User Manual

Tektronix

VM5000HD
Automatic Video Measurement Set

071-1252-00

This document applies to firmware version 1.0
and above.

www.tektronix.com

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

WARRANTY

Tektronix warrants that the products that it manufactures and sells will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If a product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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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

Preface

This is the user manual for the VM5000HD 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* for where to find 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, remote command information, 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
VM5000HD Automatic Video Measurement Set Online Help	An integrated online help system, which can be accessed from the VM5000HD help menu (located in the middle of the screen when the VM5000HD application is open).
TDS5000 Series Digital Phosphor Oscilloscopes User Manual (.pdf file)	A .pdf file of the user manual describing the oscilloscope platform functionality. This pdf file is located on the VM5000HD product CD, 063-3653-XX.
TDS5000 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).
TDS5000 Series Digital Phosphor Oscilloscopes Reference Manual	A quick reference to major features of the ocsilloscope platform.
TDS5000 Series OscilloscopeOnline Programmer Guide	A listing of the programming commands and other information related to controlling the oscilloscope functionality over GPIB.
TDS5000 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.

Contacting Tektronix

Phone	1-800-833-9200*
Address	Tektronix, Inc. Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, OR 97077 USA
Web site	www.tektronix.com
Sales support	1-800-833-9200, select option 1*
Service support	1-800-833-9200, select option 2*
Technical support	Email: techsupport@tektronix.com 1-800-833-9200, select option 3* 6:00 a.m. – 5:00 p.m. Pacific time

*** This phone number is toll free in North America. After office hours, please leave a voice mail message.**
Outside North America, contact a Tektronix sales office or distributor; see the Tektronix Web site for a list of offices.

Getting Started

Product Description

This manual supports the VM5000HD 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 VM5000HD instrument is a high-performance solution for verification, debugging, and characterization of analog high-definition video signals. Key features include:

- Fast, accurate, and repeatable video measurements
- Fully automated, comprehensive component analog video measurements
- Supports HDTV, progressive, and PC-format component analog video (YPbPr and RGB)
- Acquisition bandwidth & high sample rates for HDTV signals
- Test signal files for convenient test signal generator setup (see page F–1 for a description of Option SS)
- Powerful automated measurement features and utilities
- Standard GPIB and LAN remote control capability
- MS Windows operating system, an intuitive graphical user interface, and online help for easy operation with minimal training time
- Video measurement accessories
- Extended documentation capabilities
- 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, the instrument incorporates the power, features, and functionality needed in R&D, QA, and Production Test applications. It enables manufacturers

to ensure that HDTV video signal quality is up to the challenge of today's high performance displays, as well as enables clear differentiation between input signal and display device impairments.

Applications include the following:

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

The VM5000HD automates a variety of component analog video measurements utilized to verify the integrity and quality of HDTV video signals. It automatically assesses conformance of selected video signal parameters to applicable EIA–770–3, SMPTE – 274M, and 296M standards. It also automates measurement of other industry-standard video parameters that are utilized to quantify the performance of Digital Set-top boxes 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 HDTV video output signal quality.

As a fully integrated video analyzer, the VM5000HD offers simple 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 reliable HDTV test results can be reliably generated, easily replicated with other VM5000HD instruments, and readily communicated across a global engineering, supply, or sales organization.

The VM5000HD offers intuitive Windows based configuration and measurement results menus 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. Users can easily navigate through the logically arranged configuration and results menus, and make selections via radio buttons or an on-screen keyboard utilizing the included USB mouse.

Firmware Upgrade

Tektronix may offer firmware upgrade kits for the VM5000HD instrument. Contact your Tektronix service representative for more information (see *Contacting Tektronix* on page xi).

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
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
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
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

Installation

This section addresses instrument installation:

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 1–19 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. 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.

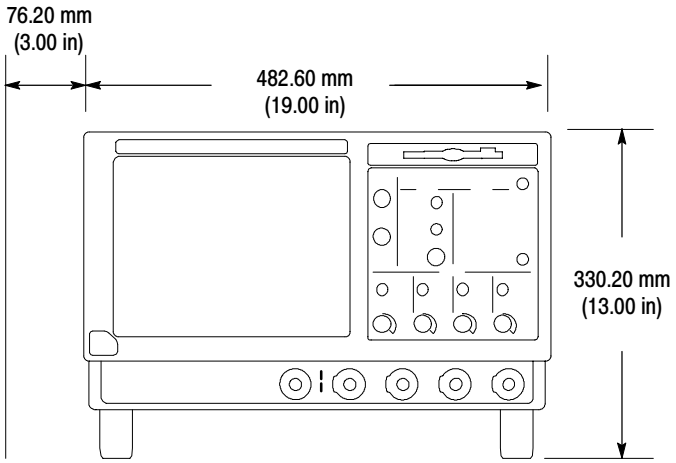


Figure 1- 1: Instrument space requirements

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 *TDS5000 Series User Manual* .pdf file on the VM5000HD product CD (063-3653-XX) for additional connection information.

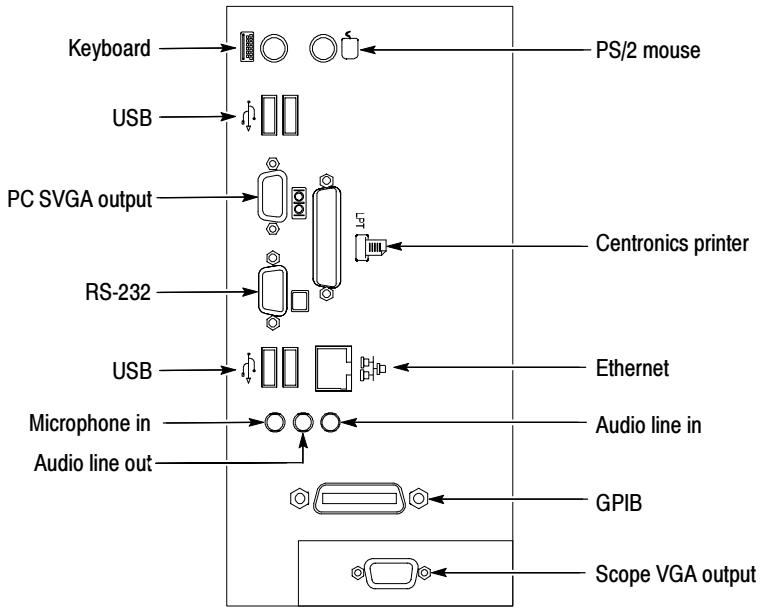


Figure 1-2: Locations of VM5000HD connectors

***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 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 5 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).

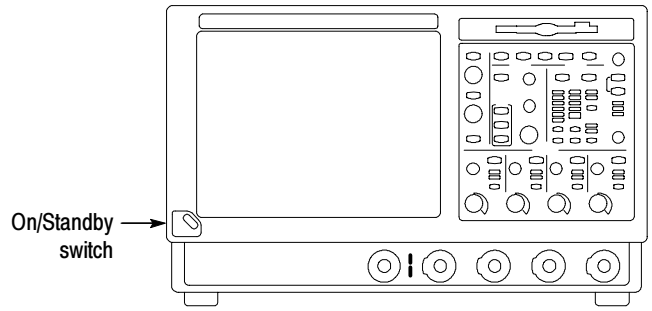


Figure 1-3: On/Standby switch location

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 in 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. Exit 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 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 *VM5000HD Automatic Video Measurement Set Product Software* CD-ROM.

VM5000HD Remote Command Information

The GPIB programmer information is available in *Appendix C*.

Programmer information for the rest of the instrument functions is available as a .pdf file on the *TDS5000 Series Product Software* CD-ROM (063-3508-XX).

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, and so forth)
- MathCad
- MATLAB

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.

Exiting the instrument Application. Before installing other desktop applications, exit 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:

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 message “Loading SETUP” 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 exit. Confirm the Save of 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.

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

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 with the mouse on the Windows desktop.

2. Select **Properties**.

3. Select the **Settings** tab.

4. Click **Advanced**.

5. Select the **Color** tab.

6. Adjust slider control for 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 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 page xi of *Preface.*

Make sure you have put the instrument into service as detailed 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. Ensure that ALL is selected from each drop-down list.

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 exit the Instrument Calibration control window.

Functional Test

This procedure uses the output from a PC VGA video card to test the VM5000HD application functionality.

Equipment required	VM5000HD
	Sync Combiner cable assembly, Tektronix part number 012-1664-XX
	75 Ω precision BNC terminations (3)
	BNC "T" connectors (3)
	A PC with a CD drive and a video graphics card capable of displaying an image at 1280 x 1024 at a 60 Hz refresh rate

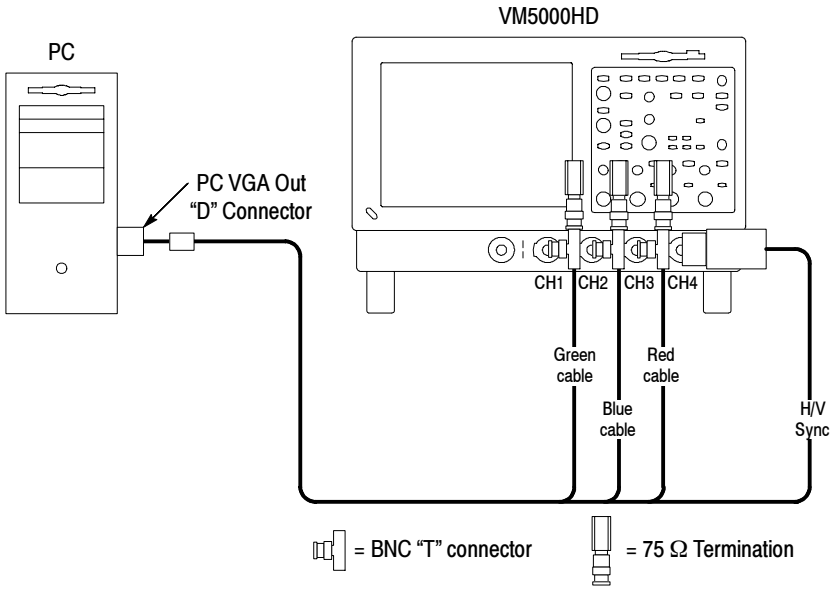
NOTE*. These procedures verify that the application features operate. They do not verify that they operate within limits. Therefore, when the instructions in these functional tests call for you to verify that a signal appears on screen "that is about five divisions in amplitude" or "has a period of about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

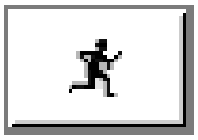
1. Set the PC monitor display properties by doing the following steps:
   a. Power on the PC and its monitor.
   b. Position the cursor anywhere in the desktop background area and click the right mouse button to show the desktop menu.
   c. Select **Properties** to show the Display Properties dialog box.
   d. Select the **Settings** tab to show the display settings fields.
   e. Set the Screen Area slider control to **1280 by 1024**.
   f. Set the color field to **True Color (24 bit)**.
   g. Select the **Advanced** button to open the advanced settings dialog.
   h. Select the **Monitor** tab to display the monitor dialog.
   i. Select **60 Hertz** in the Refresh Frequency list.
   j. Select **OK** to dismiss the advanced dialog box. Depending on your Windows settings, the settings are applied immediately or you are requested to reboot your computer.
   k. Select **OK** to apply the changes or to reboot your system.
   l. Select **OK** to dismiss the Display Properties dialog box.
2. Set the PC to generate the test signal by doing the following steps:
   a. Insert the *VM5000HD Application Software* CD in the PC CD drive.
   b. Start the Windows Paint program (**Start > Programs > Accessories > Paint**).
   c. From within the Paint program, open the file <cd-drive>: **PCMatrix1280X1024P60.bmp**.
   d. Select **View > View Bitmap** to display the file as a full-screen image (no window borders).
3. Disconnect the PCs monitor cable from the PC VGA video card output connector.
4. Connect the 15-pin connector on the Sync Combiner cable to the PC VGA video card output connector.

5. Connect the other end of the Sync Combiner cable to the VM5000HD instrument inputs as shown.



6. Power on the VM5000HD instrument and wait for it to complete the power-on process.
7. Select **File > Run Application > VM5000HD** to display the VM5000HD application window.
8. In the application window, select **File > Recall Default** to load the application default settings.
9. In the application window, select **Configuration > Format** to display the Format view.
10. Select the **SXGA/60** button.
11. In the application window, select **Configuration > Operation** to display the Operation view.
12. Select the **Channel 4** button in the Trigger area.

