHz)	Sets the measurement location frequency.
		Time (μs)	Sets the measurement location time.
	Frequency Response Results		Displays the Flag Amplitude (mV), Frequency (MHz), Amplitude (dB) with reference to the Flag, Time Position (μs), and RMS Distortion (% of Amp) of the video signal.

Menu item	Function	Setting or Field	Description
Multiburst	Measures the video channel frequency response and amplitude. The instrument measures the flag pulse on each channel to determine and measure the six burst frequencies with the largest amplitude.		
	Multiburst Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average: **1**	Sets the number of measurements acquisitions over which to calculate an average measurement value.
	Multiburst Measurement Results		Displays the flag signal value (in mV) for each channel in the first display row. The following six rows list the frequency (in MHz) and amplitude (in dB) of each channel, for each of the six burst signals.
Noise	Measures video signal noise using one of three filter settings.		
	Noise Measure-ment Setup	Line Number	Sets the video signal line number. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average: **1**	Sets the number of measurements acquisitions over which to calculate an average measurement value.
	Filter	Off	Disables (turns off) all noise signal filtering. Use this setting to measure broadband noise without any filtering.
		Unified Weighting	Enables (turns on) unified weighting noise signal filtering. Use this setting to measure noise with the psychovisual weighting established by CCIR Recommendation (Rec) 576-2, adjusted for the selected video format.
		Unweighted w/ Bandwidth	Enables (turns on) unweighted noise signal filtering and activates the filter bandwidth field. Use this setting to remove high frequency noise from your signal.
		Bandwidth Hz	Sets the bandwidth filter cutoff frequency. Selecting Unweighted activates this field. The default value depends on the input signal format as set by Configuration > Format.
	Noise at Cursor Position	Cursor (Hz)	Sets the Cursor frequency.
		Y/G	Sets the channel for the Noise Spectrum measurement.
		Spectrum	Displays Noise spectrum. The Noise measurement must be selected and running continuously to display a noise spectrum. If the Noise measurement is not running, this button is not selectable.
	Results		Displays the noise measurement results for each channel in dB (relative to peak white) and mV.

Menu item	Function	Setting or Field	Description
Non Linearity	Measures channel signal linearity based on a ramp or five-step linearity test signal. If using a ramp signal, the instrument divides the ramp signal into five values to determine the equivalent step values. The instrument then measures the bottom, individual step, and top values of the test signal, and compares these values to a nominal value to determine the percent of deviation of the test signal from the nominal signal.		
	Non Linearity Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average: **16**	Sets the number of measurements acquisitions over which to calculate an average measurement value.
	Results (%)		Displays the percent of deviation of the test signal from a nominal signal value, as a percentage, for each step on each channel.
Short Time Distortion	Measures the short time distortion of the input signal.		
	Short Time Distortion Setup	Line Number	Sets the input signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average: **1**	Sets the number of measurements acquisitions over which to calculate the average measurement value.
	Short Time Distortion Results		Displays the Rise Time (ns), Fall Time (ns), Overshoot (%), Undershoot (%), Settling Time 1 (ns), and Settling Time 2 (ns) of the video signal.
Sync	Measures the sync signal timing and voltage values. The instrument measures the sync signal rise and fall times (at the 10% and 90% signal amplitude levels) and the sync pulse width (at the 50% signal amplitude level) to determine the signal timing values.		
	Sync Measure-ment Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average: **1**	Sets the number of measurements acquisitions over which to calculate the average measurement value.
		Measured on CH1	Results in better measurement accuracy when triggering on CH4.
	Tri-Level Sync Results		Displays the sync signal timing values in ns, and the signal levels in mV. Results that are meaningless for bi-level sync appear as dashes.

Option VGA

If you change the Line Number or Average values for any measurement, then the changed measurement will stop execution and its results will change to dashes.

All the selected measurement results will be invalidated any time you change the following configurations:

- Resolution
- Refresh Rate
- Timing

If you change a configuration that is recall a setup while running a measurement, the measurement will stop execution.

The Average setting interacts with your choices for the Run Mode. For example, if you select Once for the Run Mode and you set the averages to 2, then when you select the Run button, each selected measurement will run twice and then stop. On the other hand, if you select Continuously for the Run Mode and 2 averages, then when you select the Run button, each selected measurement will run twice, display results, and then continue running and updating the results for every two measurements.

For a detailed discussion of measurements, refer to page 3–27.

Values in bold text in the *Setting or field* column in the following tables indicate default values.

Command	Function	Setting or field	Description
Summary	The Summary window displays the status of the selected measurements when they are run. It also displays the warnings, if any. The Summary window is useful when you run multiple measurements.		
Ch–Ch Mismatch	The Ch-Ch Mismatch is the difference in any steady-state voltage amplitude between R,G, and B video outputs.		
	Ch–Ch Mismatch Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	Ch–Ch Mismatch Results		Displays the Ch–Ch mismatch between G to B, G to R, and B to R channels of the video signal values in (mV) and in (%)Peak-Peak. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.

Command	Function	Setting or field	Description
Ch-Ch Skew	Ch-Ch Skew is the phase relationship (time delay) among R, G, and B video outputs of the graphics subsystem.		
	Ch-Ch Skew Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	Ch-Ch Skew Results		Displays the Ch-Ch Skew for G to B, G to R, and B to R channels values in (ns) and in (%) Pixel Clock. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.
Color Bars	Color Bars measurement measures the GBR color bars of a VGA card in a PC. The Color Bars measurement measures the amplitude level (relative to back porch) of each of the eight colors, that is, white, yellow, cyan, green, magenta, red, blue, and black for each active channel.		
	Color Bars Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	Color Bars Results in mV		Displays the amplitude for the White, Yellow, Cyan, Green, Magenta, Red, Blue, and Black colors on the G, B, and R channels (24 measurements total). Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.
H Sync	Sync is the pulse occurring from 2.4 V to 5.5 V at the beginning of each line. This pulse signal causes the monitor to go back to the left side of the display and trace another horizontal line of picture information. This measurement measures rise time, fall time, overshoot, undershoot, settling time, and monotonicity. This measurement measures the steady-state voltage and current amplitudes of logic levels '1' and '0' at 2.21 kΩ and 301 Ω termination.		
	H Sync Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	H Sync Results		Displays the Polarity (Pos/Neg), Pulse Width (µs), Sync Period (µs), Frequency (kHz), Rise Time (ns), Fall Time (ns), Overshoot (%), Undershoot (%), Overshoot S.T. (ns), Undershoot S.T. (ns), Monotonic Rise (Y/N), Monotonic Fall (Y/N), Logic Level "1" (mV) @2.21 kΩ and ±8 mA, and Logic Level "0" (mV) @2.21 kΩ and ±8 mA. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.

Command	Function	Setting or field	Description
H Sync Jitter	H Sync Jitter is the time superimposed image of the second sync pulse over the first, or triggered edge.		
	H Sync Jitter Measurement Setup	No. of Lines	Sets the number of lines to measure.
	H Sync Jitter Results		Displays the H Sync Jitter in (ns) and in (%) Pixel Clock. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.
H Timing	H Timing comprises of the horizontal sync pulse, the back porch, the addressable video signal, the front porch, the left border, and the right border.		
	H Timing Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	H Timing Results		Displays the Back Porch (μs), Left Border (μs), Addressable Video (μs), Right Border (μs), Front Porch (μs) on the G, B, and R channels, and Sync Pulse Width (μs), Pixel Clock (MHz). Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.
Linearity	Linearity is a measure of how well the device-under-test performs analog to digital and digital to analog conversions. Linearity consists of the Resolution, Integral linearity, Differential linearity, and Monotonic measurements.		
	Linearity Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	Linearity Results		Displays the Resolution (Bits), Max INL (LSB), @ Step No, Max DNL (LSB), @ Step No, Monotonic (Y/N), and @ Step No on the G, B, and R channels. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.

Command	Function	Setting or field	Description
Luma Levels	Luma corresponds to the sensitivity of human vision to each of the RGB primaries standardized for video. The Luma Levels measurement reports the minimum and maximum level from the five white and black bars of the active video for each of the three channels.		
	Luma Levels Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	Luma Levels Results in mV		Displays the Max and the Min luminance of the displayed image on the G, B, and R channels. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.
Noise Inj Ratio	Noise Injection Ratio is the noise injected in the VGA output for the Device Under Test. It is the amount of noise relative to the signal amplitude rather than the absolute amount of noise that tends to cause problems. Noise Inj Ratio measures the signal-to-noise ratio of the three channels simultaneously.		
	Noise Inj Ratio Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	Noise Inj Ratio Results		Displays the Noise mV, dB, and Inj Ratio (%) on the G, B, and R channels of the video signal. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.
V Sync	This measurement measures the steady-state voltage and current amplitudes of logic levels '1' and '0' at 2.21 kΩ and ±8 mA termination. It also measures rise time, fall time, overshoot, undershoot, settling time, and monotonicity.		
	V Sync Measurement Setup	Average	Sets the number of acquisitions over which to calculate an average measurement value.
	V Sync Results		Displays the Polarity (Pos/Neg), Pulse Width (μs), Sync Period (ms), Frequency (Hz), Rise Time (ns), Fall Time (ns), Overshoot (%), Undershoot (%), Overshoot S.T. (ns), Undershoot S.T. (ns), Monotonic Rise (Y/N), Monotonic Fall (Y/N), Logic Level "1" (mV) @2.2k and ±8 mA, and Logic Level "0" (mV) @2.2k and ±8 mA. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.

Command	Function	Setting or field	Description
V Timing	V Timing comprises of the vertical sync pulse, the back porch, the addressable lines, the front porch, top border, and bottom border.		
	V Timing Measurement Setup	Average	Sets the number of acquisitions over which to calculate an average measurement value.
	V Timing Results		Displays the Back Porch (Line), Top Border (Line), Addressable Lines (Line), Bottom Border (Line), and Front Porch (Line) on the G, B, and R channels and the Sync Pulse Width (Line). Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.
Video Transient	Video Transients are the video signals that endure for a brief time. Use the Video Transient measurement to check synchronization signal timing and amplitude. It also measures video rise time, fall time, overshoot, undershoot, and settling time.		
	Video Transient Measurement Setup	Line Number	Sets the video signal line number to measure. The default value depends on the input signal format as set by Configuration > Format, and assumes that the appropriate Matrix image file is being used to generate the test signal.
		Average	Sets the number of acquisitions over which to calculate an average measurement value.
	Video Transient Results		Displays the Video Rise Time (ns), Video Fall Time (ns), Video Rise Time (%), Video Fall Time (%), Overshoot (%), Undershoot (%), Overshoot Settling Time (ns), and Undershoot Settling Time (ns) on the G, B, and R channels. Results are reported on the Measured tab, and if enabled, on the Relative, Reference, and Limits tabs.

Utilities Menu



CAUTION. *To avoid losing unsaved measurement results, generate a report before you recall a setup file or change any configuration parameters other than selecting measurements or turning warnings on or off.*

Command	Function	Setting or field	Description
Generate Report	You can save measurement results in three popular data formats.		
	Format	RTF	Use RTF (Rich Text Format) to create results data that you can incorporate into documents.
		PDF	Use PDF (Portable Document Format) to create PDF files of the measurement data for distribution and viewing.
		CSV VM5000 (Option SD/HD) or CSV (Option VGA)	CSV VM5000 – contains measurement results and some more information. The Legacy format includes only the information on measurements that were available in the VM5000HD software. Results for newer measurements only appears in the CSV VM5000 format.
		CSV Legacy (Option SD/HD)	CSV Legacy – Original format for VM5000. It is provided for compatibility for customers that use an Excel spreadsheet macro to process the file.
	File Name	Text entry field	Field in which to enter the report file name. (Option SD/HD) **C:\VM5000TV\Tek0.rtf** (Option VGA) **C:\VM5000PC\Reports\Tek0.rtf**
		Browse	Selects the location to which to write (save) the report.
		Get Default	Sets the report write directory to the default location and name (Option SD/HD) **C:\VM5000TV\Tek0.rtf** (Option VGA) **C:\VM5000PC\Reports\Tek0.rtf**
	(Option SD/HD) **Report Heading** (Option VGA) **Description**	Text entry field	Adds a brief note into the report file. You can enter up to 46 characters.
	Measurements	All	Creates a report with all the measurements that you have run since starting the application.
		Selected	Creates a report with only the measurements that are currently selected in the Configuration > Measurements screen.
	Generation	Generate Report	Writes the specified measurement data in the selected report format to the specified location.

Help Menu

Command	Function	Setting or field	Description
Help Topics	Opens the VM5000 online help window that provides you with application information on your instrument screen.		
About VM5000	Displays a VM5000 dialog that contains the application software version number.		

Option SD/HD Detailed Measurement Information

For a high-level procedure on how to take a measurement, refer to page 2–23.

For a high-level overview of all the measurements, refer to the table beginning on page 3–16.

The following information applies to all the measurements.

Matrix Signals and Line Numbers

The matrix signals that are included with the Signal Source Set (refer to page E–1) provide appropriate signals for all the measurements. Refer to the Readme.txt files on the Signal Source Set for extensive information about the files provided.

Averaging

The higher the average, the lower the variance of the measurement in the presence of noise or other transient signal components. Set the average higher if you would like to reduce the fluctuations in the measurement results.

The instrument averages results, not input waveforms. (If, on the other hand, the Noise waveforms were averaged instead of the Noise results, the noise results would appear lower than they should. Because of the instrument average results, this problem is avoided.)

Channel Delay

The channel delay measurement is used to verify relative timing of the three channels of video. Nominal channel delay is zero between all channels. Deviations from zero correspond to decreased video quality. For example, the greater the delay between channels, the more likely the edges in video will be perceived as distorted. Using a narrow band signal, the delay at a particular frequency band can be measured and thus group delay can be obtained.

In addition, channel delay is a function of relative cable lengths for each of the channels. Thus, if a splitter is used at the video source output, delay due to cable length mismatch can be measured.

Signal Source

You can use the matrix signal, or you can use a signal with high cross-correlation between each pair of channels to be tested. The default signal is the multiburst signal used for multiburst measurement, but many other types of signals can be used, including sweeps and even some live program material. If the cross-correlation is high enough for at least one pair of channels, the measurement results will display. Otherwise, running the measurement will result in '---' for each channel. If warnings are enabled, low correlation between channels will result in associated warnings.

Interpreting Results

A positive number indicates that the first signal arrives later than the second signal. For example, Y to Pb delay of 4.03 ns means that the signal in the Y channel is delayed 4.03 ns relative to Pb. However, the signals may contain distortions, which create different delays for different portions of the video line. In such a case, the measurement result is the delay compensation required to maximize the cross-correlation of the second channel with the first, generally giving a weighted average of the various delays. For narrow band signals, the delays at a particular frequency band may be measured. An ensemble of such measurements may be collected to develop a portrait of group delay.

If the signals of the three channels are highly mutually correlated (which is the case if the signals are reconstructed well and free of distortions other than delay), the 'loop' delay will be approximately zero:

Delay1 – Delay2 + Delay3 = 0, where

Delay1 is Y to Pb or G to B
Delay2 is Y to Pr or G to R
Delay3 is Pb to Pr or B to R

The more the loop delay deviates from zero, the less the three signals mutually correlate. High loop delay corresponds to different types of signals among the three channels, because of differences either in distortions or in the inherent source signal (as in some live program material, for example). Loop delay greater than 5ns will generate a warning if warnings are enabled.

How Results are Calculated

The maximum cross-correlation of transitions is found between each pair of channels. The location of the maximum is the delay in time. Generally, one may think of the calculation of the delay as the average match of transitions, weighted by the amplitude of each transition.

The Channel Delay relative to reference value is calculated as follows:

$$Result = (measured\ value - reference\ value)$$

Color Bars

Measuring GBR color bars from a set-top-box can be used to verify the correct colorimetry conversion. Likewise, conversion from 1080i/720p to 480p colorimetry in YPbPr can be verified. The Color Bars measurement also can be used to check individual channel gain. In addition, it can be used as a crude check of linearity since severe clipping or other non-linear distortions will alter the measurement results from the ideal.

Signal Source

You can use the matrix signal, or you can use a signal with all eight valid color bars on the line. There is no requirement for the order of the bars except for the bias that black will be searched after (to the right of) blue. Each of the bars should be at least 1/24 of the active line time in duration.

Interpreting Results

The Color Bars measurement measures the amplitude level (relative to back porch) of each of the eight colors (white, yellow, cyan, green, magenta, red, blue, black) for each active channel. Therefore, this measurement makes eight measurements on three channels for 24 total measurements. The software assumes Y is on Channel 1, Pb is on Channel 2, and Pr is on Channel 3.

***NOTE**. Some signals intentionally reverse or change the order from the traditional color bar test signal order. Because the bars are measured regardless of order, if channel inputs are swapped, especially in the case of RGB, the resulting input will consist of 'valid' color levels for all eight bars, but the order will be incorrect.*

How Results are Calculated

First, the bars are identified using the relative amplitudes of the three channels and the specification for the selected format and colorimetry.

The amplitudes are calculated using waveform averaged values within each identified bar relative to back porch. Thus, it is important to ensure that the sync signal is within the captured data window for valid measurements. For example, if a manual setup is performed, not only are all eight bars required on the waveform display, but the entire horizontal blanking area to the right of the

signal being measured is also required to locate the sync signal and the associated back porch.

The Color Bars relative to reference values are calculated as follows:

mV : $Result = (measured\ value - reference\ value)$

$$\%: Result = \left(\frac{measured\ value - reference\ value}{reference\ value}\right) \times 100$$

Frequency Response

The Frequency Response measurement technique provides the most accurate representation of display performance. Frequency response is measured on a sweep signal, not a burst. This measurement evaluates a system ability to uniformly transfer signal components of different frequencies without affecting their amplitudes. The amplitude variation can be expressed in dB or percent. The reference amplitude (0dB, 100%) is typically the flag. Frequency response problems can cause a wide variety of aberrations in the picture.

The flag amplitude measurement is a reference signal amplitude. Amplitude is measured with reference to the flag amplitude.

Signal Source

Use a sweep signal with a flag on the front of the signal. You can also use the matrix signal, or any multiburst signal with a reference flag preceding the bursts. The more cycles present in each burst, the more robust and generally more accurate the measurement will be. A burst with less than two cycles is not recommended.

Interpreting Results

Frequency Response measurements are made with a sweep signal by measuring the peak-to-peak amplitude of the sweep signal at a specified point. The sweep input must begin with a reference flag. The point at which the measurement is made is selectable as Freq 4:4:4, Freq 4:2:2, or Time. If Time is selected, the measurement is made on all three channels of the sweep signal at the specified time. If Frequency 4:4:4 is selected, the specified Frequency is found on all three channels. If Frequency 4:2:2 is selected, the specified Frequency is found on Channel 1 and one-half the specified frequency is found on Channels 2 and 3. This is the same for both formats YPbPr and RGB. After the specified point is found on the input sweep signal, five results are
measured:

- The frequency is measured at the specified time if time is selected; otherwise the specified frequency is found and displayed in MHz.
- The time is measured at the specified frequency if frequency is selected; otherwise the input time is displayed in μs.

- The amplitude of the input signal is measured relative to the flag on the input signal and the result is displayed in dB.
- The flag amplitude is measured and displayed in mV.
- The RMS Distortion is measured as the vector sum of all additional sinusoidal components normalized by the amplitude of the fundamental sinusoid at the specified time location.

How Results are Calculated

If a time is specified, the instantaneous frequency (within the context of a 3 µs raised cosine window centered at this time) is measured along with frequencies and amplitudes of nonlinear distortion.

If a frequency is specified, the same algorithm used in the multiburst measurement is used for measuring flag amplitude and relative sinusoidal signal amplitude along with frequencies and amplitudes of nonlinear distortion. If Freq 4:4:4 is specified, the specified frequency is used for all channels. If Freq 4:2:2 is specified, the specified frequency is used for Y and 1/2 the input frequency is used for Pb and Pr.

The Flag Amplitude (mV) is calculated as the peak to peak amplitude of the flag signal.

Freq (MHz) calculated is the frequency specified in the Meas Location (MHz).

Time (µs) is calculated at the Meas Location (MHz).

The frequency response distortion result is calculated as the percent ratio of the square root of the sum of the squares of the additional spectral components above the noise floor.

Relative to Reference Calculation

The Relative to Reference values for mV | Hz | µs units are calculated as follows:

Frequency: Result = Frequency measured – Frequency reference

Time: Result = Time measured – time reference

Flag: Result = Flag measured – flag reference

Amplitude: Result = Amplitude measured (in dB) – Amplitude reference (in dB)

RMS Distortion: Result = RMS distortion measured – RMS distortion reference

The Relative to Reference values for the % display are calculated as follows:

$$Frequency = \left(\frac{measured\ frequency - reference\ frequency}{reference\ frequency} \right) \times 100$$

$$Time = \left(\frac{measured\ time - reference\ time}{reference\ time} \right) \times 100$$

$$Flag = \left(\frac{measured\ flag - reference\ flag}{reference\ flag} \right) \times 100$$

$$Flag = 20 \log \left(\frac{\frac{measured\ amplitude}{reference\ flag} - reference\ amplitude}{reference\ amplitude} \right) \times 100$$

$$RMS\ Distortion = \left(\frac{measured\ distortion - reference\ distortion}{reference\ distortion} \right) \times 100$$

Measured Calculation

The measured values appear in the Results panel when Measured tab is selected. These values are calculated as follows:

Frequency = Frequency measured

Time = Time measured

Flag = Measured flag amplitude in mV

Amplitude = Amplitude of signal at the time or frequency input

$$Result = 20 \log \left(\frac{measured\ amplitude}{measured\ flag\ amplitude} \right)$$

Amplitude (note that attenuated signals give results in -dB)

$$Result = \left(\frac{RMS\ correlated\ distortion\ amplitude}{RMS\ signal\ amplitude} \right) \times 100$$

Multiburst

The Multiburst measurement is used to verify frequencies and corresponding amplitudes of sinusoidal bursts. It can be used to verify the proper reconstruction of a band-limited video signal across the frequency spectrum. For example, a frequency roll-off (decrease in amplitude with increasing frequency) is seen with video from an analog-to-digital converter that lacks a reconstruction filter with sin(x)/x correction. In this example, quality is reduced by things like loss of detail in the video or color shifts in details.

Deviations in frequency from the reference test signal frequency (for example, a 30 MHz burst is rendered as a 20 MHz burst) may indicate things such as a frequency shift due to format change, frequency aliasing due to digital and/or analog re-sampling, and/or frequency aliasing due to the lack of a proper reconstruction filter.

The flag amplitude measurement can be used to verify the channel gain across a wider frequency range than each burst. Burst amplitudes are measured relative to the flag amplitude.

Signal Source

You can use the matrix signal, or you can use any multiburst signal with a reference flag preceding the bursts. The more cycles present in each burst, the more robust and generally more accurate the measurement will be. A burst with less than 2 cycles is not recommended.

The frequencies are always displayed from lowest to highest regardless of the order of burst frequencies in the multiburst signal. To avoid confusion regarding the correspondence between the results burst numbering and the signal burst ordering, a signal with increasing burst frequencies (from left to right) is recommended.

Interpreting Results

For multiburst signals free of non-linear distortion and with increasing burst frequencies, the ‘Frq(MHz)’ column displays the fundamental frequency of burst specified in each row. The “Amp(dB)” column has the magnitude of the corresponding burst.

However, if non-linear distortion is present, interpreting results may be less straight forward.

In many consumer set-top boxes, lack of a reconstruction filter (with out-of-band rejection plus sin(x)/x correction) leads to roll-off in the fundamental frequency component of the bursts even though the envelope of the bursts may be flat on average. In this case, the amplitude results for the highest frequency may be low by a few dB even though the waveform shows the same burst with peak-to-peak amplitude closer to 0 dB. This indicates that the burst is no longer a pure windowed sinusoid, but has other spectral content (at least one alias frequency in

this example). If the extra spectral content is removed by filtering, the resulting sinusoid will have the amplitude shown in the results.

Generally, if the signal has undergone processing without a required anti-alias filter (as in re-sampling for format conversion, or signal reconstruction), each burst may contain one or several frequency aliases. In such cases, burst frequencies that increase with each burst of the input signal may contain burst frequencies in nearly any order in the output of the device under test.

For example, in the 480p rendering of an ATSC 1080i multiburst signal, 5 MHz is rescaled to 4.85 MHz, 10 MHz to 9.71, but 15 MHz, 20 MHz, 25 MHz, and 30 MHz become any number of frequencies (including 12.44 MHz, 7.58 MHz, 2.73 MHz, and 2.12 MHz respectively). These frequency aliases and respective amplitudes are measured and displayed in order: 2.12 MHz, 2.73 MHz, 4.85 MHz, 7.58 MHz, 9.71 MHz, 12.44 MHz.

How Results are Calculated

The six largest peaks are found in the spectrum of signal on the pedestal. These frequencies are displayed in order from lowest to highest. For each of these frequencies, the maximum magnitude of the cross-correlation between the signal within the pedestal area and a windowed complex sinusoid is found. This gives the amplitude.

Noise

The unweighted noise within the nominal bandwidth of the video signal is measured to ensure that the video quality is not reduced by random errors such as those that cause ‘snow’.

Signal Source

You can use the matrix signal, or you can use any flat line or line pedestal signal.

Interpreting Results

As a rule of thumb, errors generally become visible when the signal-to-noise dB measurement ranges in the low 40s. However, the degree of visibility depends on many factors, including spectral distribution of the noise. In standard definition television, noise weighting filters such as the CCIR Recommendation (Rec) 576–2 unified weighting filter are used to weight the noise spectrum to better match the visibility of noise in typical viewing conditions. The unified weighting filter has been modified to exactly match the ‘visibility of noise characteristics’ of 576–2 on the screen for each selected video format.

How Results are Calculated

After line tilt and other low frequency distortions are removed from the signal, all AC signal content is spectrally weighted by the selected filter, if any, and the resulting RMS voltage is calculated along with the signal-to-noise ratio in dB using a 700 mV peak signal value.

The Noise relative to reference value is calculated as follows:

Result = (*measured value* − *reference value*)

NonLinearity

This measurement is used to measure deviations from a straight line ramp test signal. Deviations can be caused by such things as soft-limiting from analog amplifiers and digital processing errors. Problems in linearity can reduce video quality by, for example, reducing contrast at various average luminance levels, or creating color shifts.

Signal Source

You can use the matrix signal, or you can use either a ramp or step signal. However, a ramp signal will give the best accuracy.

Interpreting Results

The measurement shows deviations from linear increase in the test signal as a percentage of the largest increase per time found.

How Results are Calculated

In the case of steps, results are deviations in step amplitudes in the test signal as a percentage of the largest step found.

In the case of ramps, using six equal time intervals across the ramp, results are deviations from linear increase in the test signal as a percentage of the largest increase per time found.

The Non Linearity relative to reference value is calculated as follows:

Result = (*measured value* − *reference value*)

Short Time Distortion

The Short Time Distortion measurement measures the rise and fall time, overshoot and undershoot, settling time on the rising edge, and the settling time on the falling edge. Short time distortions produce fuzzy vertical edges.

Signal Source

Short time distortion can be measured with any signal that has a T rise time white bar and pulse section of the matrix signal. The pulse is used for the K2T measurement; the bar is used for the other measurements. A T rise time bar has a 10% to 90% rise time of nominally 100 ns. Many common test signals have 2T rather than T rise times and are not suitable for this measurement. Also note that T rise time signals will suffer significant distortion when passed through a TV transmitter as they contain spectral components that will be removed by the transmitter 5 or 6 MHz lowpass filter. Short time distortion measurements made

on transmitted signals will therefore evaluate only those components in approximately the 200 ns to 1 μs range.

Interpreting Results

The affected signal components range in duration from 0.100 μs to 1 μs. Short time distortions are most often characterized by measuring $K_{2T.}$

The rise and fall times are calculated on the bar using the 10% and 90% points. The result is displayed in ns. The overshoot is calculated as the highest excursion of the signal on the positive edge relative to the Vmax steady state. The undershoot is calculated as the lowest excursion of the signal on the negative edge relative to Vmin steady state. These two results are displayed in % using the steady state value as a reference. The Settling time on the rising edge is measured from the end of the overshoot to the point where the amplitude of the video ringing is down to ± 5% of the final steady state value. The Settling time on the falling edge is measured from the end of the undershoot to the point where the amplitude of the video ringing is down to ± 5% of the final steady state value. The K2T measurement is an indicator of the quality of the video signal as perceived by a human viewer.

How Results are Calculated

K2T is an estimate of the degradation of subjective quality due to linear distortions of the video signal. Linear distortions include any linear combination of the original pulse such as repeated pulses (from reflections, for example), ringing, etc. Ideally, the signal beyond 2T before and after the center of the pulse is practically zero. Linear distortions can cause deviations from zero. The greatest perceptual deviation from zero is used as the K2T measurement. Perceptually, a low amplitude pulse far from the original pulse is more noticeable than the same pulse very close to the original. Therefore, signal amplitude deviations are weighted accordingly. A reference signal deviation far from the pulse is used. CCIR specifies 4% of the test pulse amplitude as the reference deviation amplitude (K = .04).

Measurements of the undershoot, and overshoot at the edge of a T rise bar are not generally calculated as a percent of the transition amplitude but in terms of an amplitude weighing system that yields results in percent SD. This weighing is necessary because the amount of distortion depends not only on the distortion amplitude but also on the time the distortion occurs with respect to the transition.

The Short Time Distortion relative to reference value is calculated as follows:

Result = (*measured value* − *reference value*)

Sync

This measurement is used to check synchronization signal timing and amplitude, including the relative position of the start and end of active video (interpreted by looking at front and back porch times).

Signal Source

You can use the matrix signal, or you can use a signal with signal amplitude greater than 7.5% at the beginning and end of active video in order to measure front porch and back porch times.

Interpreting Results

The amplitudes are measured relative to back porch.

Selecting either 1080 or 720 formats will display the tri-level sync results. Selecting either 480 or 576 will display the bi-level sync results.

How Results are Calculated

The amplitudes are measured relative to back porch.

The times are taken as the time between half amplitudes of adjacent transitions. For example, “Neg. Sync Width” is the measured time between the half amplitude of the falling or leading edge of negative sync and the half amplitude of the rising or trailing edge of negative sync.

In the absence of sufficiently large (greater than 7.5%) video signal, the width of front porch and back porch may not be found. In this case, the measurement of the respective porch widths will not be valid.

The Sync relative to reference value is calculated as follows:

$$Result = (measured\ value - reference\ value)$$

Option VGA Detailed Measurement Information

For a high-level procedure on how to take a measurement, refer to page 2–23.

For a high-level overview of all the measurements, refer to the table beginning on page 3–16.

The following information applies to all the measurements.

Matrix Signals and Line Numbers

The matrix signals that are included with the Signal Source Set (refer to page E–1) provide appropriate signals for all the measurements. Refer to the Readme.txt files on the Signal Source Set for extensive information about the files provided.

When using Tektronix supplied matrix test signals, if a .vmset file is provided for that format of matrix test signal, be sure to use the default line numbers in the associated .vmset file (File > Recall). Otherwise, under most circumstances, use the instrument default line numbers (File > Recall Defaults).

For example, click **File > Recall**, and then navigate to where you have saved the setup file:

Tek.vmset

The line numbers in this setup file may be used for all formats, such as 640X480, 800X600, 1024X768, 1280X1024, 1600X1200, and 1920X1200 @60, 75, and 85 Hz in RGB.

For the equivalent matrix test signal, the Signal Sources disk supplies .bmp files. The device under test generates the signal that the VM5000 analyzes.

Averaging

The higher the average, the lower the variance of the measurement in the presence of noise or other transient signal components. Set the average higher if you would like to reduce the fluctuations in the measurement results.

The instrument averages results, not input waveforms. (If, on the other hand, the Noise waveforms were averaged instead of the Noise results, the noise results would appear lower than they should. Because of the instrument average results, this problem is avoided). The maximum average value you can set in the Results screen is 64.

Ch-Ch Mismatch Measurement

The Ch-Ch Mismatch measurement measures the difference in any steady-state voltage amplitude between R, G, and B video outputs. The amplitude difference of all the 32 steps is measured between two channels. The maximum amplitude difference is shown as the result.

Signal Source

The test signal used for Ch-Ch Mismatch measurement is a 32 Step Staircase (required to test for compliance with the VESA Test procedure), which is located on the Test Signal Files CD-ROM.

The 32 Step Staircase test signal contains a pattern where each step is equal to 1/32 of the maximum input voltage (700 mV) for R, G, and B channels. The PC color setting must be set to True Color mode.

If you plan to take only Ch-Ch Mismatch measurement, use a 32-Step Staircase Full Field test pattern. Select the bitmap file that matches the format and the refresh rate of the test. For example, look for the 640x480–32Steps.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal refer to page 2–16. For example, look for the 640x480–Matrix.bmp. This file has a 32 Step Staircase which is suited to the Ch-Ch Mismatch measurement.

Interpreting Results

The maximum limit for the Ch-Ch Mismatch is 6% of any voltage over the full range in accordance with the VESA specifications.

The ideal value of Ch-Ch mismatch result should be 0 mV. A positive value indicates that the step voltage of the first channel is greater than that of the second channel. A negative value indicates that the step voltage of the first channel is less than that of the second channel.

For example, –8.923 mV mismatch between G to B channel indicates that the step voltage of the G channel is less than the step voltage of the B channel.

How Results are Calculated

For a given step, the voltage amplitude is measured with reference to the back porch. The amplitude is measured for two channels (say G and B). The amplitude difference of two channels is calculated and displayed as the result. The results are reported as a percentage by dividing the calculated result by Vmax steady state (typically 700 mV).

Ch-Ch Skew Measurement

Ch-Ch Skew is the phase relationship (time delay) among R, G, and B video outputs of the graphics subsystem. In addition, Ch-Ch Skew is a function of the relative cable lengths for each of the channels.

The Ch-Ch Skew measurement is used to verify the relative timing of the three video channels. Nominal Ch-Ch Skew is zero between all the channels. The Ch-Ch Skew measurement also displays the pixel clock (%) in the Results window that is the channel-to-channel delay as a percentage of the pixel clock period.

Ch-Ch Skew incurs a slight color shift at the edge of the white bar. Visually, it appears as a focus error.

Signal Source

The test signal used for the Ch-Ch Skew measurement is the Alternate White and Black Bars (required to test for compliance with the VESA Test procedure), which is located on the Test Signal Files CD-ROM.

There are nine bars in the Alternate White and Black bars test signal.

If you plan to take only Ch-Ch Skew measurement, use an Alternate White and Black bars Full Field test pattern. Select the bitmap file that matches the format and the refresh rate of the device under test. For example, look for an 640x480–AlternateWhite&BlackBars.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal refer to page 2–16. For example, look for a 640X480–Matrix.bmp file to test a 640x480 resolution format.

Interpreting Results

The ideal value of Ch-Ch skew is 0 ns. A positive number indicates that the first signal arrives later than the second signal. For example, G to B delay of 4.03 ns means that the signal in the G channel is delayed 4.03 ns relative to B.

If the signals of the three channels are highly correlated, the “loop” delay will be approximately zero:

Delay1 – Delay2 + Delay3 = 0,

where

Delay1 is between channels G to B

Delay2 is between channels G to R

Delay3 is between channels B to R

How Results are Calculated

The leading edge position of the second white bar is determined for all three video channels. For each pair of channels, the difference in the above values is computed and reported. The result is also reported as a percentage of the pixel clock period.

Color Bars Measurement

The Color Bars measurement measures the GBR color bars of a VGA card in a PC. The Color Bars measurement measures the amplitude level (relative to back porch) of each of the eight colors, that is, white, yellow, cyan, green, magenta, red, blue, and black for each active channel. Therefore, this measurement makes eight measurements on three channels for 24 total measurements. The software assumes that G is on Channel 1, B is on Channel 2, and R is on Channel 3.

The Color Bars measurement is also used to check individual channel gain. In addition, it can be used as a crude check of linearity because severe clipping or other non-linear distortions will alter the measurement results from the ideal.

Signal Source

The test signal used for the Color Bars measurement is the color bars pattern located on the Test Signal Files CD-ROM.

The color bars test signal used has nine colors. They are white, yellow, cyan, green, magenta, red, blue, black, and white. If you generate your own color bars test signal, it should have the first and the last bar white and the remaining seven color bars in any order. Each of the bars should be at least 1/24 of the active line time in duration.

If you plan to take only Color Bars measurements, use a Full Field test pattern of the type Color Bars. Select the bitmap file that matches the format and the refresh rate of the test. For example, use the 640x480-ColorBars.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal refer to page 2-16. For example, look for a 640x480-Matrix.bmp file to test a 640x480 resolution format.

Interpreting Results

The reference value of the amplitude level relative to the back porch of each of the colors is either 0 mV or 700 mV for G, B, and R channels.

For example, relative value of 15 mV for yellow (G channel) indicates that the measured value of the signal is greater than the reference value of the signal.

How Results are Calculated

First, the bars are identified using the relative amplitudes of the three channels and the specification for the selected format and colorimetry.

The amplitudes are calculated using waveform averaged values within each identified bar relative to the back porch. Thus, it is important to ensure that the

sync signal is within the captured data window for valid measurements. For example, if a manual setup is performed, all eight bars are required on the waveform display.

The Color Bars relative to reference values are calculated as follows:

mV : $Result = (measured\ value - reference\ value)$

$$\%: Result = \left(\frac{measured\ value - reference\ value}{reference\ value}\right) \times 100$$

H Sync Measurement

Horizontal Sync is the pulse occurring from 2.4 V to 5.5 V at the beginning of each line. This pulse causes the electronic beam of a CRT to go back to the left side of the display and trace another horizontal line of picture information. This measurement characterizes the rise time, fall time, overshoot, undershoot, and settling time shown in the Figure 3-1.

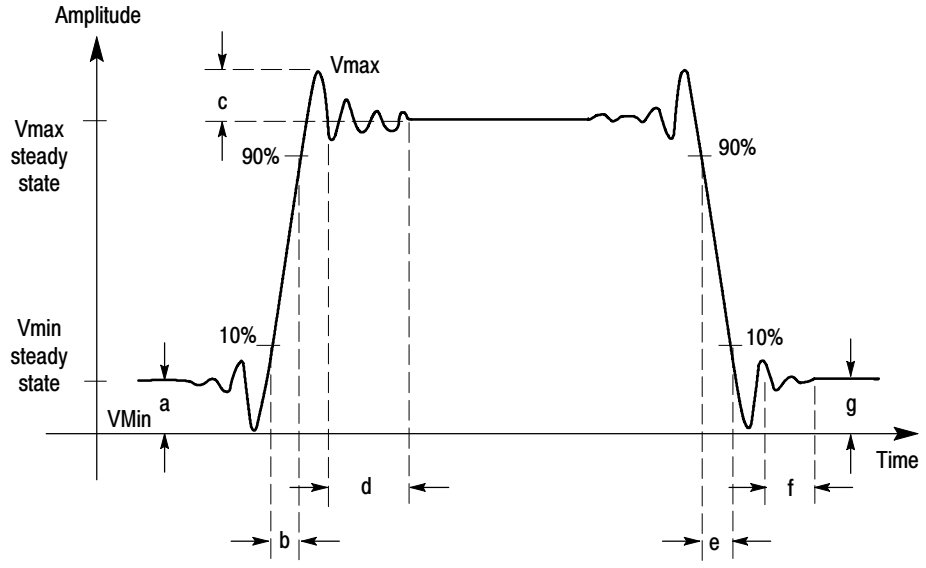


Figure 3-1: Signal definitions (H Sync)

where a – Vmin steady state amplitude before transition
b – Rise Time
c – Overshoot
d – Settling time
e – Fall time
f – Settling time
g – Undershoot

This measurement also characterizes monotonicity and steady-state voltage amplitude at logic levels '1' and '0'. When the MIU is present, a current source inside the MIU automatically presents the required load. So no manual intervention is required. In the absence of the MIU, external 2.21 kilo ohms and 301 ohms terminations have to be manually presented. The user is prompted to change the termination from 2.21 kilo ohms to a 301 ohms termination for measuring the level when drawing maximum current.

Variations in the sync pulse voltage may cause instability in the displayed image or for extreme cases may even prevent the monitor from locking on to the correct scan frequency.

Rise time is measured from the 10% to the 90% amplitude points of a positive-going transition.

Fall time is measured from the 90% to the 10% amplitude points of a negative-going transition.

Overshoot refers to rise above the steady state value in a positive-going transition. Undershoot refers to fall below the steady state value in a negative-going transition.

Settling time is measured from the end of the overshoot or undershoot to the point where the amplitude of the video ringing is down to ±5% of the final steady state value.

Monotonicity is the property whether or not the video signal is continuously rising or falling without any inflection points. Monotonicity is decided by determining the progression of the successive gray levels.

When measuring transients (rise time, fall time, overshoot, etc.), the MIU is set to use the Sync Wide bandwidth path. When measuring amplitude levels, the MIU is set to use the Sync low bandwidth path.

Signal Source

The H Sync measurement does not require a specific test pattern. It can be taken with any of the patterns in the Matrix signal (located on the Test Signal Files CD-ROM).

Interpreting Results

Horizontal Sync polarity is detected by looking at the signal level after skipping a nominal pulse width duration. It is considered to be positive if the signal level

is less than one volt. If not, the polarity is negative. H Sync edge and corner characteristics are determined by detecting the edge of the H sync signal. A smaller rise/fall time value indicates a higher quality signal. The overshoot and undershoot amplitude, and settling time should be zero under ideal conditions. When H Sync monotonicity is Yes in the results panel, it indicates that the incoming signal does not change its sign during the rise/fall period.

How Results are Calculated

The Scope trace is triggered by the trailing edge of the H Sync pulse. Transient and pulse width measurements are made on the H Sync pulse at the end of the specified line.