13. 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 shown below.

Results (mV)

	Y/G	Pb/B	Pr/R
White	692.24	684.13	686.69
Yellow	694.35	1.00	689.86
Cyan	695.61	686.12	1.64
Green	696.74	1.40	0.46
Magenta	2.03	686.63	688.50
Red	0.37	1.37	690.86
Blue	-0.17	687.41	1.86
Black	-0.43	2.12	0.20

Your actual measurement values will depend on your VGA output levels. They will vary from the nominals (700 mV and 0 mV) by about ±50 mV, but you should observe the pattern shown in the screen capture above.

You have completed the VM5000HD functional verification procedure.

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.

Table 1-2: Instrument options

Hardware	18	Touch-screen interface
Mounting	1R	Rackmount kit
Software	SS	Complete set of test signals (four CDs, two DVDs)
Power cords	A0	North America power cord
	A1	Universal EURO power cord
	A2	United Kingdom power cord
	A3	Australia power cord
	A5	Switzerland power cord
	AC	China power cord
	A99	No power cord
Service	D1	Calibration data report
	C3	Additional two years of calibration
	D3	Calibration data report for Option C3
	R3	Additional two years of repair
	C5	Additional four years of calibration
	D5	Calibration data report for Option C5
	R5	Additional four years of repair

Accessories

This section lists the standard and optional accessories available. The accessories listed in Table 1–3 are shipped standard with the instrument.

Table 1-3: Standard accessories

Accessory	Part number
VM5000HD Automatic Video Measurement Set User Manual	071-1252-XX
TDS5000 Series Digital Phosphor Oscilloscopes Reference *English* *French* *German* *Italian* *Spanish* *Portuguese* *Japanese* *Korean* *Simplified Chinese* *Traditional Chinese*	020-2398-XX
Oscilloscope Analysis and Connectivity Made Easy manual with software	020-2449-XX
VM5000HD Product Software CD-ROM (includes VM5000HD product software, VM5000HD online help, VM5000HD user manual PDF, TDS5000 user manual PDF, and release notes)	063-3653-XX
TDS5000 Series Product Software CD-ROM (includes TDS5000 product software, TDS5000 online help, *VM5000HD Online Programmer Guide* (GPIB online help and PDF), Performance Verification PDF, release notes, VISA information)	063-3508-XX
TDS5000 Series OS Restore CD-ROM	063-3509-XX
Calibration Certificate documenting NIST traceability, Z540-1 compliance, and ISO9001 registration	— —
U.S. power cord	161-0104-00
Mouse	119-6298-XX
USB keyboard	119-6633-XX
Front cover	200-4651-XX
Blank CDR / CDRW	020-2434-XX
Click'N Burn CD	063-3575-XX
75 Ohm terminations (3)	011-0102-XX
BNC "T" connectors (3)	103-0030-XX
VGA Sync Combiner cable	012-1664-XX

The accessories in Table 1–4 were orderable for use with the instrument at the time this manual was published. Consult a current Tektronix catalog for additions, changes, and details.

Table 1-4: Optional accessories

Accessory	Part number
TDS5000 Series Digital Phosphor Oscilloscopes Service Manual	071-1004-XX
K420 Scope Cart with mouse accessory tray	436-0317-XX
Transit case	016-1522-XX
TDS5000 Series, VM5000HD rackmount kit	016-1887-XX
Video display clamp	013-0278-00
P5050 500 MHz 10x passive probe	P5050
GPIB cable (3.3 ft, or 1 m)	012-0991-01
GPIB cable (6.6 ft, or 2 m)	012-0991-00
Centronics cable	012-1214-00

Operating Basics

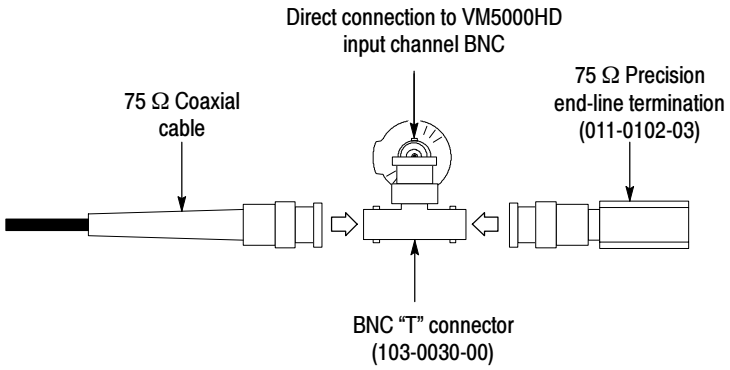
Operating Basics

This section provides basic information about using the VM5000HD. More detailed measurement information can be found in the *Reference* section.

Input Signal Connection Requirements

Use only 75 Ω coaxial cables to connect the video device under test to the VM5000HD 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. For accurate frequency response measurements, it is important to attach the "T" connector directly to the VM5000HD input channel BNCs.

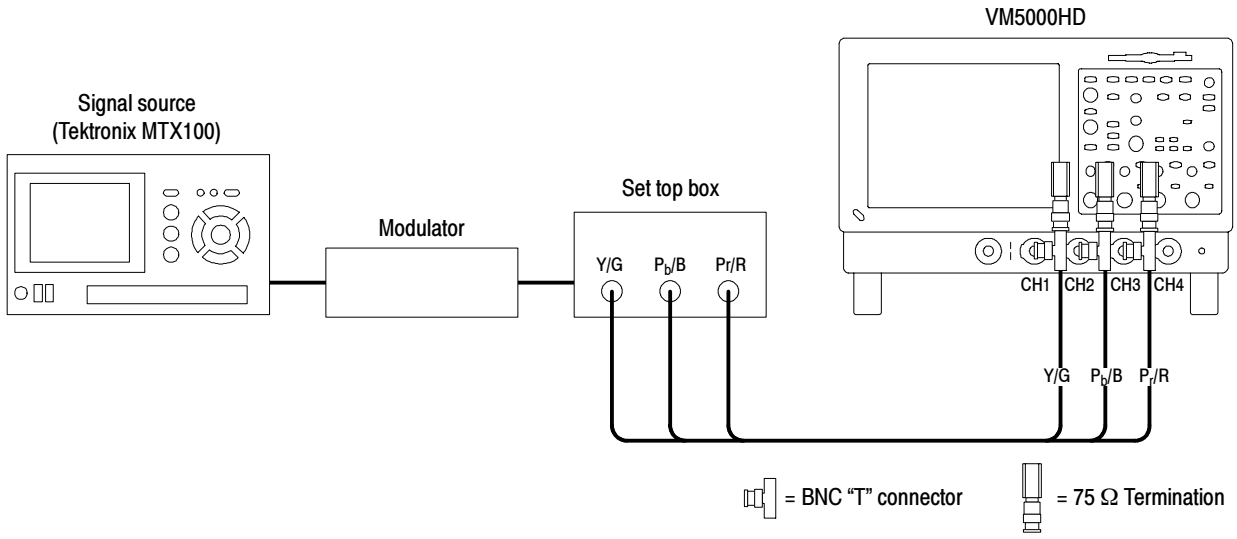


Connecting Input Signals

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

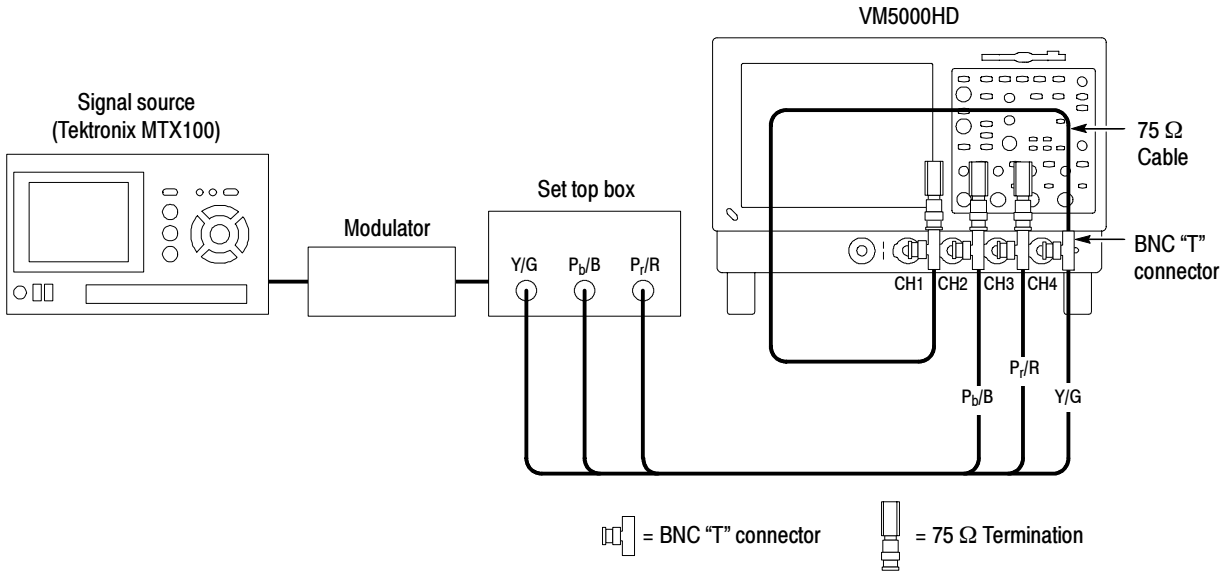
3-Wire Video with Composite Sync, Setup 1

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, triggering the instrument on channel 1 (the default trigger setting). This setup provides the most accurate frequency response information, but limits noise measurement on Y/G to –65 dB (30 MHz noise bandwidth).



3-Wire Video with Composite Sync, Setup 2

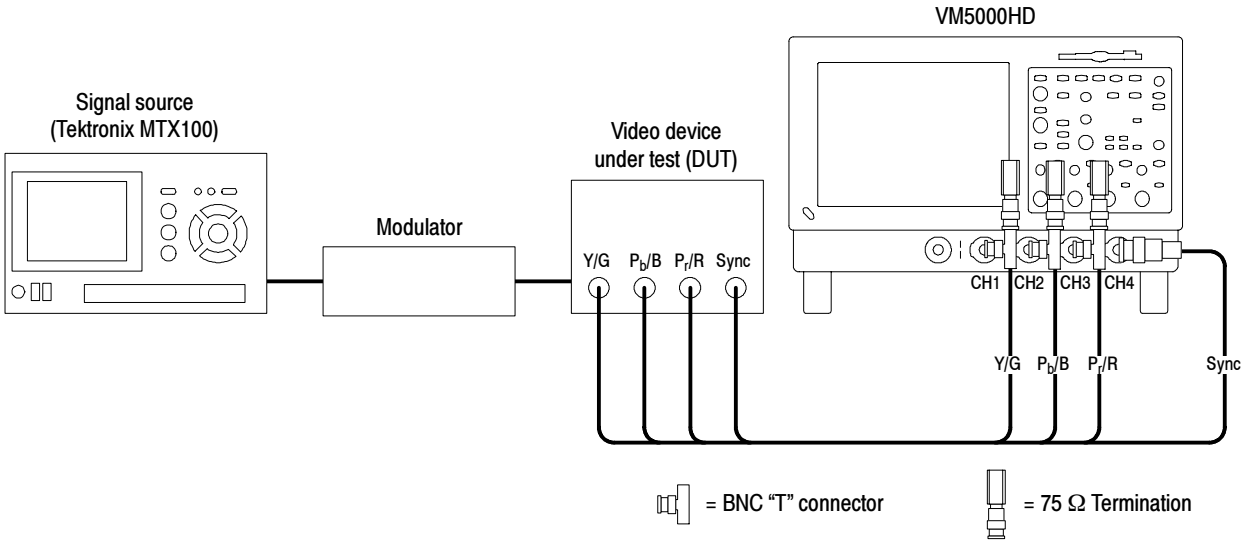
Use this setup for testing 3-wire component analog video signals (Y/G, Pb/B, Pr/R) with the composite sync signal on Y/G, triggering the instrument on channel 4. This configuration provides more accurate low-level (below –60 dB at 30 MHz bandwidth) noise measurements than setup 1. Frequency response measurements on the Y/G will be degraded by approximately 0.04 dB (0.5%) at 30 MHz due to the additional loading from the CH4 input.



***NOTE**. Be sure to set the trigger channel to channel 4; the default trigger channel is channel 1. If you do not change the trigger setting (Configuration > Operation), you will see signal warning messages and be unable to take measurements.*

4-Wire Video with Separate Composite Sync

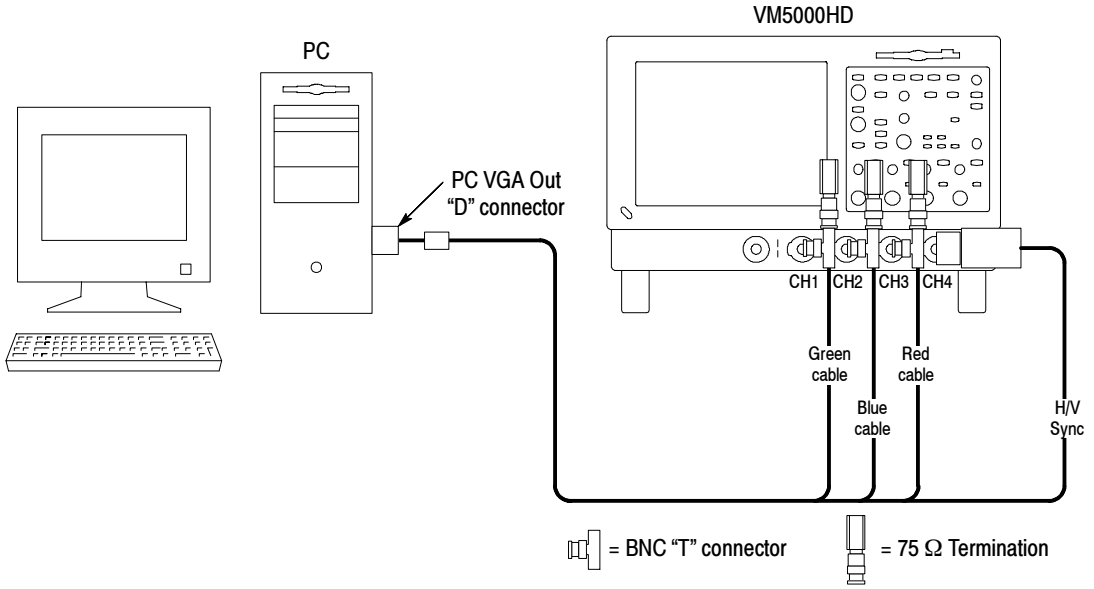
Use this setup for testing 4-wire component analog video signals (Y/G, Pb/B, Pr/R) with the composite sync signal on a separate output line. For CH4, termination is optional. For CH4 only, you can use no termination or a 75 Ω termination of lower accuracy than the 75 Ω terminations that are provided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



***NOTE**. Be sure to set the trigger channel to channel 4; the default trigger channel is channel 1. If you do not change the trigger setting (Configuration > Operation), you will see signal warning messages and be unable to take measurements.*

VGA PC Video Card Signal Measurement Setup

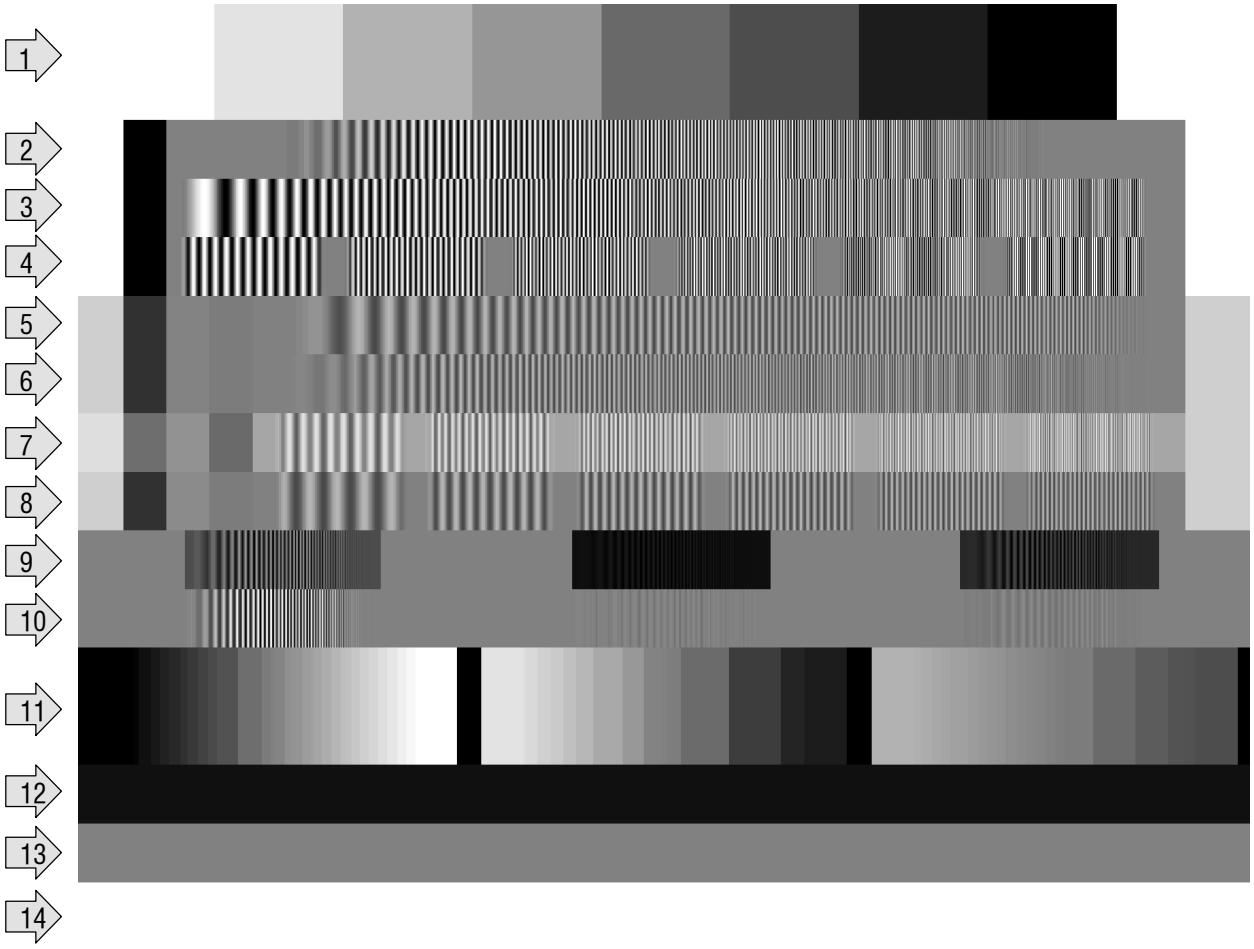
Use this setup for testing 3-wire component analog video signals (Y/G, Pb/B, Pr/R) without the composite signal on Y/G, and triggering the instrument on channel 4. Use the special VGA sync combiner cable to connect the PC video card to the instrument. (Use this setup for the Functional Tests beginning on page 1–14.)



***NOTE**. Be sure to set the trigger channel to channel 4; the default trigger channel is channel 1. If you do not change the trigger setting (Configuration > Operation), you will see signal warning messages and be unable to take measurements.*

The Matrix Test Signal

The Matrix test signal, shown below, is provided with Option SS. It incorporates all analog HD video signal requirements into different line numbers within one test pattern field. Using a single test pattern eliminates the need to change test signals when doing different measurements. All you need to change is line numbers. Use the setup file (.vmset) that matches the format of the Matrix test signal you are using; this provides appropriate line numbers as default settings for each measurement type. See page F–1 for a full description of the Option SS files.

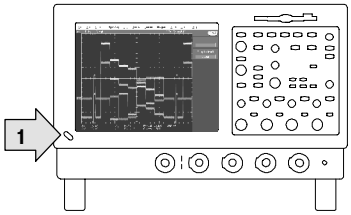


Signal	Format	Signal	Format	Signal	Format
1. Color bars	All	**6.** Sweep	YPbPr	**11.** Valid ramp	All
2. Sweep	RGB	**7.** 30 MHz MB	YPbPr	**12.** Flat field: 0% black	All
3. Sweep	RGB	**8.** 15 MHz MB	YPbPr	**13.** Flat field: 50% grey	All
4. Multiburst	RGB	**9.** Windowed sweep	RGB	**14.** Flat field: 100% white	All
5. Sweep	YPbPr	**10.** Windowed sweep	YPbPr		

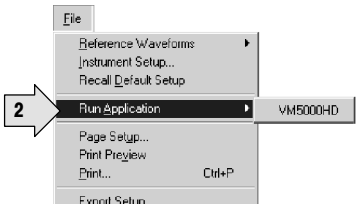
Starting the Application

Make sure you have set up the input signal sources before taking measurements (see page 2–9).

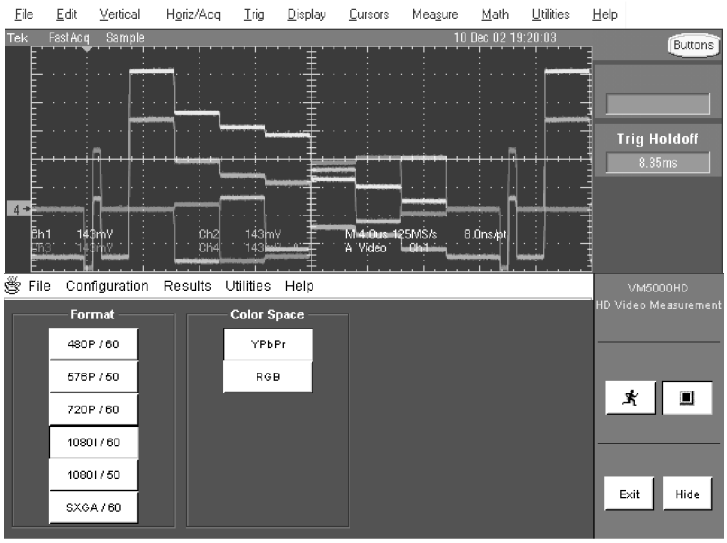
1. Power on the instrument. The instrument displays the default main screen.



2. In the menu bar, select **File > Run Application > VM5000HD**.

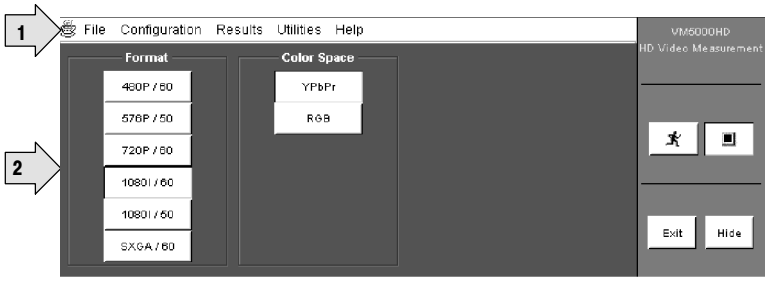


The instrument reduces the waveform area to the upper half of the display, and opens the VM5000HD application in the lower half of the display.

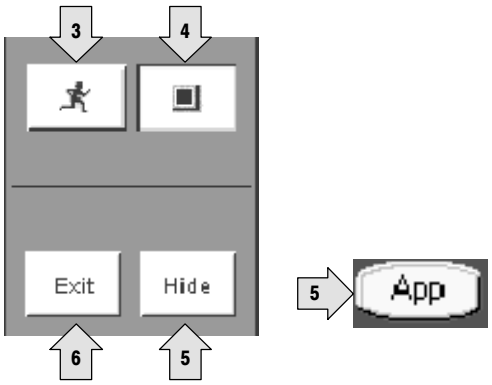


The VM5000HD Application User Interface

1. Menu bar: Selects setting controls and results information to display in the Application view.
2. Application view: Displays configuration controls and measurement results.



3. Run Button: Sets up, starts taking measurements, and displays results.
4. Stop button: Halts the measurements.



5. Hide button: Restores the main display to full-screen and hides the application window behind the main display.

   To restore the application window after hiding it, select the **App** button on the main display.

   To access the MS Windows desktop (for viewing reports), select **Hide.** In the main display, select **File > Minimize**, and then select the application **Hide** button again.

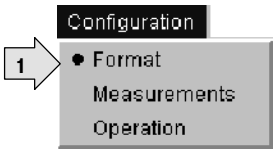
6. Exit button: Exits (closes) the application and returns the instrument to the default main display.