Sync levels are measured with reference to oscilloscope ground and reported at two different conditions:

- When the H Sync signal or channel is terminated by a 2.21 kΩ resistor
- When the H Sync signal or channel is connected to a current source of ±8 mA (+8 mA is connected when H Sync level is high, –8 mA when H Sync level is low)

Horizontal Sync amplitude is determined by averaging the points that lie between 30% and 90% of the pulse width. Sync pulse width is determined by detecting the edges of the sync signal. The position difference between the two edges is shown as the result.

Rise time is the time taken for the signal to rise from 10% to 90% of steady state level.

Overshoot/Undershoot settling time is the time taken for the signal to reach 5% of its steady state value.

H Sync frequency is derived from pulse time value.

H Sync Jitter Measurement

Horizontal Sync Jitter is the time between the superimposed image of the second sync pulse over the first, or triggered edge. Jitter is the variation of a digital signal's significant instants, such as transition points from the ideal positions in time. Use the **H Sync Jitter** measurement to measure the Horizontal Sync Jitter. See Figure 3–2.

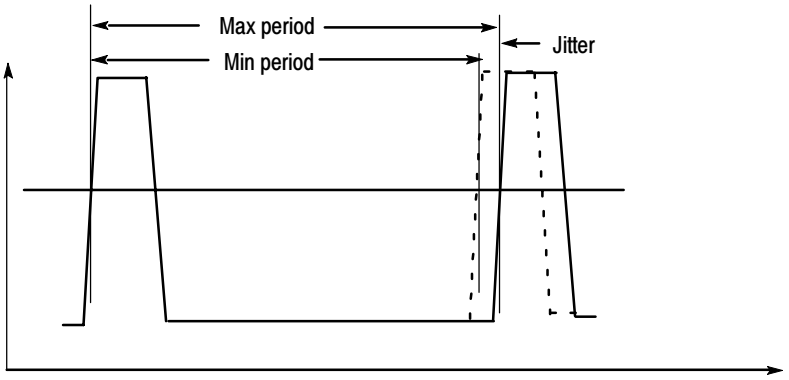


Figure 3- 2: Jitter in H Sync period

Signal Source

The test signal used for the H Sync Jitter measurement can be any of the available patterns in the Matrix signal, which is located on the Test Signal Files CD-ROM.

Interpreting Results

A low numeric value of the H Sync jitter indicates a higher quality of incoming signal.

How Results are Calculated

The peak to peak H Sync Jitter is calculated as follows:

$$Jitter\ (peak - peak) = \left(\frac{Max.\ SyncPeriod\ value\ -\ Min.\ SyncPeriod\ value}{2}\right)$$

$$Jitter(\%) = \frac{Jitter\ (peak - peak)}{pixel\ clock\ period}$$

The H Sync Jitter is calculated for N consecutive lines of video frames. N is entered by the user.

Half of the difference between the minimum and maximum is reported as the H Sync period jitter. This value is also quantified as a percentage of the pixel clock period.

H Timing Measurement

The Horizontal Timing measurement consists of the following measurements: the horizontal sync pulse, the back porch, the addressable video signal, the front porch, the left border, and the right border.

Back porch is the portion of the video signal that lies between the trailing edge of the horizontal sync pulse and the start of the active picture.

Border is the period during which a background colored border is displayed in order to allow the image to extend beyond the limits of the surrounding bezel on overscan type monitors. The duration of the left border or the right border in the active video constitute one-tenth of the total time.

Addressable video is the period during which active video image information is transmitted.

Front porch is the portion of the video signal between the end of the active picture and the leading edge of the horizontal sync.

Sync pulse width is the period of the active sync pulse.

Signal Source

The test signal used for the H Timing measurement is Black White Black (required to test for compliance with the VESA Test procedure), which is located on the Test Signal Files CD-ROM.

The Black White Black test signal contains a black pattern (10%) followed by a white pattern (80%), and this is again followed by a black pattern (10%). Because some graphics cards insert a border around the picture, this test signal facilitates border detection.

If you plan to take only H Timing measurements, use a Black White Black Full Field test pattern. Select the bitmap file that matches the format and the refresh rate of the test. For example, use the 640x480–BlackWhiteBlackBars.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal refer to page 2–16. For example, use the 640x480–Matrix.bmp file to test a 640x480 resolution format.

Interpreting Results

The H Timing Results must match the values specified by the standards depending on the timing standard selected.

How Results are Calculated

In H Timing, if any borders are detected, their width is measured. A border is considered present if there are pulses around SAV or EAV with heights of at least 15% of the white level. Edges of the white band are detected and addressable video width is estimated by considering the white band is 80% of the addressable portion of the H sync pulse width. Sync period is measured by detecting the edges in the sync signal.

Linearity Measurement

Linearity is a measure of how well the device-under-test performs analog to digital and digital to analog conversions.

Linearity consists of the Resolution, Integral linearity, Differential linearity, and Monotonic measurements.

The integral linearity is the actual nth value compared to the ideal nth value, normalized to the ideal LSB command voltage (LSBc).

Differential linearity is the difference between the DAC output voltage measured in the nth value and that of the previous value (n-1) normalized to the ideal LSB command voltage (LSBc).

Resolution refers to the number of distinct vertical levels in the video signal based on the steps. Resolution is represented as a bit.
For a 256 level DAC, the resolution is reported as eight bits. For levels greater than 128 and less than 256, the resolution reported is eight bits.

Monotonicity is the property whether or not the video signal is continuously rising or falling without any inflection points. Monotonicity is decided by determining the progression of the successive gray levels.

Signal Source

The test signal used for the Linearity measurement is the Staircase, which is located on the Test Signal Files CD-ROM.

The Staircase test signal contains a pattern ranging from black to white. The file is available in BMP format for an 8-bit staircase test signal and in PNG format for a 10-bit staircase test signal.

If you plan to take only Linearity measurements, use a Staircase Full-Field test pattern. Select the bitmap file that matches the format and the refresh rate of the test. For example, look for a 640x480–Staircase.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal refer to page 2–16. For example, look for a 640x480–Matrix.bmp file to test a 640x480 resolution format.

Interpreting Results

By using a staircase signal, the bit resolution of the device under test can be determined. The integral and differential linearity values should be close to zero under ideal conditions.

How Results are Calculated

The Linearity of an input signal is calculated by using the RGB wide bandwidth signal path of the MIU.

Normalized Integral Linearity Error is calculated as follows:

$$NormIntegLinErr = \left(\frac{V\,actval - V\,idealval}{LSBc}\right)$$

where

NormIntegLinErr is the Normalized Integral Linearity Error

V actval is the actual voltage amplitude of the step

V idealval is the ideal voltage amplitude of the step

LSBc (for an 8-bit DAC) is given by

$$\left(\frac{Voltage\ amplitude\ of\ 255th\ step - Voltage\ amplitude\ of\ 0th\ step}{255}\right)$$

Normalized Differential Linearity Error is calculated as follows:

$$NormDiffLinErr = \left(\frac{V\,actvalnstep - V\,actvalnprestep}{LSBc}\right)$$

where

NormDiffLinErr is the Normalized Differential Linearity Error

actvalnstep is the actual voltage amplitude of the Nth step

V actvalnprestep is the actual voltage amplitude of the previous (N-1)th step

The Normalized Integral Linearity Error and the Normalized Differential Linearity Error are calculated for each step. The step at which the maximum Normalized Integral Linearity Error and the Normalized Differential Linearity Error observed is displayed in the Linearity results window.

Luma Levels Measurement

Luma corresponds to the sensitivity of human vision to each of the RGB primaries standardized for video.

The Luma Levels measurement reports the minimum and maximum level from the five white and black bars of the active video for each of the three channels.

Signal Source

The test signal used for the Luma Levels measurement is Alternate White and Black Bars (required to test for compliance with the VESA Test procedure), which is located on the Test Signal Files CD-ROM.

The Alternate White and Black bars test signal contains alternating white and black bars. There are five white and black bars in this pattern.

If you plan to take only Luma Levels measurements, use the Alternate White and Black Bars Full Field test pattern. Select the bitmap file that matches the format and the refresh rate setting of the test device. For example, use the 640x480–AlternateWhite&BlackBars.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal refer to page 2–16. For example, use a 640x480–Matrix.bmp file to test a 640x480 resolution format.

Interpreting Results

The Luma Levels measurement results indicate the purity of the signal on the selected channel.

How Results are Calculated

The results are calculated with reference to the oscilloscope ground by taking an average of 100,000 points between the 20% and 80% regions of the addressable video range. The selected line from consecutive frames will be used to get the required number of points. The maximum and minimum amplitude values are shown as the result.

Noise Inj Ratio Measurement

Noise Injection Ratio is the ratio of the peak-peak noise amplitude injected to the maximum signal amplitude in the video signal.

To make use of the instrument's full bandwidth and get the highest sampling rate, each channel is acquired separately at 5 GS/s (gigasamples per second). The minimum bandwidth as specified by the VESA specification for Noise Injection Ratio measurement is 500 MHz. There can be minor variations in the Noise floor of different instruments, which can result in different results for the same DUT, therefore a filter option is provided to limit the bandwidth to a pre–defined value. By using a 500 MHz filter, more accurately measured values are obtained for the signal noise regardless of bandwidth of the measurement devices.

With the 500 MHz Filter option selected, the data is low–pass filtered with a single pole filtered with the response shown. See Figure 3–3.

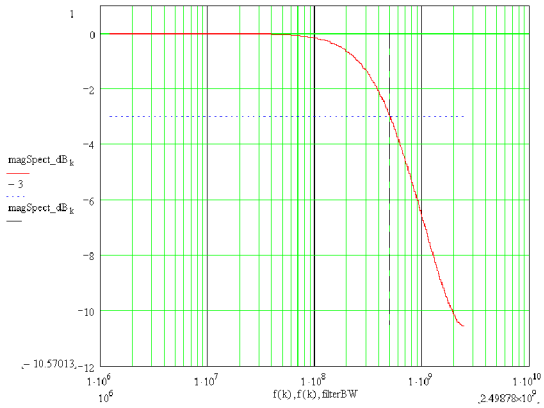


Figure 3-3: Frequency response with 500 MHz filter for Noise In Ratio measurement

Signal Source

The test signal used for the Noise Injection Ratio measurement is Full White, which is located on the Test Signal Files CD-ROM.

If you plan to take only Noise Inj Ratio measurements, use a Full White Full Field test pattern. Select the bitmap file that matches the format and refresh rate of the test. For example, use the 640x480–FullWhite.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal refer to page 2–16. For example, use the 640x480–Matrix.bmp file to test a 640x480 resolution format.

Interpreting Results

When the injection ratio is below a certain threshold, noise will not be perceived. With the injection ratio greater than the threshold, perceived image quality is degraded as a function of noise injection ratio. Noise Injection Ratio in dB is less negative when the noise amplitude increases.

How Results are Calculated

Using a Full White signal, the peak-to-peak fluctuation in luminance voltage (of at least 100,000 samples) is measured. The noise amplitude is measured with reference to oscilloscope ground. The Noise Injection Ratio measurement uses the video wide bandwidth signal path of the MIU. The maximum value of the fluctuation is used for computing the Noise Injection Ratio as shown in the Figure 3–4.

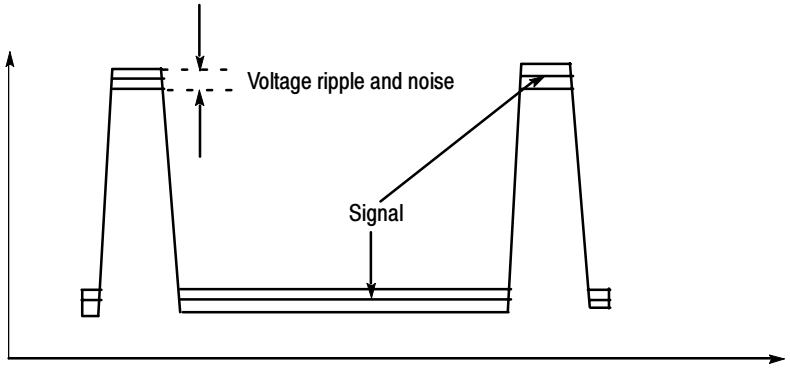


Figure 3-4: Voltage ripple and noise

The noise amplitude is calculated as follows:

$$Noise\ amplitude\ (mV) = \sqrt[n]{(Vpeak - peak)^2 - (NF)^2}$$

where

Vpeak-peak is the peak to peak fluctuation in the input signal
NF is the peak to peak fluctuation observed with oscilloscope channel coupling set to ground

$$Injection\ ratio\ (\%) = \left(\frac{Noise\ amplitude\ (mV)}{Vsignal\ amplitude}\right) \times 100$$

The signal-to-noise ratio in dB is calculated using the average signal amplitude.

V Sync Measurement

The Vertical Sync measurement is used to check synchronization signal timing. This measurement measures the steady-state voltage amplitudes of logic levels '1' and '0'. When the MIU is present, a current source inside the MIU automatically presents the required load, so no manual intervention is required. In the absence of the MIU, external 2.21 kilo ohms and 301 ohms terminations have to be manually presented. The user is prompted to change the termination from 2.21 kilo ohms to a 301 ohms termination for measuring the level when drawing maximum current. This measurement characterizes the rise time, fall time, overshoot, undershoot, and settling time shown in the Figure 3–5.

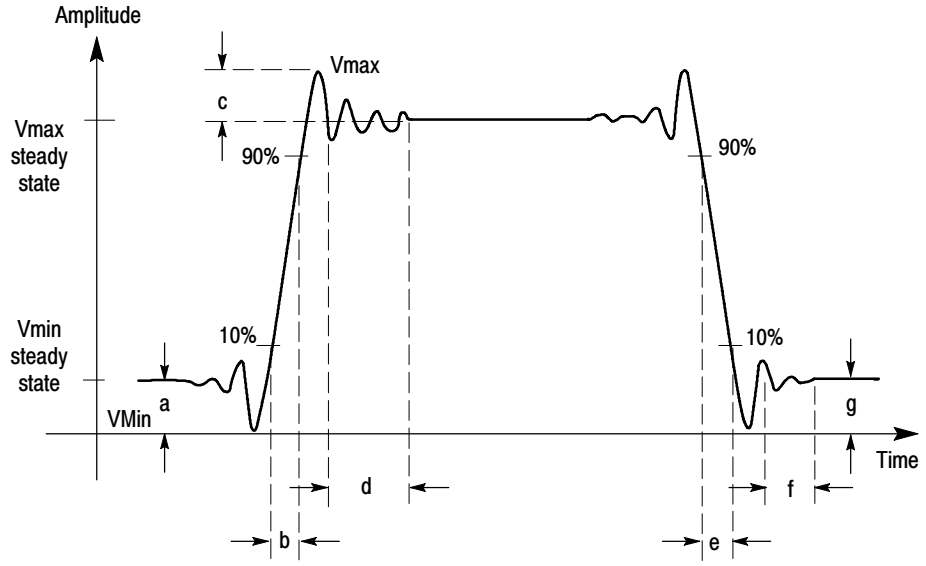


Figure 3- 5: Signal definitions (V Sync)

where a – Vmin steady state amplitude before transition
b – Rise Time
c – Overshoot
d – Settling time
e – Fall time
f – Settling time
g – Undershoot

The measurement also characterizes the Monotonicity of the H Sync pulse. Variations in the sync pulse voltage may cause instability in the displayed image or for extreme cases may even prevent the monitor from locking on to the correct scan frequency.

Rise time is measured from the 10% to the 90% amplitude points of a positive-going transition.

Fall time is measured from the 90% to the 10% amplitude points of a negative-going transition.

Overshoot refers to the rise above the steady state value in a positive-going transition. Undershoot refers to the fall below the steady state value in a negative-going transition.

Settling time is measured from the end of the overshoot or undershoot to the point where the amplitude of the video ringing is less than or equal to ±5% of the final steady state value.

Monotonicity is the property whether or not the video signal is continuously rising or falling without any inflection points. Monotonicity of the signal is decided by determining the progression of the successive gray levels.

When measuring transients, the MIU is set to use the Sync wide bandwidth path. When measuring amplitude levels, the MIU is set to use the Sync low bandwidth path.

For V Sync Period, the scope horizontal scale is adjusted to be able to see at least two V sync pulses and the duration between the leading edges of the two sync pulses is measured.

Signal Source

The test signal used for the V Sync measurement can be any of the available patterns in the Matrix signal, which is located on the Test Signal Files CD-ROM.

Interpreting Results

Vertical Sync polarity is detected by looking at the signal level after skipping a nominal pulse width duration. It is considered to be positive if the signal level is less than one volt. If not, the polarity is negative.

V Sync edge and corner characteristics are determined by detecting the edge of the V sync signal. A numerically smaller rise/fall time value indicates a higher quality signal. The overshoot and undershoot amplitude, and settling time should be zero under ideal conditions. When V Sync monotonicity is Yes in the results panel, it indicates that the incoming signal does not change its polarity during the rise/fall period.

How Results are Calculated

The Scope trace is triggered by the leading edge of the V Sync pulse. Sync levels are measured with reference to oscilloscope ground and reported at two different conditions:

- When V Sync is terminated by a 2.21 kΩ resistor
- When V Sync is connected to a current source of ± 8 mA (+8 mA is connected when the voltage level is high, –8 mA when the voltage level is low).

Vertical Sync amplitude is determined by averaging the points that lie between 30% and 90% of the pulse width. Sync pulse width is determined by detecting the edges of the sync signal. The position difference between the two edges is shown as the result. Rise time is the time taken for the signal to rise from 10% to 90% of the steady state level. Overshoot/Undershoot settling time is the time taken for the signal to reach 5% of its steady state value. V Sync frequency is derived from pulse time value.

V Timing Measurement

V Timing consists of the measurements: the vertical sync pulse, the back porch, the addressable lines, the front porch, top border, and bottom border.

Back porch is the portion of the video signal that lies between the trailing edge of the vertical sync pulse and the start of the active picture.

Border is the period during which a background colored border is displayed in order to allow the image to extend beyond the limits.

Addressable Lines is the period during which active video image information is transmitted.

Front porch is the portion of the video signal between the end of the active picture and the leading edge of the horizontal sync.

Sync pulse width is the period of the active sync pulse.

Signal Source

The test signal used for the V Timing measurement is Half White & Half Black Bars (required to test for compliance with the VESA Test procedure), which is located on the Test Signal Files CD-ROM.

The Half White & Half Black bars test signal contains a white bar and a black bar.

If you plan to take only V Timing measurements, use the Half White & Half Black Full Field test pattern. Select the bitmap file that matches the format and the refresh rate of the test. For example, use the 640x480–HalfWhiteHalf-Black.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal, refer to page 2–16. For example, use the 640x480–Matrix.bmp file to test a 640x480 resolution format.

Interpreting Results

The V Timing Results must match the values specified by the timing standard selected.

How Results are Calculated

The V Timing measurement requires a test pattern with lines that are half white and half black. The first and the last addressable lines are required to be in this pattern and they indicate the beginning and end of the addressable video. If any non-black lines are detected before the beginning of the addressable video or after the end of it, they are considered part of the top or bottom border respectively.

Beginning five lines before the first addressable line (as per the standard), 15 lines are scanned to detect the first addressable line. With the start of addressable video, the scan begins again at five lines before the nominal end of the address-

able video and continues on for 15 lines. The MIU is set to use the low bandwidth path for Video and Sync.

Video Transient Measurement

Use the Video Transient measurement to check the transient characteristics of the video. The measurement characterizes the video rise time, fall time, overshoot, undershoot, and settling time as shown in the Figure 3–6.

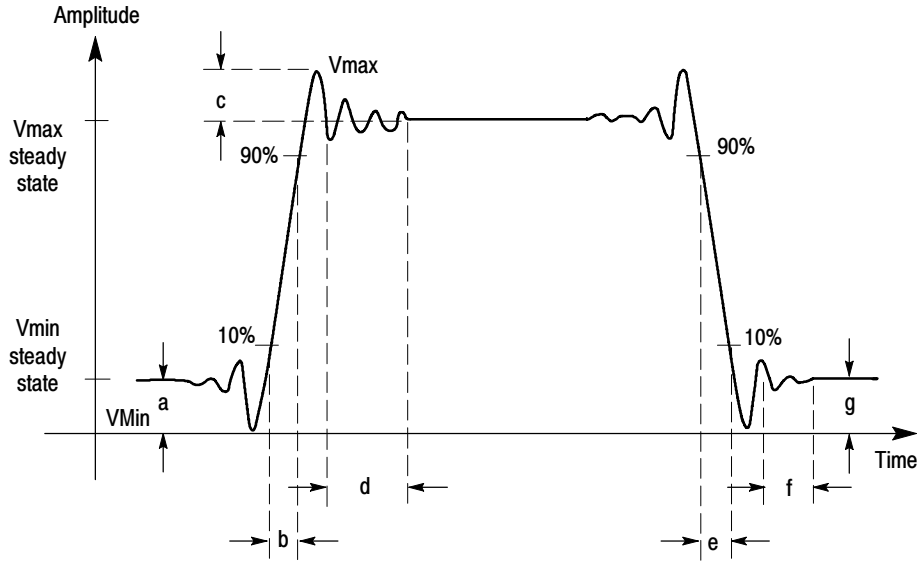


Figure 3- 6: Signal definitions (Video transient)

where a – Vmin steady state amplitude before transition
b – Rise Time
c – Overshoot
d – Settling time
e – Fall time
f – Settling time
g – Undershoot

Video Transient measurement reports the result of the middle bar (the third white bar).

Rise time is measured from the 10% to the 90% amplitude points of a positive-going transition.

Fall time is measured from the 90% to the 10% amplitude points of a negative-going transition.

Overshoot refers to the rise above the steady state value in a positive-going transition. Undershoot refers to the fall below the steady state value in a negative-going transition.

Settling time measured from the end of the overshoot or undershoot to the point where the amplitude of the video ringing is down to ±5% of the final steady state value.

To make use of the full bandwidth and get highest sampling rate with the instrument, each channel is acquired separately at 5 gigasamples per second.

Signal Source

The test signal used for the Video Transient measurement is Alternate White and Black bars (required to test for compliance with the VESA Test procedure), which is located on the Test Signal Files CD-ROM.

The Alternate White and Black bars test signal contains a series of alternating white and black bars. There are nine bars in this test signal.

If you plan to take only the Video Transient measurement, use the Alternate White and Black bars Full Field test pattern. Select the bitmap file that matches the format and the refresh rate of the test. For example, use the 640x480–AlternateWhite&BlackBars.bmp file to test a 640x480 resolution format.

You can also use a Matrix signal as a test signal. For more information on the Matrix signal refer to page 2–16. For example, use the 640x480–Matrix.bmp file to test a 640x480 resolution format.

Interpreting Results

A numerically smaller rise/fall time value indicates a higher quality signal. The overshoot and undershoot amplitude, and settling time should be zero under ideal conditions.

How Results are Calculated

The MIU is set to the high-bandwidth path for Video. The Alternate White and Black bar pattern is used for measuring video transients. Measurements are made on the middle white bar. . The results are compensated for the MIU transient characteristics. Rise time is the time taken for the signal to rise from 10% to 90% of steady state level. Overshoot/Undershoot settling time is the time taken for the signal to reach 5% of its steady state value.

Setting Up Measurements

There are three ways set up the VM5000 to take measurements: taking measurements, taking measurements relative to a reference, and taking measurements with limit testing. The differences between the three ways of taking measurements are:

- Taking measurements displays only the results of the measurements.
- Taking measurements relative to a reference displays the results of the measurements taken and the difference between the measured value and a reference value.
- Taking measurements with limit testing displays the results of the measurements taken and a Pass/Fail indication of whether the taken measurement falls within (pass) or outside (fail) specified maximum and minimum values.

You can choose to take measurements relative to a reference and with limit testing concurrently.

Taking Measurements

The procedure for taking measurements is:

1. Option SD/HD: Select the appropriate format and the color space for the input signal.
   or
   Option VGA: Select the appropriate resolution, the refresh rate and the timing standard for the input signal.
2. Select one or more measurements to take.
3. Select **Configuration > Operations**.
4. Set the Setup And/Or Run, Run Mode, and Auto Scaling setting for controlling the operation.
5. Select the Run button to take and view the measurements.
6. Views the measurement results by selecting the corresponding menu item in the results panel of the measurement.

Figure 3-7 shows the results of the Color Bars measurement.

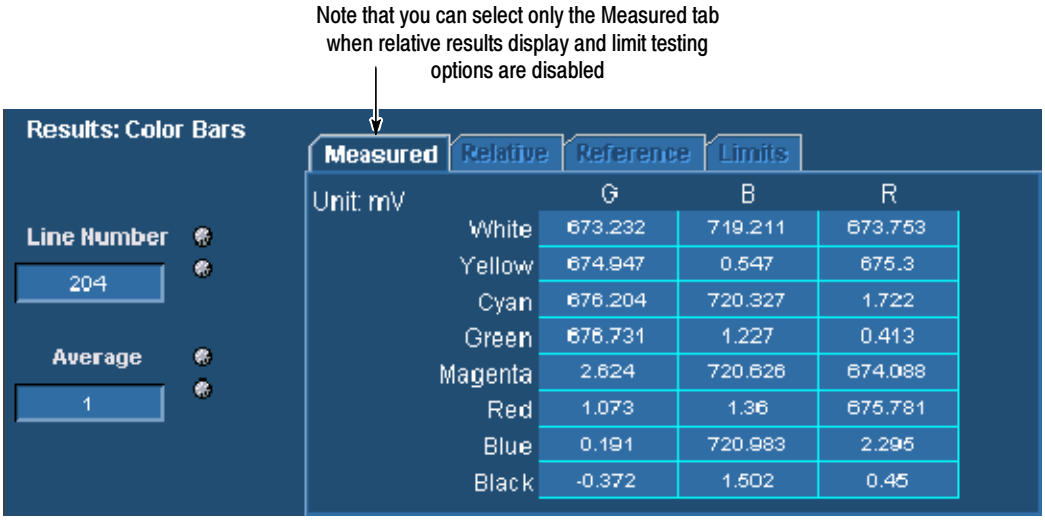


Figure 3-7: Results of the Color Bars measurement

Taking Measurements Relative to a Reference

The procedure to take measurements relative to a reference is:

1. Option SD/HD: Select the appropriate format and the color space for the input signal. or

   Option VGA: Select the appropriate resolution, the refresh rate, and the timing standard for the input signal.

2. Select one or more measurements to take.

3. Set the measurement run operation.

4. Select **Configuration > Reference & Limits**.

5. Select **Enable Relative Result Display**. See Figure 3-8.

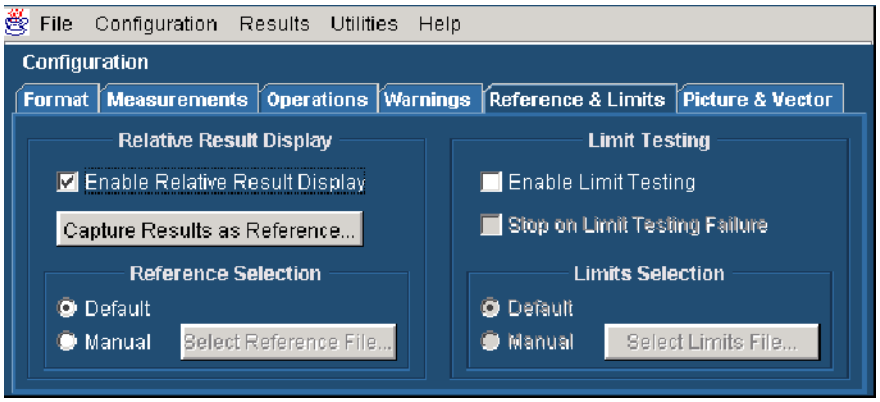


Figure 3-8: Enabling relative to reference results

By default, the software selects a reference file appropriate to the specified signal format. However, you can specify a different reference file by selecting **Manual** in the **Reference Selection** pane.

6. To specify a reference file, click **Manual** under **Reference Selection**. Click **Select Reference File** and navigate to the required reference file and select it.

7. After you have selected the reference file, click the Run button to take and view the measurements.

8. Views the measurement results by selecting the corresponding menu item in the results panel of the measurement.

In Figure 3-9 (and Figure 3-10 for Option VGA), note that the **Measured**, **Relative**, and **Reference** tabs are selectable. To display the value of the measurements relative to the reference value, select the **Relative** tab in the Results display.

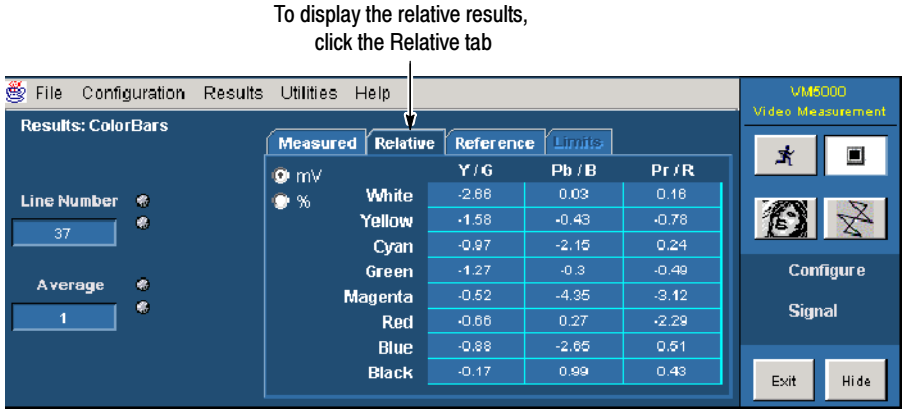


Figure 3-9: Relative to reference results displayed (Option SD/HD)

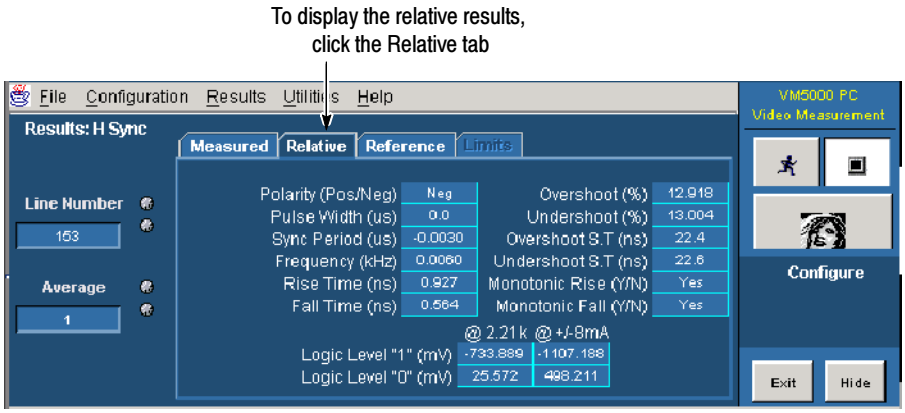


Figure 3-10: Relative to reference results displayed (Option VGA)

Creating a Custom Reference File

Reference files are used as the source of comparison for calculating the Relative to Reference values for the measurements. The VM5000 includes a set of reference files that you can use as a starting point to create reference files to suit your needs.

Option SD/HD: There is a different file for each signal format and color space or Option VGA: There is a different file for each signal resolution, refresh rate, and timing standard.

The reference files are saved in CSV format. The VM5000 includes a set of default reference files and you can create your own reference file. Reference values for all measurements are in one file. Each format has its own reference file. The reference file contains the details shown in Table 3-2.

Table 3-2: Elements of the reference file

Option SD/HD	Option VGA
Format	Resolution
Color Space type	Refresh Rate type

- Name of the measurement, parameters measured with the nominal values

There are two ways to create a custom reference file: edit an existing reference file and capture a set of measurement results to create a new reference file.

Using an Existing Reference File to Create a New Reference File

One way to create a custom reference file is to edit an existing reference file. The easiest way to edit a reference file is to use a spreadsheet program, such as Microsoft Excel or OpenOffice.org. See Figure 3-11. Because the files are in plain ASCII format, you can also edit the files with a text editor. If you choose to edit files with a text editor, make sure that the CSV format is maintained.

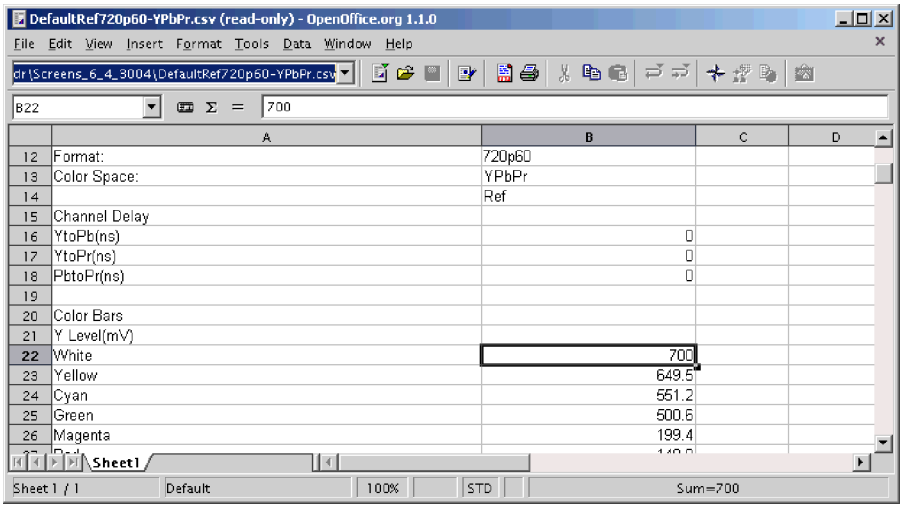


Figure 3-11: Editing a reference file

To customize an existing reference file:

1. Open a reference file for the appropriate input signal format standard by using a spreadsheet program (or a text editor).
2. Change the values in the file to those that suit your needs.
3. Save the file under a new name. Remember to save the file in CSV format.

Capturing Measurement Results to Create a New Reference File

A second way to create a reference file is to use the **Capture Results as Reference** button. The Capture Results as Reference function saves measurements to a reference file using the actual measured values as the reference values.

To create a new reference file:

1. Select **Configuration > Reference & Limits**.
2. Select **Enable Relative Result Display**.
3. Configure and run the measurements to save the result values in the reference file.
4. Select **Configuration > Reference & Limits**.
5. Select **Capture Results as Reference...**.
6. Save the file to the desired location by using the Save dialog box.

Taking Measurements with Limit Testing

The procedure to take measurements with limit testing is:

1. Option SD/HD: Select the appropriate format and the color space for the input signal or

   Option VGA: Select the appropriate resolution, the refresh rate, and the timing standard for the input signal.
2. Select one or more measurements to take.
3. Set the measurement run operation.
4. Select **Configuration > Reference & Limits**.

5. Select **Enable Limit Testing**. See Figure 3-12 or Figure 3-13.

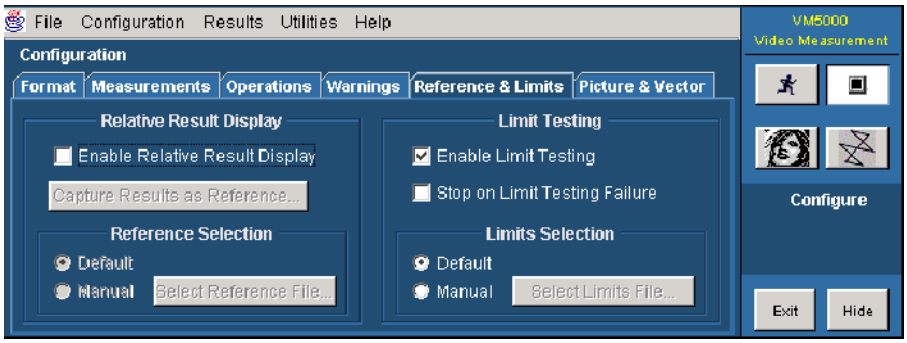


Figure 3-12: Enabling limit testing (Option SD/HD)

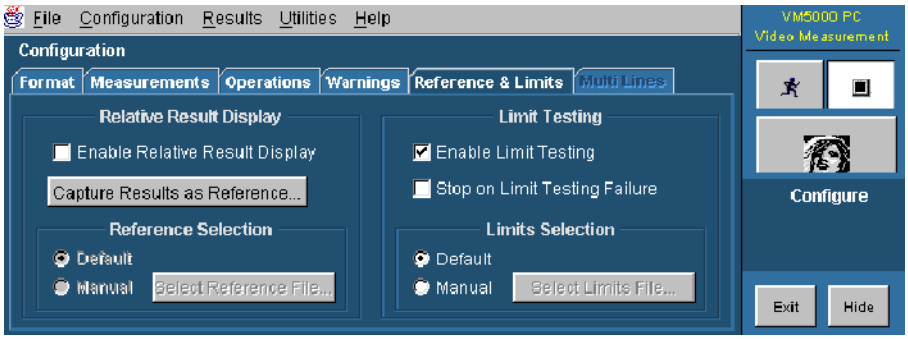


Figure 3-13: Enabling limit testing (Option VGA)

By default, the software selects a limit file appropriate to the specified signal. However, you can specify a different reference file by selecting **Manual** in the **Limits Selection** area.

6. To specify a non-default limits file, select **Manual** under **Limits Selection**. Click **Select Limits File** and navigate to the desired limits file and select it.

7. After you have selected the limits file, select the run button to take and view the measurements.

8. Views the measurement results by selecting the corresponding menu item in the results panel of the measurement. See Figure 3-14.

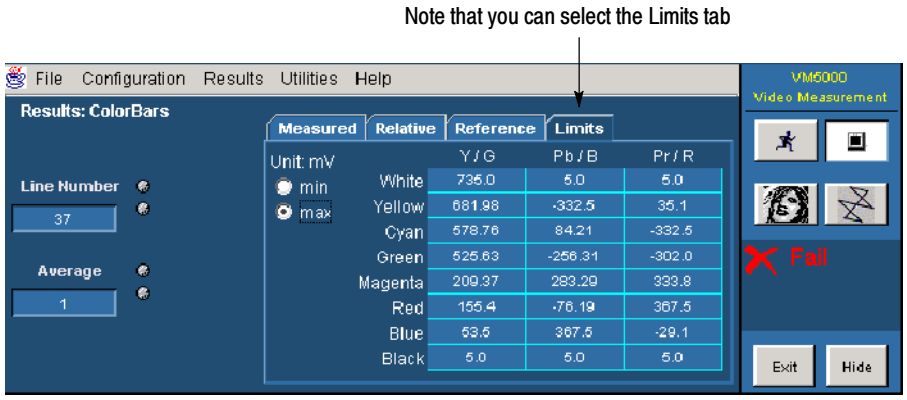


Figure 3-14: Results when limit testing is available

Customizing a Limits File

A limits file defines the maximum and minimum acceptable values for measurements. Limits files are used as the source of comparison for Limit Testing measurements. The VM5000 includes a set of limits files which you can use as a starting point to create limits files to suit your needs. There is a different file for each signal (Option SD/HD) format and color space or (Option VGA) resolution, refresh rate, and timing standard.

The limits file is in Comma-Separated-Value (CSV) format. The limit values for all measurements are in one file. The reference file contains the following details:

- Format
- (Option SD/HD) Color Space type or (Option VGA) Refresh Rate
- Name of the measurement with maximum and minimum acceptable values

The easiest way to edit a limits file is to use a spreadsheet program, such as Microsoft Excel or OpenOffice.org. See Figure 3–15. Because the files are in plain ASCII format, you can also edit the files with a text editor. If you do edit files with a text editor, be certain to maintain the CSV format.

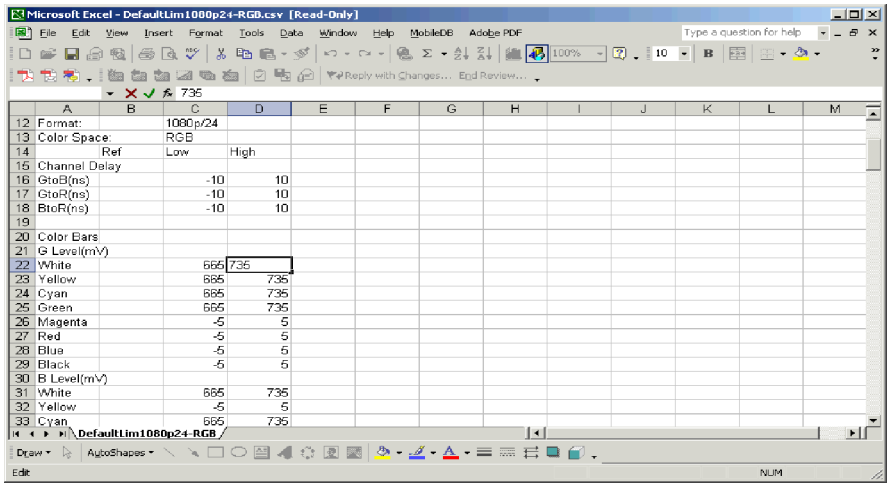


Figure 3- 15: Customizing a limits file

To customize a limits file:

1. Open a reference file for the appropriate format and color space using a spreadsheet program (or a text editor).
2. Change the values in the file to those that suit your needs. Use columns C and D for the min. and max values.
3. Save the file under a new name; remember to save the file in CSV format.

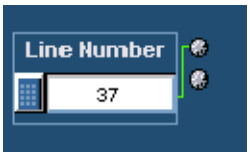
Setting Up the Channel Delay Measurement

Option SD/HD

To set up the channel delay measurements, select Results > Channel Delay to display the result panel. The results panel for the measurement shows the settings that can be changed for the measurement. For channel delay, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change settings for the Channel Delay measurements:

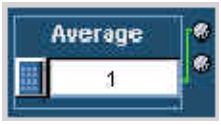
1. Select **Results > Channel Delay**.
2. To change the setting for Line Number, click the Line Number box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Channel Delay measurement is run, it will run with the newly entered numbers.

Setting Up the Color Bars Measurement

Option SD/HD

To set up the Color Bars measurements, select Results > Color Bars to display the result panel. The results pane for the measurement shows the settings that can be changed for the measurement. For color bars, you can choose the line on which the measurement is made and the number of times the measurement is averaged. To change settings for the Color Bars measurements:

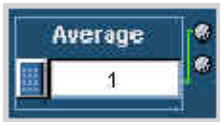
1. Select **Results > Color Bars**.
2. To change the setting for Line Number, click the Line number box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Color Bars measurement is run, it will run with the newly entered numbers.

Setting Up the Frequency Response Measurement

Option SD/HD

To set up the Frequency Response measurements, select Results > Frequency Response to display the result panel. The results pane for the measurement shows the settings that can be changed for the measurement. For frequency response, you can choose the line on which the measurement is made, and the number of times the measurement is averaged. You can set the measurement location to either Frequency or Time, specify a value, and set the filter bandwidth frequency.

To change settings for the Frequency Response measurements:

1. Select **Results > Frequency Response**.

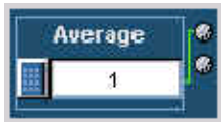
2. To change the setting for Line Number, click the Line Number box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



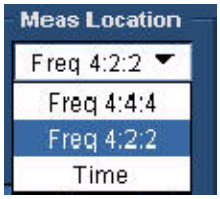
There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

When Meas Location is set to Freq 4:4:4, the measurement uses the same frequency for the measurement location on all three signals (CH1 (Y/G), CH2 (Pb/B), and CH3 (Pr/R)).

This setting is the best option for RGB (GBR) signals.

When Meas Location is set to Freq 4:2:2, the measurement uses the full frequency for CH1 and half that frequency for CH2 and CH3.



Click the Freq (MHz) box to change the measurement location to a particular frequency.



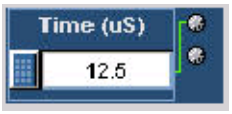
There are three ways to change the frequency:

- Turn the top knob on the front panel to change the frequency location. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the frequency location to perform.
- Using the keyboard to directly input the desired value.

When Meas Location is set to Time, the measurement reports the waveform frequency at that specified time.



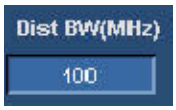
Click the Time (μs) box to change the measurement location to a particular time.



There are three ways to change the time:

- Turn the top knob on the front panel to change the time location. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the time location to perform.
- Using the keyboard to directly input the desired value.

Click the Dist BW(MHz) box to change the distortion bandwidth frequency. This setting applies only to the RMS Distortion measurement.



There are three ways to change the frequency:

- Turn the top knob on the front panel to change the frequency location. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the frequency location to perform.
- Using the keyboard to directly input the desired value.

The next time the Frequency Response measurement is run, it will run with the newly entered numbers.

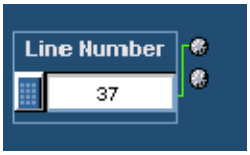
Setting Up the Multiburst Measurement

Option SD/HD

To set up the Multiburst measurements, select Results > Multiburst to display the result panel. The results panel for the measurement shows the settings that can be changed for the measurement. For Multiburst, you can choose the line on which the measurement is made, and the number of times the measurement is averaged.

To change settings for the Multiburst measurements:

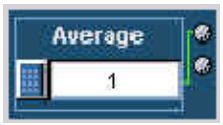
1. Select **Results > Multiburst**.
2. To change the setting for Line Number, click the Line Number box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Multiburst measurement is run, it will run with the newly entered numbers.

Setting Up the Noise Measurement

Option SD/HD

To set up the Noise measurements, select Results > Noise to display the result panel. The results panel for the measurement shows the settings that can be changed for the measurement. For noise, you can choose the line on which the measurement is made, and the number of times the measurement is averaged. You can specify the filter type and the cut-off frequency of bandwidth filter.

To change settings for the Noise measurements:

1. Select Results > Noise.
2. To change the setting for Line Number, click the Line Number box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

To change the Filter type and the cut-off frequency of the bandwidth filter, change the settings under Filter.



Select a Filter type from the three available options Off, Unified Weighting, and Unweighted Bandwidth.

- Set the Filter option to Off to measure the broadband noise without any filter.
- Set the Filter option to Unified Weighting to measure the noise using the psychovisual weighting established by CCIR Recommendation (Rec.) 576-2, adjusted for the selected video format.
- Set the Filter option to Unweighted Bandwidth to remove high frequency noise from your signal.

To change the cut-off frequency of the filter bandwidth (this option is available only if the filter type selected is Unweighted Bandwidth).



Click the box below Bandwidth (Hz). There are three ways to change the number:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Noise measurement is run, it will run with the newly entered numbers.

Setting Up the Noise Spectrum Measurement

Option SD/HD

To set up the Noise Spectrum measurement, select Results > Noise to display the result panel. The results panel for the measurement shows the settings that can be changed for the measurement. For noise spectrum, you can choose the Cursor and select a channel (G, B, or R).

To change settings for the Noise Spectrum measurements:

1. Select **Results > Noise**.
2. To change the setting for the Cursor, click the Cursor (Hz) box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

Select one of the channels (G, B, or R) in the list box to change the channel for the noise spectrum measurement.



The next time the Noise Spectrum measurement is run, it will run with the newly entered numbers.

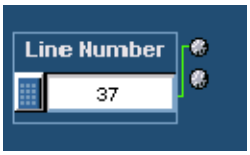
Setting Up the NonLinearity Measurement

Option SD/HD

To set up the NonLinearity measurements, select Results > NonLinearity to display the result panel. The results panel for the measurement shows the settings that can be changed for the measurement. For NonLinearity, you can choose the line on which the measurement is made, and the number of times the measurement is averaged.

To change settings for the NonLinearity measurements:

1. Select **Results > NonLinearity**.
2. To change the setting for Line Number, click the Line Number box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Non Linearity measurement is run, it will run with the newly entered numbers.

Setting Up the Short Time Distortion Measurement

Option SD/HD

To set up the Short Time Distortion measurements, select Results > Short Time Distortion to display the result panel. The results panel for the measurement shows the settings that can be changed for the measurement. For Short time Distortion, you can choose the line on which the measurement is made, and the number of times the measurement is averaged.

To change settings for the Short Time Distortion measurements:

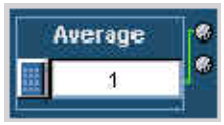
1. Select **Results > Short Time Distortion.**
2. To change the setting for Line Number, click the Line Number box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Short Time Distortion measurement is run, it will run with the newly entered numbers.

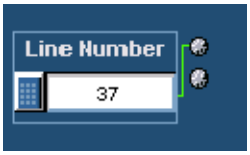
Setting Up the Sync Measurement

Option SD/HD

To set up the Sync measurements, select Results > Sync to display the result panel. The results panel for the measurement shows the settings that can be changed for the measurement. For Sync, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change settings for the Sync measurements:

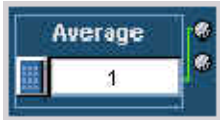
1. Select **Results > Sync.**
2. To change the setting for Line Number, click the Line Number box.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

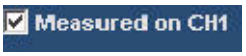
3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

Select the **Measured on CH1** check box to take the measurements on channel CH1 for better measurement accuracy. This option is available only if triggering on CH4, which is the default.



When the triggering is set to channel CH1, the **Measured on CH1** check box is not available.

The next time the Sync measurement is run, it will run with the newly entered numbers.

Configuring the Device Under Test for Option VGA

To perform measurements on the DUT, you must provide an appropriate video signal to the VM5000. You accomplish this by displaying a bitmap file on the PC in which the DUT is operating. The preferred bitmap file, when taking multiple measurements, is the Matrix signal. All the necessary Matrix signal and full-field test pattern bitmaps required to test for compliance to the VESA Test Procedure – Evaluation of Display Graphics Subsystems (Version 1 Rev. 1), are located on the Test Signal Files CD-ROM.

1. Set the resolution, refresh rate, and timing standard of the DUT to the required values corresponding to the selected matrix signal.
2. On the PC containing the DUT, display the contents of the Test Signal Files CD-ROM.
3. Display the contents of either the Matrix or Full Field folder.
   - If you plan to take multiple measurements, open the Matrix folder.
   - If you plan to take only one measurement, open the Full Field folder and select the appropriate test pattern using Table 3–3.

Table 3-3: Matching measurements to the appropriate Full Field test pattern

Measurement	Test Pattern
Ch-Ch Mismatch	32-step Staircase
Ch-Ch Skew	Alternate White and Black
Color Bars	Nine Color Bars
H Sync	Any pattern
H Sync Jitter	Any pattern
H Timing	Black-White-Black
Linearity	Staircase
Luma Levels	Alternate White and Black
Noise Inj Ratio	Full White
V Sync	Any pattern
V Timing	Half White and Half Black
Video Transient	Alternate White and Black

Whether you choose a single test pattern or take multiple measurements, you must select the appropriate file that you will use to generate the video test signal. The file you select depends on the format you want to test and for some patterns, refresh rate must also be considered. Suppose you want to test a 1280x1024 resolution format. Within the appropriate folder, look for a file that matches the format of the test you want to perform. If you want to test Linearity, you would need to choose either full-field Staircase test pattern or use the Matrix test pattern. Within the Staircase folder, you would look for a file named 1280x1024-Matrix.bmp (refresh rate is important for the Matrix pattern).

4. Select the bitmap file that fits your requirements and open the file with a program such as Paint Shop Pro. If you set up the DUT to drive a second display, you can set the background of the second display to the bitmap file rather than opening the file with a bitmap editor. This displays the bmp file in full screen mode without any borders (applied for Single Monitor mode).



Figure 3- 16: Illustration of the BMP test signal in full screen mode

5. From the File menu, select File > Set as Wallpaper (centered).



Figure 3- 17: Illustration of the BMP image set as wallpaper

6. Disconnect the output of the DUT from the monitor and connect the output of the DUT to the VM5000.

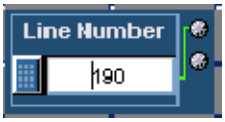
Setting Up the Ch-Ch Mismatch Measurement

Option VGA

To set up the Ch-Ch Mismatch measurement, select Results > Ch-Ch Mismatch to display the result panel. The results panel for the measurement shows the settings that can be changed for the measurement. For Ch-Ch Mismatch, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the Ch-Ch Mismatch measurements:

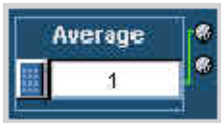
1. Click **Results > Ch-Ch Mismatch**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Ch-Ch Mismatch measurement is run, it will run with the newly entered numbers.

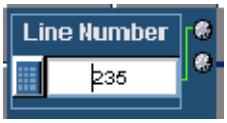
Setting Up the Ch-Ch Skew Measurement

Option VGA

To set up the Ch-Ch Skew measurement, select Results > Ch-Ch Skew to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For Ch-Ch Skew, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the Ch-Ch Skew measurement:

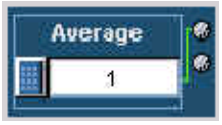
1. On the menu bar, click **Results > Ch-Ch Skew**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the number:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Ch-Ch Skew measurement is run, it will run with the newly entered numbers.

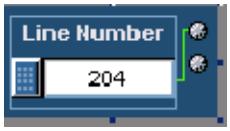
Setting Up the Color Bars Measurement

Option VGA

To set up the Color Bars measurement, select Results > Color Bars to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For Color Bars, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the Color Bars measurement:

1. On the menu bar, click **Results > Color Bars**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Color Bars measurement is run, it will run with the newly entered numbers.

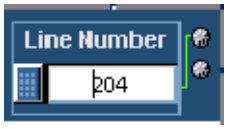
Setting Up the H Sync Measurement

Option VGA

To set up the H Sync measurement, select Results > H Sync to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For H Sync, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the H Sync measurement:

1. On the menu bar, click **Results > H Sync**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.

- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the H Sync measurement is run, it will run with the newly entered numbers.

Setting Up the H Sync Jitter Measurement

Option VGA

To set up the H Sync Jitter measurement, select Results > H Sync Jitter to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For H Sync Jitter, you can choose the number of lines on which the measurement is made.

To change the settings for the H Sync Jitter measurement:

1. On the menu bar, click **Results > H Sync Jitter**.
2. To change the number of lines, click the No. of Lines box.



There are three ways to change the number of lines:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to save the change.
- Click the keypad button to the left of the Line Number box to open the virtual keyboard. Use the pop-up keypad to enter the new value for the line number.
- Using the keyboard to directly input the desired value.

The next time the H Sync Jitter measurement is run, it will run with the newly entered numbers.

Setting Up the H Timing Measurement

Option VGA

To set up the H Timing measurement, select Results > H Timing to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For H Timing, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the H Timing measurement:

1. On the menu bar, click **Results > H Timing**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the H Timing measurement is run, it will run with the newly entered numbers.

Setting Up the Linearity Measurement

Option VGA

To set up the Linearity measurement, you must display the Results > Linearity pane. The results panel for the measurement shows the settings that you can change for the measurement. For Linearity, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the Linearity measurement:

1. On the menu bar, click **Results > Linearity**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Linearity measurement is run, it will run with the newly entered numbers.

Setting Up the Luma Levels Measurement

Option VGA

To set up the Luma Levels measurement, select Results > Luma Levels to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For Luma Levels, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the Luma Levels measurement:

1. On the menu bar, click **Results > Luma Levels**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.

- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Luma Levels measurement is run, it will run with the newly entered numbers.

Setting Up the Noise Inj Ratio Measurement

Option VGA

To set up the Noise Inj Ratio measurement, select Results > Noise Inj Ratio to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For Noise Inj Ratio, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the Noise Inj Ratio measurement:

1. On the menu bar, click **Results > Noise Inj Ratio**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

4. Select the 500 MHz Filter, to ensure accuracy and compliance with VESA specifications. With the filter off, you can run the measurement over a bandwidth greater than 500 MHz.



The next time the Noise Inj ratio measurement is run, it will run with the newly entered numbers.

Setting Up the V Sync Measurement

Option VGA

To set up the V Sync measurement, select Results > V Sync to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For V Sync, you can choose the number of times the measurement is averaged.

To change the settings for the V Sync measurement:

1. On the menu bar, click **Results > V Sync**.

2. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the V Sync measurement is run, it will run with the newly entered numbers.

Setting Up the V Timing Measurement

Option VGA

To set up the V Timing measurement, select Results > V Timing to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For V Timing, you can choose the number of times the measurement is averaged.

To change the settings for the V Timing measurement:

1. On the menu bar, click **Results > V Timing**.
2. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.

- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the V Timing measurement is run, it will run with the newly entered numbers.

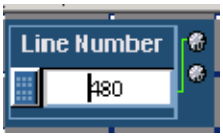
Setting Up the Video Transient Measurement

Option VGA

To set up the Video Transient measurement, select Results > Video Transient to display the result panel. The results panel for the measurement shows the settings that you can change for the measurement. For Video Transient, you can choose the line on which the measurement is made and the number of times the measurement is averaged.

To change the settings for the Video Transient measurement:

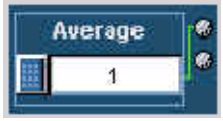
1. On the menu bar, click **Results > Video Transient**.
2. To change the line number, click the Line Number box.



There are three ways to change the line number:

- Turn the top knob on the front panel to change the number. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the line number.
- Using the keyboard to directly input the desired value.

3. Click the Average box to change the number of times the measurement is averaged.



There are three ways to change the average:

- Turn the top knob on the front panel to change the number of averages. When it is set to the correct number, click outside the box to enter the change.
- Click the keypad button to the left of the number entry box. Use the pop-up keypad to enter a setting for the number of averages to perform.
- Using the keyboard to directly input the desired value.

The next time the Video Transient measurement is run, it will run with the newly entered numbers.

Viewing Measurement Results

Use the Results menu to select the measurement results you want to display. You can choose to display a summary of all results or select a single measurement to see complete results for that measurement.

Displaying the Results Summary

The results summary panel is displayed automatically if more than one measurement has been selected for execution. When only a single measurement is selected, the results panel corresponding to the selected measurement gets displayed automatically. However, the results summary can be manually selected at any point of time by selecting Results > Summary. With the Multi Line measurements enabled, the results summary is not available.

A Results Summary window displays the Status and Warnings for the selected measurements, and the status for unselected measurements is displayed as '---'. Refer to Figure 3-18 for Option SD/HD. Refer to Figure 3-19 for Option VGA.



Figure 3-18: Displaying the results summary (Option SD/HD)

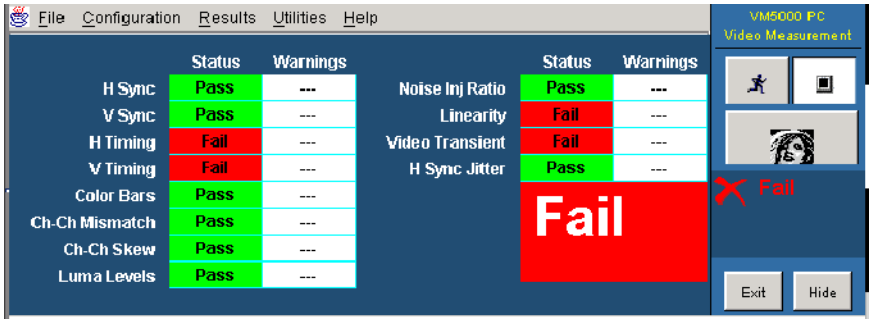


Figure 3-19: Displaying the results summary (Option VGA)

The Results Summary displays the current status of the measurements. If no measurements have been taken, --- is displayed in all the boxes in the summary table. Once measurements have been taken, the contents vary depending on whether limit testing was enabled, and whether warnings were generated.

Tables 3–4 and 3–5 describe the indicators that can appear in the Results Summary.

Table 3-4: Status Box Indicators in Results Summary pane

Status box	Description
---	No measurements taken
Done	Measurement completed
Fail	Measurement completed with Limit testing enabled and Failed
Pass	Measurement completed with Limit testing enabled and Passed
Stopped	Measurement halted before completion

Table 3-5: Warning Box Indicators in Results Summary pane

Warning box	Description
--- (gray)	No warnings; no measurements taken
--- (white)	Measurements completed with no warnings
Yes	Measurements completed with warnings

Displaying Channel Delay Measurement Results

Option SD/HD

Configure the Channel Delay measurements as explained in *Setting Up the Channel Delay Measurement* on page 3-68. Take the measurement by clicking the Run button. Click **Results > Channel Delay.** Refer to Figure 3-20.

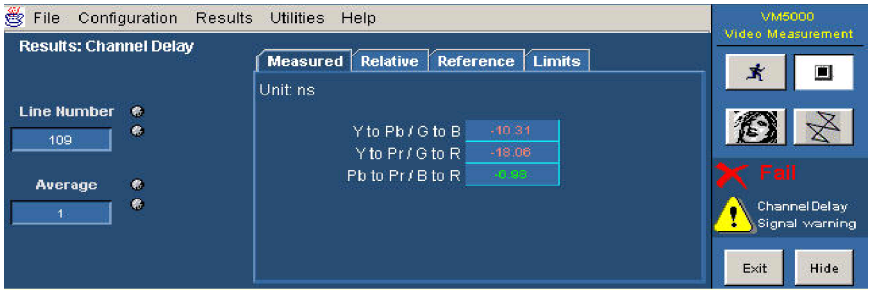


Figure 3-20: Displaying the Channel Delay measurement

Measured Values

Click the **Measured** tab to display the measured channel delay in ns in the Results Channel Delay panel for the channel delay measurement.

Relative Values

If Relative to Reference testing is enabled (see *Taking Measurements Relative to a Reference*, on page 3-60), you can display the calculated relative values by clicking the **Relative** tab.

Reference Values

If Relative to Reference testing is enabled you can display the reference values by clicking the **Reference** tab. (To create a custom reference file, see *Creating a Custom Reference File* on page 3-62).

Limit Values

If Limit testing is enabled (see *Taking Measurements with Limit Testing* on page 3-64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for each signal format and color space.

Select the **min** option to display the minimum channel delay values. Select the **max** option to display the maximum channel delay values. Refer to Figure 3-21.

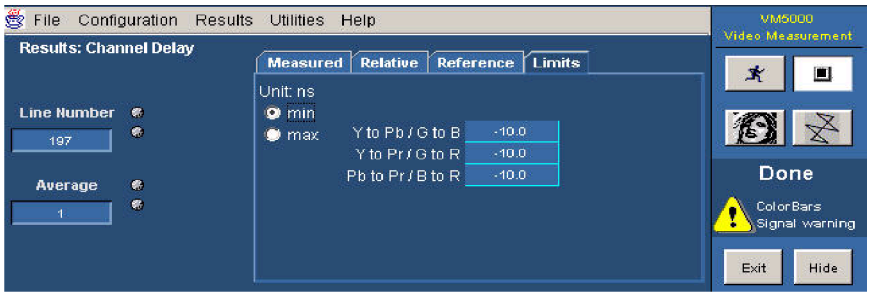


Figure 3-21: Displaying limit values for the Channel Delay measurement

Displaying Color Bars Measurement Results

Option SD/HD

Configure the Color Bars measurements as explained in *Setting Up the Color Bars Measurement* on page 3-69. Take the measurement by clicking the Run button. Click **Results > Color Bars.** Refer to Figure 3-22.

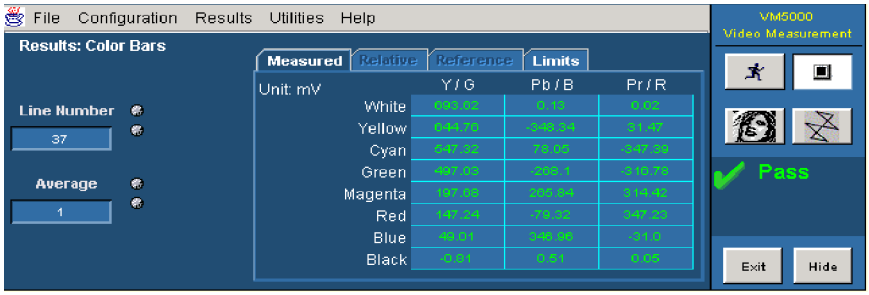


Figure 3-22: Displaying the Color Bars measurement

Measured Values

Click the **Measured** tab to display the measured amplitude levels for each of the eight colors for the color bars measurement.

Relative Values

If Relative to Reference testing is enabled (see *Taking Measurements Relative to a Reference* on page 3-60), you can display the calculated relative values by clicking the **Relative** tab.

Reference Values

If Relative to Reference testing is enabled you can display the reference values by clicking the **Reference** tab (To create a custom reference file see *Creating a Custom Reference File* on page 3-62).

Limit Values

If Limit testing is enabled (see *Taking Measurements with Limit Testing* on page 3-64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for each signal format and color space. Select the **min** option to display the minimum limit values. Select the **max** option to display the maximum limit values. Refer to Figure 3-23.

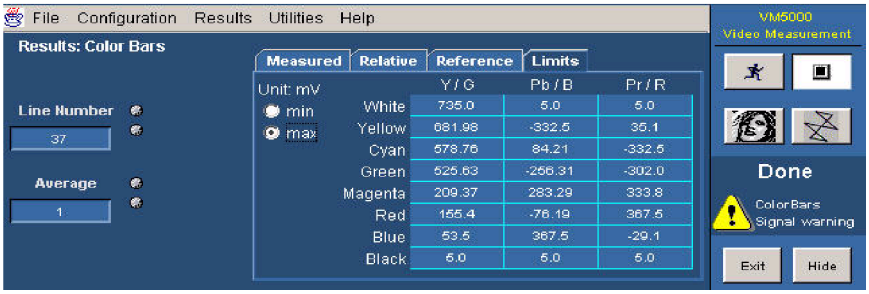


Figure 3-23: Displaying limit values for the Color Bars measurement

Additional Units

The only additional unit available in the Results panel for the Color Bars measurement is % under the Relative tab.

Displaying Frequency Response Measurement Results

Option SD/HD

Configure the Frequency Response measurements as explained in *Setting Up the Frequency Response Measurement* on page 3–70. Take the measurement by clicking the Run button. Click **Results > Frequency Response.** Refer to Figure 3–24.

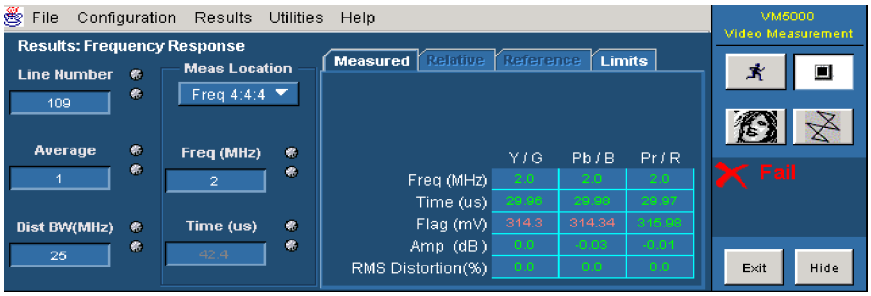


Figure 3-24: Displaying the Frequency Response measurement

Measured Values

Click the **Measured** tab to display the Flag amplitude (mV), Frequency (MHz), Amplitude (dB), Time Position (µs), and RMS Distortion (% of Amp) measured values.

Relative Values

If Relative to Reference testing is enabled (see *Taking Measurements Relative to a Reference*, on page 3–60), you can display the calculated relative values by clicking the **Relative** tab.

Reference Values

If Relative to Reference testing is enabled you can display the reference values by clicking the **Reference** tab (To create a custom reference file see *Creating a Custom Reference File*, on page 3–62).

Limit Values

If Limit testing is enabled (see *Taking Measurements with Limit Testing*, on page 3–64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for each signal format and color space.

Select the **min** option to display the minimum values specified for the measurement. Select the **max** option to display the maximum values specified for the measurement. Refer to Figure 3-25.

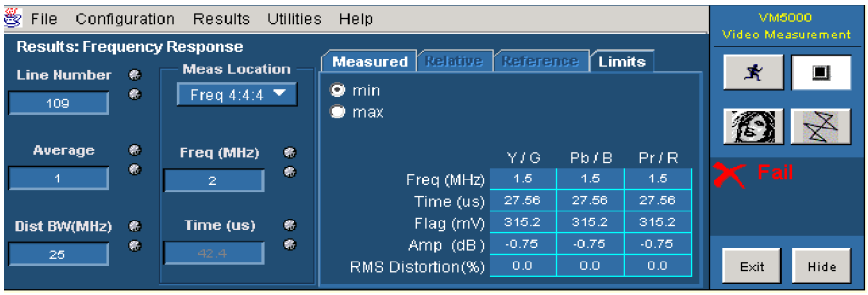


Figure 3-25: Displaying limit values for the Frequency Response measurement

Additional Units

The only additional unit in the Results panel for Frequency Response measurements is % under the Relative tab. In the results display, the readout '-Infinity' indicates that there was an attempt to divide a result by zero, and 'NaN' indicates that there was an attempt to divide zero by zero. Refer to Figure 3-26.

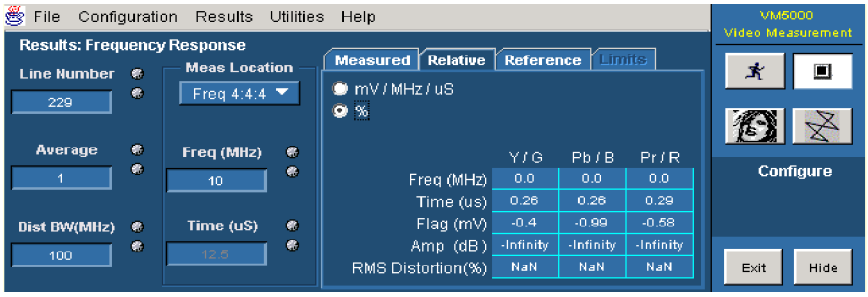


Figure 3-26: Displaying additional units for the Frequency Response measurement

Displaying Multiburst Measurement Results

Option SD/HD

Configure the Multiburst measurements as explained in *Setting Up the Multiburst measurement* on page 3-73. Take the measurement by clicking the Run button. Click **Results > Multiburst.** Refer to Figure 3-27.

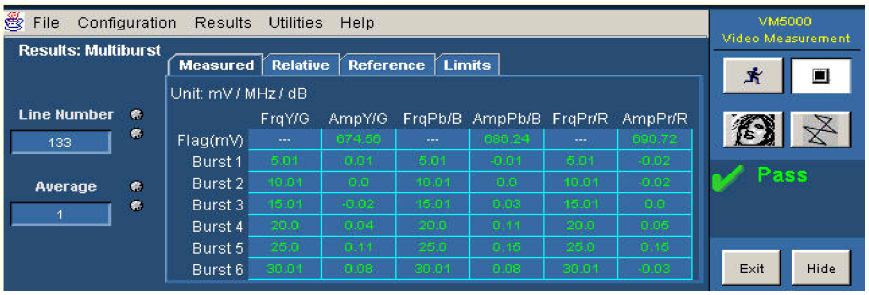


Figure 3-27: Displaying the Multiburst measurement

Measured Values

Click the **Measured** tab to display the Flag (mV), Burst1, Burst2, Burst3, Burst4, Burst5, and Burst6 values.

Relative Values

If Relative to Reference testing is enabled (see *Taking Measurements Relative to a Reference*, on page 3-60), you can display the calculated relative values by clicking the **Relative** tab.

Reference Values

If Relative to Reference testing is enabled you can display the reference values by clicking the **Reference** tab (To create a custom reference file see *Creating a Custom Reference File*, on page 3-62).

Limit Values

If Limit testing is enabled (see *Taking Measurements with Limit Testing*, on page 3-64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for each signal format and color space.

Select the **min** option to display the minimum values for the measurement. Select the **max** option to display the maximum values for the measurement. Refer to Figure 3-28.



Figure 3-28: Displaying limit values for the Multiburst measurement

Additional Units

The only additional unit in the Results pane for Multiburst measurement is % under the Measured tab and Relative tab.

Displaying Noise Measurement Results

Option SD/HD

Configure the Noise measurements as explained in *Setting Up the Noise Measurement* on page 3-74. Take the measurement by clicking the Run button. Click **Results > Noise.** Refer to Figure 3-29.

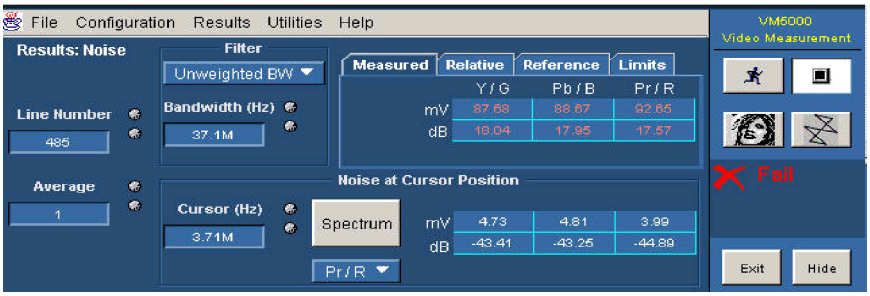


Figure 3-29: Displaying the Noise measurement

Measured Values

Click the **Measured** tab to display the measured amplitude level values.

Relative Values

If Relative to Reference testing is enabled (see *Taking Measurements Relative to a Reference*, on page 3-60), you can display the calculated relative values by clicking the **Relative** tab.

Reference Values

If Relative to Reference testing is enabled you can display the reference values by clicking the **Reference** tab (To create a custom reference file see *Creating a Custom Reference File*, on page 3-62).

Limit Values

If Limit testing is enabled (see *Taking Measurements with Limit Testing*, on page 3-64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for each signal format and color space. Select the **min** option to display the minimum amplitude level values. Select the **max** option to display the maximum amplitude level values. Refer to Figure 3-30.

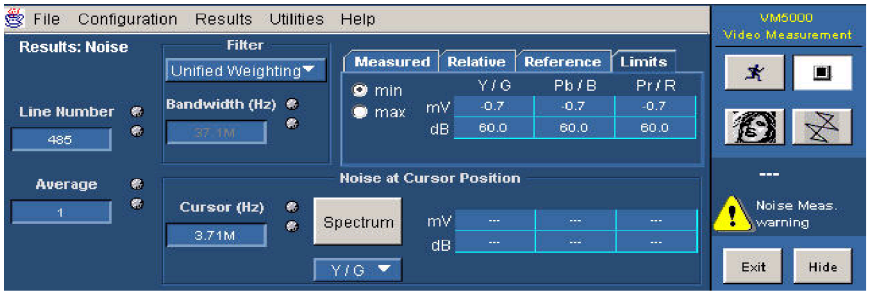


Figure 3-30: Displaying limit values for the Noise measurement

Displaying Noise Spectrum

Configure the Noise Spectrum measurements as explained in *Setting up for Noise Spectrum measurements* on page 3-77. Take the measurement by clicking the Run button. Refer to Figure 3-31.

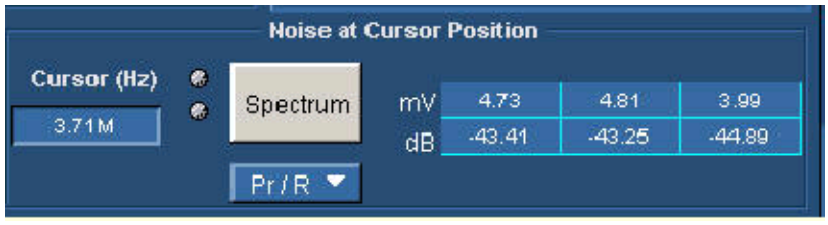


Figure 3-31: Displaying the Noise Spectrum measurement

Click the **Spectrum** box to get the noise spectrum display on the VM5000 video monitor; refer to Figure 3-32.

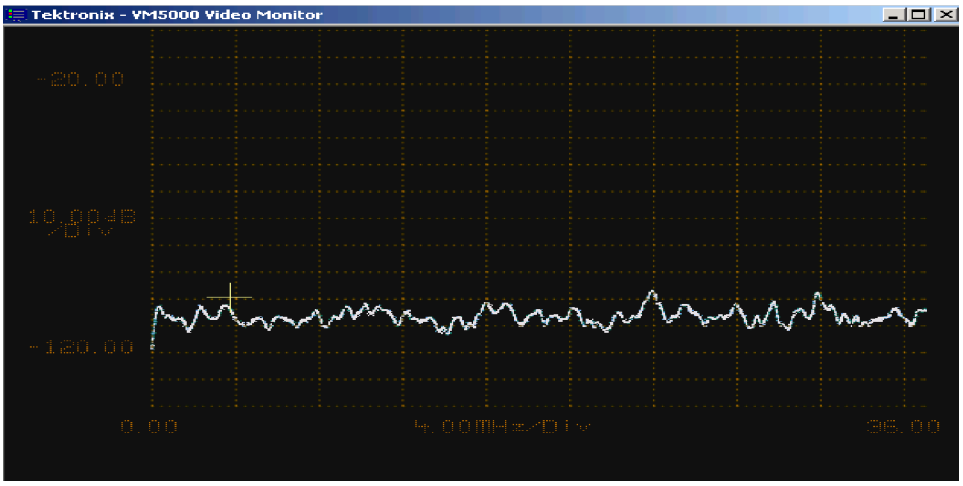


Figure 3-32: Displaying the Noise Spectrum on the VM5000 video monitor

Displaying NonLinearity Measurement Results

Option SD/HD

Configure the NonLinearity measurements as explained in *Setting Up the NonLinearity Measurement* on page 3-77. Take the measurement by clicking the Run button. Click **Results > NonLinearity.** Refer to Figure 3-33.

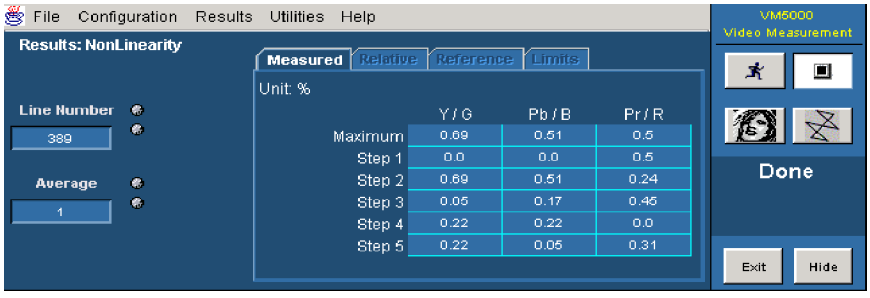


Figure 3-33: Displaying the NonLinearity measurement

Measured Values

Click the **Measured** tab to display the measured NonLinearity values.

Relative Values

If Relative to Reference testing is enabled you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference*, on page 3-60).

Reference Values

If Relative to Reference testing is enabled you can display the reference values by clicking the **Reference** tab (To create a custom reference file see *Creating a Custom Reference File*, on page 3-62).

Limit Values

If Limit testing is enabled (see *Taking Measurements with Limit Testing*, on page 3-64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for each signal format and color space. Select the **min** option to display the minimum Non Linearity values. Select the **max** option to display the maximum Non Linearity values. Refer to Figure 3-34.

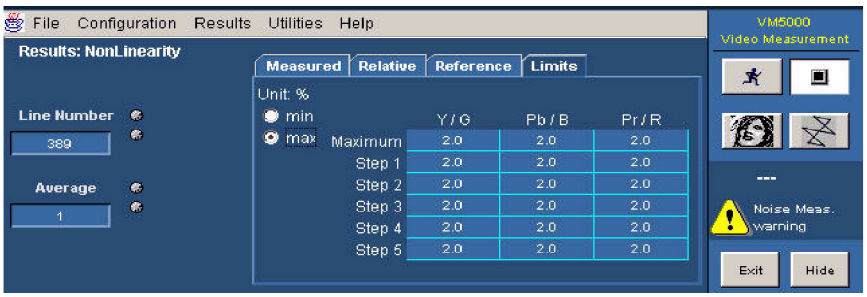


Figure 3-34: Displaying limit values for the NonLinearity measurement

Displaying Short Time Distortion Measurement Results

Option SD/HD

Configure the Short Time Distortion measurements as explained in *Setting Up the Short Time Distortion Measurement* on page 3–79. Take the measurement by clicking the Run button. Click **Results > Short Time Distortion**. Refer to Figure 3–35.

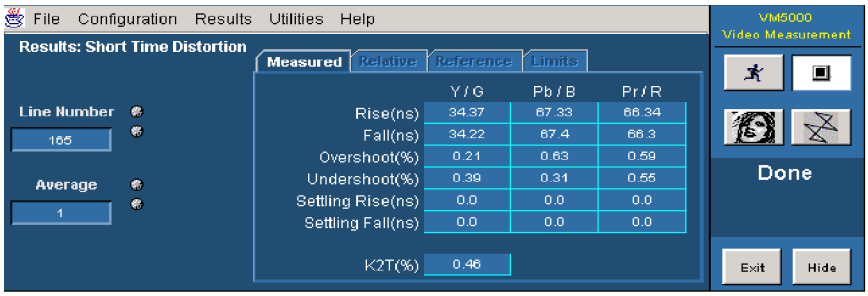


Figure 3- 35: Displaying the Short Time Distortion measurement

Measured Values

Click the **Measured** tab to display the Rise Time, Fall time, Overshoot, Undershoot, and Settling Time.

Relative Values

If Relative to Reference testing is enabled (see *Taking Measurements Relative to a Reference*, on page 3–60), you can display the calculated relative values by clicking the **Relative** tab.

Reference Values

If Relative to Reference testing is enabled you can display the reference values by clicking the **Reference** tab (To create a custom reference file see *Creating a Custom Reference File*, on page 3–62).

Limit Values

If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing*, on page 3–64). The minimum and maximum values are set in the limits file for each signal format and color space.

Select the **min** option to display the minimum values. Select the **max** option to display the maximum values. Refer to Figure 3-36.

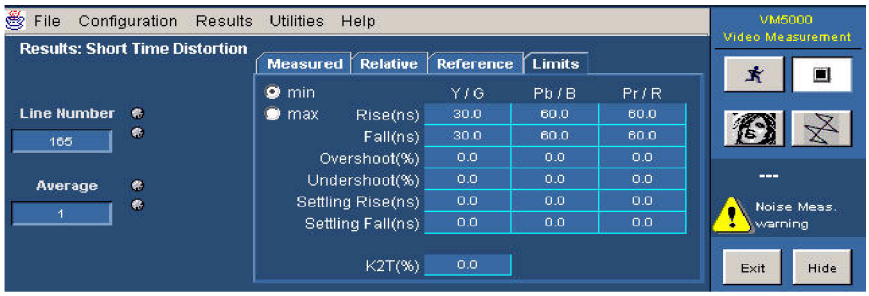


Figure 3-36: Displaying limit values for the Short Time Distortion measurement

Displaying Sync Measurement Results

Option SD/HD

Configure the Sync measurements as explained in *Setting Up the Sync Measurement* on page 3-80. Take the measurement by clicking the Run button. Refer to Figure 3-37.

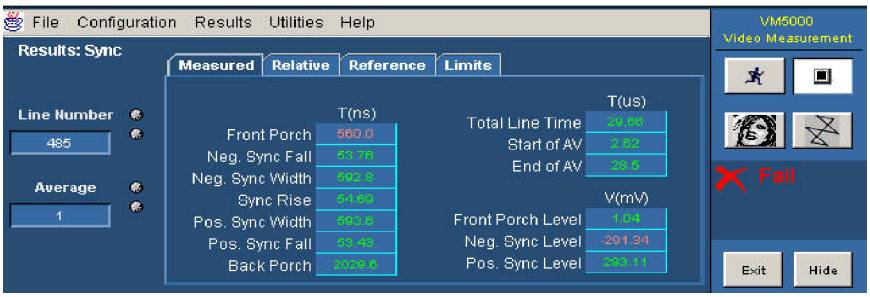


Figure 3-37: Displaying the Sync measurement

Measured Values

Click the **Measured** tab to display the measured Sync values.