Measurement Steps Overview

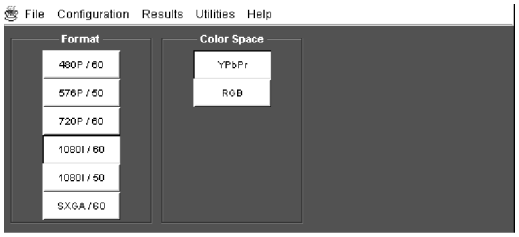
1. Set the input signal format standard (such as 1080i/60) and color space (Y Pb Pr or RGB) by using the Configuration > Format menu (page 2–9).
2. Select one or more measurements to take by using the Configuration > Measurements menu (page 2–10).
3. Set the measurement run operations, such as run mode and trigger channel, by using the Configuration > Operation menu (page 2–11).
4. Select the Run button to take and view measurements (page 2–13).
5. Save measurement results by using the Utilities > Generate Reports menu (page 2–17).

Setting the Input Signal Format

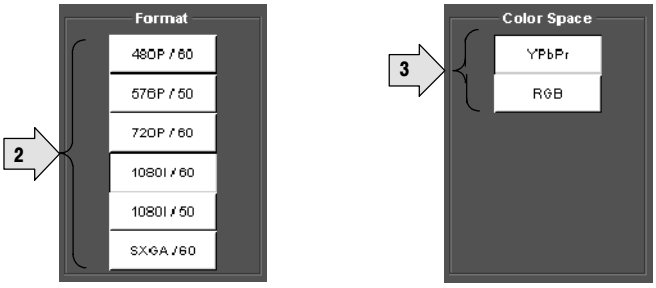
1. Select **Configuration > Format**.



The application opens the Format view.

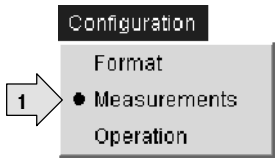


2. Select the appropriate video format for the signal you are measuring.
3. Select the appropriate color space type for the signal you are measuring.

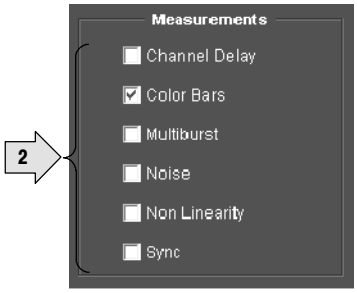


Selecting Measurements

1. Select **Configuration > Measurements**.

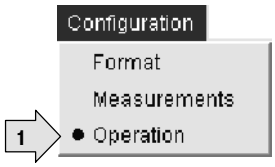


2. Select from one to six measurements, in any combination.

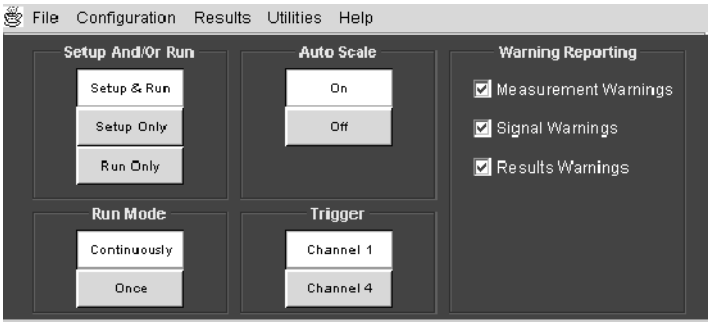


Setting the Measurement Run Operations

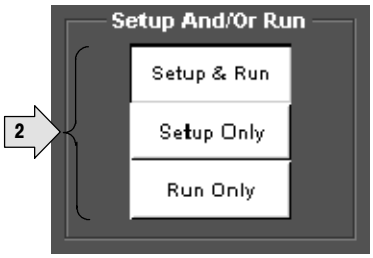
1. Select **Configuration > Operation**.



The instrument displays the Operation view. These settings control how the instrument sets up and acquires measurements when you select the Run button.

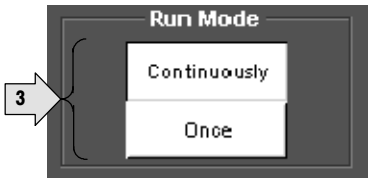


2. Select how the instrument sets up and runs measurements.



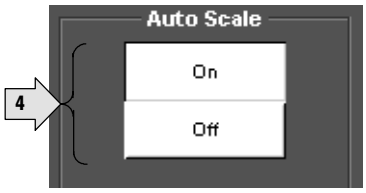
- **Setup & Run** configures the instrument settings and takes a measurement, for each selected measurement, and for each measurement acquisition. Use this when taking multiple measurements that require different instrument setups.
- **Setup Only** configures the instrument for a measurement but does 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.
- **Run Only** takes a measurement using the existing instrument configuration. Designed for taking measurements with custom settings (see Setup Only description above).

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



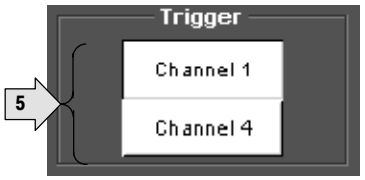
- **Continuously** continually takes measurements. You must select the Stop button to stop measurements.
- **Once** takes each selected measurement the number of times determined by the averaging setting, then stops taking measurements.

4. Enable or disable waveform autoscaling. 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.
Refer to page 3–7 for details.



5. 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 2–2.



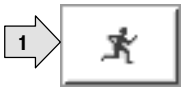
6. Select which warning messages to display.

   See page 3–7 for more information.

Taking and Viewing Measurements

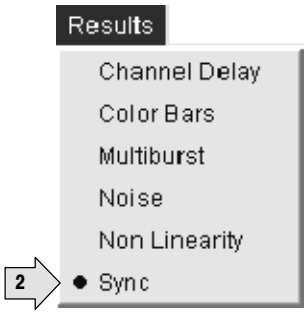
Make sure you have selected a signal format, selected one or more measurements, and configured the run options before taking a measurement.

1. Select the **Run** button.

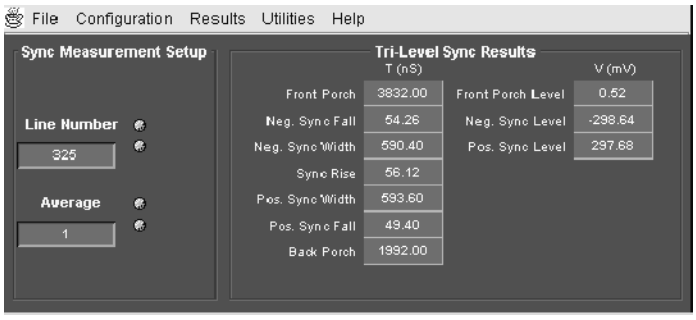


The instrument begins taking measurements and displays the measurement results view for the most recently-selected measurement result.

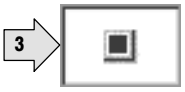
2. To view the results for other measurements, select the measurement from the Results menu. For example, to view the Sync measurement results, select **Results > Sync.**



The instrument displays the selected measurement results. You can only display results for measurements that are selected in the Format > Measurements view.

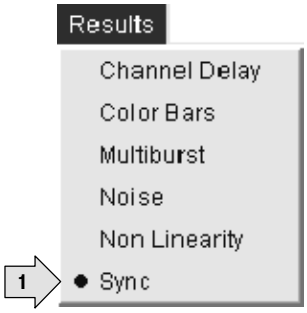


3. If you set the run operation to Continuously, press the **Stop** button to stop taking measurements.

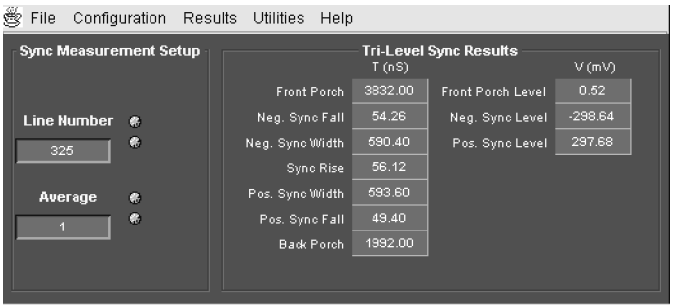


Changing Line Number or Averaging on the Results Screen

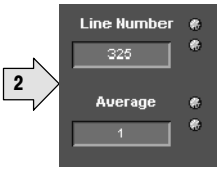
1. Select a measurement from the Results menu. For example, select **Results > Sync.**



The instrument displays the selected measurement results.

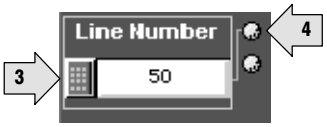


2. You can change the video signal line number and the number of measurements to average before displaying results. The instrument stops measuring, changes results to dashes, and uses the new settings at the start of its next measurement cycle. Refer to page 3–8 for information on line numbers and averaging.

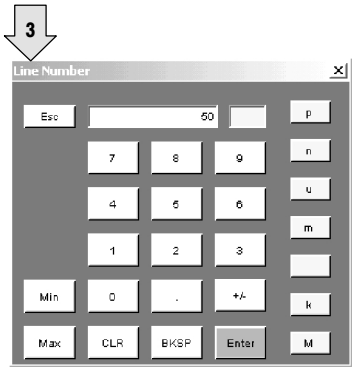


To change a value, select the field and enter a value by keyboard. You can also change values using one of these methods:

3. Select the keypad icon to the left of the field to display a virtual keyboard to enter values using the touch screen.

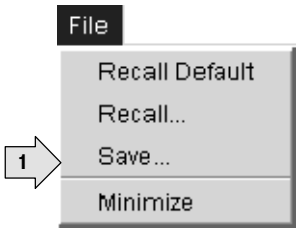


4. Use the indicated general purpose knob to change the value.



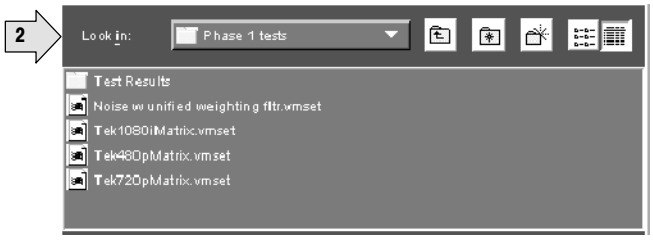
Saving Measurement Setups

1. Select **File > Save**.



The application displays the Save dialog. The default save location is C:\VM5000HD.

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

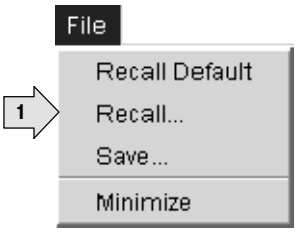


3. Enter a file name in the File Name field. The instrument offers an available file name (or you can choose your own). It automatically appends .vmset to the file name of measurement setup files.

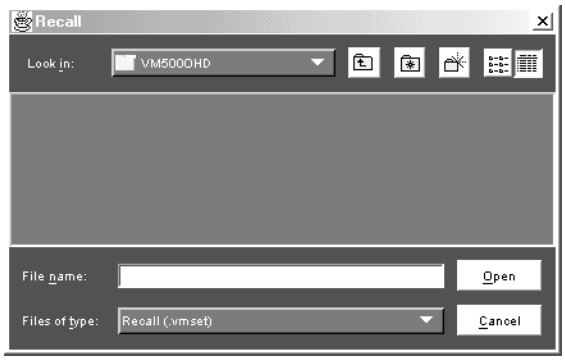
4. Select **Save** to save the measurement settings to the specified location and file name.

Recalling Measurement Settings

1. Select **File > Recall**.



The application displays the Recall dialog and lists all instrument setting files that are present in the default C:\VM5000HD directory.



2. Select the **Look In:** button to navigate to a different directory other than the default location (if desired).
3. Select a file from those listed.

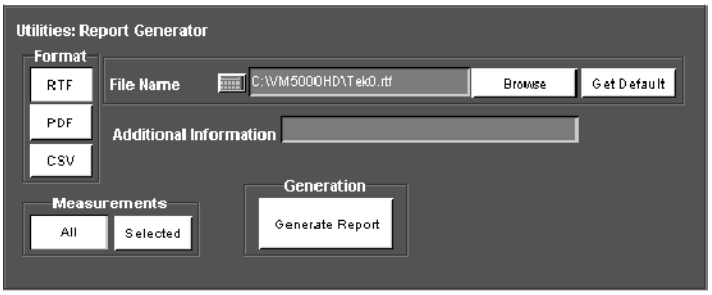
4. Enter a file name in the **File name:** field or select a file from the list.
5. Select **Open** to load the settings file and configure the instrument.

Saving Measurement Results (Reports)

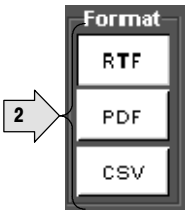
You can use the Generate Report function to save your measurement results.

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

The instrument displays the Utilities Report Generator view.



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



- **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. PDF is especially useful for ensuring that the results cannot be altered.
- **CSV**: Use CSV (Comma-Separated Values) to create results data that you can insert into spreadsheets or math software in which you can create limits to verify that your results are within expected range.

3. Use the File Name field 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.

4. Use the Additional Information field to add notes into the report file. You can enter up to 46 characters. For example: “Serial Number 123456789012 tested by J. Smith”

5. Use the Measurements buttons to select which mesurements 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.

6. 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.

Reference

Reference Overview

This chapter provides a detailed description of the VM5000HD instrument menus and measurements.

- Menu descriptions. The table below lists the top level of the instrument menus and the sections in this chapter that document those menus. The menu descriptions include high-level descriptions of the six measurements.
- Measurement details. Refer to page 3–13 for an in-depth description of each of the six measurements.

Overview of menu descriptions

Menu	Submenu	Function	Page
File	Recall Default	Restores default application measurement settings	3-3
	Recall	Recalls (loads) saved application measurement setups	
	Save	Saves (writes) saved application measurement setups	
	Minimize	Minimizes the application to the Windows task bar	
Configuration	Format	Sets the input signal format	3-5
	Measurements	Selects measurements to take	
	Operation	Sets measurement runtime options	
Results	Channel Delay, Color Bars, Multiburst, Noise, Non Linearity, Sync	Displays the selected measurement results Adjusts individual measurement settings	3-8
Utilities	Generate Report	Saves measurement results to specified file format	3-11
Help	Help Topics	Opens the VM5000HD online help system	3-12
	About VM5000HD	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 first starting the application or after doing a Recall Default operation.

The File Menu

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

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

Menu item	Function	Setting or field	Description
Recall Default	Recalls (loads) and applies the default application measurement settings.		
Recall			Recalls (loads) and applies application measurement settings from the specified file.
	Look in	Drop-down menu **VM5000HD**	Sets the directory to list in the File list area.
	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 menu **.vmset**	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. For example, for the Option SS 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 defaults.
	Open		Loads and applies the specified instrument setting file.
	Cancel		Closes (exits) the Recall dialog and does not load or apply any settings.
Save	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.		

Menu item	Function	Setting or field	Description
	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.		

The Configuration Menu

All the selected measurement results will appear as dashes any time you change any 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.

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

Menu item	Function	Setting or field	Description
Format	Sets 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	480P / 60 576P / 50 720P / 60 **1080I / 60** 1080I / 50 SXGA / 60	Sets the input signal format.
	Color Space	**YPbPr** RGB	Sets the input signal color space type.
Measurements	Selects the video signal measurements to take. You can select from one to six measurements, in any combination.		
	Measurements	Channel Delay **Color Bars** Multiburst Noise Non Linearity Sync	Selects from one to six measurements, in any combination. When you click the Run button, the selected measurements will be taken. The results of the measurements you select here will be included in any report you generate, if you select Utilities > Generate Report and then set Measurements to Selected. For a detailed discussion of measurements, refer to page 3-13. For a high-level overview of measurements, refer to page 3-8.

Menu item	Function	Setting or field	Description
Operation	Sets the measurement runtime options, including test run mode, input trigger channel, and warning message display.		
	Setup And/Or Run	**Setup & Run**	Automatically configures the instrument settings 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. Customized settings might include changes to the instrument Horizontal or Vertical front panel controls to display and measure a non-supported video signal standard. 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.
		Run Only	**Run Only** Uses the current instrument and application settings to take a measurement. Use this for taking measurements after setting up the instrument using Setup Only to create custom settings.

Menu item	Function	Setting or field	Description
	Run Mode	**Continuously**	**Continuously** continually takes measurements, in the order the measurements are listed in the Configuration > Measurements view. You select the Stop button to stop measurements.
		Once	Takes each selected measurement the number of times required for the averaging you have selected, and then stops taking measurements.
	Auto Scale	**On** Off	Enables or disables waveform Auto Scaling. 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 doing only one type of measurement and change the amplitude of the signal, you may need to auto-scale again: set Auto Scale to Off and then to On again. If you don't re-auto-scale in this way, then you might get bad results, inefficient use of the dynamic range, or your signal may be out of range. 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 1** Channel 4	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 Reporting	**Measurement Warnings** **Signal Warnings** **Results Warnings**	Sets which warning messages to display on the instrument screen while taking measurements. All warning messages are enabled by default. Clear a warning message check box to disable displaying warning messages. Measurement warnings include the most general information about potential problems in making the measurement. Signal warnings appear if signals are absent or change. If there are some valid results, Results warnings let you know if some of the displayed results may not be valid. A Results warning message box also tells you which types of test results are included in a 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, disable all of the Warning reporting, especially if you are using the GPIB interface.

The Results Menu

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

All the selected measurement results will appear as dashes any time you change any 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.

If you are using Option SS Matrix signal source files, be sure to use the appropriate matching .vmset setup file, if necessary, to get the correct default values for Line Number for each measurement. See page F–1 for more information about Option SS files.

For a detailed discussion of measurements, refer to page 3–13.

Menu item	Function	Setting or field	Description
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 is based on using the Matrix test signal to generate the test signal.
		Average: **1**	Sets the number of acquisitions over which to calculate an average measurement value.
	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.		

Menu item	Function	Setting or field	Description
	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 is based on using the Matrix test signal 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).
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.		
	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 is based on using the Matrix test signal 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.

Menu item	Function	Setting or field	Description
Noise	Measures video signal noise using one of three filter settings.		
	Noise 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 is based on using the Matrix test signal 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.
	Results		Displays the noise measurement results for each channel in dB (relative to peak white) and mV.
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 is based on using the Matrix test signal 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.
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 is based on using the Matrix test signal to generate the test signal.
		Average: **1**	Sets the number of measurements acquisitions to take and then calculate the average measurement value.
	Tri-Level Sync Results		Displays the sync signal timing values in ns, and the signal levels in mV.

The Utilities Menu

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

Menu item	Function	Setting or field	Description
Generate Report	Save (write) 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	Use CSV (Comma-Separated Values) to create results data that you can insert into spreadsheets or math software.
	File Name	Text entry field **C:\VM5000HD\Tek0.rtf**	Field in which to enter the report file name.
		Browse	Selects the location to which to write (save) the report.
		Get Default	Sets the report write directory to the default location and name (C:\VM5000HD\Tek0.rtf).
	Additional Information	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.

The Help Menu

Menu item	Function	Setting or field	Description
Help Topics	Opens the VM5000HD online help window that provides you with application information on your instrument screen.		
About VM5000HD	Displays a VM5000HD dialog that contains the application software version number.		

Detailed Measurement Information

For a high-level procedure for how to take a measurement, refer to page 2–9.

For a high-level overview of all the measurements, refer to the table beginning on page 3–8.

The following information applies to all measurements.

Matrix Signals and Line Numbers

The matrix signals provided with Option SS (see page F–1) provide appropriate signals for all measurements. See the Readme.txt files on the Option SS discs 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, when using the ATSC transport stream file:

Tektronix1080iATSCMatrix.trp,

you should select File > Recall... and then navigate to where you have saved the setup file:

Tektronix1080iATSCMatrix.vmset.

The line numbers in this setup file may be used for all formats including 1080i, 720p, and 480p in both YPbPr and RGB.

For the equivalent matrix test signal .DNL from a Tektronix TG700 video generator, use the default settings.

Averaging

The higher the averaging, the lower the variance of the measurement in the presence of noise or other transient signal components. Set the averaging 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 the instrument averaging results, this problem is avoided.)

Measuring Channel Delay

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.

Measuring 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 8 colors (white, yellow, cyan, green, magenta, red, blue, black) for each active channel. Therefore, this measurement makes 8 measurements on 3 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. Since 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 set-up 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 in order to locate the sync signal and the associated back porch.

Measuring 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 format change through frequency shift, 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.

Measuring 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 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 700mV peak signal value.

Measuring Non Linearity

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, 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.

Interpret ing 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.

Measuring 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.

InterpretResults

The amplitudes are measured relative to back porch.

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

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–10 on page A–15.
- The instrument must be powered from a source that meets the specifications listed in Table A–8 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 after the 20-minute warm-up period. If the ambient temperature changes more than 5 °C (10 °F) you must restart the procedure. In the TDS5000 user manual, see the appendix *Optimizing Measurement Accuracy* for instructions to perform this procedure.

Table A- 1: Video measurement specifications

Characteristic		Description	
Color bar measurement accuracy		±2.0 mV ±1.5 V% 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, ±2 dB	Unified Weighting Filter. Trigger on CH 4 required for measurements below -60 dB.
	Noise floor	Less than -76 dB, 30 MHz noise bandwidth	Typical is less than -80 dB, 30 MHz noise bandwidth

Table A-1: Video measurement specifications (Cont.)

Characteristic		Description	
Multiburst measurement		*Accuracy*	
	Flag amplitude	±2mV ±1.5% of reading	
	1 MHZ to 10 MHz packets	±0.5 dB	Measurement relative to reference flag amplitude
	10 MHZ to 30 MHz packets	±0.75 dB	
	Frequency readout		Multiburst packet frequency is measured and displayed.
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.
Sync measurement		*Accuracy*	
	Sync amplitude	±2mV ±1.5% of reading	Blanking interval measurements, including sync amplitude, width, and rise time.
	Sync timing	±5 ns	
	Rise 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-2: Channel input and vertical specifications

Characteristic	Description
Input coupling	DC, AC, and GND
Input channels	Four, all identical
Input impedance, DC coupled	1 MΩ ± 1.0% in parallel with 18 pF ±2 pF 50 Ω ±2.5%; VSWR ≤ 1.5:1 from DC to 1 GHz
Maximum voltage at input BNC (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 and above.
Maximum voltage at input BNC (50 Ω)	5 V_{RMS}, ±30 V peak

Table A- 2: Channel input and vertical specifications (Cont.)

Characteristic	Description	
Differential delay at input BNC	≤ 100 ps between any two channels with the same scale and coupling settings	
Deskew range, typical	±75 ns	
Channel-to-channel crosstalk	≥ 100:1 at 100 MHz, and ≥ 30:1 at the rated bandwidth for any two channels with the same scale and coupling settings	
Digitizers	8-bit resolution, separate digitizers for each channel sample simultaneously	
Sensitivity range	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 Fine adjustment available with ≤1% resolution	
Analog bandwidth	DC 50 Ω coupling, bandwidth limit set to Full, operating ambient ≤30 °C, derated by 2.5 MHz/°C above 30 °C	
	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
Analog bandwidth limit, typical	Selectable between 20 MHz, 150 MHz, or Full	
Lower frequency limit, AC coupled	< 10 Hz for 1 MΩ, reduced by a factor of ten when using a 10X probe; <200 kHz for 50 Ω	
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 and step amplitude	*Settling error at time after step*
	1 mV/div to 99.5 mV/div, with ≤ 2 V step	20 ns: ≤ 0.5% 100 ns: ≤ 0.2% 20 ms: ≤ 0.1%
	100 mV/div to 1 V/div, with ≤ 20 V step	20 ns: ≤ 1.0% 100 ns: ≤ 0.5% 20 ms: ≤ 0.2%
	1.01 V/div to 10 V/div, with ≤ 200 V step	20 ns: ≤ 1.0% 100 ns: ≤ 0.5% 20 ms: ≤ 0.2%

Table A-2: Channel input and vertical specifications (Cont.)

Characteristic	Description	
Position range	± 5 divisions	
Offset range	1 M Ω coupling	
	SCALE range	*Offset range*
	1 mV/div to 99.5 mV/div	±1 V
	100 mV/div to 1V/div	±10 V
	1.01 V/div to 10 V/div	±100 V
	50 Ω coupling	
	SCALE range	*Offset range*
	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 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)) At temperatures above 40 °C: ±((0.75% × | Net Offset |) + 150 mV + (0.1 div × V/div setting))
	where, net offset = offset - (position × volts/division)	

Table A-2: Channel input and vertical specifications (Cont.)