Relative Values

If Relative to Reference testing is enabled (see *Taking Measurements Relative to a Reference*, on page 3-60), you can display the calculated relative values by clicking the **Relative** tab.

Reference Values

If Relative to Reference testing is enabled you can display the reference values by clicking the **Reference** tab (To create a custom reference file see *Creating a Custom Reference File*, on page 3–62).

Limit Values

If Limit testing is enabled (see *Taking Measurements with Limit Testing*, on page 3–64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for each signal format and color space. Select the **min** option to display the minimum values. Select the **max** option to display the maximum values. Refer to Figure 3–38.

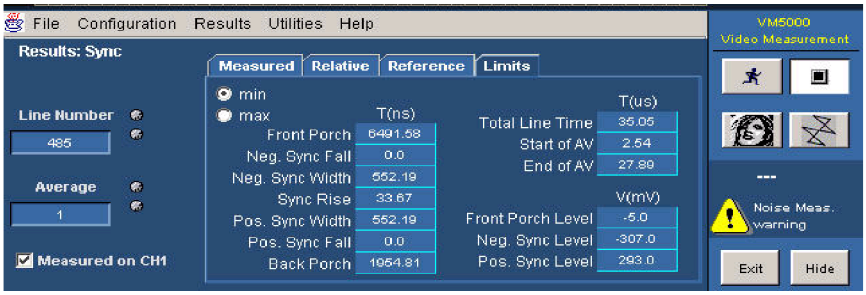


Figure 3-38: Displaying limit values for the Sync measurement

Displaying Ch-Ch Mismatch Measurement Results

Option VGA

Configure the Ch-Ch Mismatch measurement as explained in *Setting Up the Ch-Ch Mismatch Measurement* on page 3–84. Take the measurement by clicking the Run button. Click **Results > Ch-Ch Mismatch.** Refer to Figure 3–39.

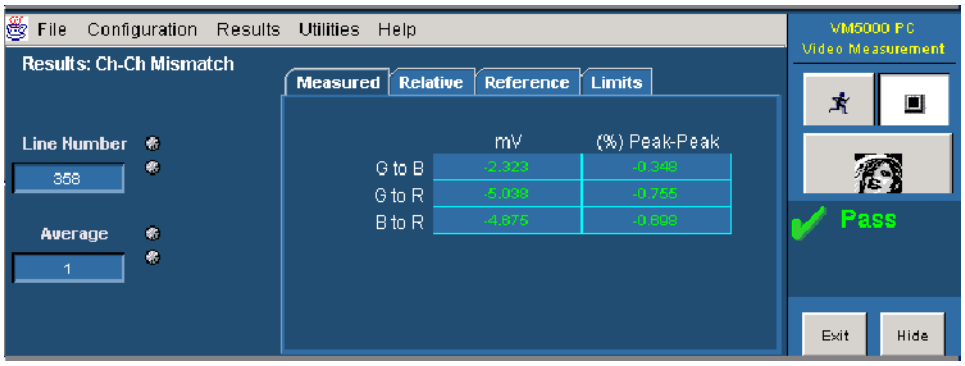


Figure 3-39: Ch-Ch Mismatch measurement results

Measured Values Click the **Measured** tab to display the measured values in mV and %Peak-Peak.

Relative Values If Relative to Reference testing is enabled you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference*, on page 3-60).

Reference Values If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File*, on-page 3-62).

Limit Values If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing*, on page 3-64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard. Select the **min** option to display the minimum limit values. Select the **max** option to display the maximum limit values. Refer to Figure 3-40.

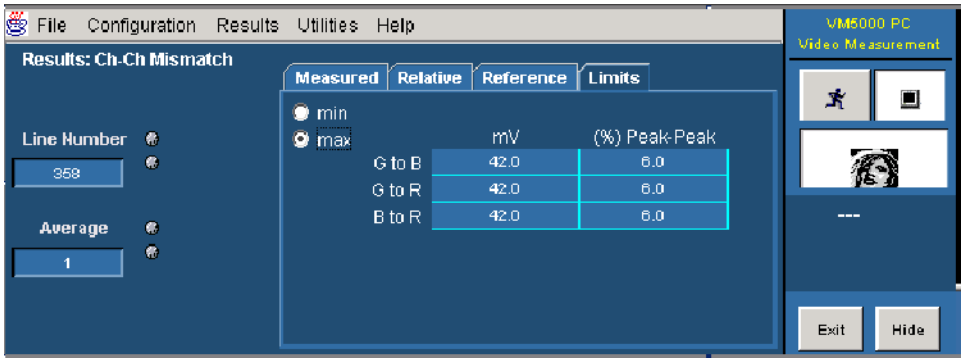


Figure 3-40: Limit values for the Ch-Ch Mismatch measurement

Displaying Ch-Ch Skew Measurement Results

Option VGA

Configure the Ch-Ch Skew measurement as explained in *Setting Up the Ch-Ch Skew Measurement* on page 3–85. Take the measurement by clicking the Run button. Click **Results > Ch-Ch Skew.** Refer to Figure 3–41.

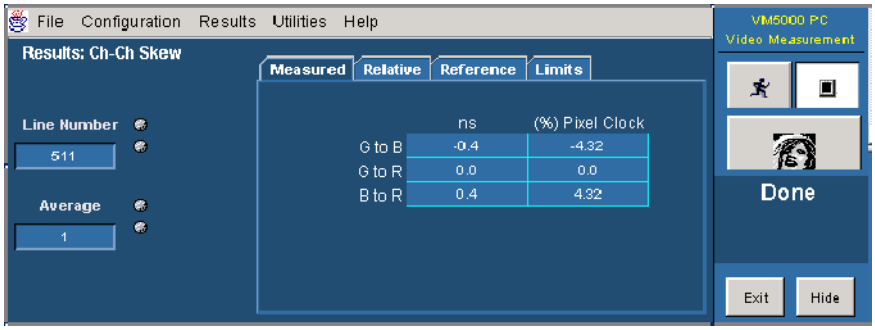


Figure 3-41: Ch-Ch Skew measurement results

Measured Values

Click the **Measured** tab to display the measured values in ns and (%)Pixel Clock.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3–60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3–62).

Limit Values

If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing* on page 3–64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard.

Select the **min** option to display the minimum limit values. Select the **max** option to display the maximum limit values. Refer to Figure 3-42.

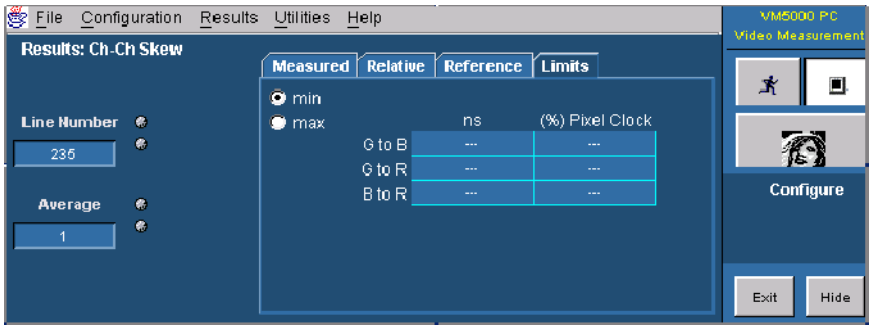


Figure 3-42: Limit values for the Ch-Ch Skew measurement

Displaying Color Bars Measurement Results

Option VGA

Configure the Color Bars measurements as explained in *Setting Up the Color Bars Measurements* on page 3-86. Take the measurement by clicking the Run button. Click **Results > Color Bars**. Refer to Figure 3-43.

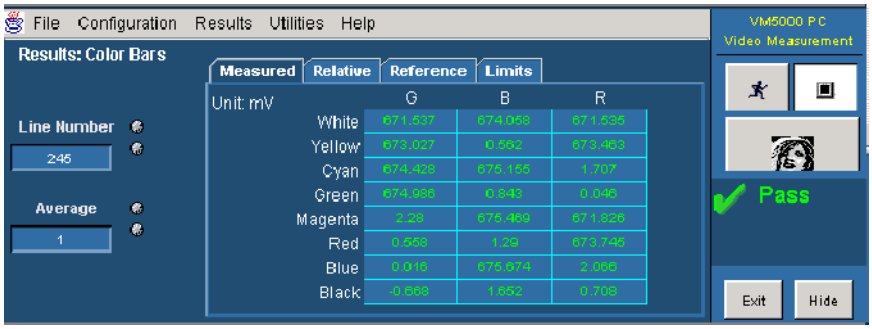


Figure 3-43: Color Bars measurement results

Measured Values

Click the **Measured** tab to display the measured amplitude levels for each of the eight colors for the Color Bars measurement.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3-60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3-64).

Limit Values

If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing* on page 3-64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard. Select the **min** option to display the minimum limit values. Select the **max** option to display the maximum limit values. Refer to Figure 3-44.

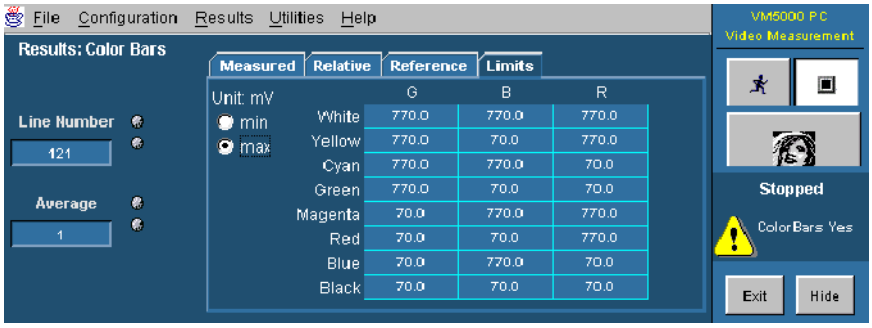


Figure 3-44: Limit values for the Color Bars measurement

Additional Units

The only additional unit available in the Results window for the Color Bars measurement is % in the **Relative** tab.

Displaying H Sync Measurement Results

Option VGA

Configure the H Sync measurements as explained in *Setting Up the H Sync Measurement* on page 3–87. Take the measurement by clicking the Run button. Click **Results > H Sync.** Refer to Figure 3–45.

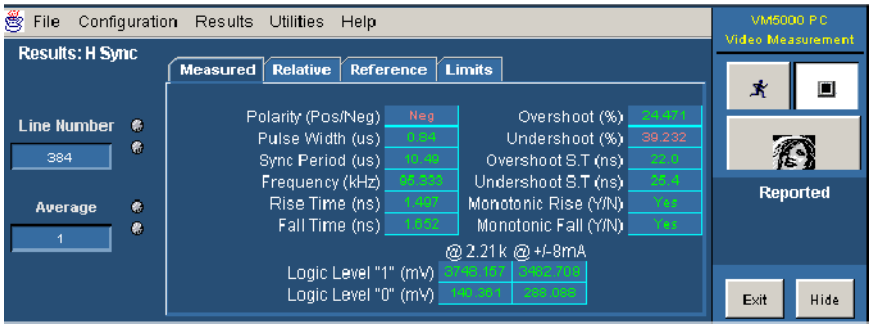


Figure 3-45: H Sync measurement results

Measured Values

Click the **Measured** tab to display the measured values.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3–60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3–62).

Limit Values

If Limit testing is enabled, (see *Taking Measurements with Limit Testing* on page 3–64) you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard.

Select the **min** option to display the minimum limit values specified for the measurement. Select the **max** option to display the maximum limit values specified for the measurement. Refer to Figure 3–46.

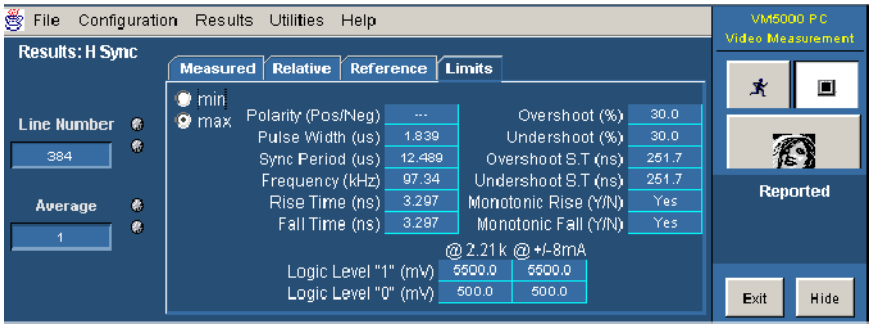


Figure 3- 46: Limit values for the H Sync measurement

In the Result panel of the H Sync measurement, the parameters are different in the absence of MIU.

Additional Units

The only additional unit available in the Results window for the H Sync measurement is % in the **Relative** tab.

Displaying H Sync Jitter Measurement Results

Option VGA

Configure the H Sync Jitter measurements as explained in *Setting Up the H Sync Jitter Measurement* on page 3–88. Take the measurement by clicking the Run button. Click **Results > H Sync Jitter.** Refer to Figure 3–47.

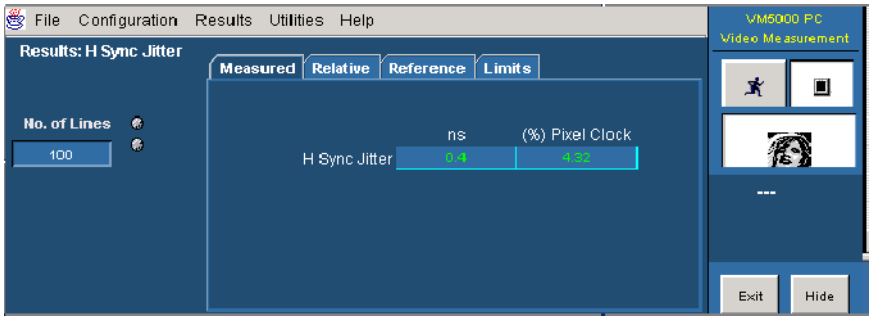


Figure 3- 47: H Sync Jitter measurement results

Measured Values Click the **Measured** tab to display the measured values.

Relative Values If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3-60).

Reference Values If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3-62).

Limit Values If Limit testing is enabled (see *Taking Measurements with Limit Testing* on page 3-64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard. Select the **min** option to display the minimum limit values for the measurement. Select the **max** option to display the maximum limit values for the measurement. Refer to Figure 3-48.

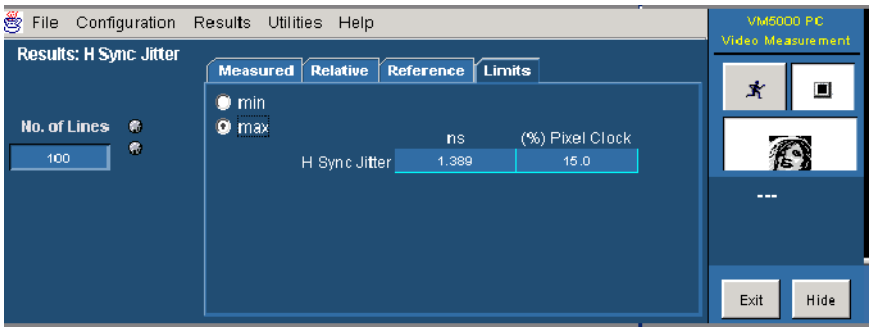


Figure 3-48: Limit values for the H Sync Jitter measurement

Additional Units The only additional unit available in the Results window for the H Sync Jitter measurement is % in the **Measured** tab and the **Relative** tab.

Displaying H Timing Measurement Results

Option VGA

Configure the H Timing measurements as explained in *Setting Up the H Timing Measurement* on page 3–89. Take the measurement by clicking the Run button. Click **Results > H Timing**. Refer to Figure 3–49.

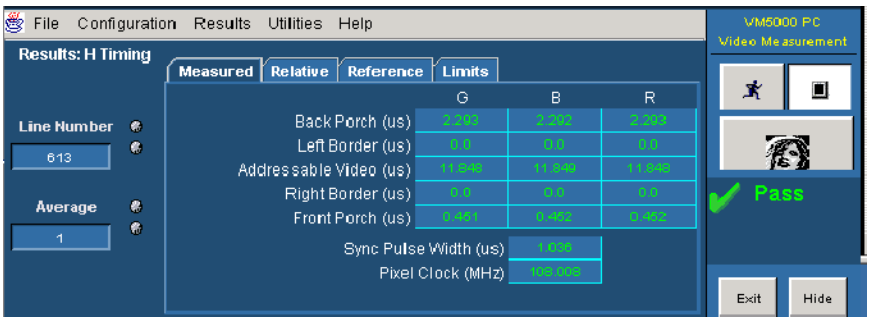


Figure 3- 49: H Timing measurement results

Measured Values

Click the **Measured** tab to display the measured values.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3–60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3–62).

Limit Values

If Limit testing is enabled (see *Taking Measurements with Limit Testing* on page 3–64), you can display the Limit values by clicking the **Limits** tab. The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard.

Select the **min** option to display the minimum limit values for the measurement. Select the **max** option to display the maximum limit values for the measurement. Refer to Figure 3-50.

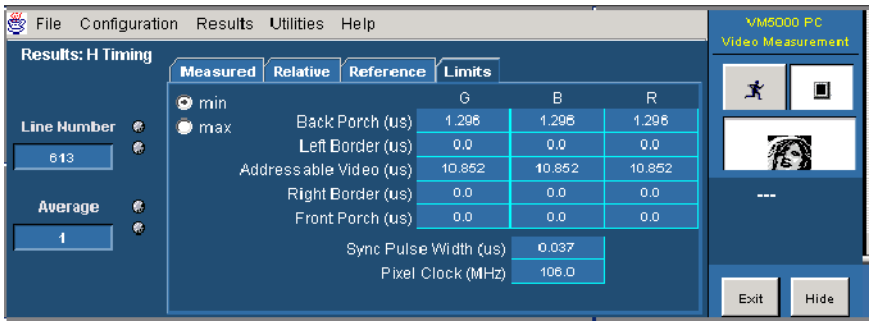


Figure 3-50: Limit values for the H Timing measurement

Displaying Linearity Measurement Results

Option VGA

Configure the Linearity measurements as explained in *Setting Up the Linearity Measurement* on page 3-90. Take the measurement by clicking the Run button. Click **Results > Linearity**. Refer to Figure 3-51.

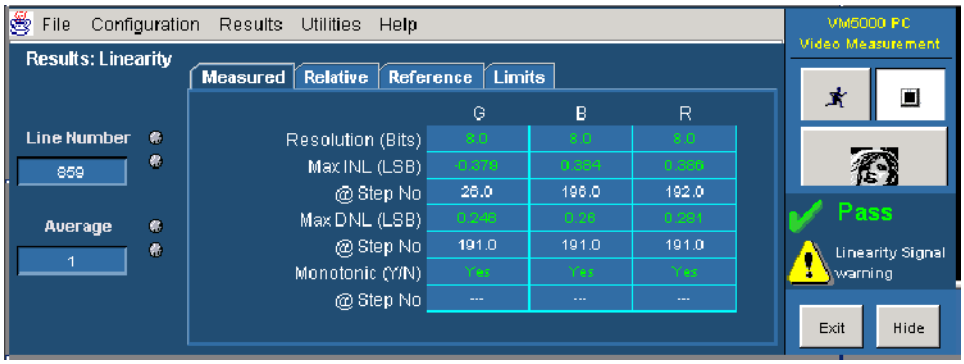


Figure 3-51: Linearity measurement results

Measured Values

Click the **Measured** tab to display the measured values.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3-60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3-62).

Limit Values

If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing* on page 3-64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard. Select the **min** option to display the minimum limit values for the measurement. Select the **max** option to display the maximum limit values for the measurement. Refer to Figure 3-52.

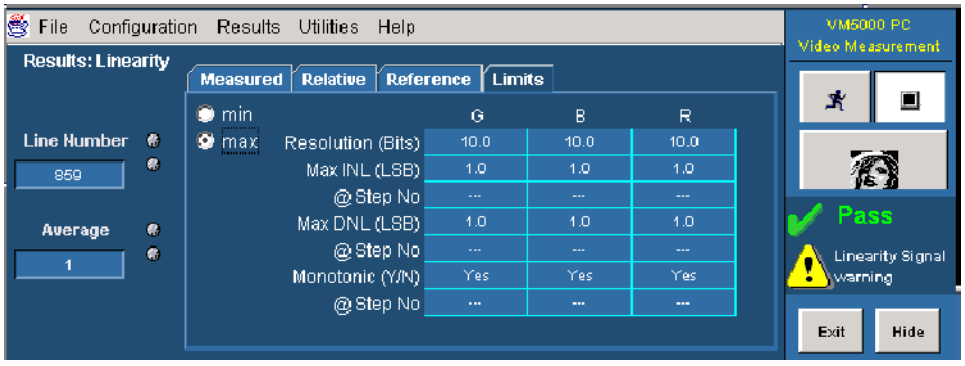


Figure 3-52: Limit values for the Linearity measurement

Displaying Luma Levels Measurement Results

Option VGA

Configure the Luma Levels measurements as explained in *Setting Up the Luma Levels Measurement* on page 3-91. Take the measurement by clicking the Run button. Click **Results > Luma Levels**. Refer to Figure 3-53.

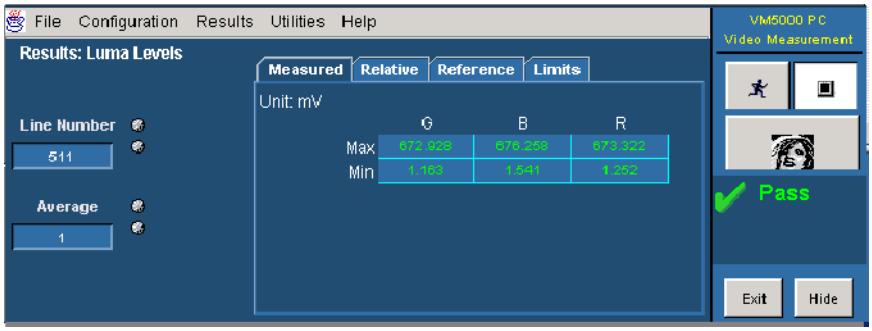


Figure 3-53: Luma Levels measurement results

Measured Values

Click the **Measured** tab to display the measured values.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3-60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3-62).

Limit Values

If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing* on page 3-64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard.

Select the **min** option to display the minimum limit values for the measurement. Select the **max** option to display the maximum limit values for the measurement. Refer to Figure 3-54.

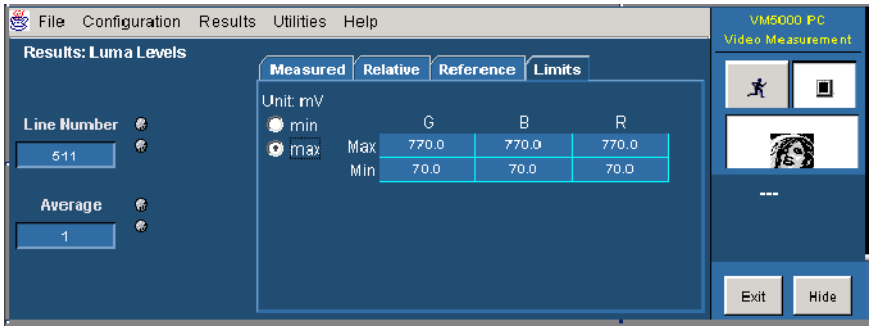


Figure 3-54: Limit values for the Luma Levels measurement

Additional Units

The only additional unit available in the Results window for the Luma Levels measurement is % in the **Relative** tab.

Displaying Noise Inj Ratio Measurement Results

Option VGA

Configure the Noise Inj Ratio measurements as explained in *Setting Up the Noise Inj Ratio Measurement* on page 3-93. Take the measurement by clicking the Run button. Click **Results > Noise Inj Ratio**. Refer to Figure 3-55.

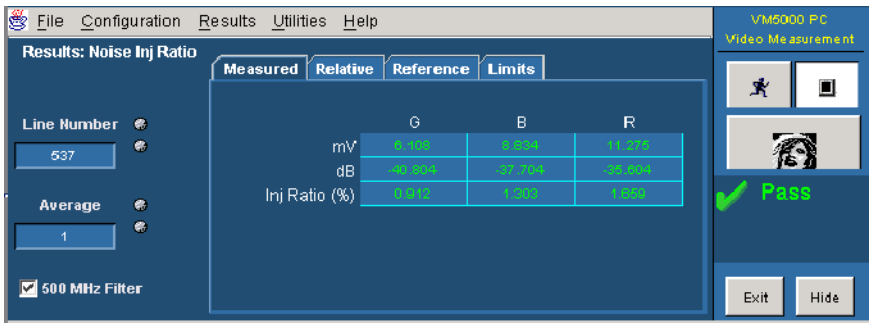


Figure 3-55: Noise Inj Ratio measurement results with MIU

Measured Values

Click the **Measured** tab to display the measured values in mV, dB, and Inj Ratio (%). When the MIU is used, the measured values of Noise (in mV) less than 1 mV are displayed as <1. When the MIU is not used, the measured values of Noise (in mV) less than 0.1 mV are displayed as <.1.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3-60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3-62).

Limit Values

If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing* on page 3-64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard. Select the **min** option to display the minimum limit values. Select the **max** option to display the maximum limit values. Refer to Figure 3-56.

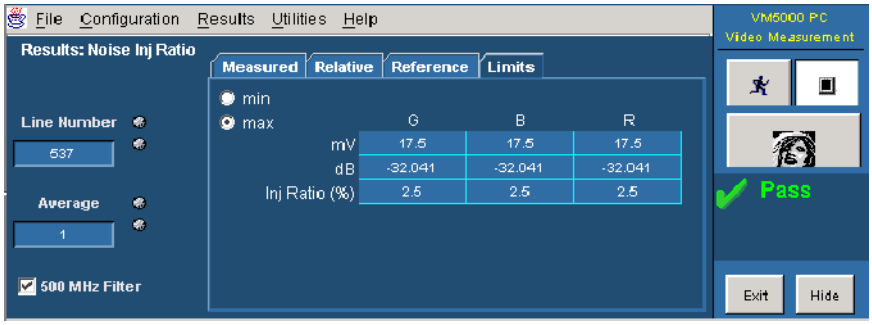


Figure 3-56: Limit values for the Noise Inj Ratio measurement

Displaying V Sync Measurement Results

Option VGA

Configure the V Sync measurements as explained in *Setting Up the V Sync Measurement* on page 3–94. Take the measurement by clicking the Run button. Click **Results > V Sync**. Refer to Figure 3–57.

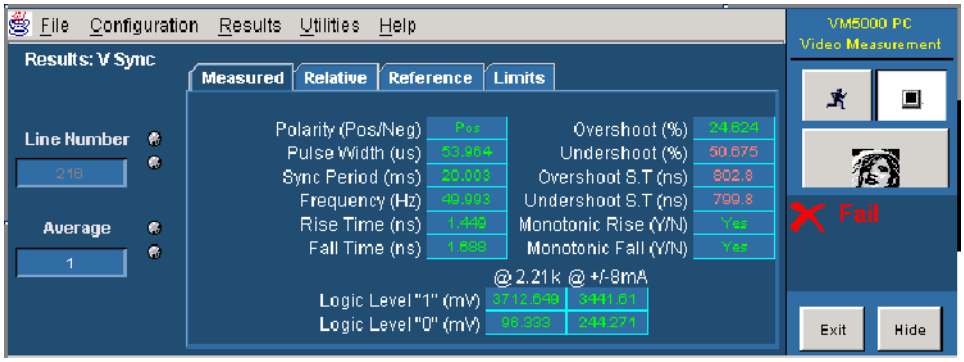


Figure 3-57: V Sync measurement results

Measured Values

Click the **Measured** tab to display the measured values.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3–60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3–62.)

Limit Values

If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing* on page 3–64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard.

Select the **min** option to display the minimum limit values. Select the **max** option to display the maximum limit values. Refer to Figure 3-58.

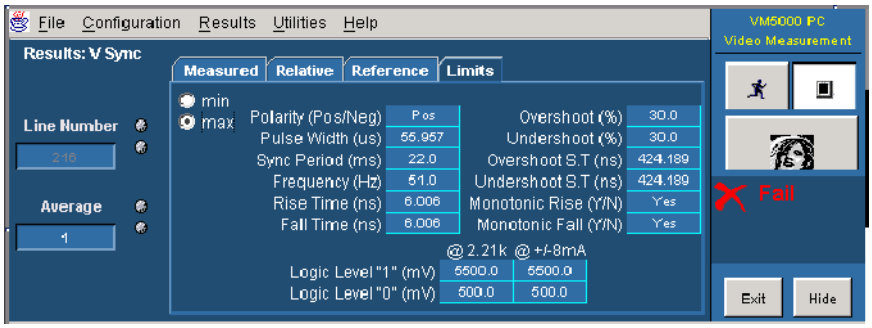


Figure 3-58: Limit values for the V Sync measurement

In the Result panel of the V Sync measurement, the parameters are different in the absence of MIU.

Displaying V Timing Measurement Results

Option VGA

Configure the V Timing measurements as explained in *Setting Up the V Timing Measurement* on page 3-95. Take the measurement by clicking the Run button. Click **Results > V Timing**. Refer to Figure 3-59.

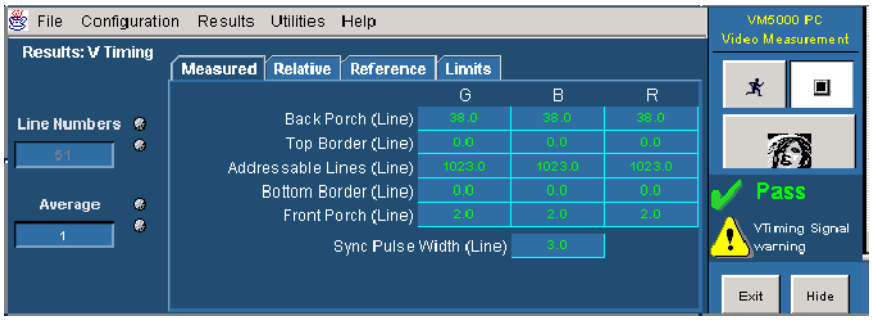


Figure 3-59: V Timing measurement results

Measured Values Click the **Measured** tab to display the measured values.

Relative Values If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3-60).

Reference Values If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3-62).

Limit Values If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing* on page 3-64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard. Select the **min** option to display the minimum limit values for the measurement. Select the **max** option to display the maximum limit values for the measurement. Refer to Figure 3-60.

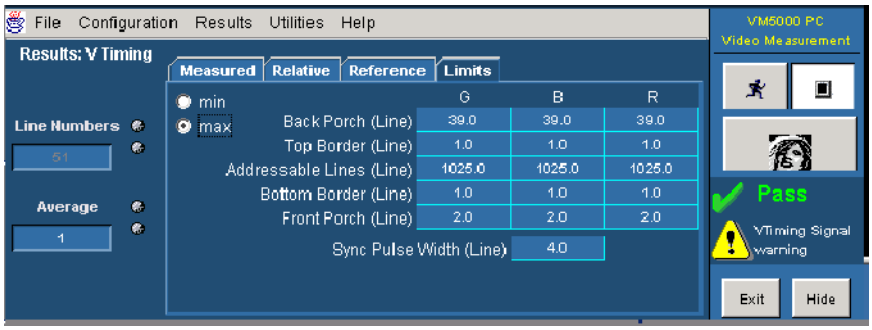


Figure 3-60: Limit values for the V Timing measurement

Displaying Video Transient Measurement Results

Option VGA

Configure the Video Transient measurements as explained in *Setting Up the Video Transient Measurement* on page 3–96. Take the measurement by clicking the Run button. Click **Results > Video Transient**. Refer to Figure 3–61.

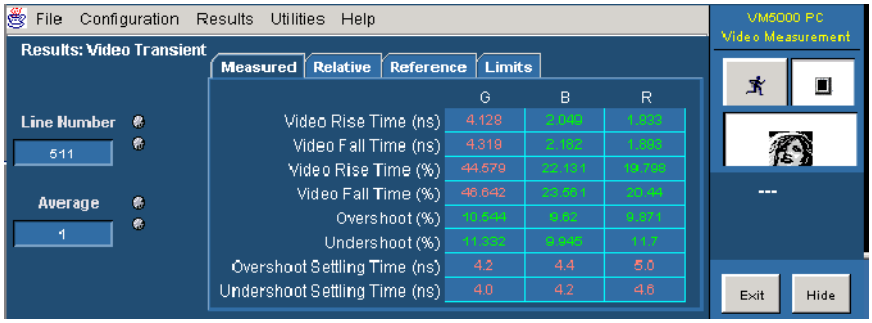


Figure 3-61: Video Transient measurement results

Measured Values

Click the **Measured** tab to display the measured values.

Relative Values

If Relative to Reference testing is enabled, you can display the calculated relative values by clicking the **Relative** tab (see *Taking Measurements Relative to a Reference* on page 3–60).

Reference Values

If Relative to Reference testing is enabled, you can display the reference values by clicking the **Reference** tab (see *Creating a Custom Reference File* on page 3–62.)

Limit Values

If Limit testing is enabled, you can display the Limit values by clicking the **Limits** tab (see *Taking Measurements with Limit Testing* on page 3–64). The minimum and maximum values are set in the limits file for the supported combination of resolution, refresh rate, and timing standard.

Select the **min** option to display the minimum limit values. Select the **max** option to display the maximum limit values. Refer to Figure 3-62.

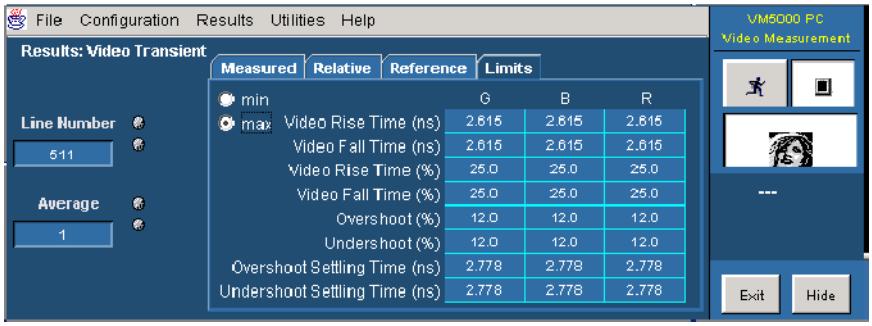


Figure 3-62: Limit values for the Video Transient measurement

Displaying Pass/Fail Results

To display Pass/Fail results, the user must enable Limit Testing. Note that results that Pass appear in green and results that Fail appear in red. You can display the Pass/Fail results for more than one measurement in the results summary. Refer to Figure 3-63 for Option SD/HD. Refer to Figure 3-64 for Option VGA.



Figure 3-63: Displaying Pass/Fail results in results summary for Option SD/HD

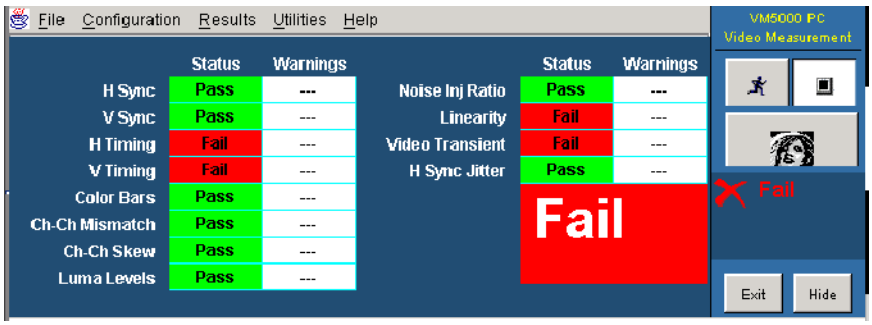


Figure 3-64: Displaying Pass/Fail results in results summary for Option VGA

To display the pass/fail results for a specific measurement, select it from the Results menu. After selecting a measurement, the results display for that measurement appears where you can view the pass/fail status of individual measurements. Refer to Figure 3-65 for Option SD/HD. Refer to Figure 3-66 for Option VGA.

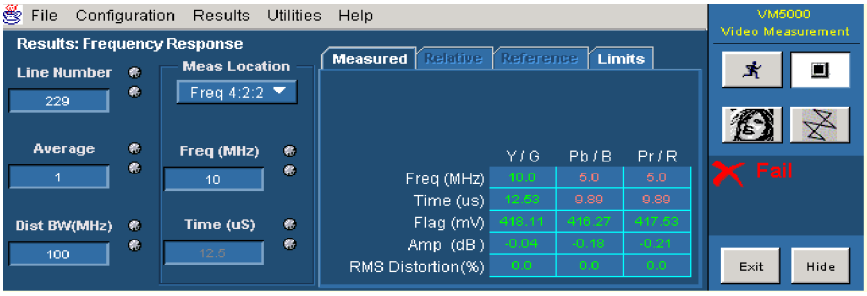


Figure 3-65: Displaying Pass/Fail results (Option SD/HD)

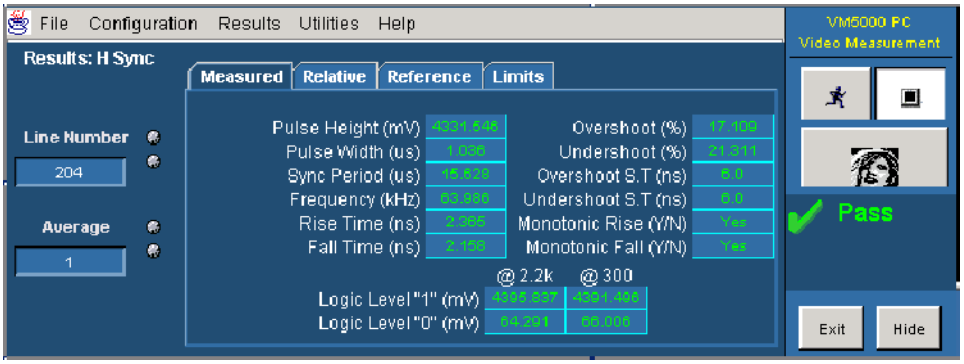


Figure 3-66: Displaying Pass/Fail results (Option VGA)

To display Pass/Fail results for an individual measurement:

1. Enable limit testing as described on page 3-64.
2. Select **Configure > Measurements**. Select the measurements you wish to run.
3. Click the Run button to take the measurements.
4. Select the measurement you wish to view from the Results menu.

Results appear in green text if the measurement falls between the maximum and minimum limits. Results appear in red text if the measurement falls above the maximum limit or below the minimum limit.

Appendices

Appendix A: Specifications

All specifications are guaranteed unless labeled “typical.” Typical specifications are provided for your convenience but are not guaranteed.

- The instrument must have been calibrated in an ambient temperature between 20 °C and 30 °C (68 °F and 86 °F).
- The instrument must be operating within the environmental limits listed in Table A–9 on page A–15.
- The instrument must be powered from a source that meets the specifications listed in Table A–7 on page A–14.
- The instrument must have been operating continuously for at least 20 minutes within the specified operating temperature range.
- You must perform the Signal Path Compensation procedure (Option SD/HD only) after the 20-minute warm-up period. If the ambient temperature changes more than 5 °C (10 °F) you must restart the procedure. See *Signal Path Compensation for Option SD/HD* on page 2–13.

The specifications listed in Tables A–1 through A–10 apply to all options. The specifications specific to Option SD/HD begin on page A–19. The specifications specific to Option VGA begin on page A–22.

Table A-1: Channel input and vertical specifications

Characteristic	Description
Input coupling	AC, DC, and GND
Input channels	Four identical channels
Input impedance selection	50 Ω or 1 MΩ Bandwidth limited to 500 MHz, 1 MΩ selected
Input impedance, DC coupled	50 Ω ±2.5%, typical 1 MΩ ±1.0% in parallel with 18 pF ±2 pF VSWR ≤1.5:1, typical, from DC to 1 GHz
Maximum voltage at input BNC	AC, DC, or GND coupled
1 MΩ	150 V_{RMS} CAT I, and ≤400 peak For steady state sinusoidal waveforms, derate at 20 dB/decade above 200 kHz to 9 V_{RMS} at ≥3 MHz
50 Ω	< 1 Vrms for settings below 100mV/div < 5 Vrms for 100 mV/div settings and above

Table A-1: Channel input and vertical specifications (Cont.)

Characteristic		Description	
Differential delay, DC 50 Ω input		≤100 ps between any two channels with DC input coupling and the same V/div scale settings at or above 10 mV/div	
Deskew range, typical		±75.0 ns	
Channel-to-channel crosstalk		≥100:1 at ≤100 MHz	
		≥30:1 at >100 MHz up to the rated bandwidth for any two channels with equal V/div settings	
Digitizers		8-bit resolution Four separate digitizers, each channel sampled simultaneously	
Sensitivity range		Fine adjustment available with ≤1% resolution	
	1 MΩ	1 mV/div to 10 V/div, in a 1-2-5 sequence	
	50 Ω	1 mV/div to 1 V/div, in a 1-2-5 sequence	
Analog bandwidth		*SCALE range*	*Bandwidth*
		1 mV/div to 1.99 mV/div	DC to 175 MHz
		2 mV/div to 1 V/div	DC to 1 GHz
		DC 50 Ω coupling; bandwidth limit set to Full; operating ambient ≤30 °C; derated by 5 MHz/°C above 30 °C	
Analog bandwidth selections		20 MHz, 150 MHz, or Full	
Analog Bandwidth Limit			
	Low frequency, AC coupled	50 Ω: < 200 kHz	
		1 MΩ: < 10 Hz, reduced by a factor of ten when using a 10X probe	
	High frequency, typical	20 MHz: with 20 MHz bandwidth limit turned on	
		150 MHz: with 150 MHz bandwidth limit turned on	
Calculated rise time, typical		DC 50 Ω coupling, bandwidth limit set to Full	
		SCALE range	*Rise time*
		1 mV/div to 1.99 mV/div	2.29 ns
		2 mV/div to 1 V/div	300 ps
Step response settling errors, typical		Bandwidth limit set to Full	
		SCALE range	*Settling error at time after step*
	≤2 V step amplitude	1 mV/div to 99.5 mV/div	20 ns: ≤0.5%
			100 ns: ≤0.2%
			20 ms: ≤0.1%

Table A-1: Channel input and vertical specifications (Cont.)