Characteristic	Description	
DC gain accuracy, Sample or Average acquisition mode	±1.5% + 1.0% × |net offset /offset range| 2 mV/div - 3.98 mV/div: ±3% + 1.0% × |net offset /offset range| Refer to *Offset Range* specifications	
DC voltage measurement accuracy	*Measurement type*	*DC accuracy (in volts)*
Sample acquisition mode, typical	Absolute measurement of any waveform point, and High, Low, Max, and Min measurements	±[1.5% + 1.0% × |net offset /offset range| × |reading - net offset| + offset accuracy + 0.13 div × V/div setting + 0.6 mV] 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, and all other automatic measurements	±[1.5% + 1.0% × |net offset /offset range| × |reading - net offset| + 0.26 div × V/div setting + 1.2 mV] 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)	

Table A-2: Channel input and vertical specifications (Cont.)

Characteristic	Description	
Average acquisition mode (≥16 averages)	Absolute measurement of any waveform point, and High, Low, Max, and Min measurements	±[1.5% + 1.0% × |net offset /offset range|] × |reading - net offset | + 0.06 div × V/div + offset accuracy] 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 points acquired under the same setup and ambient conditions, and all other automatic measurements	±[1.5% + 1.0% × |net offset /offset range| × |reading - net offset| + 0.1 div × V/div setting + 0.3 mV] 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	
Effective bits, typical	Sine wave input at the indicated frequency and peak to peak amplitude, at 50 mV/division and 25 °C	
	Signal and input conditions	*Effective bits*
	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- 3: Horizontal and acquisition system specifications

Characteristic		Description	
Acquisition modes		Sample, Peak detect, Hi Res, Average, and Envelope	
Acquisition rate		Up to 100,000 waveforms per second in Fast Acquisition mode Up to 130 waveforms per second with Fast Acquisition off	
Minimum record length		500 points	
Maximum record length		Depends on the number of active channels and the amount of memory installed	
	Standard	100,000 points (3 or 4 channels) 200,000 points (2 channels) 400,000 points (1 channel)	
	Option 1M installed	500,000 points (3 or 4 channels) 1,000,000 points (2 channels) 2,000,000 points (1 channel)	
	Option 2M installed	2,000,000 points (3 or 4 channels) 4,000,000 points (2 channels) 8,000,000 points (1 channel)	
Real-time sample rate range		*Number of channels acquired*	*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
Equivalent-time sample rate or interpolated waveform rate range		2.5 GS/s to 250 GS/s Equivalent-time acquisition can be enabled or disabled. When disabled, waveforms are interpolated at the fastest time base settings.	
Seconds/division range		200 ps/div to 40 s/div	
Maximum FastFrame update rate, nominal		225,000 frames per second	
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)]	

Table A-3: Horizontal and acquisition system specifications (Cont.)

Characteristic	Description	
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-4: Trigger specifications

Characteristic	Description	
Auxiliary input resistance, typical	≥ 1.5 kΩ	
Maximum auxiliary input voltage	±20 V (DC or peak AC)	
Edge Trigger Sensitivity	*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
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

Table A- 4: Trigger specifications (Cont.)

Characteristic	Description	
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	
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
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	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 point + 1ns)
	Envelope	± (2 displayed points + 1ns)
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

Table A- 4: Trigger specifications (Cont.)

Characteristic		Description	
Advanced trigger timing		For vertical scale settings ≥10 mV/div and ≤1 V/div	
		Minimum recognizable event width or time	*Minimum re-arm 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
	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
	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

Table A-4: Trigger specifications (Cont.)

Characteristic		Description	
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*
		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-5: Display specifications

Characteristic	Description
Display type	211.2 mm (8.3 in) width × 158.4 mm (6.2 in) height, 264 mm (10.4 in) diagonal, liquid crystal active-matrix color display
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

Table A- 5: Display specifications (Cont.)

Characteristic	Description
Display refresh rate	59.94 frames per second
Displayed intensity levels	Supports Windows SVGA high-color mode (16- or 24-bit)

Table A- 6: 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 amplitude	Rear-panel BNC connector, provides a buffered version of the signal that is attached to the channel 3 input 20 mV/div ± 20% into a 1 MΩ load 10 mV/div ± 20% into a 50 Ω load	
Analog Signal Output 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	
External Reference Input	Rear-panel BNC connector	
	9.8 MHz to 10.2 MHz	
	200 mV p-p to 7 V p-p	
	>1.5kΩ in series with ~10 nf DC blocking capacitor	

Table A- 6: Input/output port specifications (Cont.)

Characteristic		Description
Side-panel I/O ports		Ports located on the rear 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
	Audio ports	Miniature phone jacks for stereo microphone input and stereo line output
	USB ports (4)	Allows connection or disconnection of USB keyboard, mouse and/or other devices while scope power is on
	Keyboard port	PS-2 compatible, instrument power must be off to make connection
	Mouse port	PS-2 compatible, instrument power must be off to make connection
	LAN port	RJ-45 connector, supports 10 base-T and 100 base-T
	Serial port	DB-9 COM1 port, 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
	GPIB port	IEEE 488.2 standard interface
	Scope VGA video port	Lower video port, DB-15 female connector, 31.6 kHz sync, EIA RS-343A compliant, connect to show the instrument display, including live waveforms, on an external monitor

Table A- 7: Data storage specifications

Characteristic	Description
CD-ROM	Side-panel CD-RW drive
Floppy disk	Front-panel 3.5 in floppy disk drive, 1.44 MB capacity
Hard disk	Internal hard disk drive, ≥ 20 GB capacity

Table A-8: Power source specifications

Characteristic	Description
Source voltage and frequency	100 to 240 V ±10%, 47 Hz to 63 Hz
Power consumption	≤220 W
Overvoltage Category	Overvoltage Category II (as defined in IEC61010-1/A2)

Table A-9: Mechanical specifications

Characteristic		Description	
Weight			
	Benchtop configuration	22 lbs (10 kg) instrument only 55 lbs (25 kg) when packaged for domestic shipment	
	Rackmount kit	4 lbs (1.8 kg) rackmount conversion kit 11 lbs (5 kg) kit packaged for domestic shipment	
Dimensions			
	Benchtop configuration	11.2 in (284.5 mm) height, 12.8 in (325.1 mm) with feet extended 17.6 in (447 mm) width 11.35 in (288.3 mm) depth	
	Rackmount configuration (Option 1R)	10.5 in (267 mm) height 19 in (483 mm) width 11.35 in (288.3 mm) depth	
Cooling		Fan-forced air circulation with no air filter.	
	Required clearances	Top	0 in (0 mm)
		Bottom	0.25 in (6.5 mm) minimum or 0 in (0 mm) when standing on the extended 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 are constructed of aluminum alloy, front panel is constructed of plastic laminate, circuit boards are constructed of glass laminate, outer shell is molded and textured from a polycarbonate/ABS blend	

Table A- 10: Environmental specifications

Characteristic		Description
Temperature		
	Operating	+5 °C to +45 °C
	Nonoperating	-20 °C to +60 °C
Humidity		
	Operating	20% to 80% relative humidity with a maximum wet bulb temperature of +29 °C at or below +45 °C, noncondensing Upper limit derated to 30% relative humidity at +45 °C
	Nonoperating	With no diskette in floppy disk drive 5% to 90% relative humidity with a maximum wet bulb temperature of +29 °C at or below +60 °C, noncondensing Upper limit derated to 20% relative humidity at +60 °C
Altitude		
	Operating	10,000 ft (3,048 m)
	Nonoperating	40,000 ft (12,190 m)
Random vibration		
	Operating	0.22 g_{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis
	Nonoperating	2.28 g_{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis
Shock, nonoperating		30 g (11 ms half-sine wave or less)

Table A-11: 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] Class A Radiated and Conducted Emissions EN 61326 Immunity [1, 2, 4] IEC 61000-4-2 Electrostatic Discharge Immunity ±4 kV contact discharge, ±8 kV air discharge, performance criterion C IEC 61000-4-3 RF field immunity 3 V/m, 80 MHz to 1 GHz, 80% amplitude modulated with a 1 kHz sinewave performance criterion A IEC 61000-4-4 Electrical Fast Transient/Burst Immunity 1 kV on AC mains, 500 V on !/O cables, performance criterion C IEC 61000-4-5 AC Surge Immunity 500 V differential mode, 1 kV common mode, performance criterion B IEC 61000-4-6 RF Conducted Immunity 3 V, 150 kHz to 80 MHz, amplitude modulated with a 1 kHz sinewave, performance criterion A IEC 61000-4-11 AC Mains Voltage Dips and Interruption Immunity 100% reduction for one cycle, performance criterion B EN 61000-3-2 Power Harmonic Current Emissions 1 If interconnect cables are used, they must be low-EMI shielded cables such as the following Tektronix part numbers or their equivalents: 012-0991-01, 012-0991-02 or 012-0991-03 GPIB Cable; 012-1213-00 (or CA part number 0294-9) RS-232 Cable; 012-1214-00 Centronics Cable; or LCOM part number CTL3VGAMM-5 VGA Cable. 2 The performance criteria for when the instrument is subjected to the conditions described above are defined as follows: A — ≤0.2 division waveform displacement or ≤0.4 division increase in peak-to-peak noise B — temporary, self-recoverable degradation or loss of performance is allowed, but no change of actual operating state or loss of stored data is allowed C — temporary loss of function is allowed provided that the function is self recoverable or can be restored by the operation of the controls 3 Radiated emissions may exceed the levels specified in EN 61326 when this instrument is connected to a test object. 4 USB mouse and keyboard only, performance criterion C. Normal USB keyboard or mouse operation can be restored by unplugging and reconnecting the USB connector to the instrument. If the USB mouse, front-panel controls, or touch screen do not respond, press the On/Standby switch for five seconds to cycle power.
FCC	Radiated and conducted emissions do not exceed the levels specified in FCC47 CFR, Part 15, Subpart B, for Class A equipment.

Table A- 11: 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 CAT II CAT I	Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location. Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected. Secondary (signal level) or battery operated circuits of electronic equipment.
Pollution Degree	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 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.
Safety Certification Compliance		
Equipment Type	Test and measuring	
Safety Class	Class 1 (as defined in IEC 61010-1/A2) - grounded product	
Pollution Degree	Pollution Degree 2 (as defined in IEC 61010-1/A2). Note: Rated for indoor use only.	

Appendix B: Performance Verification

This Performance Verification checks that the VM5000HD meets its video measurement specifications (Table A–1 in Appendix A, Specifications).

Prerequisites

- The test signal generator and VM5000HD instrument require a minimum 20 minute warm-up time before doing any performance verification tests.
- Perform the VM5000HD instrument internal system diagnostics in the Utilities menu. The instrument must pass the diagnostics before you can verify performance.
- Perform the VM5000HD instrument Signal Path Calibration (SPC) procedure. The instrument must pass the SPC before you can verify performance.

Required Equipment

Table B- 1: Required test equipment

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
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

VM5000HD Tests

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.

Equipment required	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 prior to 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 CH 1 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.

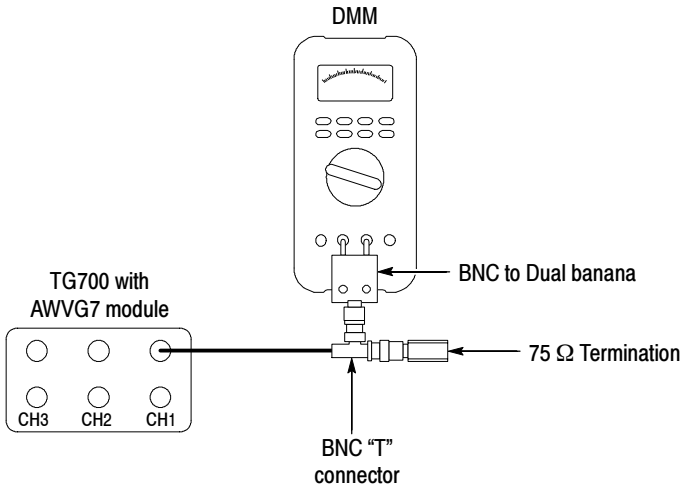


Figure B-1: Signal output amplitude test hookup

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 CH 1 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 CH 2 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 CH 3 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 CH 2 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

	CH 1	CH 2	CH 3
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 (CH 1, CH 2, CH 3) 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.

Equipment required	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 prior to doing this test. You must have completed the procedure *Determine the AWVG7 Signal Outlet Amplitude* 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 VM5000HD, so that the cable from the AWVG7 CH1 output goes to the VM5000HD CH1 input.
   - **d.** Connect the CH2 cable to the VM5000HD CH2 input and the CH3 cable to the VM5000HD CH3 input.

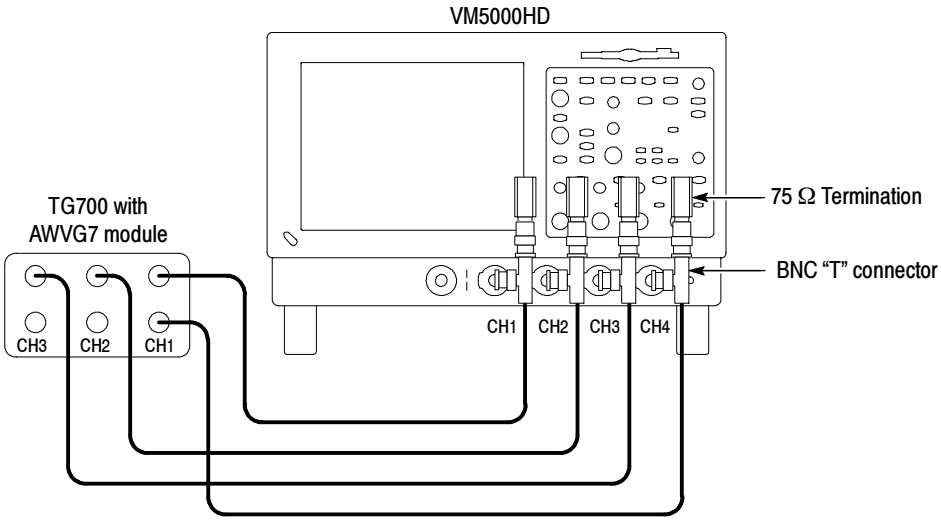


Figure B-2: Amplitude accuracy test hookup

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 VM5000HD 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.*

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6. Press **COLOR BAR** repeatedly to display **100% Color Bars**.

7. Start the VM5000HD application (**File > Applications > VM5000HD**).

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.

11. Select the VM5000HD **Run** button. The color bar measurement results table should appear with continuously updated measurements.

12. In the Color bar measurements view, change the **Averages** setting to **64**.

13. Record the VM5000HD 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

	CH 1 (Y/G)	CH 2 (B/Pb)	CH 3 (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			
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 VM5000HD white limit, using equation 1, and enter the values in row 2, Table B–3.

c. For each channel, calculate the Upper VM5000HD white limit, using equation 2, and enter the values in row 3, Table B–3.

15. Check that the VM5000HD 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

	CH 1 (Y/G)	CH 2 (B/Pb)	CH 3 (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 VM5000HD 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 VM5000HD video input channels (CH 1, CH 2, CH 3) 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.

Equipment required	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 prior to doing this test.

***NOTE**. The AWVG7 must meets its frequency response specification of ±1%(0.09dB) 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 VM5000HD, so that the cable from the AWVG7 CH1 output goes to the VM5000HD CH1 input.
   d. Connect the CH2 cable to the VM5000HD CH2 input and the CH3 cable to the VM5000HD 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 VM5000HD CH4 input.

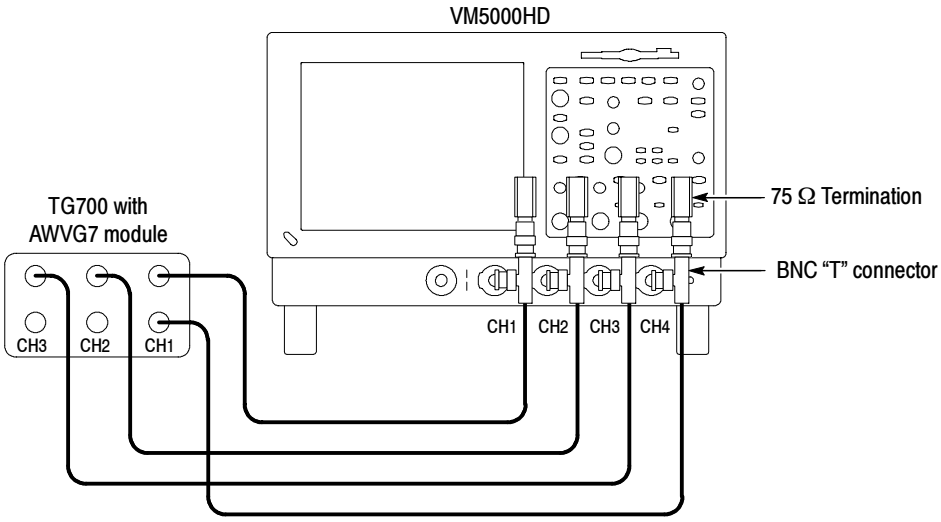

Figure B-3: Frequency accuracy test hookup

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 VM5000HD application (**File > Applications > VM5000HD**).
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 VM5000HD **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.
17. Select the VM5000HD **Stop** button to halt measurement.
18. Press the TG700 **Multiburst** button repeatedly to display **Multiburst 10-20 MHz.**
19. Select the VM5000HD **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 ±0.75 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.
21. Select the VM5000HD **Stop** button to halt measurement.
22. Press the TG700 **Multiburst** button repeatedly to display **Multiburst 20-30 MHz.**
23. Select the VM5000HD **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 ±0.75 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.

Check Noise Floor Measurement Accuracy

This test verifies the noise floor of the three VM5000HD video input channels (CH 1, CH 2, CH 3) 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.

Equipment required	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 prior to 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 VM5000HD CH 4 input and a 75 Ω termination using a BNC 'T' connector.
   - **c.** Place 75 Ω terminations on the VM5000HD CH 1, CH 2, and CH 3 inputs.

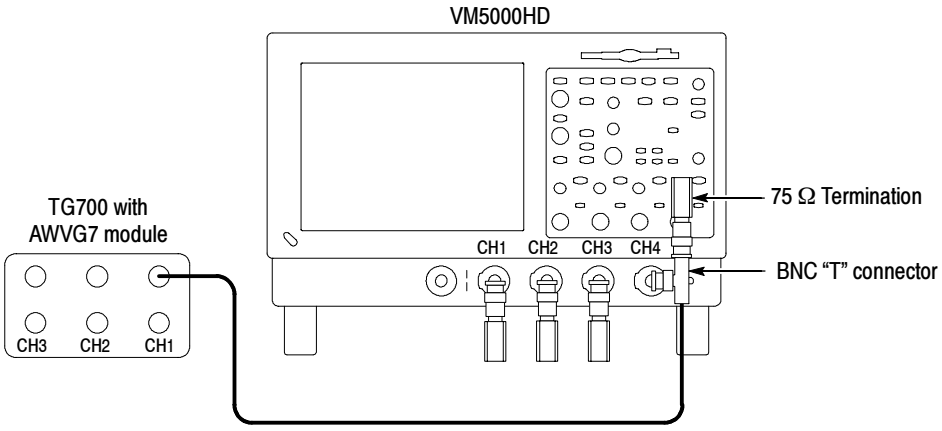

Figure B-4: Noise floor accuracy test hookup

2. Start the VM5000HD application (**File > Applications > VM5000HD**).
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 VM5000HD **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 VM5000HD CH 1, CH 2, and CH 3 measurement channels. Delay match error affects Channel Delay measurement accuracy. The specification for delay match error between any two channels is less than 1 ns.

Equipment required	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 prior to 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 VM5000HD CH 1 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 VM5000HD CH 4 input and a 75 Ω termination using a BNC 'T' connector.

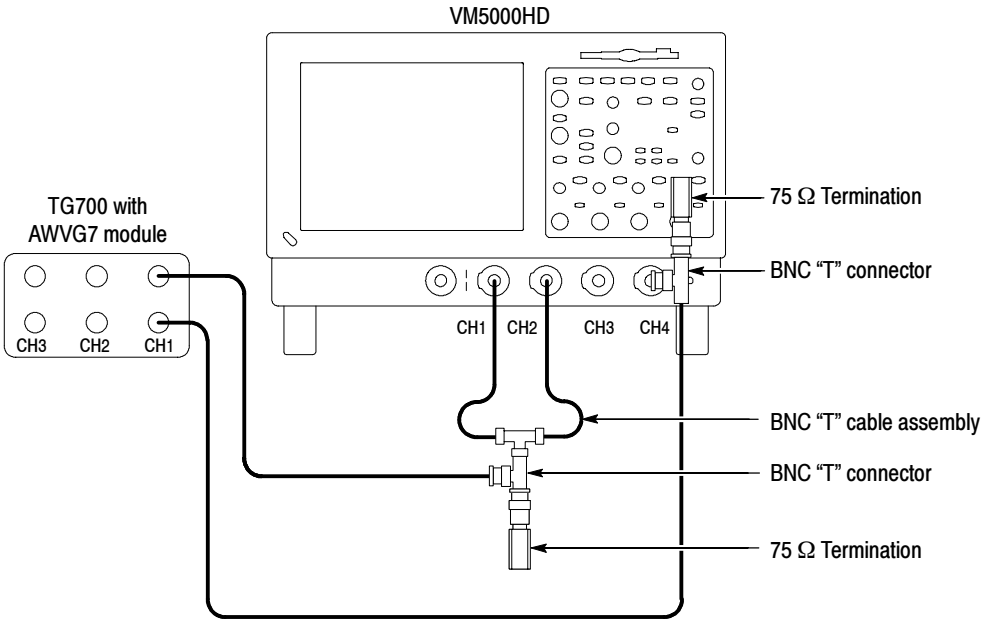

Figure B-5: Channel delay match test hookup

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 VM5000HD application (**File > Applications > VM5000HD**).

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 VM5000HD **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 CH 1 and CH 2.

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 VM5000HD CH 1 and CH 3 inputs. Repeat the procedure in steps 14 through 17 for the G-R measurement.

19. Connect the BNC 'T' Cable to the VM5000HD CH 2 and CH 3 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 VM5000HD performance verification.

Appendix C: Remote Commands

You can control the VM5000HD through the GPIB interface using commands and queries. The remote commands have the same functionalities as the menus and buttons in the user interface. You can see the effect of the commands on the interface as they are received.

***NOTE**. All oscilloscope platform GPIB commands are supported on the VM5000HD instrument. For documentation on these commands, please refer to the* TDS5000 GPIB Online Programmer Guide *provided on the TDS5000 product software CD (063-3508-XX); see the installation instructions in the CD booklet.*

This section covers the following information:

Syntax

Commands consist of set commands and query commands (usually simply called commands and queries). Commands modify the VM5000HD settings or tell the instrument to perform a specific action. Queries cause the VM5000HD to return data and information about its status.

Most commands have both a set and a query form, although some commands only have a query form.

Command Structure

VM5000HD instrument commands have the structure:

```
:VARIable:VALue "<Command>", "<Argument>"
```

- You can abbreviate `VARIable:VALue` to `VARI:VAL` if desired, and it is case insensitive.
- There are no abbreviated versions of the `"<Command>", "<Argument>"` part of the VM5000HD commands; you must enter the full name of this part of a command.

- The <Command> field is case sensitive, and use of incorrect command case spelling can result in unexpected results.
- All commands have a single <Argument>, which is case insensitive and cannot be the empty string "".
- Arguments are limited to a maximum of 60 characters. Arguments longer than 60 characters can cause unexpected behavior of the instrument and may require the application to be restarted, so this should be avoided.
- The comma character (,) and the double quote character (") are special characters and should not be used in the argument, otherwise unexpected behavior can result. All other printable characters are permitted in the argument.
- Commands that accept numeric arguments accept either integer or floating point values, with or without an exponent. This is equivalent to GPIB standard numeric formats <NR1>, <NR2>, and <NR3>.
- The VM5000HD instrument does not support using a semicolon (;) to concatenate commands.

Query Structure

VM5000HD instrument queries have the structure:

```
:VARIable:VALue? "<Command>"
```

- You can abbreviate VARIable:VALue? to VARI:VAL? if desired, and it is case insensitive.
- There are no abbreviated versions of the "<Command>" part of the VM5000HD queries; you must enter the full name of a query.
- The <Command> field is case sensitive, and use of incorrect command case spelling can result in unexpected results.
- The VM5000HD does not support using a semicolon (;) to concatenate queries.
- Query responses are always in upper case.
- The units and precision of result queries are identical to those in the user interface and those produced by generating a report.