Characteristic	Description	
≤20 V step amplitude	100 mV/div to 1.0 V/div	20 ns: ≤1.0%
		100 ns: ≤0.5%
		20 ms: ≤0.2%
≤200 V step amplitude	1.01 V/div to 10 V/div	20 ns: ≤1.0%
		100 ns: ≤0.5%
		20 ms: ≤0.2%
Position range	±5 divisions	
Peak Detect or Envelope Mode Pulse Response	Capture of single event pulses	
	Number of channels	*Minimum pulse width*
	1 or 2	400 ps
	3 or 4	800 ps
Offset range	User-adjustable input offset voltages	
	SCALE range	*Offset range*
1 MΩ coupling	1 mV/div to 99.5 mV/div	±1 V
	100 mV/div to 1 V/div	±10 V
	1.01 V/div to 10 V/div	±100 V
50 Ω coupling	1 mV/div to 50 mV/div	±0.5 V
	50.5 mV/div to 99.5 mV/div	±0.25 V
	100 mV/div to 500 mV/div	±5 V
	505 mV/div to 1 V/div	±2.5 V
Offset accuracy	*SCALE range*	*Offset range*
	1 mV/div to 9.95 mV/div	±[(0.2% × | net offset |) + 1.5 mV + (0.1 div × V/div setting)]
	10 mV/div to 99.5 mV/div	±[(0.35% × | net offset |) + 1.5 mV + (0.1 div × V/div setting)]
	100 mV/div to 1.0 V/div	±[(0.35% × | net offset |) + 15 mV + (0.1 div × V/div setting)]
	1.01 V/div to 10 V/div	±[(0.25% × | net offset |) + 150 mV + (0.1 div × V/div setting]

Table A-1: Channel input and vertical specifications (Cont.)

Characteristic		Description	
		Temperatures >40 °C	±[(0.75% × | net offset |) + 150 mV + (0.1 div × V/div setting)]
		where, net offset = offset - (position × volts/division)	
DC gain accuracy, Sample or Average acquisition mode		±3% + 1.0% × |net offset /offset range| for 2 mV/div - 3.98 mV/div	
DC voltage measurement accuracy		*Measurement type*	*DC accuracy (in volts)*
	Sample acquisition mode, typical	Any sample	2 mV/div - 3.98 mV/div ±[(1.5% + 3.0% × |net offset /offset range|) × |reading - net offset| + offset accuracy + 0.13 div × V/div setting + 0.6 mV]
		Delta voltage measurement between any two points acquired under the same setup and ambient conditions	2 mV/div - 3.98 mV/div ±[1.5% + 3.0% × |net offset /offset range| × |reading - net offset| + 0.26 div × V/div setting + 1.2 mV]
		Where, net offset = offset - (position × volts/division)	
	Average acquisition mode	Average of ≥16 waveforms	2 mV/div - 3.98 mV/div ±[1.5% + 3.0% × |net offset /offset range| × |reading - net offset| + offset accuracy + 0.06 div × V/div]
		Delta voltage measurement between any two averages of ≥16 waveforms acquired under the same setup and ambient conditions	2 mV/div - 3.98 mV/div ±[1.5% + 3.0% × |net offset /offset range| × |reading - net offset| + 0.1 div × V/div + 0.3 mV]
		Where, net offset = offset - (position × volts/division)	
Nonlinearity, typical		< 1 LSB differential, < 1 LSB integral, independently based	

Table A-1: Channel input and vertical specifications (Cont.)

Characteristic	Description	
Effective bits, typical	*Signal and input conditions*	*Signal and input conditions*
Sine wave input at the indicated frequency and pk-pk amplitude, 50 mV/div and 25 °C	1 MHz, 9.2 div, 5 GS/s sample rate, Sample acquisition mode	6.6 bits
	1 MHz, 9.2 div, 10 MS/s sample rate, HiRes acquisition mode	9.0 bits
	1 GHz, 6.5 div, 5 GS/s sample rate, Sample acquisition mode	4.7 bits

Table A-2: Horizontal and acquisition system specifications

Characteristic		Description	
Acquisition modes		Sample, Peak detect, Hi Res, Average, and Envelope	
Fast acquisition rate		Up to 100,000 waveforms-per-second with Fast Acquisition mode on	
		Up to 130 waveforms-per-second with Fast Acquisition mode off	
Minimum record length		500 points	
Maximum record length		Depends on number of active channels and amount of memory installed	
	Standard	2,000,000 points (3 or 4 channels) 4,000,000 points (2 channels) 8,000,000 points (1 channel)	
	Option 3M installed	4,000,000 points (3 or 4 channels) 8,000,000 points (2 channels) 16,000,000 points (1 channel)	
Sample rate range, real-time		*Number acquired channels*	*Sample rate range*
		1	1.25 S/s to 5 GS/s
		2	1.25 S/s to 2.5 GS/s
		3 or 4	1.25 S/s to 1.25 GS/s

Table A-2: Horizontal and acquisition system specifications (Cont.)

Characteristic	Description	
Equivalent-time sample rate or interpolated waveform rate range	2.5 GS/s to 250 GS/s Listed values depend on the number of channels in use, horizontal scale, and resolution settings. Equivalent-time acquisition can be enabled or disabled. When disabled, waveforms are interpolated at the fastest time base settings.	
Seconds/division range	(s/div x 10) to 1,000 s	
Horizontal delay range	16 ns to 250 s	
Long term sample rate and delay time accuracy	±15 ppm over any ≥1 ms interval	
RMS aperture uncertainty, typical	≤ [3 ps + (0.1 ppm × record duration)] for real-time or interpolated records with a duration ≥1 minute	
Delta time measurement accuracy	For a single channel, with signal amplitude > 5 div, reference level set at 50%, interpolation set to sin(x)/x, volts/division set to ≥ 5 mV/div, with (displayed risetime)/(sample interval) ratio between 1.4 and 4, where sample interval = 1/(real-time sample rate)	
	Conditions	*Accuracy*
	Single shot signal, Sample, or Hi Res acquisition mode, Full bandwidth	± (15 ppm × | reading | + 0.3 sample intervals)
	Average acquisition mode, ≥100 averages, Full bandwidth	± (15 ppm × | reading | + 20 ps)

Table A-3: Trigger specifications

Characteristic	Description	
Auxiliary trigger input resistance, typical	≥1.5 kΩ	
Maximum trigger input voltage, typical	±20 V (DC or peak AC)	
Edge trigger sensitivity, Main and Delayed trigger	*Trigger Source*	*Sensitivity*
	Any channel, DC coupled	0.35 div from DC to 50 MHz, increasing to 1 div at 1 GHz
	Auxiliary input	400 mV from DC to 50 MHz, increasing to 750 mV at 100 MHz

Table A-3: Trigger specifications (Cont.)

Characteristic	Description	
Edge trigger sensitivity, typical	All sources, for vertical scale settings ≥10 mV/div and ≤1 V/div	
	Trigger coupling	*Sensitivity*
	NOISE REJ	3 × the DC-coupled limits
	AC	Same as DC-coupled limits for frequencies ≥60 Hz; attenuates signals <60 Hz
	HF REJ	1.5 × the DC-coupled limits from DC to 30 kHz; attenuates signals >30 kHz
	LF REJ	1.5 × the DC-coupled limits for frequencies ≥80 kHz; attenuates signals <80 kHz
Advanced trigger sensitivity, typical	For all trigger types except Edge, with vertical scale settings ≥10 mV/div and ≤1 V/div	
	1.0 div from DC to 500 MHz	
Event count sensitivity, typical	For sequential trigger delayed by events, with vertical scale settings ≥10 mV/div and ≤1 V/div	
	1.0 div, from DC to 500 MHz	
Video trigger sensitivity, typical	For delayed and main triggers, with vertical scale settings ≥10 mV/div and ≤1 V/div	
	Any channel	0.6 to 2.5 divisions of video sync tip
Video Trigger Format	Triggers from negative sync composite video, field 1 or field 2 for interlaced systems, any field, specific line, or any line for interlaced or noninterlaced systems	
	Supported systems include NTSC, PAL, SECAM, and analog HDTV	
Trigger level or threshold range	*Trigger Source*	*Sensitivity*
	Any channel	±10 divisions from center of screen
	Auxiliary input	±8 V
	Line	Fixed at zero volts

Table A-3: Trigger specifications (Cont.)

Characteristic	Description	
Trigger level or threshold accuracy, typical	Edge trigger, DC coupling, for signals having rise and fall times ≤20 ns	
	Trigger Source	*Accuracy*
	Any channel	± [(2% × | setting − net offset |) + (0.3 div × volts/div setting) + offset accuracy]
	Auxiliary	Not calibrated or specified
	Where, net offset = offset − (position × volts/division)	
Set level to 50% function, typical	Operates with signals ≥30 Hz	
Trigger position error, typical	Edge trigger, DC coupling, for signals having a slew rate at the trigger point of ≤0.5 div/ns	
	Acquisition mode	*Error*
	Sample, Average	± (1 displayed pt + 1 ns)
	Envelope	± (2 displayed pts + 1 ns)
Trigger jitter, typical	σ = 8 ps RMS	
B Event (Delayed) trigger	*Trigger After Time*	*Trigger on n^{th} Event*
Range	Delay time = 16 ns to 250 s	Event count = 1 to 10^7
Minimum time between arm (A Event) and trigger (B Event), typical	2 ns from the end of the time period to the B trigger event	2 ns between the A trigger event and the first B trigger event
Minimum pulse width, typical	—	B event width ≥1 ns
Maximum frequency, typical	—	B event frequency ≤500 MHz
Advanced trigger timing	For vertical scale settings ≥10 mV/div and ≤1 V/div	
	Minimum recognizable event width or time	*Minimum rearm time to recognize next event*
Glitch type	Minimum glitch width = 1 ns	2 ns + 5% of glitch width setting
Runt or window type	Minimum runt width = 2 ns	2 ns
Runt or window type (time qualified)	Minimum runt width = 2 ns	8.5 ns + 5% of runt width setting
Runt or window type (logic qualified)	Minimum runt width = 2 ns	8.5 ns + 5% of runt width setting

Table A-3: Trigger specifications (Cont.)

Characteristic		Description	
	Width type	Minimum difference between upper and lower limits = 1 ns	2 ns + 5% of upper limit setting
	Timeout type	Minimum timeout time = 1 ns	2 ns + 5% of timeout setting
	Transition type	Minimum transition time = 600 ps	8.5 ns + 5% of transition time setting
	Pattern type, typical	Minimum time the pattern is true = 1 ns	1 ns
	Logic	Not applicable	1 ns
	Events Delay	1 ns (single channel)	Not applicable
	State type, typical	Minimum true time before clock edge = 1 ns Minimum true time after clock edge = 1 ns	1 ns
	Setup/Hold type, typical	*Minimum clock pulse width from active edge to inactive edge*	*Minimum clock pulse width from inactive edge to active edge*
		3 ns + hold time setting	2 ns
		Setup and Hold parameters	*Limits*
		Setup time (time from data transition to clock edge)	-100 ns minimum +100 ns maximum
		Hold time (time from clock edge to data transition)	-1 ns minimum +102 ns maximum
		Setup time + Hold time (algebraic sum of the two settings)	+2 ns minimum +202 ns maximum
Advanced trigger timer ranges		*Limits*	
	Glitch type	1 ns to 1 s	
	Runt or window type, wider than	1 ns to 1 s	
	Runt or window type, time qualified	1 ns to 1 s	
	Width type	1 ns to 1 s	
	Timeout type	1 ns to 1 s	
	Transition type	1 ns to 1 s	
	Pattern type	1 ns to 1 s	
	Setup/Hold type	*Setup and Hold timers*	*Limits*

Table A-3: Trigger specifications (Cont.)

Characteristic	Description	
	Setup time (time from data transition to clock edge)	-100 ns to +100 ns
	Hold time (time from clock edge to data transition)	-1 ns to +100 ns
	Setup time + Hold time (algebraic sum of the two settings)	+2 ns to +200 ns
Advanced trigger timer accuracy	For Glitch, Timeout, or Width types	
	Time range	*Accuracy*
	1 ns to 500 ns	±(20% of setting + 0.5 ns)
	520 ns to 1 s	±(0.01% of setting + 100 ns)
Trigger holdoff range	1.5 μs to 12 s, minimum resolution is 8 μs for settings ≤1.2 ms	

Table A-4: Display specifications

Characteristic	Description
Display Type	264 mm (10.4 in) diagonal, liquid crystal active-matrix color display
	Width: 211.2 mm (8.3 in) Length: 158.4 mm (6.2 in)
Display resolution	640 horizontal × 480 vertical pixels
Pixel pitch	0.33 mm horizontal, 0.33 mm vertical
Contrast ratio, typical	150:1
Response time, typical	50 ms, black to white
Display refresh rate	59.94 frames per second
Display Format	YT, XY, XYZ
Displayed intensity levels	Supports Windows SVGA high-color mode (16-bit or 24-bit)
Waveform Styles	Vectors, Dots, Intensified Samples, Variable Persistence, Infinite Persistence.

Table A-5: Input/output port specifications

Characteristic	Description	
Probe Compensator Output	Front-panel terminals	
	Output voltage	*Frequency*
	1.0 V (from base to top) ±1.0% into a ≥ 10 kΩ load	1 kHz ±5%
Analog Signal Output	Rear-panel BNC connector, provides a buffered version of the signal that is attached to the channel 3 signal input	
	50 mV/div ±20% into a 1 MΩ load 25 mV/div ±20% into a 50 Ω load	
Bandwidth, typical	100 MHz into a 50 Ω load	
Auxiliary Output levels	Rear-panel BNC connector, provides a TTL-compatible, negative-polarity pulse for each A or B trigger (selectable)	
	V_{out} *high*	V_{out} *low (true)*
	≥2.5 V into open circuit, ≥1.0 V into 50 Ω load	≤0.7 V with ≤4 mA sink, ≤0.25 V into 50 Ω load
Auxiliary Output pulse width, typical	Pulse width varies, 1 μs minimum	

Table A-5: Input/output port specifications (Cont.)

Characteristic		Description
External Reference Input		Rear-panel BNC connector
		9.8 MHz to 10.2 MHz
		200 mV_{p-p} to 7 V_{p-p}
		$<$ 1.5 kΩ in series with ~10 nF DC blocking capacitor
Side-panel I/O ports		Ports located on the side panel
	Parallel port (IEEE 1284)	DB-25 connector, supports the following modes: Standard, output only Bidirectional, PS-2 compatible Bidirectional Enhanced Parallel Port (IEEE 1284 standard, mode 1 or mode 2, v 1.7) Bidirectional High-speed Extended Capabilities Port
	Audio ports	Miniature phone jacks for stereo microphone input and stereo line output
	USB port (2)	Allows connection or disconnection of USB keyboard and/or mouse while oscilloscope power is on
		Supports USB 2.0 protocol
	Keyboard port	PS-2 compatible, oscilloscope power must be off to make connection
	Mouse port	PS-2 compatible, oscilloscope power must be off to make connection
	LAN port	RJ-45 connector, supports 10 base-T and 100 base-T
	Serial port (COM1)	DB-9 connector, uses NS16C550-compatible UARTS, transfer speeds up to 115.2 kb/s
	SVGA video port	Upper video port, DB-15 female connector, connect a second monitor to use dual-monitor display mode, supports Basic requirements of PC99 specifications
		Display resolutions up to 1,920 X 1,440
	GPIB port	IEEE 488.2 standard interface
		Can be configured for talk/listen or controller mode
	Scope VGA video port	Lower video port, DB-15 female connector, 31.6 kHz sync, EIA RS-343A compliant, connect to show the oscilloscope display, including live waveforms, on an external monitor or projector
Video Input		Front-panel BNC connectors (3) for 3-wire CAV.
		A fourth BNC for separate composite sync or H sync on RGBHV signals.

Table A-5: Input/output port specifications (Cont.)

Characteristic	Description
Video Input	A fifth BNC (auxiliary input) for V sync on RGBHV signals.
	Trigger level range is adjustable from +8 V to -8 V. The maximum input voltage is ±20 V (DC + peak AC) and input resistance is ≥1.5 kΩ

Table A-6: Data storage specifications

Characteristic	Description
CD-ROM	Side-panel CD-R/W drive; reads CD/CD-ROM, CD-R, and CD-R/W disks
	24X read speed; 24X write speed
Floppy disk	Front-panel 3.5 in USB floppy disk drive, 1.44 MB capacity
Hard disk	Standard internal hard disk capacity: 80 GB
	External hard disk capacity: refer to added options

Table A-7: Power source specifications

Characteristic	Description
Source voltage and frequency	100 to 240 V_{RMS} ±10%, 47 Hz to 63 Hz CAT II, or 115 V_{RMS} ±10%, 360 to 440 Hz
Power consumption	≤ 220 Watts
Fuse rating	Internal to power supply; not serviceable by user
Nonvolatile memory retention	CMOS settings stored for a period of 3 years without instrument connection to power mains
	Calibration settings and error log entries stored for 1 million cycles or 20 years
Overvoltage Category	Overvoltage Category II (as defined in IEC61010-1/A2)

Table A-8: Mechanical specifications

Characteristic		Description	
Weight			
	Benchtop configuration	24.75 lbs (10.2 kg) oscilloscope only 56.5 lbs (25.6 kg) when packaged for domestic shipment	
	Rackmount kit	5 lbs (2.3 kg) rackmount conversion kit 8 lbs (3.6 kg) kit packaged for domestic shipment	
Dimensions			
	Benchtop configuration	Height: 14.2 in (360.7 mm) Height:, feet extended:14.25 in (362 mm) Width: 17.6 in (447 mm) Depth: 11.35 in (288.3 mm)	
	Rackmount configuration (Option 1R)	Height: 10.5 in (267 mm) Width: 19 in (483 mm) Depth: 9.1 in (231 mm)	
Cooling		Fan-forced air circulation with no air filter	
	Required clearances	Top	0 in (0 mm)
		Bottom	0.25 in minimum or 0 in (0 mm) when standing on the feet
		Left side	3 in (76 mm)
		Right side	0 in [5 in (126 mm) required to access CD-ROM]
		Front	0 in (0 mm)
		Rear	0 in (0 mm)
Construction material		Chassis parts constructed of aluminum alloy; front-panel constructed of plastic laminate; circuit boards constructed of glass laminate; outer shell molded and textured from a polycarbonate/ABS blend	

Table A-9: Environmental specifications

Characteristic		Description
Temperature		
	Operating	+5 °C to +45 °C (+41 °F to +113 °F)
	Nonoperating	-20 °C to +60 °C (-4 °F to +140 °F) without diskette in floppy drive

Table A-9: Environmental specifications (Cont.)

Characteristic	Description
Humidity	
Operating	20% to 80% relative humidity with a maximum wet bulb temperature of +29 °C (84.2 °F) at or below +45 °C (113 °F), noncondensing Upper limit derated to 30% relative humidity at +45 °C (113 °F)
Nonoperating	With no diskette in floppy disk drive 5% to 90% relative humidity with a maximum wet bulb temperature of +29 °C (84.2 °F) at or below +60 °C (+140 °F), noncondensing Upper limit derated to 20% relative humidity at +60 °C (+140 °F)
Altitude	
Operating	10,000 ft (3,048 m)
Nonoperating	40,000 ft (12, 190 m)
Random vibration	
Operating	0.1 G_{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis, 3-axes, 30 minutes total
Nonoperating	2.0 G_{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis, 3-axes, 30 minutes total
Shock, nonoperating	30 g (11 ms half-sine wave) or less

Table A-10: Certifications and compliances

Category	Standards or description
EC Declaration of Conformity – EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Union: EN 61326 Emissions [1, 3, 4] Class A Radiated and Conducted Emissions EN 61326 Immunity [1, 4] IEC 61000-4-2 Electrostatic Discharge Immunity ±4 kV contact discharge, ±8 kV air discharge IEC 61000-4-3 RF field immunity 3 V/m, 80 MHz to 1 GHz, 80% amplitude modulated with a 1 kHz sinewave [2] IEC 61000-4-4 Electrical Fast Transient/Burst Immunity 1 kV on AC mains, 500 V on I/O IEC 61000-4-5 AC Surge Immunity 500 V differential mode, 1 kV common mode IEC 61000-4-6 RF Conducted Immunity 3 V, 150 kHz to 80 MHz, amplitude modulated with a 1 kHz sinewave [2] IEC 61000-4-11 AC Mains Voltage Dips and Interruption Immunity 100% reduction for one cycle EN 61000-3-2 Power Harmonic Current Emissions EN 61000-3-3 Voltage Changes, Fluctuations, and Flicker [1] Use low-EMI shielded interconnect cables, equivalent to the following Tektronix cables: GPIB cable: 012-0991-01, 012-0991-02, or 012-0991-03. RS-232 cable: 012-1213-00 or CA part number 0294-9. Centronics Cable: 012-1214-00 or LCOM part number CTL3VGAMM-5 VGA Cable. [2] Under theses conditions, the specifications are amended as follows: 1 mV/division to 1 V/division: ≤0.2 division waveform displacement or ≤0.4 division increase in peak-to-peak noise. [3] Radiated emissions may exceed the levels specified in EN 61326 when this instrument is connected to a test object. [4] Tested in accordance with EN 61326 Annex D.
FCC	Radiated and conducted emissions do not exceed the levels specified in FCC47 CFR, Part 15, Subpart B, for Class A equipment.

Table A-10: Certifications and compliances (cont.)

Category	Standards or description	
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Union:	
	Low Voltage Directive 73/23/EEC, amended by 93/68/EEC	
	EN 61010-1/A2:1995	Safety requirements for electrical equipment for measurement control and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	UL3111-1, First Edition	Standard for electrical measuring and test equipment.
Canadian Certification	CAN/CSA C22.2, No. 1010.1-92	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Additional Compliance	IEC61010-1/A2	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Installation (Overvoltage) Category	Terminals on this product may have different installation (overvoltage) category designations. The installation categories are:	
	CAT III	Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location.
	CAT II	Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected.
	CAT I	Secondary (signal level) or battery operated circuits of electronic equipment.
Pollution Degree Descriptions	A measure of the contaminates that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.	
	Pollution Degree 1	No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.
	Pollution Degree 2	Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.
	Pollution Degree 3	Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.
	Pollution Degree 4	Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.
Pollution Degree	Pollution Degree 2 as defined in IEC 61010-1/A2	
	Rated for indoor use only	

Table A-10: Certifications and compliances (cont.)

Category	Standards or description
Safety Certification Compliance	
Equipment Type	Test and measuring
Safety Class	UL61010, CSA-22.2 No. 1010.1, EN61010-1, Class 1 (as defined in IEC 61010-1/A2) - grounded product
IEC 1000-4-3	RF field immunity 3 V/m, 80 MHz to 1 GHz 80% amplitude modulated with a 1 kHz sinewave Performance criteria: The noise floor of the VM5000 with MIU is degraded up to 30dB while exposed to 3 V/m electric fields. This degradation is a function of both the electric field frequency and polarization; see Figure A-1 for a graph of typical behavior. For critical VM5000 Noise measurements in an environment where electric field levels are unknown it is recommended that the VM5000 Noise Floor be determined. This will show if any impairment is present for Noise measurements. See the VM5000 Option VGA Performance Verification for this procedure on page B-24.

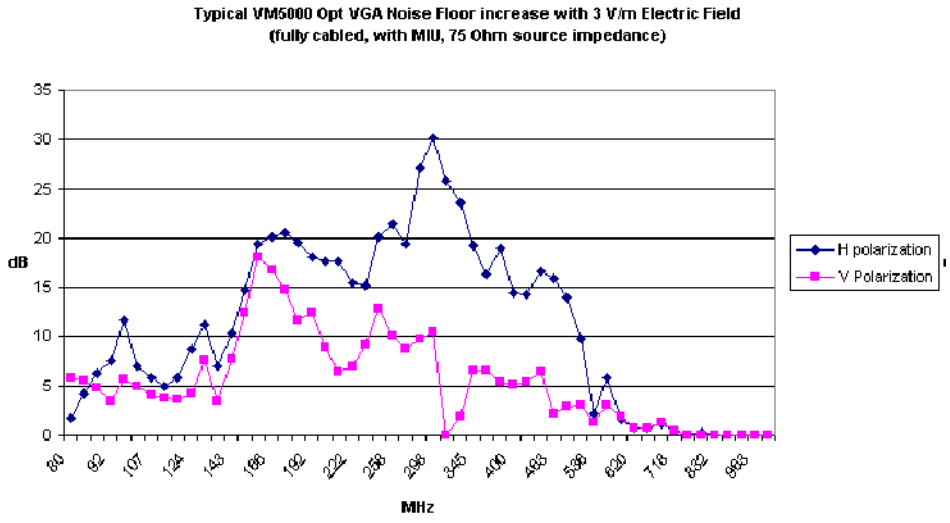


Figure A-1: Graph of Immunity behavior

Option SD/HD

Tables A–11 and A–12 provide characteristics specific to Option SD/HD.

Table A-11: Video measurement specifications

Characteristic		Description	
Color bar measurement accuracy		±2.0 mV ±1.5 % of reading	Measurement of all 8 bar levels, displayed in absolute (mV) values. YPbPr or RGB formats.
Noise measurement		*Range and Accuracy*	
	Unweighted	-20 to -60 dB, ±1 dB (30 MHz measurement bandwidth)	Noise measurement bandwidth selectable, 200 KHz to 250 MHz. Trigger on CH 4 required for measurements below -60 dB (30 MHz BW).
		-60 to -70 dB, ±2 dB (30 MHz measurement bandwidth)	
	Weighted	-20 to -60 dB, ±1 dB -60 to -70 dB, ±2 dB	Unified Weighting Filter. Trigger on CH 4 required for measurements below -60 dB.
	Noise floor	< -76 dB, 30 MHz noise bandwidth	Typical < -80 dB, 30 MHz noise bandwidth
Multiburst measurement		*Accuracy*	
	Flag amplitude	±2 mV ±1.5% of reading	
	1 MHz to 10 MHz packets	±0.5 dB	Measurement relative to reference flag amplitude
	10 to 30 MHz packets	±0.75 dB	
	Frequency readout	±0.1 MHz	Multiburst packet frequency is measured and displayed.

Table A-11: Video measurement specifications (Cont.)

Characteristic		Description	
Frequency Response Measurement		*Accuracy*	
	Flag Amplitude	±2 mV ±1.5% of reading	
	Amp: 10 MHz to 30 MHz frequency range	±0.75 dB	Measurement relative to reference flag amplitude
	Frequency readout	<5 MHz: 0.25 MHz ≥5 MHz: ±0.1 MHz	Selected frequency is measured and displayed.
	Distortion	< 10%: ± 2%	Correlated distortion relative to amplitude of fundamental frequency sinusoid. Effective Filter BW resolution is approximately 0.3 MHz or sweep BW within 3 μS, whichever is greater.
Non-linearity measurement accuracy		±1.5%	Non-linearity measurement using a ramp test signal. Incremental linearity reported over five equally spaced intervals, as well as an overall linearity figure for each channel.
Transient Response Measurement		*Accuracy*	
	Rise Time & Fall Time	±5 ns	
	K2T	±1.0%	Better than ±0.5% typical
	Overshoot & Undershoot	±1.5% of reading	
	Rise & Fall Settle Times	±5 ns	
Sync measurement		*Accuracy*	
	Sync Amplitude	±2 mV ±1.5% of reading	Blanking interval measurements, including sync amplitude, width, and rise time.
	Sync Timing	(0.06/sample rate + 15 ppm x (Reading)) rms	
	Rise Time and Fall time	±5 ns	
Channel delay		CH 1 to CH 2, CH 1 to CH 3, CH 2 to CH 3; readouts in ns.	
		Range	*Accuracy*
	Measurement	±35 ns	±5 ns
	Delay Match Error	Less than 1 ns	Any two channels

Table A-12: Sync Pick-Off Accessory Characteristics

Characteristic	Description	Reference Information
Trigger Path		
DC Attenuation	10X ± 0.7%, typical	Termination is 1.00 MΩ ±0%
	10X ± 1.5%, typical	Termination is 1.00 MΩ 1%. This specification will be met if the 10X ±0.7% specification above is met.
DC Attenuation Temperature Coefficient		±0.1% / 10°C, typical
Load on Main Signal Path		10 MΩ in parallel with 6 pF, typical
Minimum compensation range	12 pF to 24 pF, typical	18 pF is nominal
Frequency Response		
Main Signal Path	50 kHz to 30 MHz ±1%, typical	Measured in 50 or 75 Ω system
Trigger Path	50 kHz to 30 MHz ±5%, typical	Terminated in 1 MΩ, 18 pF with compensation properly adjusted at 25 °C. Main path is driven by 50 or 75 Ω system
Operating Temperature	+5 °C to +45 °C, typical	
Operating Humidity	20% to 80% RH, non-condensing	

Option VGA

Tables A–14 and A–13 describe characteristics specific to Option VGA.

Table A-14: Option VGA Video Measurements

Characteristic	Accuracy	Description
Amplitude Measurements		
Luma Level, Max and Min (mV)	±8 mV ±2.0%	VESA 6.1
Color Bars (mV)	±3 mV ±1.8%	Relative to back porch
H and V sync Logic “0” and “1” (mV)	±[8mV ±(0.0085)*(p-p sync amplitude)] ±1.8%	VESA 7.1; (p-p sync amplitude)=(logic 1 voltage)-(logic 0 voltage)
Ch-Ch Mismatch (mV)	±3 mV ±3.6% of reading	32-step staircase signal. VESA Sec 6.5
Ch-Ch Mismatch (%)	±0.4% ±(3.6%)*(Luma Level)/(Max Luma Level;); maximum ±4%	Channel voltage levels measured relative to back porch
Linearity, Resolution, Monotonicity Measurement		
Integral Linearity (%)	±2%	VESA 6.4
Differential Linearity	±0.25 LSB (8 bit) ±0.5 LSB (10 bit)	Requires step response compliant to VESA limits for overshoot/undershoot, amplitude and settle time
RGB Video Monotonicity	±0.25 LSB (8 bit) ±0.5 LSB (10 bit)	Monotonicity checks every step on the ramp to ensure signal is always rising.
Resolution Measurement Range	5 to 10 bits	Resolution measured in bits
HV Sync Monotonic Rise and Fall	Detects monotonicity errors as small as 1% of p-p sync amplitude	Checks sync for always rising and always-falling characteristic. Requires VESA compliant amplitude, noise, rise and fall.

Table A-14: Option VGA Video Measurements (Cont.)

Characteristic	Accuracy	Description
Noise Measurement		
Noise (mV) Measurement Range 8-15 mV	±5.25 mV	Measurement of RGB noise on constant pedestal, 0 to 700 mV. Output in mV Pk-Pk, dB below 700 mV, VESA Sec 6.6. Displayed value corrected for instrument noise. Specification applies with 500 MHz bandwidth filter and 10 averages selected.
Noise (mV) Measurement Range 15-25 mV	The lesser of ±7 mV or ±35%	
Noise Injection Ratio (%) Measurement Range 1.1% to 2.1%	±0.75%	
Noise Injection Ratio (%) Measurement Range 2.1% to 3.6%	±1%	
Timing Measurement		
Channel Skew Measurement range ±35 ns	±500 ps	Alternate implementation of VESA 6.7; Any two channels
H Timing (ns) - Front and Back Porch, Left and Right Border, Addressable Video	360 ps ±15 ppm x reading	
H Sync Period, H and V Sync Pulse width (ns)	80 ps ±15 ppm x reading	
V Sync Period (μs)	20 ns ±15 ppm x reading	Read out (precision) is 1 μs
V Timing (lines)-Front and Back Porch, Top and Bottom Border, Addressable Lines		Read out (precision) is 1 line. Functions within ± 10 lines of VESA reference value
Frequency Measurement		
H and V sync Frequency and Pixel Clock Frequency	±0.01% of reading	
Transient Response		
Video Rise and Fall time Measurement range > 1.3 ns	±5% of reading	VESA 6.8 Video Transient Response: Utilizes Course grille, VESA Section 6.2, 6.3, 6.8 Asymmetrical specification incorporates acquisition system rise time.
Video Rise and Fall time Measurement range 800 ps to 1.3 ns	±10% of reading	
Video Rise and Fall time Measurement range 450 ps to 800 ps	±20% of reading	
RGB System Rise Time	350 ps (typical)	

Table A-14: Option VGA Video Measurements (Cont.)

Characteristic	Accuracy	Description
Sync Rise and Fall time Measurement range > 5 ns	±5%	VESA Section 7.1-7.4 Displayed results corrected for H/V measurement system bandwidth limitations
Sync Rise and Fall time Measurement range 2 ns to 5 ns	±11%	
RGB and HV Sync Overshoot and Undershoot Amplitude %, Settle time: 0-1 ns	±2% of reading (typical)	
RGB and HV Sync Overshoot and Undershoot Amplitude %, Settle time: 1-10 ns	±1% of reading (typical)	
RGB and HV Sync Overshoot & Undershoot Settling Time, Amplitude > 5%	±T rise (typical)	VESA 6.3
Jitter Measurement		
H Sync Jitter (ns)	100 ps ±15 ppm *H-Sync period ±14% of reading	VESA 7.5 Requires VESA compliant amplitude, noise, rise and fall characteristics
H Sync Jitter (% of Pixel Clock Period) Measurement Range: < 200 MHz PCF	< 4%	
H Sync Jitter (% of Pixel Clock Period) Measurement Range: 200 to 400 MHz PCF	< 7.5%	

Table A-15: RGBHV Measurement Interface Unit (MIU)

Characteristic	Specification Wideband Mode	Specification Precision LF Mode	Reference Information
DC Gain			
RGB Channels	0.1 ±3% (typical)	1.0 ±0.002%	VM5000 automatically compensates for Wideband mode attenuation
HV Channels	0.01 ±5% (typical)	1.0 ±0.002%	
DC Termination			
RGB Channels	75 Ω nominal	75 Ω ±0.3%	
HV Channels	2.2 kΩ ±3%	2.2 kΩ ±1.5%	
Bandwidth			
RGB Channels	< 3 dB down at 1,500 MHz	DC to 10 MHz (typical)	
HV Channels	< 3 dB down at 320 MHz	DC to 10 MHz (typical)	

Table A-15: RGBHV Measurement Interface Unit (MIU) (Cont.)

Characteristic	Specification Wideband Mode	Specification Precision LF Mode	Reference Information
RGB Channels Input Return Loss			
1MHz to 100MHz	> 27 dB		27 dB RL is equivalent to ±7.5 Ω variation from 75 Ω
100MHz to 250MHz	> 21 dB		21dB RL is equivalent to ±15 Ω variation from 75 Ω
HV channels Input Capacitance	3 pF (typical)		
Current Source Loads (HV Channels)		+8mA ±2.5% -8mA ±2.5%	Current sources provide loads for Voh and Vol testing of H and V sync signals

Appendix B: Performance Verification

Use the procedures in this appendix to verify that your VM5000 meets it warranted characterics. There are two major sections to this appendix. The first section contains the performance verification for Option SD/HD. The second section contains the performace verification for Option VGA.

Option SD/HD Performance Verification

This Performance Verification checks that the VM5000 meets its video measurement specifications (Table A–11 in *Appendix A, Specifications*).

Prerequisites

The prerequisites for the performance verification are:

- The test signal generator and VM5000 instrument require a minimum 20 minute warm-up time before doing any performance verification tests.
- Perform the VM5000 instrument internal system diagnostics in the Utilities menu. The instrument must pass the diagnostics before you can verify performance.
- Perform the VM5000 instrument Signal Path Calibration (SPC) procedure. The instrument must pass the SPC before you can verify performance.

Required Equipment

The Option SD/HD performance verification requires the equpiment shown in Table B–1.

Table B- 1: Required test equipment for Option SD/HD performance verification

Item number and description	Minimum requirements	Example	Purpose
HD CAV Television Test Signal generator (one required)		Tektronix TG700 with AWVG7 module	All tests
Digital Multimeter (one required)	5-1/2 digits, better than 0.1% DC accuracy 0 - 1 V	Fluke 8842A or Fluke model 45	AWVG7 signal output test
75 Ω BNC Cable (four required)	42 inches (106.68 cm) long	Tektronix part number 012-0074-00	All tests

Table B-1: Required test equipment for Option SD/HD performance verification (Cont.)

Item number and description	Minimum requirements	Example	Purpose
75 Ω precision BNC terminations (four required)	0.025% Accuracy	Tektronix part number 011-0102-03	All tests
Connector, Dual-Banana (one required)	Female BNC-to-dual banana	Tektronix part number 103-0090-00	AWVG7 signal output test
Connector, BNC 'T' (four required)	Male BNC-to-dual female BNC	Tektronix part number 103-0030-00	All tests
Coupler, Dual-Input BNC 'T' cable assembly (one required)	Female BNC-to-dual male BNC	Tektronix part number 067-0525-02	Channel delay match test

Option SD/HD Procedure

Determine the AWVG7 Signal Output Amplitude

This procedure determines the test signal generator output signal amplitude. You will need this value for calculating measurements. This procedure assumes you are using a Tektronix TG700 test signal generator with an AWVG7 module. If you are using a different test signal source, modify the steps according to your particular setup.

Required equipment	HD CAV Television Test Signal generator (Tektronix TG700 with AWVG7 module) Digital multimeter 75 Ω BNC Cable (1) 75 Ω precision BNC terminations (1) Connector, Dual-Banana (1) Connector, BNC 'T' (1)
Prerequisites	The test signal generator and multimeter must warm up for at least 20 minutes before doing this test.

***NOTE**. Make sure that the AWVG7 generator module and the multimeter have had a warm up period of at least 20 minutes.*

1. Connect the digital multimeter to the test signal source. Refer to Figure B–1 while doing the following steps:
   a. Connect one end of a 75 Ω BNC cable to the upper CH1 connector on the AWVG7 generator module.

b. Connect the other cable end to the digital multimeter with a BNC 'T' connector, 75 Ω precision termination, and BNC female-to-dual banana adapter.

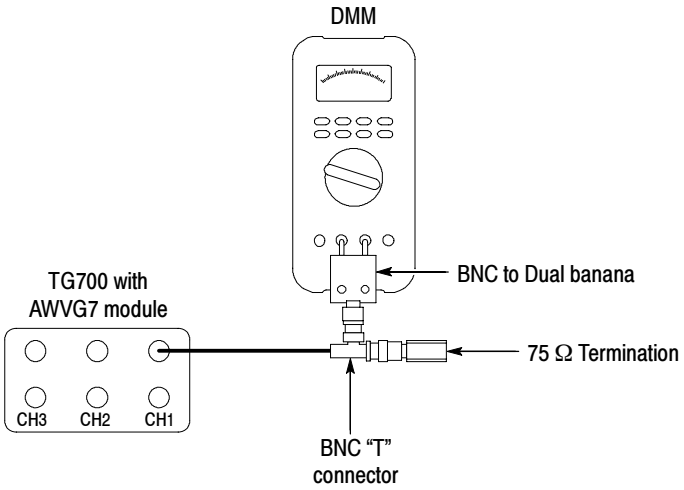


Figure B-1: Signal output amplitude test hookup

2. On the TG700, press the **MODULE**, **FORMAT**, and **FRONT PANEL ENABLE** buttons simultaneously, and then release the **MODULE** and FORMAT buttons. Continue to hold the **FRONT PANEL ENABLE** button to display **Factory Startup Mode**.

3. Enable the **DAC Gain (GBR) : 0 mV** calibration signal as follows:

a. Press the **MODULE** button to display the AWVG7 main menu.

b. Press the up or down arrow button to select **CALIBRATION**.

c. Press the left or right arrow button to select **DAC Gain (GBR)**.

d. Press the **ENTER** button.

e. Press the left or right arrow button to select **0 mV**.

f. Press the **ENTER** button.

4. Enter the digital multimeter reading in Table B–2, row DC0, column CH1.

5. Move the BNC cable from the upper CH1 connector to the upper CH 2 connector on the AWVG7 generator module.

6. Enter the digital multimeter reading in Table B–2, row DC0, column CH 2.

7. Move the BNC cable from the upper CH2 connector to the upper CH 3 connector on the AWVG7 generator module.
8. Enter the digital multimeter reading in Table B–2, row DC0, column CH 3.
9. On the TG700, press the left or right arrow button to select **700.397 mV**.
10. Press the ENTER button.
11. Enter the digital multimeter reading in Table B–2, row DC700, column CH 3.
12. Move the BNC cable from the upper CH3 connector to the upper CH 2 connector on the AWVG7 generator module.
13. Enter the digital multimeter reading in Table B–2, row DC700, column CH 2.
14. Move the BNC cable from the upper CH2 connector to the upper CH 1 connector on the AWVG7 generator module.
15. Enter the digital multimeter reading in Table B–2, row DC700, column CH 1.
16. Subtract the DC0 values from the DC700 values, for each of the three channels in Table B–2. The resulting three numbers are the Blanking-to-White levels for each channel.

Table B-2: Measured blanking to white levels

	CH1	CH2	CH3
DC700 (measured)			
DC0 (measured)			
Blanking-to-white level (DC700 minus DC0)			

Check Absolute Amplitude Measurement Accuracy

This test verifies the measurement amplitude accuracy of the three video input channels (CH1, CH2, CH3) and digitizers. This checks the accuracy specification for the Color Bars measurement, Multiburst Flag amplitude, and Sync Amplitude. The accuracy specification for all three is ±2mV ±1.5% of reading.

Required equipment	HD CAV Television Test Signal generator (Tektronix TG700 with AWVG7 module) 75 Ω BNC cables (4) 75 Ω precision BNC terminations (4) Connector, BNC 'T' (4)
Prerequisites	The test signal generator must warm up for at least 20 minutes before doing this test. You must have completed the *Determine the AWVG7 Signal Outlet Amplitude* procedure on page B-2.

1. Connect the instrument to the test signal source. Refer to Figure B-2 while doing the following steps:

a. Connect a 75 Ω BNC cables to each of the upper CH1, CH2, and CH3 AWVG7 outputs.

b. Connect the other end of each cable to a BNC 'T' connector and a precision 75 Ω termination.

c. Connect the BNC 'T' connector to the VM5000, so that the cable from the AWVG7 CH1 output goes to the VM5000 CH1 input.

d. Connect the CH2 cable to the VM5000 CH2 input and the CH3 cable to the VM5000 CH3 input.

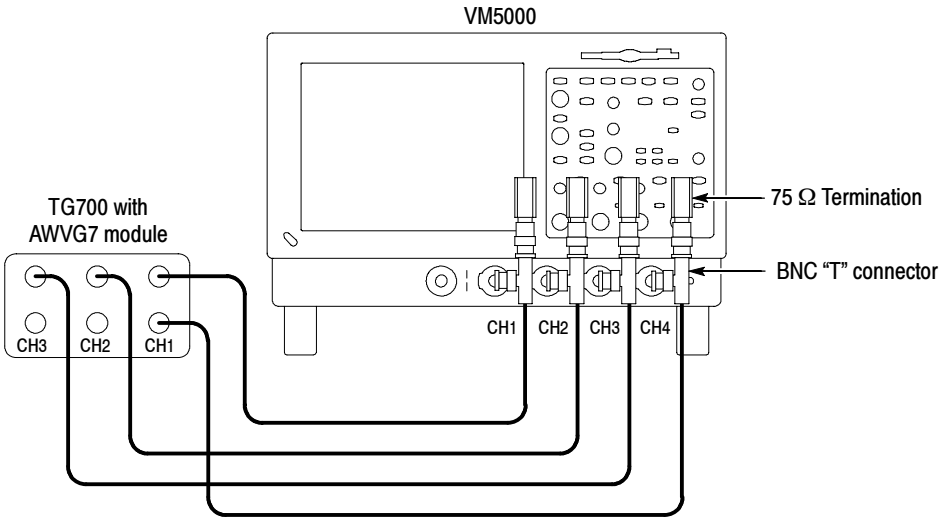


Figure B-2: Amplitude accuracy test hookup

e. Connect a fourth 75 Ω BNC cable to the lower AWVG7 CH1 output.

f. Connect the other end of this cable to a BNC 'T' connector and a 75 Ω termination.

g. Connect the BNC 'T' connector to the VM5000 CH4 input.

2. On the TG700, press the **MODULE**, **FORMAT**, and **FRONT PANEL ENABLE** buttons simultaneously to return the generator to normal operating mode.

3. After it is finished loading, press **MODULE** repeatedly to display **AWVG7**.

4. Press **FORMAT** repeatedly to display **1080 59i GBR**.

5. Press **ENTER**.

***NOTE**. Press and hold the FRONT PANEL ENABLE button to unlock the front panel.*

6. Press **COLOR BAR** repeatedly to display **100% Color Bars**.

7. Start the VM5000 application (**File > Applications > VM5000**).

8. Select **File > Recall Default**.

9. Select **Configuration > Format**, and select **RGB Color Space**.

10. Select **Configuration > Operation**, and select **Channel 4** as the trigger. Select <b>Configuration<b> > <b>Warnings<b> and then deselect <b>Measurement Warnings<b>.

11. In the Color bar measurements view, change the **Averages** setting to **64**.

12. Select the VM5000 **Run** button. The color bar measurement results table should appear with continuously updated measurements.

13. Record the VM5000 measurement value for the white bar measurement, for each of the three channels, in row 4 of Table B–3.

Table B-3: White bar measurement

	CH1 (Y/G)	CH2 (B/Pb)	CH3 (R/Pr)
AWVG7 Blanking-to-White level (DC700–DC0) (from Table B–2)			
Lower white limit value (equation 1)			
Upper white limit value (equation 2)			
White measurement			

Table B-3: White bar measurement (Cont.)

	CH1 (Y/G)	CH2 (B/Pb)	CH3 (R/Pr)
Equation 1: Lower White limit value = (DC700-DC0) X (0.985) - 2 mV			
Equation 2: Upper White limit value = (DC700-DC0) X (1.015) + 2 mV			

14. Calculate the instrument white bar measurement as follows:

a. Copy the AWVG7 Blanking-to-White level values (from Table B–2, row 3) for each channel in row 1 of Table B–3.

b. For each channel, calculate the Lower VM5000 white limit, using equation 1, and enter the values in row 2, Table B–3.

c. For each channel, calculate the Upper VM5000 white limit, using equation 2, and enter the values in row 3, Table B–3.

15. Check that the VM5000 white measurement (row 4) falls between the Lower (Line 2) and Upper (Line 3) limit values, for all three channels.

Table B–4 is an example of typical measurements and the calculation results.

Table B-4: Example white bar measurement values

	CH1 (Y/G)	CH2 (B/Pb)	CH3 (R/Pr)
AWVG7 Blanking-to-White level (DC700-DC0) (from Table B-2)	700.05 mV	700.00 mV	701.04 mV
Lower white limit value (equation 1)	687.55 mV	687.50 mV	688.52 mV
Upper white limit value (equation 2)	712.55 mV	712.50 mV	713.56 mV
White measurement	696.55 mV	700.25 mV	695.01 mV
Equation 1: Lower White limit value = (DC700-DC0) X (0.985) - 2 mV			
Equation 2: Upper White limit value = (DC700-DC0) X (1.015) + 2 mV			

The calculated VM5000 white measurements in row 4 are between the LOWER and UPPER limit values (rows 2 and 3), so the measurements are within specification for all channels.

Check Frequency Response Measurement Accuracy

This test verifies the frequency response accuracy of the three VM5000 video input channels (CH1, CH2, CH3) and digitizers. This directly checks the Multiburst measurement accuracy, and indirectly the Noise measurement up through 30 MHz. The Multiburst accuracy specification is ±0.5dB up through 10MHz, and ±0.75dB from 10 to 30 MHz.

Required equipment	HD CAV Television Test Signal generator (Tektronix TG700 with AWVG7 module) 75 Ω BNC cables (4) 75 Ω precision BNC terminations (4) Connector, BNC 'T' (4)
Prerequisites	The test signal generator must warm up for at least 20 minutes before doing this test.

***NOTE**. The AWVG7 must meet its frequency response specification of ±1%(0.09 dB) to 20 MHz, ±2%(0.17dB) to 28 MHz, and ±3%(0.26dB) to 30 MHz. If you are uncertain about the test signal generator calibration status, perform the AWVG7 frequency response performance verification described in the* AWVG7 Service Manual.

1. Connect the instrument to the test signal source. Refer to Figure B–3 while doing the following steps:
   - **a.** Connect 75 Ω BNC cables to the upper CH1, CH2, and CH3 AWVG7 outputs.
   - **b.** Connect the other end of each cable to a BNC T connector and a 75 Ω termination.
   - **c.** Connect the BNC T connector to the VM5000, so that the cable from the AWVG7 CH1 output goes to the VM5000 CH1 input.
   - **d.** Connect the CH2 cable to the VM5000 CH2 input and the CH3 cable to the VM5000 CH3 input.
   - **e.** Connect a fourth 75 Ω BNC cable to the lower AWVG7 CH1 output.
   - **f.** Connect the other end of this cable to a BNC T connector and a 75 Ω termination.
   - **g.** Connect the BNC T connector to the VM5000 CH4 input.

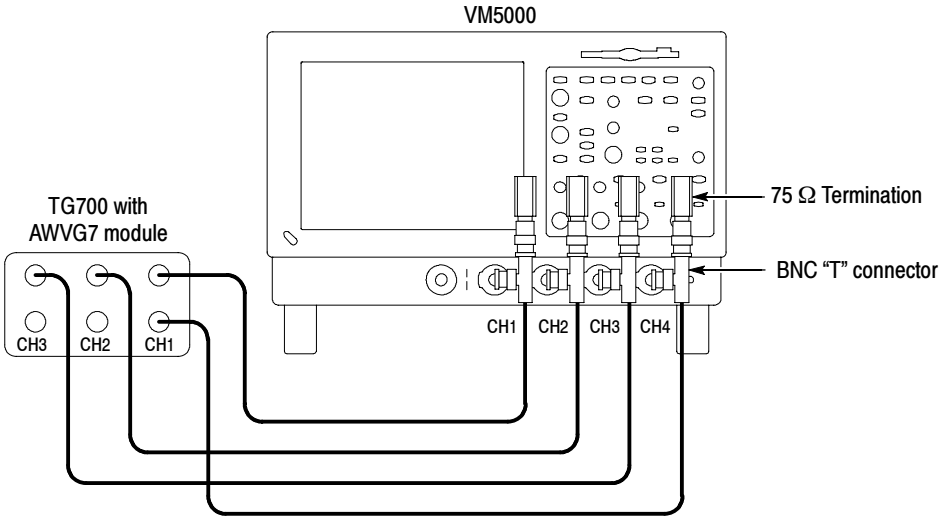


Figure B-3: Frequency accuracy test hookup

2. On the TG700, press **Module** repeatedly to display **AWVG7**.
3. Press **FORMAT** repeatedly to display **1080 59i GBR**.
4. Press **ENTER**.
5. Press **Multiburst** repeatedly to display **Multiburst 1-10 MHz**.

***NOTE**. Press and hold the FRONT PANEL ENABLE button to unlock the front panel.*

6. Start the VM5000 application (**File > Applications > VM5000**).
7. Select **File > Recall Default**.
8. Select **Configuration > Format**.
9. Select **RGB Color Space**.
10. Select **Configuration > Measurements**.
11. Select the **Multiburst** check box and deselect the **Color Bars** check box.
12. Select **Configuration > Operation**, and select **Channel 4** as the trigger.
13. Select **Results > Multiburst**.
14. Select the VM5000 **Run** button. The Multiburst measurement results table should display with continuously updated measurements.

15. Change the **Averages** setting to **64**.

16. Check the following:

    a. The six Multiburst packet Amp(dB) readings (1, 2, 4, 6, 8, and 10 MHz) should be less than ±0.5 dB, for each of the three channels (G, B, R).

    b. The flag amplitude for each channel should be 420.0 mV ±8.3 mV.

    c. The frequency, "Frq" (MHz) should be within ±0.05 MHz of the nominal (1, 2, 4, 6, 8, 10 MHz).

17. Select the VM5000 **Stop** button to halt measurement.

18. Press the TG700 **Multiburst** button repeatedly to display **Multiburst 10-20 MHz.**

19. Select the VM5000 **Run** button.

20. Check the following:

    a. The six Multiburst packet Amp(dB) readings (10, 12, 14, 16, 18, and 20 MHz) should be less than ±0.5 dB, for each of the three channels (G, B, R).

    b. The flag amplitude for each channel should be 420.0 mV ±8.3 mV.

    c. The frequency, "Frq" (MHz) should be within ±0.05 MHz of the nominal (10, 12, 14, 16, 18, 20 MHz).

21. Select the VM5000 **Stop** button to halt measurement.

22. Press the TG700 **Multiburst** button repeatedly to display **Multiburst 20-30 MHz.**

23. Select the VM5000 **Run** button.

24. Check the following:

    a. The six Multiburst (20, 22, 24, 26, 28, and 30 MHz) packet Amp(dB) readings are less than ±0.5 dB, for each of the three channels (G, B, R).

    b. The flag amplitude for each channel should be 420.0 mV ±8.3 mV.

    c. The frequency, "Frq" (MHz) should be within ±0.05 MHz of the nominal (20, 22, 24, 26, 28, and 30 MHz).

Check Noise Floor Measurement Accuracy

This test verifies the noise floor of the three VM5000 video input channels (CH1, CH2, CH3) and digitizers. Noise floor affects the linearity of the noise measurement between -60 and -70 dB. The -76 dB Noise Floor specification ensures a noise floor error contribution of less than 1 dB for a -70 dB noise measurement. Together with the Amplitude Accuracy (Check A) and Frequency

Response (Check B) checks, this indirectly checks the Noise measurement accuracy.

Required equipment	HD CAV Television Test Signal generator (Tektronix TG700 with AWVG7 module) 75 Ω BNC cable (1) 75 Ω precision BNC terminations (4) Connector, BNC 'T' (1)
Prerequisites	The test signal generator must warm up for at least 20 minutes before doing this test.

1. Connect the instrument to the test signal source. Refer to Figure B–4 while doing the following steps:
   a. Connect a 75 Ω BNC cable to the CH1 AWVG7 outputs.
   b. Connect the other end of the cable to the VM5000 CH 4 input and a 75 Ω termination using a BNC 'T' connector.
   c. Place 75 Ω terminations on the VM5000 CH1, CH2, and CH3 inputs.

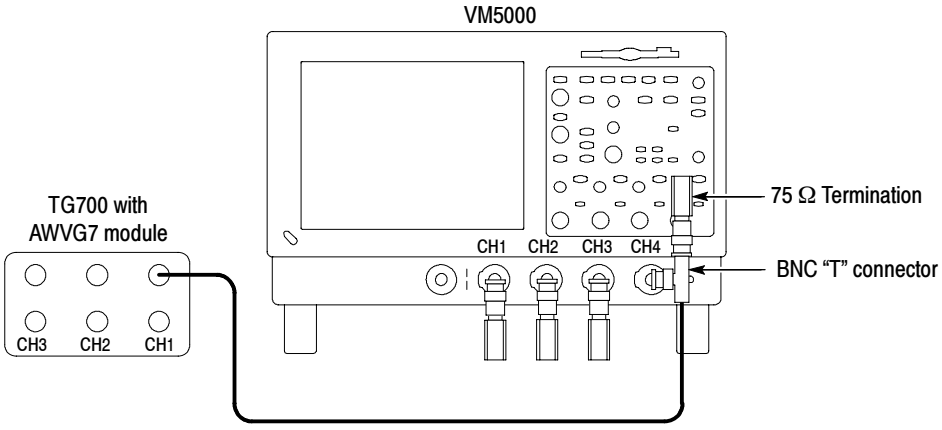


Figure B- 4: Noise floor accuracy test hookup

2. Start the VM5000 application (**File > Applications > VM5000**).
3. Select **File > Recall Default**.
4. Select **Configuration > Format** and select **RGB Color Space**.

5. Select **Configuration > Measurements**.
6. Select the **Noise** check box and deselect the **Color Bars** check box.
7. Select **Configuration > Operation**, and select **Channel 4** as the trigger.
8. Select **Results > Noise**.
9. Select **Unweighted BW** in the Filter area.
10. Adjust the **Bandwidth Hz** setting to **30.0 MHz**.
11. Change the **Averages** setting to **64**.
12. Select the VM5000 **Run** button. The Noise measurement results table should appear with continuously updating measurements.
13. Check that the noise measurement dB values are greater than 76 dB for all three channels.

    For example, a 78 dB reading passes. A 74 dB reading fails.

Check Channel Delay Match

This check verifies the delay match between the VM5000 CH1, CH2, and CH3 measurement channels. Delay match error affects Ch-Ch Skew measurement accuracy. The specification for delay match error between any two channels is less than 1 ns.

Required equipment	HD CAV Television Test Signal generator (Tektronix TG700 with AWVG7 module) 75 Ω BNC cables (2) 75 Ω precision BNC terminations (2) Connector, BNC 'T' (2) Coupler, Dual-Input BNC 'T' cable assembly (1)
Prerequisites	The test signal generator must warm up for at least 20 minutes before doing this test.

1. Connect the instrument to the test signal source. Refer to Figure B–5 while doing the following steps:
   a. Connect a 75 Ω BNC cable to the upper CH1 AWVG7 output.
   b. Connect the other end of the cable to a BNC 'T' connector, BNC 'T' Cable Assembly, and 75 Ω termination.

c. Connect the BNC 'T' Cable Assembly to the VM5000 CH1 and CH 2 inputs.

d. Connect a second 75 Ω BNC cable to the lower CH1 AWVG7 output.

e. Connect the other end of the cable to the VM5000 CH 4 input and a 75 Ω termination using a BNC 'T' connector.

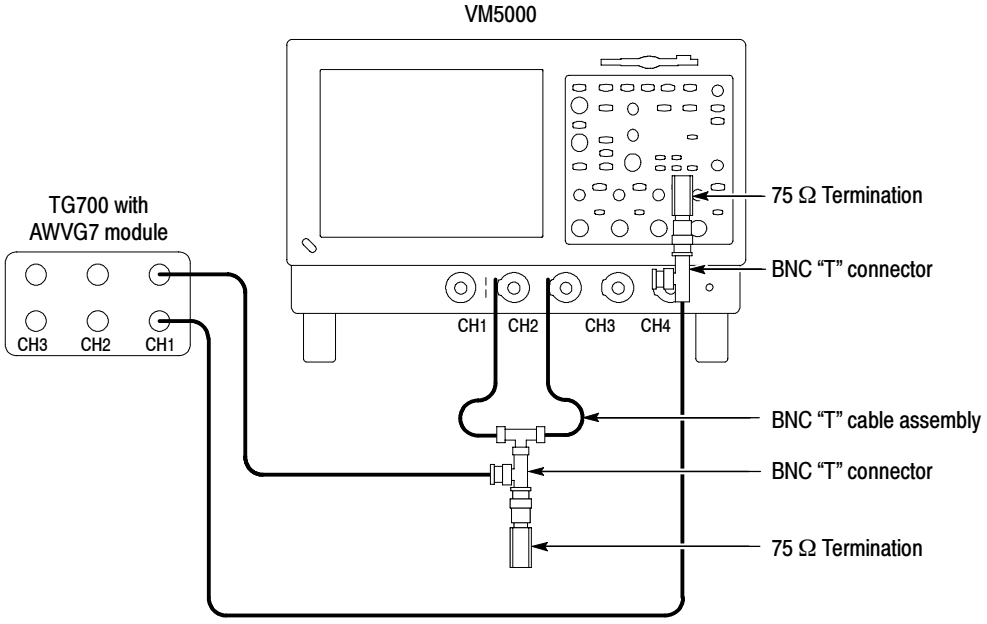


Figure B-5: Channel delay match test hookup

2. On the TG700, press the **Module** button repeatedly to display **AWVG7**.

3. Press **FORMAT** repeatedly to display **1080 59i GBR.**

4. Press **ENTER**.

5. Press **Multiburst** repeatedly to display **Multiburst 10-20 MHz**.

***NOTE**. Press and hold the FRONT PANEL ENABLE button to unlock the front panel.*

6. Start the VM5000 application (**File > Applications > VM5000**).

7. Select **File > Recall Default**.

8. Select **Configuration > Format** and select **RGB Color Space**.

9. While still in **Configuration > Measurements**, select the **Channel Delay** check box and deselect the **Color Bars** check box.
10. Select **Configuration > Operation**:
    a. Deselect all the **Warning Reporting** boxes.
    b. Select **Channel 4** as the trigger.
11. Select **Results > Channel Delay**.
12. Change the **Averages** setting to **64**.
13. Select the VM5000 **Run** button. The Channel Delay measurement results table should appear with continuously updating measurements.
14. Note the G-B measurement results (including sign) in row 1 of Table B–5.
15. Reverse the BNC 'T' Cable connections on CH1 and CH2.
16. Note the G-B measurement results (including sign) in row 2 of Table B–5.
17. Subtract line 2 from line 1 in Table B–5. Divide this result by 2 and enter it in row 3 of Table B–5.

Table B-5: Delay error measurements

	G-B (ns)	G-R (ns)	B-R (ns)
Connection 1			
Connection 2			
Net delay error (equation 3)			
Equation 3: [(Connection 1) - (Connection 2)] ÷ 2			

18. Connect the BNC 'T' Cable to the VM5000 CH1 and CH3 inputs. Repeat the procedure in steps 14 through 17 for the G-R measurement.
19. Connect the BNC 'T' Cable to the VM5000 CH2 and CH3 inputs. Repeat the procedure in steps 14 through 17 for the B-R measurement.
20. Check that the net delay error (row 3) is less than ±1 ns for G-B, G-R, and B-R.

This completes the VM5000 Option SD/HD performance verification.

Option VGA Performance Verification

This procedure verifies that the measured signal characteristics meet the warranted specifications of the product (Table A–14 in *Appendix A, Specifications*).

The System Performance Verification procedure does the following:

- Establish a reference point for the test equipment being used before proceeding with the measurements.
- Look at worst case (warranted) transient and amplitude characteristics of Video and Sync signals. This will cover Video Transient, H Sync, V Sync and Luma Levels measurements.
- Characterize Noise, Linearity and inter-channel measurements.

Prerequisites

The prerequisites for the performance verification are:

- The Oscilloscope Calibrator (Fluke/Wavetek 9500B), VM5000 instrument and Arbitrary Waveform Generator AWG710B require a minimum 20 minute warm-up time before doing any performance verification tests.
- Perform the VM5000 instrument internal system diagnostics in the Utilities menu. The instrument must pass the diagnostics before you can verify performance.
- Perform the VM5000 instrument Signal Path Compensation (SPC) procedure. The instrument must pass the SPC before you can verify performance.

Required Equipment

The Option VGA performance verification requires the equpiment shown in Table B–6.

Table B- 6: Required test equipment for Option VGA performance verification

Description	Quantity Required	Minimum Requirement	Recommended Equipment	Where Used
VM5000 with MIU, Test Signal CD, cables, mouse and keyboard	1	Tektronix VM5000HD or TDS5104x	Tektronix VM5000	All checks
Arbitrary Waveform Generator	1	2 GHz Analog bandwidth; rise time better than 300 ps	Tektronix AWG710B with Option 02	Transient and Linearity tests

Table B- 6: Required test equipment for Option VGA performance verification (Cont.)

Description	Quantity Required	Minimum Requirement	Recommended Equipment	Where Used
Digital Multimeter	1	4-1/2 digits, better than 0.1% DC accuracy, 0 to 2.5 volts	Keithley Model 2000	9500B signal output test
Oscilloscope Calibrator	1	Amplitude accuracy ±1 mV	Fluke/Wavetek model 9500B	Amplitude tests
Active Head	1	3 GHz bandwidth	Fluke/Wavetek model 9530	Amplitude tests
50 ohms coaxial cable	1		Tektronix part number 012-0057-01	Amplitude tests
75 ohms Terminators	3	2 V max, ±0.025%	Tektronix part number 011-0102-03	9500B signal output test, Noise Floor measurement
BNC T-Connector	1		Tektronix part number 103-0030-00	9500B signal output test
3 feet VGA to 5x BNC cable	1		Tektronix part number 174-5126-00	Noise floor measurement, Channel skew match
Min Loss Pad	1	50 to 75 ohms	Tektronix part number 011-0057-01	Amplitude tests, Transient, Linearity
Windows based PC	1	Pentium P4, 1.8 GHz, 20 GB HDD, VGA, NI PCI-GPIB IEEE 488.2 interface card		Sync Absolute Amplitude measurement, Channel skew match, Noise floor measurement accuracy
6 dB Attenuators	2	±0.3 dB DC - 1000 MHz, and ±0.5 dB 1000 - 2000 MHz	Tektronix part number 011-0069-03	10-bit Linearity
Connector, Dual Banana	1		Tektronix part number 103-0090-00	9500B signal output amplitude test
BNC adapter-Female to Female	1			Luminance level measurement accuracy
50 Ω SMA cable (male both ends) co-axial cable	3	1 GHz bandwidth	Tektronix part number 174-1480-00	Transient Response Tests, Linearity Test

Initial Setup

VM5000

The steps to set up the VM5000 for the performance verification are:

1. From the TekScope application, select File > Run Applications > VM5000 VGA Video.
2. Ensure that Option VGA application is launched.
3. From the VM5000 VGA Video application, select File > Recall Default setup. This ensures that the configuration parameters are in the default state.

Windows-based PC

To perform measurements on the VM5000, you must provide an appropriate video signal to the VM5000. You accomplish this by displaying a bitmap file on the PC in which the DUT is operating. The preferred bitmap file, when taking multiple measurements, is the Matrix signal. If you need to take only one measurement, you can use a full-field test pattern rather than the Matrix signal. All the necessary Matrix signals and full-field test pattern bitmaps for performance verification are located on the Test Signal Files CD-ROM.

1. Set the resolution to 1024x768 and refresh rate to 60 Hz.
2. Copy the following files from the Test Signal Files CD-ROM to a floppy disk:

   pvvidtranssetup.set
   pvlinearltysetup.set
   pvhsyncsetup.set
   LinearityNoStepsOrSyncVolts2kx1p5kat85HzDoubled.wfm
   2kx1p5kx85TransientPvVoltsOffset200mVDoubled.wfm
   2kx1p5kx85HsyncTransientTestVoltsPosDoubled.wfm

Performance Verification Procedures

Check Luminance Level Measurement Accuracy

This test verifies the amplitude measurement accuracy of the three video input channels (CH1/G, CH2/B, CH3/R), checking the specification for the Color Bar and Luma Level measurements. The accuracy is checked at the nominal White and Black level points, 700 mV and 0 V, respectively. The specification is ±3 mV ±1.5% of the reading.

Required equipment	Fluke/Wavetek model 9500B Oscilloscope Calibrator 9530 Active head Keithley Model 2000 multimeter 50 Ω co-axial cable 75 Ω precision BNC termination Connector, Dual Banana BNC Adapter, Female/Female BNC T connector Min loss pad 50 to 75 Ω
Prerequisites	The oscilloscope calibrator and multimeter must warm up for at least 20 minutes before doing this test

Part 1: Determine the 9500B signal output amplitude. The MIU G, B, and R inputs are specified for a 75 Ω source. To adapt the 50 Ω output of the 9500B calibrator, a 50 to 75 Ω minimum loss (min-loss) pad is used. The min-loss pad inserts loss between the calibrator and 75 Ω MIU inputs. The Part 1 procedure

determines the proper calibrator voltage setting to produce 700 mV across a precision 75 Ω load. You will need this information for Part 2. This procedure assumes that you are using a Fluke/Wavetek 9500B Oscilloscope Calibrator. If you are using a different test signal source, modify the steps according to your particular setup.

***NOTE**. Make sure that the 9500B Oscilloscope Calibrator and the multimeter have had a warm up period of at least 20 minutes.*

1. Connect the equipment as shown in Figure B-6.

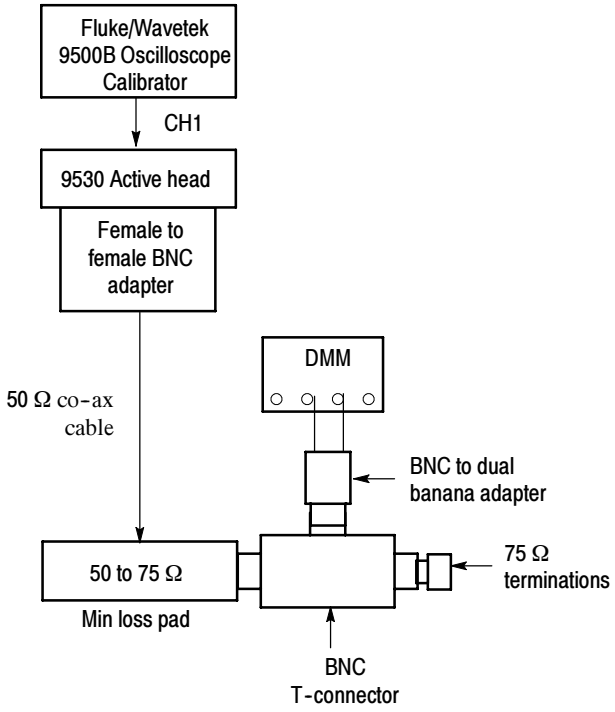


Figure B-6: Setup to determine 9500B signal output amplitude

a. Connect the 9530 Active head to channel 1 of the 9500B Oscilloscope Calibrator.

b. Connect a female/female BNC adapter to the 9530 head output. Connect a 50 Ω coaxial cable to the other end of the BNC adapter.

c. Connect a 50 Ω to 75 Ω min-loss pad to the open end of the coaxial cable.

***NOTE**. The female side of the min-loss pad must be the 50 Ω side.*

d. Connect the other end of the min-loss pad to the BNC "T" adapter.

e. Connect a 75 Ω precision terminator and the BNC female to dual banana adapter to the other ends of the BNC "T" adapter.

f. Connect the dual banana adapter to the Volts input of the multimeter. Check that the adapter is oriented so that the coaxial shield is connected to the "low" side of the Volts input. On most adapters, this is marked with a small tab labeled "GND".

2. Configure the 9500B for 50 Ω output, Positive DC waveform, Direct Entry mode, and 1.10 volt amplitude:

a. On the 9500B, press the CHANNEL SELECT button.

b. Press the LOAD button to select 50 Ω output impedance.

c. Press the EXIT button.

d. Press WAVEFORM.

e. Select POSITIVE DC. On the 9500B, this is the fourth waveform from the top.

f. Using the bottom right-most soft key, select DIRECT entry mode (symbol is "1.0" with up/down arrows).

g. Using the keypad, enter "1.1" volts and press ENTER (ENTER is large oval-shaped key with an arrow on it, just to the right of the keypad).

3. If you are using the Keithley 2000 multimeter, set it to AUTO range. Otherwise, select the 1 V scale.

4. Select the 9500B OUTPUT ON button and ensure that the corresponding red LED glows. The multimeter should read approximately 700 mV.

5. Adjust the 9500B output amplitude until the multimeter reads as close as possible to 700 mV. Use the "<" and ">" keys to select the digit and the "∧" and "∨" keys to adjust. Your final reading on the multimeter should be between 699.9 mV and 700.1 mV.

6. Enter both the multimeter reading (to the nearest 0.1 mV) and the 9500B amplitude setting in Table B–7, row DC700.

7. On the 9500B, select "ground" mode by pressing the bottom soft key below the ground symbol. The multimeter should read approximately 0 V.

8. If you are using the Keithley 2000 multimeter, leave it in AUTO range. Otherwise, select the 100 mV scale.

9. Enter the multimeter reading in Table B–7, row DC0. Record the voltage to the nearest 0.1 mV. Take care to notice the dimensional units reported on the multimeter readout; for the 700 mV reading the unit is probably Volts while the ground reading is probably in millivolts.

10. Select OUTPUT OFF. Disconnect the min-loss pad from the BNC "T" adapter, leaving the other end of the pad connected to the coaxial cable.

This completes the 9500B signal output amplitude determination.

Table B-7: Format for Luminance level measurement results

	9500B Amplitude Setting	Multimeter reading
DC700		
DC0	GND	

Table B-8: Example for Luminance level measurement results

	9500B Amplitude Setting	Multimeter reading
DC700	1.1056V	700.1 mV
DC0	GND	0.0 mV

Part 2: Check Amplitude Measurement Accuracy. The perform the initial set up of the VM5000 as follows:

1. The Part 1 procedure should have been performed just before this portion. This will minimize errors from potential thermal drift in the 9500B Oscilloscope Calibrator and min-loss pad. You must use the same Calibrator and min-loss pad from Part 1, and the ambient temperature must be within 5 °C of that during Part 1.

2. Ensure that the MIU is fully connected (CH1–4, AUX, RS-232) to the VM5000. Nothing should be connected to the five MIU input BNCs.

3. If the VM5000 VGA Video application is not already running, start it now: from the TekScope menu bar, select File > Run Application > VM5000 VGA Video.

4. In the VM5000 VGA Video application, select the default setup: from the VM5000 VGA Video application menu bar, select File > Recall Default Setup.

5. Enable only the Luma Levels measurement. From the VM5000 menu bar, select Configuration > Measurements. Press Clear All to de-select all measurements, and select "Luma Levels".

6. Run the Luma Levels measurement by clicking the Run button. After about 40 seconds, a Signal Warning message “Luma Levels: Acquisition Problem” will appear. This is normal, as no video signal has been applied. Click “OK” to clear the warning message. The measurement will then stop. No values will be reported in “Results”.

***NOTE**. The purpose of this step is to properly set the channel gains and offsets.*

From Part 1, the 9500B Oscilloscope Calibrator should already have a coaxial cable connected to its output, with a min-loss pad on the other end of the cable.

7. Connect the open (male) end of the min-loss pad to the MIU G input. See Figure B–7.

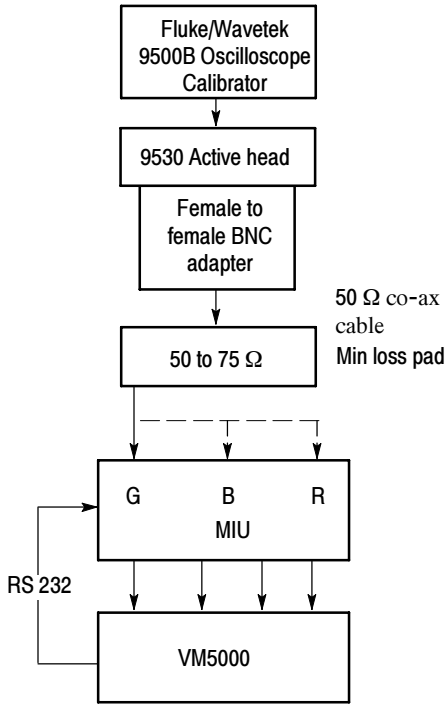


Figure B-7: Setup to determine absolute amplitude measurement accuracy

8. On the VM5000 front panel, under TRIGGER, press the MODE button to change from NORM to AUTO.

9. From Part 1, the 9500B Amplitude should already be set to produce 700 mV at the MIU input. Check that the 9500B Amplitude setting matches the entry recorded in Table B–7 on page B–20, 9500B Amplitude Setting, DC700.

10. On the 9500B, turn off “ground” mode and select OUTPUT ON. The CH1 oscilloscope trace should move from approximately 1.5 div. below graticule center to 3.5 div. above.

11. Now select the CH1 Mean voltage measurement:

    a. From the Tekscope menu bar, select Measure > Measurement Setup. The measurement menu appears.

    b. A listing of enabled measurements appears in the Measurements table. Press the Clear button as needed until no measurements are listed.

    c. Under Source, Ch tab, select Channel 1. Under the Ampl tab, select Mean. “Mean-Ch1” should appear in the Measurements table.

    d. Under “Setup”, press the Statistics button. Under “Measurement Statistics” press Mean. Press Close to clear the menu. The TekScope graticule should appear full screen, with a “Mean (C1)” voltage readout on the right. The entry preceded by the ”μ” symbol is the Average Mean voltage measurement for CH1 (G channel).

12. Record the Average Mean measurement value to the nearest 0.1 mV. In Table B–9, “Measured White level”, in the “G” column.

13. Temporarily turn off the measurement statistics: Measure > Statistics > Off.

14. Select “ground” on the 9500B. The scope trace will drop down to approximately 1.5 div. below graticule center.

15. Turn Mean measurement statistics back on: Measure > Statistics > Mean.

16. Record the Average Mean measurement value, to the nearest 0.1mV, in Table B–9, “Measured Black level”, in the “G” column.

***NOTE**. The oscilloscope readout may be in micro-volts (μV) if the value is near zero.*

---

17. Move the min-loss pad and cable from the MIU “G” input to the MIU “B” input.

18. Repeat steps 10 through 16 for the B channel.

***NOTE**. Settings are for “CH2” rather than “CH1”, and “B” in place of “G”.*

---

19. Move the min-loss pad and cable from the MIU “B” input to the MIU “R” input.

20. Repeat steps 10 through 16 for the R channel.

***NOTE**. Settings are for "CH3" rather than "CH1", and "R" in place of "G".*

21. In Table B–9, subtract the Measured Black Levels (row 2) from the Measured White Levels (row 1) and enter the results in row 3. These are the Measured White-to-Black Amplitude values for each channel.

22. Calculate the Upper and Lower White limit values and the Upper and Lower Black limit values, using the equations shown in Table B–9.

***NOTE**. The equations reference the DC700 and DC0 multimeter values from Table B–8 on page B–20. For these calculations, make sure you use the multimeter values from Table B–7 on page B–20, not the 9500B Amplitude Setting values.*

23. Check that the Measured White and Black levels for each channel fall within the corresponding Upper and Lower limit vales.

24. Check that the Measured White-to-Black Amplitudes for each channel fall within the corresponding Upper and Lower limit values.

25. Turn the 9500B OUTPUT OFF and disconnect the min-loss pad and cable from the MIU input.

Table B- 9: Amplitude measurement results

Characteristic	G	B	R
Measured White level			
Measured Black level			
Lower White limit value	{(DC700) x (0.980)} – 8 mV		
Upper White limit value	{(DC700) x (1.020)} + 8 mV		
Lower Black limit value	(DC0) – 8 mV		
Upper Black limit value	(DC0) + 8 mV		
Lower White-to-Black limit value	{[(DC700) x (DC0)] x (0.982)} – 3 mV		
Upper White-to-Black limit value	{[(DC700) x (DC0)] x (1.018)} + 3 mV		

Table B–10 uses the values of DC700 DC0 from the example Table B–9 on page B–23.

Table B-10: Example of Amplitude measurement results

Characteristic	G	B	R
Measured White level	699.0 mV	696.2 mV	698.3 mV
Measured Black level	0.0 mV	-1.7 mV	-0.5 mV
Measured White-to-Black Amplitude (MWL-MBL)	699.0 mV	697.9 mV	698.8 mV
Lower White limit value	{(700.1 mV) x (0.980)} - 8 mV = 678.1 mV		
Upper White limit value	{(700.1 mV) x (1.020)} + 8 mV = 722.1 mV		
Lower Black limit value	(0.0 mV) - (8 mV) = -8.0 mV		
Upper Black limit value	(0.0 mV) + (8 mV) = +8.0 mV		
Lower White-to-Black limit value	{[(700.1 mV) x (0.0 mV)] x (0.982)} - (3 mV) = 684.5 mV		
Upper White-to-Black limit value	{[(700.1 mV) x (0.0 mV)] x (1.018)} + (3 mV) = 715.7 mV		

In this example, all three channels meet their White, Black, and White-to-Black specifications.

Check Noise Floor Measurement Accuracy

This test verifies the noise floor of the three VM5000 channels (CH1/G, CH2/B, CH3/R) and digitizers. Noise floor affects the linearity of the noise measurement between –56 dB and –32 dB.

Required equipment	A standard PC VGA to 5 BNC cable 75 Ω precision BNC terminations (3)
Prerequisites	The VM5000 (including MIU) must warm up for at least 20 minutes before doing this test.

1. If the VM5000 Option VGA application is not already running, start it now: from the Tekscope menu bar, select **File > Run Application > VM5000 VGA Video**.
2. In the VM5000 application, select the default setup: from the VM5000 menu bar, select **File > Recall Default Setup**.

3. Set the Test PC VGA output to 1024x768, 60 Hz refresh frequency:

   a. Right click on the desktop. The window that appears is labeled **Display Properties**.

   b. Select the **Settings** tab in the Display Properties window.

   c. Under **Screen Area** choose 1024x768 pixels. Click the **Advanced** button, choose the **Monitor** tab, and select 60 Hz refresh rate. Select OK for the new setting to take effect.

4. Disconnect the monitor cable from the Test PC VGA output jack. In its place, connect the 3 foot VGA to 5 BNC cable between the PC and H and V inputs of the MIU. Connect the H and V BNCs to the MIU H and V inputs. The gray BNC is "H" and the black BNC is "V". If the distance from the test PC to the MIU is greater than 3 feet, these cables may be extended.

5. Connect three 75 Ω terminators to **G**, **B**, and **R** inputs of the MIU as shown in Figure B–8.

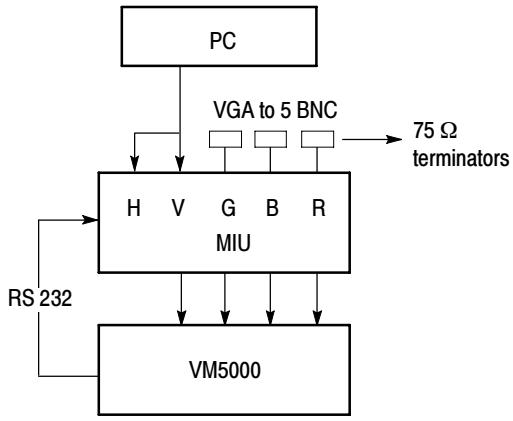


Figure B-8: Setup to determine the noise floor measurement accuracy

6. In the VM5000 VGA Video application, select **Configuration > Measurements**. Press **Clear All** button, then select **Noise Inj Ratio**.

7. Select **Results > Noise Inj Ratio**. Set the number of result averages to 10 and ensure that the 500 MHz filter is enabled.

8. Take the Noise Injection Ratio measurement by clicking the run button.

9. Write down the mV results for G, B and R channels in Table B–11. Ignore the dB and Noise Injection Ratio % reading.

10. Verify that the measured value for each channel is less than 22 mV.

11. Disconnect the 3-foot VGA to BNC cable from the Test PC VGA output and reconnect the monitor cable.

Table B-11: Noise Floor levels of G, B, and R Channels

Characteristic	G	B	R
Measured Noise value (mV)			
Lower Limit	5.25 mV	5.25 mV	5.25 mV

Check Channel Skew Match

Setup the Channel Skew Match as shown in Figure B–9.

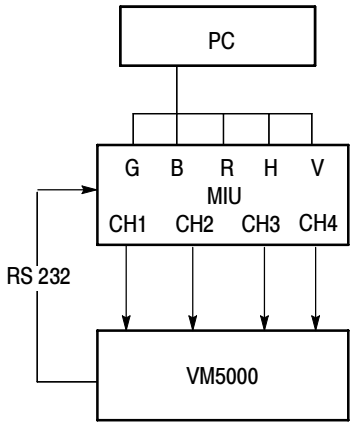


Figure B-9: Setup to check channel skew match

Required equipment	A standard PC 3-foot VGA to 5 BNC cable Test Signal CD
Prerequisites	VM5000 (including MIU) must warm up for at least 20 minutes before doing this test.

1. Generate a test signal using the test PC as follows:

   a. Display the contents of either the Matrix or Full Field folder.

   Whether you choose a single test pattern or take multiple measurements, you must select the bitmap file that you will display to generate the video test signal. The file you select depends on the format you want to test.

Suppose you want to test a 1280X1024 resolution format (the refresh rate is not considered when selecting a bitmap file). Within the appropriate folder, look for a filename that matches the format of the test you want to perform. If you want to test Linearity, you would need to choose either full-field Staircase test pattern or use the Matrix test pattern. Within the Staircase folder, you would look for a file named STEP1280X1024.bmp. Within the Matrix folder, look for a file named Matrix1024x768.bmp.

b. Select the bitmap file that fits your requirements and open the file with a program such as Paint Shop Pro. If you set up the DUT to drive a second display, you can set the background of the second display to the bitmap file rather than opening the file.

2. If the VM5000 Option VGA application is not already running, start it now: from the Tekscope menu bar, select File > Run Application > VM5000 VGA Video.

3. In the VM5000 application, select the default setup:

from the VM5000 menu bar, select File > Recall Default Setup

4. Set the Test PC display properties to 1024x768 with a 60 Hz refresh rate:

a. Right click on the desktop, the window that appears is labeled **Display Properties**.

b. Select the **Settings** tab in the Display Properties window.

c. Under **Screen Area** choose 1024x768 pixels. Click on the **Advanced** button, choose the **Monitor** tab, and select 60 Hz refresh rate. Select OK for the new setting to take effect.

5. Place the Test Signals CD into the Test PC. View the directory contents and locate the 1024x768 matrix bit-map signal: “MAT1024x768.bmp”. Double-click to open the file with the MS Paint program. The matrix test signal should appear on the Test PC monitor screen.

6. Make the signal full-screen by selecting View > View Bitmap from the MS Paint menu bar. Move the mouse pointer to the upper left screen edge.

7. Disconnect the monitor cable from the Test PC VGA output jack. In its place connect the 3-foot VGA to 5 BNC cable. Connect the 5 BNCs to the five MIU input BNCs. The gray BNC is “H” and the black BNC is “V”. If the distance from the test PC to the MIU is greater than 3 feet, these cables may be extended.

8. In the VM5000 VGA Video application, select Configuration > Measurements. Press **Clear All**, then select **Ch-Ch Skew**.

9. Run the measurement. Note the "G to B" measurement result (including sign) in row 1 of Table B–12.
10. Reverse the G and B cable connections at the MIU and re-run the measurement.
11. Note the G to B measurement result (including sign) in row 2 of Table B–12.
12. Subtract line 2 from line 1 in Table B–12. Divide this result by 2 and enter it in row 3 of Table B–12.
13. Reverse the G and B cable connections again to restore the original MIU connections (G to G, B to B).
14. Repeat the procedure in steps 9 through 12 for the G to R measurement.
15. Repeat the procedure in steps 9 through 12 for the B to R measurement.
16. Check that the net delay error (row 3) is less than 2 ns for G to B, G to R and B to R.
17. Remove the 3-foot VGA cable and reconnect the monitor to the Test PC. Close the Microsoft Paint program.

Table B-12: Channel Skew results of G, B, and R channels

	G to B	G to R	B to R
Connection 1			
Connection 2			
Net skew error (Equation 3)			
Equation 3 = (Connection 1 - Connection 2) + 2			

Check Transient Response Measurement Accuracy

This test verifies the Transient Response of VM5000. The Transient Response determines the bandwidth of the test system. Tektronix specifies the bandwidth at the probe tip when the recommended accessories are used. The specification for sync and video transient measurements is shown in the following table for reference.

Characteristic	Range	Accuracy
Video Rise and Fall time measurement	>1.3 ns	±5% of reading
	800 ps to 1.3 ns	±10% of reading
	450 ps to 800 ps	±20% of reading
Sync Rise and Fall measurement	>5 ns	±5% of reading
	2 ns to 5 ns	±11% of reading

Required equipment	AWG710B Arbitrary Waveform Generator 50 Ω SMA cables (2) SMA to BNC adapters (2)
Prerequisites	AWG710B and VM5000 (including MIU) must warm up for at least 20 minutes before doing this test.

H Sync Measurement. The steps to perform H Sync measurements are as follows:

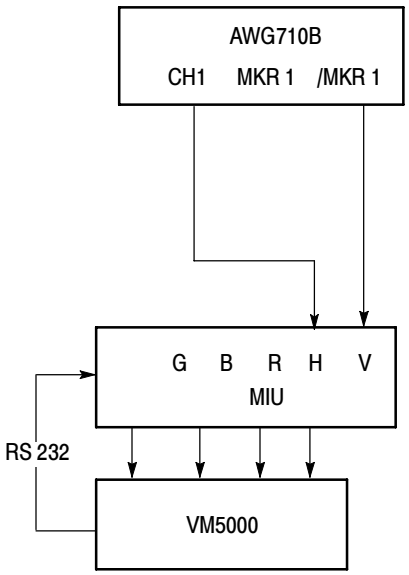


Figure B-10: Setup to measure H Sync transient response accuracy

1. Make connections as shown in Figure B–10.
   a. Connect Channel 1 of the AWG710B to the H input of the MIU.
   b. Connect /MRK 1 of the AWG710B to the V input of the MIU.
2. If the VM5000 Option VGA application is not already running, launch it by selecting **File > Run Application > VM5000 VGA Video**.
3. From the VM5000 application menu bar, select **File > Recall Default Setup**.
4. From the VM5000 application menu bar, select Configuration > Pull down menu: Format. Select 2048 x 1536 resolution and 85 Hz refresh rate.

5. From the VM5000 application menu bar, select **Configuration > Measurement > Clear All**.
6. From the VM5000 application menu bar, select **Configuration > Measurement > H Sync**.
7. On the AWG710B: Load the H sync test file and setup from the floppy drive by following these steps:
   a. Load the floppy disk containing the AWG710B .set and .wfm files into the AWG710B.
   b. Load the **pvhsyncsetup.set** setup file. Press buttons in the following sequence: setup (button) > Save/Restore (bottom) > restore setup (right) > drive (right) > floppy (center) > OK (right) > pvhsyncsetup.set (middle) > OK (right).
8. On the AWG710B: Output the test signal from AWG710B by following these steps:
   a. Press the CH1 button and enable signal output from Channel 1.
   b. Press the MARKER OUT button and enable signal output from /MKR 1.
   c. Press the Run button to start generating the signal.
9. From the VM5000 application menu bar, run H Sync measurement: Click the Run button to take the measurement (to autoscale).
10. From the VM5000 application menu bar, deselect (disable) Auto Scale: select **Configuration > Operations > Auto Scale >** deselect/disable.
11. From the VM5000 application menu bar, run the H Sync measurement: Click the Run button to take the measurement.
12. Enter the results in Table B–13 and verify that the measured values are within the lower and upper limits.

Table B-13: H Sync Transient measurement results

H-Sync parameter	Lower Limit	Measured result	Upper limit
Pulse Width (μs)	0.576		0.578
Sync Period (μs)	7.297		7.299
Rise Time (ns)	1.840		2.300
Fall Time (ns)	1.840		2.300

Video Transient Measurement

Required equipment	AWG710B Arbitrary Waveform Generator 50 Ω SMA cables (3) SMA to BNC adapters (3) 50 - 75 Ω min loss pad (1)
Prerequisites	AWG710B and VM5000 (including MIU) must warm up for at least 20 minutes before doing this test.

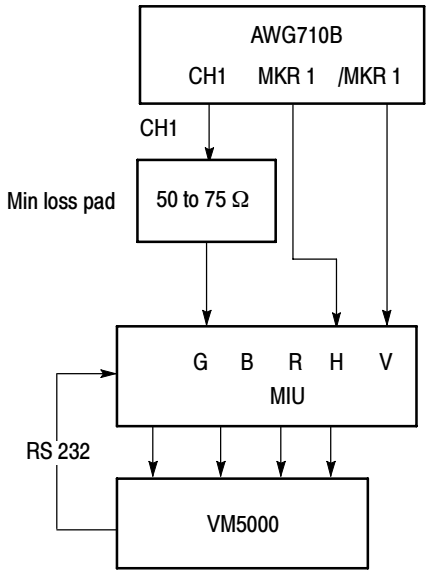


Figure B-11: Setup to perform Transient and Linearity measurements

The steps for checking the Video Transient measurement are as follows:

1. Make connections as shown in Figure B-11.
   a. Connect Channel 1 of the AWG710B to the G input of the MIU (through 50 Ω to 75 Ω min loss pad).
   b. Connect the MRK 1 output from the AWG710B to the H input of the MIU.
   c. Connect the /MRK 1 output from the AWG710B to the V input of the MIU.
2. If the VM5000 Option VGA application is not already running, launch by selecting File > Run Application > VM5000 VGA Video.
3. From the VM5000 application menu bar, select File > Recall Default Setup.

4. From the VM5000 application menu bar, select Configuration > Format panel, select 2048 x 1536 resolution and 85 Hz refresh rate (click OK in case a warning message pops up regarding this format selection).

5. From the VM5000 application menu bar, select Configuration > Measurement > Clear All.

6. From the VM5000 application menu bar, select Configuration > Measurement > Video Transient.

7. From the VM5000 application menu bar, deselect (Disable) Configuration > Operations panel > Sync polarity > Auto Detect.

8. From the VM5000 application menu bar, deselect (Disable) Configuration > Warnings > Pop Up Warning Details.

9. On the AWG710B: Load the H sync test file and setup from the floppy drive as follows:

   Load the pvvidtranssetup.set setup file: Press buttons in the following sequence: setup (button) > Save/Restore (bottom) > restore setup (right) > drive (right) > floppy (center) > OK (right) > pvvidtranssetup.set (middle) > OK (right). Wait for file loading to complete.

10. On the AWG710B: Generate a test signal by using the following steps:

    a. Press the **CH1** button to enable signal output from Channel 1.

    b. Press the **MARKER OUT** button to enable signal output from MKR 1 and /MKR 1.

    c. Press the Run button to start generating the signal.

11. From the VM5000 application menu bar, run the Video Transient measurement. Click the Run button to take the measurement.

12. Enter the results in Table B–14 and verify that the measured values are within the lower and upper limits.

Table B-14: Video rise/fall time - G Channel

G Channel parameters	Lower limit	Measured result	Upper limit
Video Rise Time (ns)	0.360		0.540
Video Fall Time (ns)	0.360		0.540

13. Move AWG710B CH1 output and min loss pad from MIU “G” to MIU “B” input.

14. From the VM5000 application menu bar, run Video Transient measurement. Click the Run button to take the measurement.

15. Enter the results in Table B–15 and ensure that the measured values are within the lower and upper limits.

Table B-15: Video rise/fall time - B Channel

B Channel parameters	Lower limit	Measured result	Upper limit
Video Rise Time (ns)	0.360		0.540
Video Fall Time (ns)	0.360		0.540

16. Move the AWG710B CH1 output and min loss pad from the MIU "B" input to the MIU "R" input.

17. From the VM5000 application menu bar, take the Video Transient measurement: Click the Run button to take the measurement.

18. Enter the results in Table B–16 and verify that the measured values are within the lower and upper limits.

19. At this point the AWG710B may be disconnected and turned off unless further verification tests are desired.

Table B-16: Video rise/fall time - R Channel

R Channel parameters	Lower limit	Measured result	Upper limit
Video Rise Time (ns)	0.360		0.540
Video Fall Time (ns)	0.360		0.540

Check Linearity Measurement Accuracy

This test verifies the accuracy of the vertical resolution, monotonicity, integral and differential linearity of the test system.

Required equipment	AWG710B Arbitrary Waveform Generator 50 Ω SMA cables (3) SMA to BNC adapters (3) 50 - 75 Ω min loss pad (1) 6 dB Attenuators (2) - Tek part number 011-0069-03
Prerequisites	The AWG710B and VM5000 (including MIU) must warm up for at least 20 minutes before doing this test.

Linearity Measurement The steps for checking the Linearity measurement are as follows:

1. Make connections as shown in Figure B–11 on page B–31.
   a. Connect the AWG710B CH1 to the G input of the MIU through the 50 Ω to 75 Ω min loss pad.
   b. Connect the MRK 1 output of the AWG710B to the H input of the MIU.
   c. Connect the /MRK 1 output of the AWG710B to the V input of the MIU.
2. If the VM5000 Option VGA application is not already running, launch by selecting File > Run Application > VM5000 VGA Video.
3. From the VM5000 application menu bar, select File > Recall Default Setup.
4. From the VM5000 application menu bar, select Configuration > Format to display the Format panel. Select 2048 x 1536 resolution and 85 Hz refresh rate.
5. From the VM5000 application menu bar, select Configuration > Measurement > Clear All.
6. From the VM5000 application menu bar, select Configuration > Measurement > Linearity.
7. From the VM5000 application menu bar, deselect (Disable) Configuration > Operations panel > Sync polarity > Auto Detect.
8. From the VM5000 application menu bar, deselect (Disable) Configuration > Warnings > Pop Up Warning Details.
9. On the AWG710B: Load the H sync test file and setup from the floppy drive by following these steps:

   Load the pvlinearltysetup.set setup file: Press buttons in the following sequence: setup (button) > Save/Restore (bottom) > restore setup (right) > drive (right) > floppy (center) > OK (right) > pvlinearltysetup.set (middle) > OK (right). Wait for file loading to complete.
10. On the AWG710B: Generate the test signal on the AWG710B by following these steps:
    a. Press the **CH1** button to enable signal output from Channel 1.
    b. Press the MARKER OUT button to enable signal output from /MKR 1.
    c. Press the Run button to start generating the signal.

8-bit INL, DNL, Monotonicity, and Resolution measurement. The steps for checking the 8-bit INL, DNL, Monotonicity, and Resolution measurement are as follows:

11. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

12. Record the measured result in Table B–17.

13. Check that the results are within the upper and lower limit.

Table B-17: 8-bit Linearity measurement results - G channel

Linearity	Lower limit	G	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.25		0.25
Monotonic (Y/N)	Yes		Yes

14. Connect the AWG710B **CH1** output to the **B** input of the MIU.

15. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

16. Record the measured result in Table B–18.

17. Check that the results are within the upper and lower limit.

Table B-18: 8-bit Linearity measurement results - B channel

Linearity	Lower limit	B	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.25		0.25
Monotonic (Y/N)	Yes		Yes

18. Connect the AWG710B **CH1** output to the **R** input of the MIU.

19. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

20. Record the measured result in Table B–19.

21. Check that the results are within the upper and lower limit.

Table B-19: 8-bit Linearity measurement results - R channel

Linearity	Lower limit	R	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.25		0.25
Monotonic (Y/N)	Yes		Yes

10-bit DNL, Monotonicity and Resolution measurement: G Channel. The steps for checking the 10-bit DNL, Monotonicity, and Resolution measurement are as follows:

22. Make connections as shown in Figure B-11 on page B-31.

- **a.** Connect the **CH1** output of the AWG710B to the G input of the MIU (through the 50 Ω to 75 Ω min loss pad).
- **b.** Connect the MRK 1 output of the AWG710B to the H input of the MIU.
- **c.** Connect the /MRK 1 output of the AWG710B to the V input of the MIU.

23. On the VM5000: Click the Run button to take the linearity measurement. It may take a few minutes for the measurement to complete.

24. Connect the AWG710B **CH1** output to the **G** input of the MIU with the two 6 dB (2x) attenuators and min loss pad added as shown in Figure B-12 on page B-40.

25. From the VM5000 application menu bar, select Configuration > Operation > Setup And/Or Run > Run Only.

26. From the TekScope application menu bar, select Vertical > Offset > Select Ch1 > enter 0.350 (Volts) in Offset box.

27. From the TekScope application menu bar, Click on **App** software button.

28. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

29. Record the results in Table B-20.

30. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-20: 10-bit Linearity, G Channel, Level 1 of 4

Linearity	Lower limit	G	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

31. From the TekScope application menu bar, select Vertical > Offset > Select Ch1 > enter 0.175 (Volts) in Offset box.

32. From the TekScope application menu bar, click on **App** software button.

33. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

34. Record the results in Table B–21.

35. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-21: 10-bit Linearity, G Channel, Level 2 of 4

Linearity	Lower limit	G	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

36. From the TekScope application menu bar, select Vertical > Offset > Ch1 > enter 0 (Volts) in Offset box.

37. From the TekScope application menu bar, click on **App** software button.

38. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

39. Record the results in Table B–22.

40. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-22: 10-bit Linearity, G Channel, Level 3 of 4

Linearity	Lower limit	G	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-20.48		20.48
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

41. From the TekScope application menu bar, select Top menu: Vertical > Offset > Select Ch1 > enter -0.175 (Volts) in Offset box.

42. From the TekScope application menu bar, click on **App** software button.

43. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

44. Record the results in Table B-23.

45. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-23: 10-bit Linearity, G Channel, Level 4 of 4

Linearity	Lower limit	G	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

46. Compute composite resolution: If the Resolution (bits) value in Tables B-20 through B-23 is the same, add 2 to the value and enter this value under "Resolution (Bits)" in Table B-24. If the value for Resolution (bits) is not the same for all tables, the Resolution portion of the performance verification for this channel has failed.

47. Determine maximum INL: find the worst case (extreme) INL value from Table B-20 to Table B-23 and enter the resulting value, or this value plus the INL value from Table B-17, which ever has the largest absolute value, under "Max INL (LSB)" in Table B-24 on page B-39.

48. Compute maximum DNL: find the worst case (extreme) DNL value from Table B-20 to Table B-23 and enter the resulting value under "Max DNL (LSB)" in Table B-24 on page B-39.

49. Determine monotonicity: enter “Yes” under “Monotonic (Y/N)” if and only if the corresponding values in Table B–20 through Table B–23 are “Yes.” Otherwise enter “No” in Table B–23 on page B–38.

50. Check that the results are within the upper and lower limits.

Table B-24: 10-bit Linearity, G Channel, All Levels

Linearity	Lower limit	G	Upper limit
Resolution (Bits)	10		10
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

10-bit DNL, Monotonicity and Resolution measurement: B Channel. The steps for checking the 10-bit DNL, Monotonicity and Resolution measurement: B Channel are as follows:

51. Make connections as shown in Figure B–11 on page B–31. Use the MIU “B” input instead of “G”:

- **a.** Connect the Channel 1 output of the AWG710B to **B** input of the MIU (through the 50 Ω to 75 Ω min loss pad).
- **b.** Connect the MRK 1 output of the AWG710B to the H input of the MIU.
- **c.** Connect the /MRK 1 output of the AWG710B to the V input of the MIU.

52. From the VM5000 application menu bar, select Configuration > Operation > Setup And/Or Run > Setup And Run.

53. From the VM5000 application menu bar, click the Run button to take the linearity measurement. It may take a few minutes for the measurement to complete.

54. Connect the AWG710B **CH1** output to **B** input of the MIU with the two 6 dB (2x) attenuators and the min loss pad added as shown in Figure B–12 on page B–40.

55. From the VM5000 application menu bar, select Configuration > Operation > Setup And/Or Run > Run Only.

56. From the TekScope application menu bar, select Vertical > Offset > Select Ch2 > enter 0.350 (Volts) in Offset box.

57. From the TekScope application menu bar, click the **App** software button.

58. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

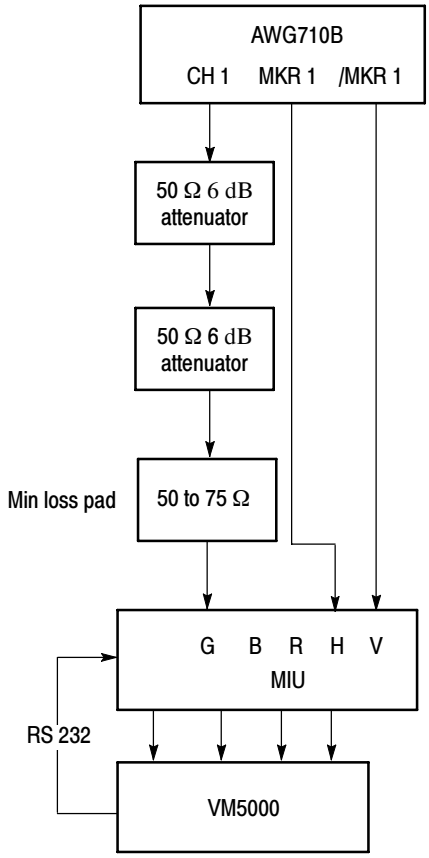


Figure B-12: Setup to perform Linearity measurement

59. Record the results in Table B–25.

60. Check that the results are within the upper and lower limits (Resolution should read 8-bit)**.**

Table B-25: 10-bit Linearity, B Channel, Level 1 of 4

Linearity	Lower limit	B	Upper limit
Resolution (Bits)		8	8
Max INL (LSB)		-5.12	5.12
Max DNL (LSB)		-0.5	0.5
Monotonic (Y/N)		Yes	Yes

61. From the TekScope application menu bar, select Vertical > Offset > Select Ch2 > enter 0.175 (Volts) in Offset box.

62. From the TekScope application menu bar, click the **App** software button.

63. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

64. Record the results in Table B–26.

65. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-26: 10-bit Linearity, B Channel, Level 2 of 4

Linearity	Lower limit	B	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

66. From the TekScope application menu bar, select Vertical > Offset > Select Ch2 > enter 0 (Volts) in Offset box.

67. From the TekScope application menu bar, click the **App** software button.

68. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

69. Record the results in Table B–27.

70. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-27: 10-bit Linearity, B Channel, Level 3 of 4

Linearity	Lower limit	B	Upper limit
Resolution (Bits)	8	8	8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

71. From the TekScope application menu bar, select Vertical > Offset > Select Ch2 > enter -0.175 (Volts) in Offset box.

72. From the VM5000 application menu bar, click the **App** software button.

73. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

74. Record the results in Table B–28.

75. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-28: 10-bit Linearity, B Channel, Level 4 of 4

Linearity	Lower limit	B	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

76. Compute composite resolution: If the Resolution (bits) value in Tables B–25 through B–28 is the same, add 2 to the value and enter this value under "Resolution (Bits)" in Table B–29. If the value for Resolution (bits) is not the same for all tables, the Resolution portion of the performance verification for this channel has failed.

77. Determine maximum INL: find the worst case INL value from Table B–25 to Table B–28 and enter the resulting value, or this value plus the INL value from Table B–12 on page B–28, which ever has the largest absolute value under "Max INL (LSB)" in Table B–29 on page B–42.

78. Determine maximum DNL: find the worst case DNL value from Table B–25 to Table B–28 and enter the resulting value under "Max DNL (LSB)" in Table B–29 on page B–42.

79. Determine monotonicity: enter "Yes" under **Monotonic (Y/N)** if and only if the corresponding values in Table B–25 through Table B–28 are "Yes." Otherwise enter "No" in Table B–28 on page B–42.

80. Check that the results are within the upper and lower limits.

Table B-29: 10-bit Linearity, B Channel, All Levels

Linearity	Lower limit	B	Upper limit
Resolution (Bits)	10		10
Max INL (LSB)	-5.12		5.12

Table B-29: 10-bit Linearity, B Channel, All Levels (Cont.)

Linearity	Lower limit	B	Upper limit
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

10-bit DNL, Monotonicity and Resolution measurement: R Channel. The steps for checking the 10-bit DNL, Monotonicity and Resolution measurement: R Channel are as follows:

81. Make connections as shown in Figure B-11 on page B-31: Setup to perform Transient and Linearity measurements. Use the MIU "R" input instead of "G":

- **a.** Connect the Channel 1 output of the AWG710B to the R input of the MIU (through the 50 Ω to 75 Ω min loss pad).
- **b.** Connect the MRK 1 output of the AWG710B to the H input of the MIU.
- **c.** Connect the /MRK 1 output of the AWG710B to the V input of the MIU.

82. From the VM5000 application menu bar, select Configuration > Operation > Setup And/Or Run > Setup And Run.

83. From the VM5000 application menu bar, click the Run button to take the linearity measurement. It may take a few minutes for the measurement to complete.

84. Connect the AWG710B **CH1** output to the **R** input of the MIU with the two 6 dB attenuators and min loss pad added as shown in Figure B-12 on page B-40.

85. From the VM5000 application menu bar, select Configuration > Operation > Setup And/Or Run > Run Only.

86. From the TekScope application menu bar, select Top menu: Vertical > Offset > Select Ch3 > enter 0.350 (Volts) in Offset box.

87. From the TekScope application menu bar, click the **App** software button.

88. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

89. Record the results in Table B-30.

90. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-30: 10-bit Linearity, R Channel, Level 1 of 4

Linearity	Lower limit	R	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

91. From the TekScope application menu bar, select Vertical > Offset > Select Ch3 > enter 0.175 (Volts) in Offset box.

92. From the TekScope application menu bar, click the **App** software button.

93. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

94. Record the results in Table B–31.

95. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-31: 10-bit Linearity, R Channel, Level 2 of 4

Linearity	Lower limit	R	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

96. From the TekScope application menu bar, select Vertical > Offset > Select Ch3 > enter 0 (Volts) in Offset box.

97. From the TekScope application menu bar, click the **App** software button.

98. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

99. Record the results in Table B–32.

100. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-32: 10-bit Linearity, R Channel, Level 3 of 4

Linearity	Lower limit	R	Upper limit
Resolution (Bits)	8		8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

101. From the TekScope application menu bar, select Vertical > Offset > Select Ch3 > enter -0.175 (Volts) in Offset box.

102. From the TekScope application menu bar, click the **App** software button.

103. From the VM5000 application menu bar, click the Run button to take the linearity measurement.

104. Record the results in Table B-33.

105. Check that the results are within the upper and lower limits (Resolution should read 8-bit).

Table B-33: 10-bit Linearity, R Channel, Level 4 of 4

Linearity	Lower limit	R	Upper limit
Resolution (Bits)	8	8	8
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

106. Compute composite resolution: If the Resolution (bits) value in Tables B-30 through B-33 is the same, add 2 to the value and enter this value under "Resolution (Bits)" in Table B-34. If the value for Resolution (bits) is not the same for all tables, the Resolution portion of the performance verification for this channel has failed.

107. Determine maximum INL: find the worst case INL value from Table B-30 to Table B-33 and enter the resulting value, or this value plus the INL value from Table B-18 on page B-35, whichever has the largest absolute value, under **Max INL (LSB)** in Table B-34 on page B-46.

108. Determine maximum DNL: find the worst case DNL value from Table B-30 to Table B-33 and enter the resulting value under **Max DNL (LSB)** in Table B-34 on page B-46.

109. Determine monotonicity: enter “Yes” in under **Monotonic (Y/N)** if and only if the corresponding values of each of Table B–30 to Table B–33 are “Yes.” Otherwise enter “No” in Table B–34 on page B–46.

110. Check that the results are within the upper and lower limits.

Table B-34: 10-bit Linearity, R Channel, All Levels

Linearity	Lower limit	R	Upper limit
Resolution (Bits)	10		10
Max INL (LSB)	-5.12		5.12
Max DNL (LSB)	-0.5		0.5
Monotonic (Y/N)	Yes		Yes

This completes the VM5000 Option VGA performance verification.

Appendix C: Cleaning

Use these procedures to clean your instrument. If additional cleaning is required, have your instrument serviced by qualified service personnel.

Exterior Cleaning

Clean the exterior surfaces of the chassis with a dry lint-free cloth or a soft-bristle brush. If any dirt remains, use a cloth or swab dipped in a 75% isopropyl alcohol solution. Use a swab to clean narrow spaces around controls and connectors. Do not use abrasive compounds on any part of the chassis.

Clean the On/Standby switch using a dampened cleaning towel. Do not spray or wet the switch directly.



CAUTION. *Do not use chemical cleaning agents that might damage the plastics used in this instrument. Use only deionized water when cleaning the front-panel buttons. Use a 75% isopropyl alcohol solution as a cleaner and rinse with deionized water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.*

To prevent getting moisture inside the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

Flat Panel Display Cleaning

The display is soft plastic and must be treated with care during cleaning.



CAUTION. *Improper cleaning agents or methods can damage the flat panel display.*

Do not use abrasive cleaners or commercial glass cleaners to clean the display surface.

Do not spray liquids directly on the display surface.

Do not scrub the display with excessive force.

Clean the flat panel display surface by gently rubbing the display with a clean-room wipe (such as Wypall Medium Duty Wipes, #05701, available from Kimberly-Clark Corporation).



CAUTION. *To prevent getting moisture inside the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.*

If the display is very dirty, moisten the wipe with distilled water or a 75% isopropyl alcohol solution and gently rub the display surface. Avoid using excess force or you may damage the plastic display surface.

Appendix D: Rebuilding the Hard Drive

If you need to rebuild the hard drive, you must install software from three CDs in the following order:

1. Follow the directions in the CD jewelcase booklet to install the operating system restore CD, 063-3693-XX.
2. Follow the directions in the CD jewelcase booklet to install the TDS5000 product software CD, 063-3692-XX.
3. Install the VM5000 application CD, 063-3768-XX.
4. Follow the online instructions.

   When asked, enter your option key information from the sticker on the back of your instrument.

Appendix E: Signal Sources Package Contents

There are two versions of the Signal Sources package. One version for Option SD/HD and one version for Option VGA. The version for Option SD/HD is described below. The description of the Option VGA version begins on page E–8.

Option SD/HD Signal Source Discs

The Signal Sources package (Option SS in upgrade kits) is a collection of DVDs and CDs that contain Matrix test pattern signal source files in a number of video formats. See page 2–16 for information on the Matrix test pattern. The Signal Sources package can contain one or two kits. One kit contains four CDs. This kit is a standard accessory for Option HD instruments. The second kit contains two DVDs. The second kit is a standard accessory with both Options HD and SD. Table E–1 lists the Signal Source discs.

Table E-1: Signal Sources discs

Title	Tektronix part number	Included with Option
Baseband Test Signals, Version 2.0	063-3794-XX	HD
ATSC Transport Streams, Version 2.0	063-3806-XX	HD
Standard Definition TV Elementary Streams, Version 2.0	063-3819-XX	HD
Advanced TV Elementary Streams, Version 2.0	063-3820-XX	HD
480 Line DVD, Version 2.0	063-3664-XX	SD, HD
576 Line DVD, Version 2.0	063-3665-XX	SD, HD

Table E–2 provides an overview of the test signal formats that can be generated using files located on the Signal Sources discs. The table also lists which TG700 modules are required to generate test signals with the TG700 using the DNL files supplied with the Signal Sources discs.

Table E- 2: Test Signal Files - File and Signal Formats

Test Signal Format	Bitmap File	TG700 DNL				ATSC Trans-port Stream	Compressed MPEG Elementary Stream	DVD
		AVG7	AWVG7	DVG7	HDVG7			
480i/59.94	X	X		X		X	X	X
576i/50	X	X		X			X	X
480p/59.94	X	X		X		X	X	
576p/50	X	X		X			X	
720p/59.94	X		X		X	X	X	
1080i/50	X		X		X		X	
1080i/59.94	X		X		X	X	X	
1080p/24	X		X		X	X	X	

Baseband Test Signals CD

The Baseband Test Signals disc (Tektronix part number 063-3794-XX) contains files for generating baseband test signals. There is one directory:

- The TG700 directory contains setup (.dnl) files for generating Matrix test signals using the Tektronix TG700 TV Signal Generator Platform. Table E–3 lists the analog image format standard .dnl setup files. Table E–4 lists the digital image format standard .dnl setup files.

Table E- 3: TG700 DNL analog signal format files

Image signal format	Field rate	TG700 module	Color space	Signal file name
480 (525 total lines)	59.94	AVG7	RGB	525I59G.DNL
			YP_bP_r	525I59Y.DNL
			RGB	525P59G.DNL
			YP_bP_r	525P59Y.DNL
576 (625 total lines)	50	AVG7	RGB	625i50G.DNL
			YP_bP_r	625i50Y.DNL
			RGB	625p50G.DNL
			YP_bP_r	625p50Y.DNL
720p	50	AWVG7	RGB	720p50G.DNL
			YP_bP_r	720p50Y.DNL
720p	59.94	AWVG7	RGB	720p59G.DNL
			YP_bP_r	720p59Y.DNL

Table E- 3: TG700 DNL analog signal format files (Cont.)

Image signal format	Field rate	TG700 module	Color space	Signal file name
1080i	50	AWVG7	RGB	1080i50G.DNL
			YP_bP_r	1080i50Y.DNL
	59.94	AWVG7	RGB	1080i59G.DNL
			YP_bP_r	1080i59Y.DNL
1080p	24	AWVG7	RGB	1080p24G.DNL
			YP_bP_r	1080p24Y.DNL

Table E- 4: TG700 DNL digital signal format files

Image signal format	Field rate	TG700 module	Color space	Signal file name
720p	50	HDVG7	YP_bP_r	720P50D.DNL
	59.94	HDVG7	YP_bP_r	720P59D.DNL
1080i	50	HDVG7	YP_bP_r	1080I50D.DNL
	59.94	HDVG7	YP_bP_r	1080I59D.DNL
1080p	24	HDVG7	YP_bP_r	1080P24D.DNL

To use the TG700 .dnl setup files, copy the required file or files to a PC. Then use the communication program that came with the TG700 to move the setup files over your network from the PC to the TG700 instrument. Figure E–1 shows a typical test signal setup using the TG700 instrument as the signal source.

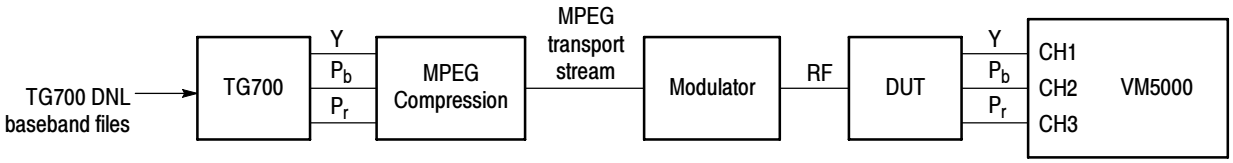


Figure E- 1: Using TG700 baseband test signals

ATSC Transport Stream CD

The ATSC Transport Streams disc (Tektronix part number 063-3806-XX) contains files for playout on an MPEG player (such as the Tektronix MTX100 MPEG Recorder and Player) to generate Matrix pattern compressed ATSC transport stream test signals for 480, 720, and 1080 standards. Table E–5 lists the available image format standard .trp setup files.

Table E- 5: Available MXT100 .trp signal setup files

Image format	Field rate	MTX100 setup file(s)
480i	59.94	M480i4x3A.trp M480i16x9A.trp
480p	59.94	M480p4x3.trp M480p16x9.trp
720p	59.94	M720p59.trp
1080p	24	M1080p24.trp
1080i	59.94	M1080i59.trp

The disc also has WFMS directory that contains .bmp-format screen captures from the Tektronix WFMNLE Software Waveform Monitor, showing individual lines and channels of the Matrix test signal 1 minute video loop, for a particular format.

To use the MTX100 .trp setup files, insert the disc into the MTX00. Refer to the *MTX100 MPEG Recorder and Player User* manual for information on loading instrument setup files. Figure E–2 shows a typical test signal setup using the MTX100 instrument as the signal source.

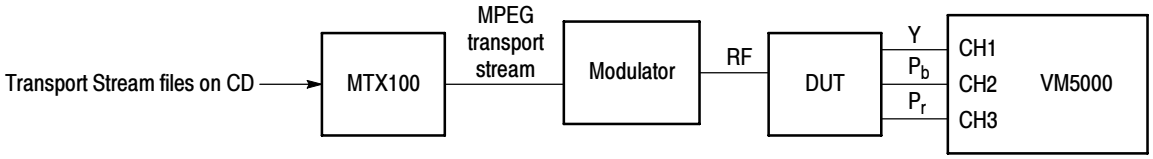


Figure E- 2: Using ATSC transport stream signals

Advanced TV Elementary Streams CD
Standard Definition TV Elementary Streams CD

The Advanced TV Elementary Streams disc (Tektronix part number 063-3820-XX) and the Standard Definition TV Elementary Streams disc (Tektronix part number 063-3819-XX) contain MPEG2-compressed elementary stream files. You use these files with a transport stream multiplexor to build advanced TV or standard definition TV transport streams. Tables E–6 and E–8 list the elementary stream formats. Each disc also contains bitmap images (in BMP format) that you can display on a PC to see what a good signal should look like when displayed on a TV monitor. Tables E–7 and E–9 list the bitmap files. The RGB .bmp files with the XT suffix have been been processed with an anti-alias filter applied to the Pb and Pr portion for 4:2:2 or 4:0:0 representation such as in the .mpg and .trp files. Use the XT files for any compression, for example MPEG2, which requires subsampling of the color difference signals.

Table E-6: Advanced TV Elementary Streams

Image format	Field rate	File	Ratio
720p	50	M720p50.mpg	16:9
	59.94	M720p59.mpg	16:9
1080p	24	M1080p24.mpg	16:9
1080i	50	M1080i50.mpg	16:9
	59.94	M1080i59.mpg	16:9

Table E-7: Advanced TV Bitmaps

Image format	File name
720	M720.BMP
	M720XT.BMP
1080	M1080.BMP
	M1080XT.BMP

Table E-8: Standard Definition TV Elementary Streams

Image format	Field rate	File	Ratio
480i	59.94	M480i4x3A.mpg	4:3
		M480i4x3D.mpg	4:3
		M480i16x9A.mpg	16:9
		M480i16x9D.mpg	16:9
480p	59.94	M480p4x3.mpg	4:3
		M480p16x9.mpg	16:9
576i	59.94	M576i4x3.mpg	4:3
		M576i16x9.mpg	16:9
576p	59.94	M576p4x3.mpg	4:3
		M576p16x9.mpg	16:9

Table E-9: Standard Definition TV Bitmaps

Image format	File name
480	M480.BMP
	M480XT.BMP
576	M576.BMP
	M576XT.BMP

To use the elementary stream files, copy the appropriate files into your transport stream multiplexor. Figure E-3 shows a typical elementary stream test setup.

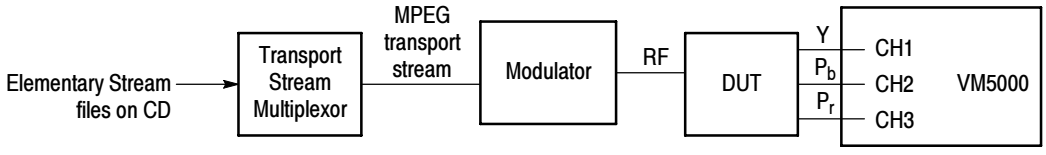


Figure E-3: Using elementary stream signals

480 and 576 Line DVDs

The 480 Line DVD (Tektronix part number 063-3795-XX) and 576 Line DVD (Tektronix part number 063-3795-XX), both generate 60-second Matrix pattern test signals for use with the VM5000 instrument. The DVD files are available in the formats listed in Table E–10.

Table E-10: Available formats of DVD files

DVD	Image format	Field rate	Program/Track	Ratio
480 Line	480i	59.94	1	16:9
			2	4:3
576 Line	576i	50	1	16:9
			2	4:3

To use the DVD, insert the appropriate DVD into the player, then select the appropriate program/track for the ratio. Figure E–4 shows the typical setup for testing DVD players.

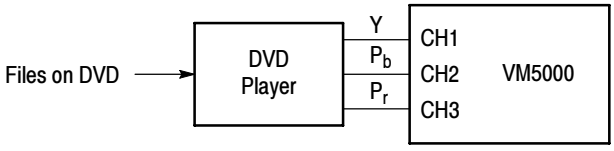


Figure E-4: Using DVD signals

NOTE. *The DVD files are in interlace format. The playback device must be set to progressive mode (480p or 576p) before sending signals to the VM5000 instrument.*

Option VGA Signal Source Disc

The Option VGA Signal Source package consists of one CD that contains Full Field/Matrix test pattern signal source files in BMP format for all the measurements except the 10-bit Linearity measurement which are in PNG format. See page 2–16 for more information on the Matrix test pattern.

PC Bitmap Graphics Test Signal Files CD-ROM

The Test Signals disc (Tektronix part number 020–2634–XX) contains files for generating test signals. The disc contains the following:

- The FullFieldSignals folder that contains a set of test pattern sub-directories to take a measurement. Select the pattern depending on the measurement selected. Once the pattern sub-directory is opened, you can see a list of files in BMP format. Select the file depending on the video format set. You can open the file with Microsoft Paint and display the test pattern in full screen mode (for a single monitor setup) or set as Wallpaper Centered (for a dual–monitor setup).
- The MatrixSignals folder that contains a set of test pattern sub-directories that contain images and takes one or more measurements. Select the pattern depending on the measurement selected. Once the pattern sub-directory is opened, you can see a list of files in BMP format. Select the file depending on the video format set. You can open the file with Microsoft Paint and display the test pattern in full screen mode (for a single monitor setup) or set as Wallpaper Centered (for a dual-monitor setup).

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Read This First

Tektronix

VM5000
Automatic Video Measurement Set
Option VGA

071-1855-00

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071185500

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Contacting Tektronix

Tektronix, Inc.
14200 SW Karl Braun Drive or P.O. Box 500
Beaverton, OR 97077 USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
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Read This First

This following procedure was inadvertently left out of the VM5000 printed user manual (Tek part number 071-1522-02). Future editions of the manual will include this procedure.

Measurement Interface Unit Performance Verification

This performance verification can be used to establish that the RGBHV Measurement Interface Unit (MIU) meets its warranted performance specifications.

Prerequisites

- Before running this procedure, verify that the host VM5000 passes internal system diagnostics (VM5000 Utilities menu).
- Running Signal Path Calibration is not required.
- Both the host VM5000 and the MIU should have a minimum 20 minutes warm-up time.
- Associated test equipment should also be warmed up according to the manufacturer's instructions, prior to making measurements.
- This procedure assumes measurements are conducted at an ambient temperature between 18 °C and 28 °C.

The seven checks below are independent of one another, so if only some specifications are of interest, then only those sections of the procedure need be performed.

Required Equipment

Table 1: Equipment required for performance verification

Description	Quantity required	Minimum requirement	Recommended equipment	Where used
VM5000 with mouse and keyboard	1	Tektronix VM5000, TDS5104x, or TDS5054x oscilloscope (provides power and mode control)	Tektronix VM5000 with 119-6298-XX Mouse and 119-6633-XX Keyboard	All tests
Digital Multimeter	1	At least 5 1/2 digits, with a 4-wire Ohms mode and DC current mode. Ohms accuracy better than 0.02% at 75 Ω, 0.1% at 2200 Ω, and 2% at 15 Ω. DC current accuracy better than 0.1% at 8 mA.	Keithley model 2000	Tests B, C, D, E
Spectrum Analyzer with Tracking Generator	1	50 Ω, minimum frequency range 1-1800 MHz, minimum Reference Level range 0dBm to –65 dBm, 0.3 dB Reference Level accuracy –20 dBm to –60 dBm, 1 dB/div and 10 dB/div display modes, response normalization mode, displayed noise floor less than –120 dBm (100 Hz RBW), minimum RBW range 300 kHz to 3 MHz, marker and center frequency accuracy better than 0.02%. Tracking generator 50 Ω, output level 0 dBm, output flatness +2 dB or better, 1 to 1500 MHz.	Agilent Technologies model E4403B option BTG	Tests F, G, H
Return Loss Bridge	1	75 Ω test port. Minimum directivity 40dB, 1-300 MHz. 50 Ω RF input/output ports (BNC female); 75 Ω test port (BNC male)	Wide Band Engineering Co. models A57TGAC or A57TUC, with options: 75 Ohm conversion, 75 Ω male BNC test port, 50 Ω female BNC RF in/out ports	Test F
75/50 Min-loss pad	2	BNC Male on 75 Ω end, BNC female on 50 Ω end. Attenuation loss 5.7 dB + 0.5 dB 1-1500 MHz. VSWR 1.2:1 or better 1-1500 MHz.	JFW Industries model 75Z-3G-BNC	Test G
6 dB Attenuator	2	50 Ω, through-style with male BNC on one end and female BNC on the other. VSWR 1.20:1 or better, 1-1500 MHz. Insertion loss 6.0 dB + 0.5 dB, 1-1500 MHz.	Tektronix part number 011-0069-03; JFW Industries 50FPG-006-BNC	Tests F, G, H
50 Ω BNC Cable	2	RG-58, male BNC connectors, length 43 inches.	Tektronix part number 012-0057-01	All tests
Type N to BNC adapter	2	50 Ω, Type N male to BNC female	Tektronix part number 103-0045-00; Amphenol 31-216-RFX	Tests F, G, H
75 Ω BNC female/female adapter	1	75 Ω female BNCs each end. VSWR 1.10:1 (26 dB RL) or better, 1-1500 MHz.	Tyco/AMP model 222117-1	Test G

Table 1: Equipment required for performance verification (Cont.)

Description	Quantity required	Minimum requirement	Recommended equipment	Where used
50 Ω BNC female/ female adapter	1	50 Ω, female BNCs each end. VSWR 1.10:1 (26 dB RL) or better, 1-1500 MHz.	Tektronix part number 103-0028-00; Amphenol 31-219-RFX	Tests C, G, H
BNC T adapter	1	50 Ω, 1 male BNC, 2 female BNCs	Tektronix part number 103-0030-00; Amphenol 31-208-RFX	Tests B, C, D, E
BNC female to dual banana adapter	2	Standard (0.750 inch) banana plug spacing	Tektronix part number 103-0090-00; Pomona Electronics model 1269	Tests B, C, D, E
BNC Shorting cap	1	BNC male connector, center conductor connected to shell with less than 0.1 Ω resistance.	Amphenol models 5275 or 31-17	Test C

Table 2: Optional equipment for performance verification

Description	Quantity required	Minimum requirement	Recommended equipment	Where used
Reference 75 Ω load	1	Minimum Return Loss 45 dB, 1-300 MHz, BNC female connector.	Wide Band Engineering Co. model A56T75B/6 with female BNC connector option	Test F
Precision 75 Ω BNC male/male adapter	1	75 Ω, male BNCs each end. VSWR 1.01:1 (45 dB RL) or better, 1-300 MHz.	Wide Band Engineering Co. model A74VA, 75 Ω, male BNCs each end.	Test F

Vendor Contact Information

Vendors for equipment listed above can be contacted at their Web sites.

- Agilent Technologies – www.agilent.com
- Amphenol – www.amphenolrf.com
- JFW Industries, Inc. – www.jfwindustries.com
- Keithley Instruments – www.keithley.com
- Pomona Electronics, Inc. – www.pomonaelectronics.com
- Tektronix, Inc. – www.tektronix.com
- Tyco/AMP – www.tycoelectronics.com
- Wide Band Engineering Co. – www.wbecoinc.com

Test A: Initial Connection and Setup

1. With the VM5000 Power off, connect all five MIU coaxial cables to the host VM5000. Use the labels on the MIU as a guide. Connect the RS232 cable between the MIU and COM1 port on the VM5000. Attach a keyboard and mouse to the VM5000. Turn on the VM5000. The MIU Power ON led should be lit and the MIU Fault LED should be off. If the Fault indicator is lit, check that all of the coaxial cables have been properly connected.

2. Open Hyperterminal on the VM5000. If an "MIU – Hyperterminal" session was previously established and saved, open it. If not, establish a session as follows:

   a. Minimize open programs, such as the oscilloscope application and the VM5000 application, so that the Windows desktop is visible.

   b. Open the terminal emulation program Hyperterminal. Hyperterminal is typically located under Start>Programs>Accessories>Communications>Hyperterminal.

   c. When Hyperterminal is first opened, a pop-up window Connection Description will open. Under name, enter MIU, and then click OK.

   d. A Connect To window will open. Under Connect using, select COM1, and click OK.

   e. A COM1 Properties window will open. Set the Port Settings as follows:

      - Bits per second=9600
      - Data bits=8
      - parity=None
      - Stop bits=1
      - Flow Control=None

   After changing the settings, click OK.

3. The Hyperterminal window should be open, as connection MIU. Select File>Properties. The MIU Properties window will appear. Select the Settings tab, followed by clicking the ASCII Setup button. Select Echo typed characters locally and Send line ends with line feeds. Click OK to close the ASCII Setup window, and then click OK to close the MIU Properties window.

4. From the keyboard, type $ID? The MIU should identify itself, returning a response similar to id=miu_v1.0. If there is no response, double check all electrical connections and the Hyperterminal settings described above.

***NOTE**. If typed keyboard characters appear in duplicate (for example. $$IIDD??), the MIU echo is on. Turn the echo off by typing $ECHO=OFF.*

5. If the terminal appears to operate properly, save the configuration by selecting File>Save in the Hyperterminal window. For convenience, place a shortcut on the Windows desktop, as this terminal connection will be used throughout this Performance Verification procedure.

Test B: RGB LF Mode DC Termination Accuracy

This test verifies the accuracy of the internal 75 Ω terminations connected to the G, B, and R inputs when the RGB LF path is active. The specification for all three terminations is 75 Ω ±0.3%.

The following equipment is required for the test:

- Host VM5000 with mouse and keyboard
- Digital Multimeter
- 50 Ω BNC cable (Qty 2)
- BNC "T" adapter (Qty 1)
- BNC female-to-dual banana adapter (Qty 2)

1. Connect the MIU to the VM5000, apply power, and establish communications using Hyperterminal as described in Test A of this procedure.
2. Check that the green LED in the RGB LF Path is illuminated. If not, using Hyperterminal, send the command $LOAD=0000000 to the MIU. Verify that the LED in the RGB LF Path is now illuminated.

***NOTE**. The V channel and H/V LF Path LEDs will also be illuminated.*

3. On the VM5000 front panel, under VERTICAL, select 1 MΩ for CH1, CH2, and CH3.
4. Connect the two BNC-to-banana adapters to the Multimeter: one to the Ohms input, the other to the Ohms Sense input. Orient the adapters so the BNC shell is connected to the LO terminal of each input (on typical adapters, the banana plug connected to the BNC shell has a GND label).
5. Connect a BNC cable to each BNC-to-banana adapter. Connect the other end of each cable to the BNC "T" adapter. This connects Ohms input and Ohms Sense input in parallel, at the BNC "T" adapter.
6. On the multimeter, select 4-wire Ohms mode and 100 Ohms range.

7. Connect the BNC “T” adapter to the G input BNC on the MIU.
8. CHECK – that the Multimeter reads between 74.840 and 75.160 Ω.
9. Connect the BNC “T” adapter to the B input BNC on the MIU.
10. CHECK – that the Multimeter reads between 74.840 and 75.160 Ω.
11. Connect the BNC “T” adapter to the R input BNC on the MIU.
12. CHECK – that the Multimeter reads between 74.840 and 75.160 Ω.
13. Disconnect the BNC “T” adapter from the R input BNC.

Test C: RGB LF Mode and HV LF Mode DC Gain

This test checks the gain error of the G, B, and R channels when the RGB LF Path is active, and of the H and V channels when the HV LF Path is active. The specification for all five channels is 1.0 ± 0.002% (20ppm) when driven from a 0 Ω source and with a 1 MΩ load (provided by the VM5000).

The following equipment is required for the test:

- Host VM5000, with mouse and keyboard
- Digital Multimeter
- BNC female-to-dual banana adapter (Qty 2)
- 50 Ω BNC cable (Qty 2)
- 50 Ω BNC female/female adapter (Qty 1)
- BNC “T” adapter (Qty 1)
- BNC shorting cap (Qty 1)

1. Connect the MIU to the VM5000, apply power, and establish communications using Hyperterminal as described in Test A of this procedure.
2. Connect the two BNC-to-banana adapters to the Multimeter: one to the Ohms input, the other to the Ohms Sense input. Orient the adapters so the BNC shell is connected to the “LO” terminal of each input (note: on typical adapters, the banana plug connected to the BNC shell has a “GND” label).
3. Connect a BNC cable to each BNC-to-banana adapter. Connect the other end of each cable to the BNC “T” adapter. This connects Ohms input and Ohms Sense input in parallel, at the BNC “T” adapter.
4. On the Multimeter, select 4-wire Ohms mode and 100 Ohms range.
5. Connect the BNC “T” adapter to the G input BNC on the MIU.

6. Connect the BNC shorting cap to one end of the BNC female/female adapter. Disconnect the MIU CH1 coaxial cable from the VM5000.

   Note that the MIU Fault LED is now illuminated. This is normal, indicating that the CH1 coaxial cable has been disconnected from the VM5000. Connect the MIU CH1 coaxial cable to the open end of the BNC female/female adapter with shorting cap. To do this, the latching ring must be rotated to the full CW position, as viewed from the pin-side of the connector. Carefully insert the BNC adapter, noting the location of the slots for the BNC "ears". This connection shorts the center conductor to the shield so that the series resistance through the MIU can be measured.

7. Check if the green LED in the RGB LF Path is illuminated. If not, using Hyperterminal, send the command $LOAD=0000000 to the MIU. Verify that the LED in the RGB LF Path is now illuminated.

***NOTE**. The V channel and H/V LF Path LEDs will also be illuminated.*

8. CHECK – that the Multimeter reads less than 15.0 Ω.

***NOTE**. The multimeter will typically read between 10 Ω and 11 Ω. If the reading is around 75 Ω, check that the BNC short is fully inserted into the MIU CH1 coaxial cable BNC and that the RGB LF Path LED is illuminated.*

9. Remove the BNC short and reconnect the MIU CH1 coaxial cable to the VM5000 CH1 input.

10. Connect the BNC "T" adapter to the B input BNC on the MIU.

11. Disconnect the MIU CH2 coaxial cable from the VM5000, and connect the BNC short to the cable end, as described in step 6.

12. Check that the green LED in the RGB LF Path is still illuminated. If not, using Hyperterminal, send the command $LOAD=0000000 to the MIU. Verify that the LED in the RGB LF Path is now illuminated.

***NOTE**. The V channel and H/V LF Path LEDs will also be illuminated.*

13. CHECK – that the Multimeter reads less than 15.0 Ω.

***NOTE**. The multimeter will typically read between 10 Ω and 11 Ω. If the reading is around 75 Ω, check that the BNC short is fully inserted into the MIU CH2 coaxial cable BNC and that the RGB LF Path LED is illuminated.*

14. Remove the BNC short and reconnect the MIU CH2 coaxial cable to the VM5000 CH2 input.

15. Connect the BNC "T" adapter to the R input BNC on the MIU.

16. Disconnect the MIU CH3 coaxial cable from the VM5000 and connect the BNC short to the cable end, just as was done for CH1 (and described in step 6 above).

17. Check that the green LED in the RGB LF Path is still illuminated. If not, using Hyperterminal, send the command $LOAD=0000000 to the MIU. Verify that the LED in the RGB LF Path is now illuminated.

***NOTE**. The V channel and H/V LF Path LEDs will also be illuminated.*

---

18. CHECK – that the Multimeter reads less than 15.0Ω.

***NOTE**. The multimeter will typically read between 10 Ω and 11 Ω. If the reading is around 75Ω, check that the BNC short is fully inserted into the MIU CH3 coaxial cable BNC and that the RGB LF Path LED is illuminated.*

---

19. Remove the BNC short and reconnect the MIU CH3 coaxial cable to the VM5000 CH3 input.

20. Connect the BNC "T" adapter to the V input BNC on the MIU.

21. Disconnect the MIU CH4 coaxial cable from the VM5000 and connect the BNC short to the cable end, just as was done for CH1 (and described in step 6 above). All of the LEDs on the MIU will be extinguished, but the MIU is still powered for the H and V channel measurements.

22. Using Hyperterminal, send the command $LOAD=0000000 to the MIU. No LEDs will be illuminated, but the V channel and HV LF Path are now selected.

23. CHECK – that the Multimeter reads less than 19.0 Ω.

***NOTE**. The multimeter will typically read between 10 Ω and 11 Ω. If the reading is >100 Ω, check that the BNC short is fully inserted into the MIU CH4 coaxial cable BNC. If the >100 Ω reading persists, check that the MIU is in the proper mode by sending the query (via Hyperterminal) $LOAD?. You should receive a reply load=0000000.*

---

24. Connect the BNC "T" adapter to the H input BNC on the MIU.

25. Using Hyperterminal, send the command $LOAD=0010000 to the MIU. No LEDs will be illuminated, but the H channel and HV LF Path are now selected.

26. CHECK – that the Multimeter reads less than 19.0 Ω.

***NOTE**. The multimeter will typically read between 10 Ω and 11 Ω. If the reading is >100 Ω, check that the BNC short is fully inserted into the MIU CH4 coaxial cable BNC. If the >100 Ω reading persists, check that the MIU is in the proper mode by sending the query (via Hyperterminal) $LOAD?. You should receive a reply load=0010000.*

---

27. Remove the BNC short and reconnect the MIU CH4 coaxial cable to the VM5000 CH4 input.

28. Disconnect the BNC "T" adapter from the H input BNC.

The above check evaluates gain error by measuring the MIU series resistance that forms a voltage divider with the 1 MΩ input resistance of the VM5000. The 15.0 Ω (G,B,R inputs) and 19.0 Ω (H,V inputs) test limits ensure that the gain error does not exceed ±20 ppm. If desired, the exact gain error can be calculated from the measured resistance *Rm* using the expressions:

G,B,R channels:

$$GainError(ppm) = \left\{ \frac{-(75.0)(Rm)}{\{(1.0E06)(75.0 - Rm) + (75.0)(Rm)\}} \right\} + (1.0E06),\ Rm\ in\ \Omega$$

H,V channels:

$$GainError(ppm) = \left\{ \frac{-(Rm)}{\{(1.0E06) + (Rm)\}} \right\} + (1.0E06),\ Rm\ in\ \Omega$$

Test D: HV Input LF Mode DC Termination Accuracy and WB Mode DC Input Impedance

This test checks the accuracy of the 2.20 kΩ termination that can be switched on in the HV LF Path (Term On LED) and the DC input impedance of the HV WB Path. The specification for the LF Path termination is 2.20 kΩ ± 1.5%. The specification for the WB path DC input impedance is 2.20 kΩ ± 3.0%.

The following equipment is required for the test:

- Host VM5000 with mouse and keyboard
- Digital Multimeter
- 50 Ω BNC cable (Qty 2)
- BNC "T" adapter (Qty 1)
- BNC female-to-dual banana adapter (Qty 2)

1. Connect the MIU to the VM5000, apply power, and establish communications using Hyperterminal as described in Test A of this procedure.
2. Using Hyperterminal, send the command $LOAD=0011000 to the MIU. Verify that the H channel, HV LF Path, and Term On LEDs are illuminated. The + 8mA and –8 mA LEDs must be off.
3. On the VM5000 front panel, under VERTICAL, select 1 MΩ for CH4.
4. Connect the two BNC-to-banana adapters to the multimeter: one to the Ohms input, the other to the Ohms Sense input. Orient the adapters so the BNC shell is connected to the "LO" terminal of each input (note: on typical adapters, the banana plug connected to the BNC shell has a "GND" label).
5. Connect a BNC cable to each BNC-to-banana adapter. Connect the other end of each cable to the BNC "T" adapter. This connects Ohms input and Ohms Sense input in parallel, at the BNC "T" adapter.
6. On the multimeter, select 4-wire Ohms mode and 10 kOhms range.
7. Connect the BNC "T" adapter to the H input BNC on the MIU.
8. CHECK – that the multimeter reads between 2175 Ω and 2225 Ω.
9. Using Hyperterminal, send the command $LOAD=0110000 to the MIU. Verify that the H channel and HV WB Path LEDs are illuminated, and that the +8 mA, –8 mA, and Term On LEDs are off.

10. On the VM5000 front panel, under VERTICAL, select 50 Ω for CH4.
11. CHECK – that the Multimeter reads between 2142 Ω and 2258 Ω.
12. Disconnect the BNC "T" adapter from the H input BNC.

Test E: HV Input LF Mode Current Sources

This test checks the accuracy of the + 8mA and –8 mA current sources. The specification is 8 mA ± 2.5% and –8 mA ± 2.5%.

The following equipment is required for the test:

- Host VM5000 with mouse and keyboard
- Digital Multimeter
- 50 Ω BNC cable (Qty 1)
- BNC female-to-dual banana adapter (Qty 1)

1. Connect the MIU to the VM5000, apply power, and establish communications using Hyperterminal as described in Test A of this procedure.
2. On the VM5000 front panel, under VERTICAL, select 1 MΩ for CH4.
3. Using Hyperterminal, send the command $LOAD=0010101 to the MIU. Verify that the H channel, HV LF Path, and +8mA LEDs are illuminated. The Term On and -8 mA LEDs must be off.
4. Connect the BNC-to-banana adapter to the Amps input of the multimeter. Orient the adapter so the BNC shell is connected to the "LO" terminal of the Amps input (on typical adapters, the banana plug connected to the BNC shell has a "GND" label).
5. Connect one end of the BNC cable to the BNC-to-banana adapter.
6. On the multimeter, select DC Amps mode and 10 mA range.
7. Connect the other end of the BNC cable to the H input BNC on the MIU.
8. CHECK – that the multimeter reads between 7.85 and 8.15 mA.
9. Using Hyperterminal, send the command $LOAD=0010011 to the MIU. Verify that the H channel, HV LF Path, and -8mA LEDs are now illuminated. The Term On and +8 mA LEDs must be off.
10. CHECK – that the Multimeter reads between -7.85 and -8.15 mA.
11. Using Hyperterminal, send the command $RESET to the MIU.
12. Disconnect the BNC cable from the H input BNC.

Test F: RGB WB Mode Input Return Loss

This test checks the Input Return Loss of the 75 Ω G, B, and R inputs when the RGB WB Path is active. The specification is >27 dB from 1 MHz to 100 MHz, and >21 dB from 100 MHz to 250 MHz.

The following equipment is required for the test:

- Host VM5000 with mouse and keyboard
- Spectrum Analyzer with Tracking Generator
- Return Loss Bridge
- 6 dB Attenuator (Qty 2)
- 50 Ω BNC cable (Qty 2)
- Type N to BNC adapter (Qty 2)

Equipment for optional checks (steps 11 – 14):

- Reference 75 Ω load
- 75 Ω BNC female/female adapter
- Precision 75 Ω BNC male-male adapter

1. Connect the MIU to the VM5000, apply power, and establish communications using Hyperterminal as described in Test A of this procedure.
2. Using Hyperterminal, send the command $LOAD=1000000 to the MIU. Verify that the RGB WB Path LED is illuminated.
3. On the VM5000 front panel, under VERTICAL, select 50 Ω for CH1, CH2, and CH3.
4. Connect a Type N to BNC adapter, followed by a 6 dB attenuator, to the tracking generator output. Connect the other end of the attenuator to the Return Loss bridge RF IN, using a 50 Ω BNC cable. Connect a second Type N to BNC adapter and 6 dB attenuator to the spectrum analyzer input, and connect the other end of this attenuator to the bridge RF OUT using a second 50 Ω BNC cable. Leave the bridge test port open.

5. Set the spectrum analyzer so that the analyzer noise floor (display with no RF signal applied to the analyzer input) is at least 40 dB below signal level produced by the bridge when the test port is open (0 dB RL), over the range of 1 MHz to 250 MHz. The analyzer settings may vary with the specific spectrum analyzer and bridge used, but the following settings should be usable with many analyzer/bridge combinations:

   - Tracking Generator output level = 0 dBm
   - Spectrum Analyzer Reference Level = –20 dBm
   - Vertical scale = 10 dB/div (10 div display)
   - Horizontal scale (Span) = 50 MHz/div (10 div display)
   - Center Frequency = 250 MHz (10 div display)
   - Resolution BW (RBW) = 3 MHz

6. A signal display should appear approximately 0.5 divisions below the analyzer Reference Level mark. This is the Return Loss of the bridge with the test port open, nominally 0dB. The display will typically have some vertical ripples across the 500 MHz span, due to amplitude flatness errors in the tracking generator. Disconnect the BNC cable from the analyzer input, and check that the signal display moves down at least 4 divisions (40dB). If it doesn't, check that all of the analyzer attenuators are set to their minimum value, and/or decrease the RBW setting. Reconnect the BNC cable.

7. Record the signal amplitudes at the 100 MHz and 250 MHz points in Table 3, row R1. These are the 0dB return loss reference values. They will be approximately –24 dBm with the typical bridge. Many analyzers have markers that readout the frequency and amplitude of the marker position which makes this task easier and more precise. Alternately, the Reference Level can be slightly adjusted until the signal display aligns with a convenient graticule mark (most analyzers have a fine Reference Level adjustment mode).

8. Connect the bridge to the G input of the MIU. If the recommended bridge is used, it will have a male BNC, allowing direct connection to the MIU BNCs. Record the signal amplitudes at 100 MHz and 250 MHz in Table 3, row R2. Calculate the Return Loss using the expression:

   $$\textit{Return Loss}\ (dB) = (0dB\ \textit{RL reference value}\ (dBm)) - (\textit{MIU input value}\ (dBm))$$

   Record this value in Table 3, row R3.

***NOTE**. Increasing return loss means less reflected power, so the display on the analyzer will move in the direction of increasing dB loss, toward the bottom of the display screen.*

***NOTE**. If a bridge with a female BNC test port is used, then some type of cable or adapter will be required to connect the bridge to the MIU input BNCs. If the adapter is not truly 75 Ω at the test frequencies, it will severely impact the Return Loss measurement. See Optional steps 11 to 14 below.*

Table 3: Input return loss worksheet

	100 MHz			250 MHz		
	G input	**B input**	**R input**	**G input**	**B input**	**R input**
R1 -- 0 dB RL reference value (bridge test port open) (dBm)						
R2 -- MIU input value (bridge test port connected to MIU input) (dBm)						
R3 -- MIU input return loss (dB) R3 = R1 - R2)						

9. CHECK – that the Return Loss (Table 3, row R3) is greater than 27.7 dB at 100 MHz and 21.7 dB at 250 MHz.

Example With the bridge test port open, the analyzer measures –23.4 dBm at 100 MHz and –24.5 dBm at 250 MHz. With the bridge connected to the MIU G input, the analyzer measures -58.0 dBm at 100 MHz and –51.3 dBm at 250 MHz. The MIU G channel 100 MHz return loss is (-23.4) - (-58.0) = 34.6 dB. The 250 MHz return loss is (-24.5) - (-51.3) = 26.8 dB.

***NOTE**. The most exact way to measure these signal level differences is to align the 0 dB return loss signal display (test port open) to a specific location on the graticule, using the Reference Level control. Note the Reference Level reading. Then connect the test port to the MIU, and adjust the Reference Level control until the new signal display is aligned with the same point on the graticule. The difference between the two Reference Level readings is the Return Loss. This method avoids any linearity errors in the analyzer's log display system.*

10. Repeat steps 8 and 9 for the Blue and Red inputs.

Optional Checks to Verify Return Loss Bridge Performance

Return Loss measurements can be severely degraded by bridge calibration errors, bridge port mismatch, and small impedance errors at the test port. The following checks can help verify that the measurement system is working properly. These checks require a Reference 75 Ω Load. The 75 Ω BNC female/female adapter and the Precision 75 Ω BNC male/male adapter may also be needed.

11. Connect the bridge as described in step 4. If any adapters or cables are normally used between the bridge test port and the MIU input BNCs, connect them to the test port, leaving the other side open. Note the analyzer signal level. This is the 0 dB Return Loss value.

12. Now attach the Reference 75 Ω load. It is important that this load have a female BNC. If the load has a male BNC, then adapt it with the 75 Ω BNC female/female adapter. Check that the analyzer signal level has decreased from the 0 dB Return Loss value by at least 37 dB at 100 MHz and by at least 31 dB at 250 MHz. If these Return Loss values are achieved, then the test setup is OK.

13. If Return Loss does not exceed 37 dB at 100 MHz and 31 dB at 250 MHz, first check the analyzer signal to noise floor. Momentarily disconnect the coaxial cable from the analyzer input and check that the display drops at least 10 dB. If the drop is less than 10 dB, try decreasing the analyzer RBW setting. If the signal to noise floor is at least 10 dB, then the problem is either with the bridge or with the adapters/cables used on the 75 Ω test port.

14. If adapters or cables are used on the bridge test port, remove them and connect the Reference 75 Ω load directly to the test port. If the test port is a female BNC, then use the Precision 75 Ω BNC male/male adapter between the test port and the Reference 75 Ω load. Again check the Return Loss. If values of at least 37 dB at 100 MHz and 31 dB at 250 MHz are now achieved, the problem is with the adapters/cables being used on the test port. If these values are not achieved, then the problem is likely in the bridge.

Test G: RGB WB Mode Bandwidth

This test checks the bandwidth of the G, B, and R inputs when the RGB WB Path is active. The specification is less than 3 dB down at 1500 MHz.

The following equipment is required for the test:

- Host VM5000 with mouse and keyboard
- Spectrum Analyzer with Tracking Generator
- 75/50 Min-loss Pad (Qty 2)
- 6 dB Attenuator (Qty 2)
- 50 Ω BNC cable (Qty 2)

- Type N to BNC adapter (Qty 2)
- 75 Ω BNC female/female adapter
- 50 Ω BNC female/female adapter

1. Connect the MIU to the VM5000, apply power, and establish communications using Hyperterminal as described in Test A of this procedure.
2. Check that the MIU RGB WB Path LED is lit. If not, using Hyperterminal, send the command $LOAD=1000000 to the MIU. Verify that the RGB WB Path LED is illuminated.
3. On the VM5000 front panel, under VERTICAL, select 50 Ω for CH1, CH2, and CH3.
4. Set the tracking generator and spectrum analyzer controls as follows:
   - Tracking Generator output level = 0 dBm
   - Spectrum Analyzer Vertical scale = 1 dB/div
   - Spectrum Analyzer Reference Level = -10 dBm
   - Horizontal scale (Span) = Max Span (or 200 MHz/div if available)
   - Center Frequency = 900-1000 MHz (10 div display)
   - Resolution BW (RBW) = 3 MHz
5. Connect a Type N to BNC adapter, followed by a 6 dB attenuator, to the tracking generator output. Connect a 50 Ω BNC cable to the other end of the attenuator. Connect a second Type N to BNC adapter and 6 dB attenuator to the spectrum analyzer input, and connect the other end of this attenuator to a second 50 Ω BNC cable. Connect the two cables together with a 50 Ω BNC female/female adapter.
6. Adjust the analyzer Reference Level control until the displayed signal is entirely on screen over the frequency range 1 MHz to 1800 MHz.
7. Using the analyzer Display memory, store the swept display. Activate the "active display minus stored display" mode (sometimes called "B minus Save A"). A straight line display, with less than 0.2 dB ripple, should appear, typically at mid-screen. This is the frequency response with the flatness errors of the tracking generator, attenuators, spectrum analyzer, and cables normalized out.
8. Connect two 75/50 min-loss pads together, using a 75 Ω BNC female/female adapter. Insert this connection in place of the 50 Ω BNC female/female adapter. Decrease the analyzer Reference Level by 11 dB, so that the frequency response of the series connected min-loss pads can be observed. Measure the response at 1500 MHz, relative to 1 MHz, and record this value

in Table 4, column C1. Divide this value by 2 and enter it in column C2. The value in column C2 is the average 1500 MHz response for the two pads.

***NOTE**. The display will typically have some amplitude ripple. Estimate the midpoint of the ripple and use this as the measurement point. Typical 1500 MHz loss for a series-connected pair of good-quality matching pads will be less than 1 dB.*

Table 4: RGB WB mode bandwidth worksheet

	C1 – series connected min-loss pad ("A"+"B") 1500 MHz response (dB)	C2 – Average 1500 MHz response of single min-loss pad (dB)	C3 – MIU 1500 MHz response with min-loss pad "A" (dB)	C4 – MIU 1500 MHz response with min-loss pad "B" (dB)	C5 – Average MIU 1500 MHz response (dB)	C6 – Corrected MIU 1500 MHz response
G CH						
B CH						
R CH						
Equations		C2=(C1)/2			C5=(C3+C4)/2	C6=C5-C2

9. Disconnect the 50 Ω cables from the series-connected min-loss pads. Separate the two min-loss pads. Connect one of the min-loss pads (male end) to the MIU G input BNC. Connect the other (female) end of the pad to the cable coming from the 6 dB attenuator and tracking generator output. Attach a 50 Ω BNC female/female adapter to the open end of the cable going to the 6 dB attenuator on the analyzer input. Disconnect the MIU CH1 cable from the VM5000. Attach this cable to open end of the BNC female/female adapter. To do this, the latching ring must be rotated to the full clockwise position, as viewed from the pin-side of the probe housing. Then carefully insert the BNC adapter, noting the location of the slots for the BNC "ears".

***NOTE**. Take care not to short the probe housing pins to the BNC adapter shell while inserting it. Momentarily shorted pins will not damage the MIU but can cause it to change operating mode.*

10. Decrease the analyzer Reference Level an additional 13dB from the level of step 8. (a total of 24 dB from the Reference Level of step 6). The frequency response of the MIU G channel should be visible.

***NOTE**. Take care in identifying the correct signal trace. On many analyzers two traces, the H channel frequency response with and without normalization, will be visible. The proper signal trace is the one that is closest to the the position of the normalized display of step 6.*

11. Measure the loss difference between low frequency (far left side of trace) and that at 1500 MHz. The measurement method will vary with analyzer model. Many analyzers have amplitude cursor modes to simplify this type of measurement. Usually the most accurate way to make this measurement (and the method to use for an analyzer without amplitude cursor modes) is to vary the analyzer Reference Level:

a. Using the fine Reference Level adjust, position the left side of the signal trace to a convenient reference line (such as a graticule line or marker).

b. Note the Reference Level reading and then adjust the Reference Level control until the signal trace at 1500 MHz aligns with the same reference line. The difference between the two Reference Level settings is the 1500 MHz response relative to the low frequency response.

c. Record this value in Table 4, column C3.

Example: The left side of trace (low frequency end) is vertically positioned, using the fine Reference Level control, so that it overlays the center graticule line. The Reference Level reads –34.0 dBm. Then the Reference Level control is decreased until the 1500 MHz portion of the trace overlays the same graticule line. The Reference Level now reads –35.5 dBm. The response at 1500 MHz, relative to low frequency, is (–35.5) – (–34.0) = –1.5 dB.

12. Replace the min-loss pad connected to the G input with the other min-loss pad. With this pad in the signal path, measure the uncorrected G channel 1500 MHz response using the procedure of step 11. Record this value in Table 4, column C4.

13. Add the values of column C3 and C4. Divide this value by 2 and enter it in column C5. This is the average uncorrected G channel 1500 MHz response. Now subtract the average min-loss pad 1500 MHz response (column C2) from the average uncorrected G channel 1500 MHz response (column C5) and enter the result in column C6. This is the G channel response at 1500 MHz.

14. CHECK – that the G channel response at 1500 MHz is less than 3.0 dB down.

15. Disconnect the MIU CH1 coaxial cable from the BNC female/female adapter, and reconnect it the VM5000 CH1 input. Disconnect the MIU CH2 cable from the VM5000. Attach this cable to open end of the BNC female/female adapter. Move the min-loss pad and cable currently connected to the

MIU G input BNC to the B input BNC. The frequency response of the MIU B channel should be visible.

16. Repeat steps 11–13 for the B channel.
17. CHECK – that the B channel response at 1500 MHz is less than 3.0 dB down.
18. Disconnect the MIU CH2 coaxial cable from the BNC female/female adapter, and reconnect it the VM5000 CH2 input. Now disconnect the MIU CH3 cable from the VM5000. Attach this cable to open end of the BNC female/female adapter. Move the min-loss pad and cable currently connected to the MIU B input BNC to the R input BNC. The frequency response of the MIU R channel should be visible.
19. Repeat steps 11–13 for the R channel.
20. CHECK – that the R channel response at 1500 MHz is less than 3.0 dB down.
21. Disconnect the MIU CH3 coaxial cable from the BNC female/female adapter, and reconnect it the VM5000 CH3 input.

Example Table 4 Calculations

The series connected min-loss pads measure –0.6 dB at 1500 MHz. The MIU G channel measures –1.6 dB at 1500 MHz with one min-loss pad, and –1.4 dB at 1500 MHz with the second min-loss pad. The corrected G channel 1500 MHz response is calculated to be –1.2 dB (column C6). See Table 5.

Table 5: Sample Table 4 worksheet

	C1 – series connected min-loss pad (“A”+”B”) 1500 MHz response (dB)	C2 – Average 1500 MHz response of single min-loss pad (dB)	C3 – MIU 1500 MHz response with min-loss pad “A” (dB)	C4 – MIU 1500 MHz response with min-loss pad “B” (dB)	C5 – Average MIU 1500 MHz response (dB)	C6 – Corrected MIU 1500 MHz response
G CH	-0.6dB	-0.3dB	-1.6dB	-1.4dB	-1.5dB	-1.2dB
B CH						
R CH						
Equations		C2=(C1)/2			C5=(C3+C4)/2	C6=C5-C2

Test H: H/V Inputs WB Mode Bandwidth

This test checks the bandwidth of the H and V inputs when the HV WB Path is active. The specification is less than 3dB down at 320 MHz.

The following equipment is required for the test:

- Host VM5000 with mouse and keyboard
- Spectrum Analyzer with Tracking Generator
- 50 Ω 6 dB Attenuator (Qty 2)
- 50 Ω BNC cable (Qty 2)
- Type N to BNC adapter (Qty 2)
- 50 Ω BNC female/female adapter

1. Connect the MIU to the VM5000, apply power, and establish communications using Hyperterminal as described in Test A of this procedure.
2. Using Hyperterminal, send the command $LOAD=0110000 to the MIU. Verify that the H input and HV WB Path LEDs are illuminated.
3. Set the tracking generator and spectrum analyzer controls as follows:
   - Tracking Generator output level = 0 dBm
   - Spectrum Analyzer Vertical scale = 1 dB/div
   - Spectrum Analyzer Reference Level = -6 dBm
   - Horizontal scale (Span) = 50 MHz/div
   - Center Frequency = 250 MHz (10 div display)
   - Resolution BW (RBW) = 3 MHz
4. Connect a Type N to BNC adapter, followed by a 6 dB attenuator, to the tracking generator output. Connect a 50 Ω BNC cable to the other end of the attenuator. Connect a second Type N to BNC adapter and 6 dB attenuator to the spectrum analyzer input, and connect the other end of this attenuator to a second 50 Ω BNC cable. Connect the two cables together with a 50 Ω BNC female/female adapter.
5. Adjust the analyzer Reference Level control until the displayed signal is entirely on screen over the frequency range 1 MHz to 500 MHz.
6. Using the analyzer Display memory, store the swept display. Activate the “active display minus stored display” mode (sometimes called “B minus Save A”). A straight line display, with less than 0.2 dB ripple, should appear, typically at mid-screen. This is the frequency response with the flatness errors of the tracking generator, attenuators, spectrum analyzer, and cables normalized out.
7. Disconnect the two 50 Ω cables at the BNC female/female adapter. Keep the female/female adapter connected to the cable going to the analyzer input.

8. Disconnect the MIU CH4 coaxial cable from the VM5000. All of the MIU LEDs, including Power, will extinguish, but the MIU is still receiving power to conduct this test. Connect the MIU CH4 coaxial cable to the cable coming from the analyzer input, using the BNC female/female adapter. To do this, the latching ring must be rotated to the full clockwise position, as viewed from the pin-side of the probe housing. Then carefully insert the BNC adapter, noting the location of the slots for the BNC "ears".

***NOTE**. Take care not to short the probe housing pins to the BNC adapter shell while inserting it. Momentarily shorted pins will not damage the MIU, but can cause it to change operating mode.*

9. Connect the cable coming from the tracking generator and 6 dB attenuator to the MIU H input BNC.

10. Using Hyperterminal, send the query $LOAD? to the MIU. Verify that you receive the response: load=0110000. This checks that the MIU operating mode did not change as a result of disconnecting the CH4 coaxial cable.

***NOTE**. If the string is not correct, send the command $LOAD=0110000 to the MIU.*

11. Decrease the analyzer Reference Level by 34dB from the Reference Level selected in step 5. For example, if the Reference Level is –6 dBm, then decrease it to –40 dBm. The frequency response of the H channel should be visible in approximately the same position as was the normalized display of step 6.

***NOTE**. Take care in identifying the correct signal trace. On many analyzers two traces, the H channel frequency response with and without normalization, will be visible. The proper signal trace is the one that is closest to the position of the normalized display of step 6.*

12. Measure the loss difference between low frequency (far left side of trace) and that at 320 MHz. The measurement method will vary with analyzer model. Many analyzers have amplitude cursor modes to simplify this type of measurement. Usually the most accurate way to make this measurement (and the method to use for an analyzer without amplitude cursor modes) is to vary the analyzer Reference Level:

    a. Using the fine Reference Level adjust, position the left side of the signal trace to a convenient reference line (such as a graticule line or marker). Note the Reference Level reading.

b. Adjust the Reference Level control until the signal trace at 320 MHz aligns with the same reference line. The difference between the two Reference Level settings is the 320 MHz response relative to the low frequency response.

The left side of trace (low frequency end) is vertically positioned, using the fine Reference Level control, so it overlays the center graticule line. The Reference Level reads (–40.25 dBm). Then the Reference Level control is decreased until the 320 MHz portion of the trace (1.2 div right from 250 MHz center screen value) overlays the same graticule line. The Reference Level now reads (–41.75 dBm). The response at 320 MHz, relative to low frequency, is (-41.75)-(-40.25)=(-1.5dB).

13. CHECK – that the H channel response at 320 MHz is less than 3.0 dB down.

14. Using Hyperterminal, send the command $LOAD=0100000 to the MIU. This selects the V channel and the HV WB path. No LEDs will be lit on the MIU.

15. Move the cable connected to the H input BNC to the V input BNC. The V channel frequency response should appear on the analyzer. Its position and appearance should be similar to the H channel response observed above. If not, verify that the MIU is in the proper mode by sending the query $LOAD?. You should receive the reply load=0100000. If the string is not correct, send the command $LOAD=0100000 .

16. Repeat the procedure of step 12 above to measure the V channel 320 MHz response.

17. CHECK – that the V channel response at 320 MHz is less than 3.0 dB down.

18. Remove the cable from the V input. Disconnect the MIU CH4 coaxial cable from the BNC female/female adapter. Reconnect the MIU CH4 coaxial cable to the VM5000 CH4 input.

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