Remote Startup and Exit of the Instrument

To start the application using remote commands, use the following command:

```
application:activate "VM5000HD"
```

To exit the application using remote commands, use the following command:

```
VARIable:VALue "application", "exit"
```

You can check whether or not the VM5000HD application is running using the following query:

```
VARIable:VALue? "application"
```

If the application is running, this query will return “VM5000HD”. However, if the application is not currently running, it will return the empty string “”.

Command Groups

Tables C–1 through C–7 list the commands organized by functional group. (Refer to the Table of Contents for a list of all the commands in alphabetical order.)

Table C-1: Configuration commands

Header	Description
:VARIable:VALue	
AutoScale	Set or query whether to use auto scale during measurement
ChannelDelaySet	Set or query whether to measure channel delay upon Execute
ColorBarsSet	Set or query whether to measure Color Bars upon Execute
ColorSpace	Set or query the video color space to use for measurement
Format	Set or query the video format to use for measurement
MultiBurstSet	Set or query whether Multiburst is to be measured upon Execute
NoiseSet	Set or query whether Noise is to be measured upon Execute
NonLinearitySet	Set or query whether Non-Linearity is to be measured upon Execute
RunMode	Set or query run mode to use for measurement
SetupAndOrRun	Set or query setup mode to use for measurement
SyncSet	Set or query whether Sync is to be measured upon Execute
Trigger	Set or query the video trigger to use for measurement
WarningReportingMeasure	Set or query whether measurement warnings create a warning message
WarningReportingResults	Set or query whether results warnings are to create a warning message
WarningReportingSignal	Set or query whether signal warnings create a warning message

Table C-2: Miscellaneous commands

Header	Description
:VARIable:VALue	
Error	Reset error to 0 or query error value.
ID?	Query the ID/Version of the application
OPComplete	Controls VM5000HD GPIB scripts by ensuring that the previous command is ready before either querying its value or calling the next command.
Warning	Reset warning to 0 or query warning value.

Table C-3: Reports commands

Header	Description
:VARIable:VALue	
ReportGenerate	Generates a measurement report of the specified type (if a measure has been run and results are available), and saves it in the specified file
ReportMeasurements	Set or query the measurements to write to the report when ReportGenerate is called
ReportString	Set or query any additional information to write to the report when ReportGenerate is called

Table C-4: Results commands

Header	Description
:VARIable:VALue:	
ChannelDelayAll?	Query all three delay measurements performed by Channel Delay
ChannelDelayCh1Ch2?	Query the Ch1Ch2 delay measurement performed by Channel Delay
ChannelDelayCh1Ch3?	Query the Ch1Ch3 delay measurement performed by Channel Delay
ChannelDelayCh2Ch3?	Query the Ch2Ch3 delay measurement performed by Channel Delay
ColorBarsmVCh[1..3]?	Query all eight level values resulting from Color Bars measurement for the specified channel
ColorBarsmVCh[1..3]Val[1..8]?	Query the value resulting from the specified Color Bars channel and value measurement
MultiburstAmpdBCh[1..3]?	Query all six amplitude values resulting from the specified Multiburst channel measurement
MultiburstAmpdBCh[1..3]Val[1..6]?	Query the amplitude value resulting from the specified Multiburst channel and value measurement
MultiburstFlagmVCh[1..3]?	Query the Flag value resulting from Multiburst measurement for the specified channel
MultiburstFreqCh[1..3]?	Query all six frequency values resulting from the specified Multiburst channel measurement
MultiburstFreqCh[1..3]Val[1..6]?	Query the frequency value resulting from the specified Multiburst channel and value measurement
NoiseAmpdBCh[1..3]?	Query amplitude value (in dB) resulting from Noise measurement for the specified channel
NoiseAmpmVCh[1..3]?	Query amplitude value (in mV) resulting from Noise measurement for the specified channel
NonLinearityPctCh[1..3]?	Query all six non-linearity values resulting from the Non-Linearity measurement for the specified channel
NonLinearityPctCh[1..3]Max?	Query the maximum non-linearity value for the specified channel
NonLinearityPctCh[1..3]Val[1..5]?	Query the maximum non-linearity value for the specified channel and value

Table C- 4: Results commands (Cont.)

Header	Description
SyncLevelsmV?	Query all synchronization levels resulting from the Sync measurement
SyncLevelsmVVal[1..3]?	Query the specified synchronization level resulting from the Sync measurement
SyncTimes?	Query all synchronization times resulting from the Sync measurement
SyncTimesVal[1..7]?	Query the specified synchronization time resulting from the Sync measurement

Table C- 5: Run commands

Header	Description
:VARIable:VALue	
Execute	Execute or stop the current set measurement(s), or query whether any measurement is currently being executed

Table C- 6: Settings commands

Header	Description
:VARIable:VALue	
DefaultSettings	Restore default (factory) settings
RecallSettings	Recall settings stored in the specified path/filename
SaveSettings	Save current settings in the specified path/filename

Table C- 7: Setup commands

Header	Description
:VARIable:VALue	
ChannelDelayAverage	Set or query the number of samples over which to average the Channel Delay measurement
ChannelDelayLine	Set or query line number that is to be used for the Channel Delay measurement
ColorBarsAverage	Set or query the number of samples over which to average the Color Bars measurement
ColorBarsLine	Set or query line number that is to be used for the Color Bars measurement
MultiburstAverage	Set or query the number of samples over which to average the Multiburst measurement
MultiburstLine	Set or query line number that is to be used for the Multiburst measurement

Table C- 7: Setup commands (Cont.)

Header	Description
NoiseAverage	Set or query the number of samples over which to average the Noise measurement
NoiseBW	Set or query bandwidth of noise filter that is to be used for Noise measurement, if the unweighted noise filter is selected
NoiseFilter	Set or query type of noise filter that is to be used for Noise measurement
NoiseLine	Set or query line number that is to be used for the Noise measurement
NonLinearityAverage	Set or query the number of samples over which to average the Non-Linearity measurement
NonLinearityLine	Set or query line number that is to be used for the Non-Linearity measurement
SyncAverage	Set or query the number of samples over which to average the Sync measurement
SyncLine	Set or query line number that is to be used for the Sync measurement

Commands

The following remote commands are listed in alphabetical order.

AutoScale < setting >

Set or query whether auto scale is to be used during measurement.

Syntax

```
VARIable:VALue "AutoScale", "< setting >"
VARIable:VALue? "AutoScale"
```

Group

Configuration

Arguments

< setting > specifies auto scale setting that is to be used.
Valid settings are: OFF, ON, 0, 1.

Returns

Query returns the current specified setting.

Examples

```
VARIable:VALue "AutoScale", "ON"
VARIable:VALue? "AutoScale"
```

Query may return: `"AutoScale 0"`

ChannelDelayAll?

Query all 3 delay measurements performed by Channel Delay.

Syntax `VARIable:VALue? "ChannelDelayAll"`

Group Results

Arguments None

Related Commands ChannelDelayCh1Ch2
ChannelDelayCh1Ch3
ChannelDelayCh2Ch3

Returns Returns all three delay measurements (in nanoseconds) performed by Channel Delay, in this order: Ch1Ch2 Ch1Ch3 Ch2Ch3.

Returns `"---"` if no valid measurement currently available.

Examples `VARIable:VALue? "ChannelDelayAll"`

Query may return: `"ChannelDelayAll 1.84 0.04 –1.54"`

ChannelDelayAverage < samples >

Set or query the number of samples over which to average the Channel Delay measurement.

Syntax

```
VARIable:VALue "ChannelDelayAverage", "< samples >"
VARIable:VALue? "ChannelDelayAverage"
```

Group

Setup

Arguments

`< samples >` can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current number of samples for Channel Delay measurement.

Examples

```
VARIable:VALue "ChannelDelayAverage", "1"
VARIable:VALue? "ChannelDelayAverage"
```

Query may return: `"ChannelDelayAverage 8"`

ChannelDelayCh1Ch2?

Query the Ch1Ch2 delay measurement performed by Channel Delay.

Syntax `VARIable:VALue? "ChannelDelayCh1Ch2"`

Group Results

Arguments None

Related Commands ChannelDelayAll
ChannelDelayCh1Ch3
ChannelDelayCh2Ch3

Returns Returns the Ch1Ch2 delay measurement (in nanoseconds) performed by Channel Delay.

Returns `"---"` if no valid measurement is currently available.

Examples `VARIable:VALue? "ChannelDelayCh1Ch2`

Query may return: `"ChannelDelayCh1Ch2 1.84"`

ChannelDelayCh1Ch3?

Query the Ch1Ch3 delay measurement performed by Channel Delay.

Syntax

```
VARIable:VALue? "ChannelDelayCh1Ch3"
```

Group

Results

Arguments

None

Related Commands

ChannelDelayAll
ChannelDelayCh1Ch2
ChannelDelayCh2Ch3

Returns

Returns the Ch1Ch3 delay measurement (in nanoseconds) performed by Channel Delay.

Returns `"---"` if no valid measurement currently available.

Examples

```
VARIable:VALue? "ChannelDelayCh1Ch3"
```

Query may return: `"ChannelDelayCh1Ch3 0.04"`

ChannelDelayCh2Ch3?

Query the Ch2Ch3 delay measurement performed by Channel Delay.

Syntax

```
VARIable:VALue? "ChannelDelayCh2Ch3"
```

Group

Results

Arguments

None

Related Commands

ChannelDelayAll
ChannelDelayCh1Ch2
ChannelDelayCh1Ch3

Returns

Returns the Ch2Ch3 delay measurement (in nanoseconds) performed by Channel Delay.

Returns `"---"` if no valid measurement is currently available.

Examples

```
VARIable:VALue? "ChannelDelayCh2Ch3"
```

Query may return: `"ChannelDelayCh2Ch3 –1.54"`

ChannelDelayLine < linenumber >

Set or query line number that is to be used for Channel Delay measurement.

Syntax

```
VARIable:VALue "ChannelDelayLine", "< linenumber >"
VARIable:VALue? "ChannelDelayLine"
```

Group

Setup

Arguments

`< linenumber >` can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current line number for Channel Delay measurement.

Examples

```
VARIable:VALue "ChannelDelayLine", "200"
VARIable:VALue? "ChannelDelayLine"
```

Query may return: `"ChannelDelayLine 325"`

ChannelDelaySet < setting >

Set or query whether Channel Delay is to be measured upon Execute.

Syntax

VARIable:VALue “ChannelDelaySet”, “< setting >”
VARIable:VALue? “ChannelDelaySet”

Group

Configuration

Arguments

`< setting >` specifies whether to perform Channel Delay measurement upon Execute.
Valid values are: OFF, ON, 0, 1.

Related Commands

Execute
ReportMeasurements

Returns

Query returns 0 or 1 depending on whether ChannelDelaySet measurement is selected.

Examples

VARIable:VALue “ChannelDelaySet”, “ON”
VARIable:VALue? “ChannelDelaySet”
Query may return: “ChannelDelaySet 1”

ColorBarsAverage < samples >

Set or query the number of samples over which to average the Color Bars measurement.

Syntax

```
VARIable:VALue "ColorBarsAverage", "< samples >"
VARIable:VALue? "ColorBarsAverage"
```

Group

Setup

Arguments

`< samples >` can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current number of samples for Color Bars measurement.

Examples

```
VARIable:VALue "ColorBarsAverage", "1"
VARIable:VALue? "ColorBarsAverage"
```

Query may return: `"ColorBarsAverage 8"`

ColorBarsLine < linenumber >

Set or query line number that is to be used for Color Bars measurement.

Syntax

```
VARIable:VALue "ColorBarsLine", "< linenumber >"
VARIable:VALue? "ColorBarsLine"
```

Group

Setup

Arguments

`< linenumber >` can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current line number for Color Bars measurement.

Examples

```
VARIable:VALue "ColorBarsLine", "200"
VARIable:VALue? "ColorBarsLine"
```

Query may return: `"ColorBarsLine 325"`

ColorBarsmVCh[1..3]?

Query all eight level values (in mV) resulting from the Color Bars measurement for the specified channel.

Syntax `VARIable:VALue? "ColorBarsmVCh[1..3]"`

Group Results

Arguments None

Related Commands ColorBarsmVCh[1..3]Val[1..8]

Returns Returns all eight delay measurements (in mV) performed by Color Bars, in this order: White Yellow Cyan Green Magenta Red Blue Black.

Returns `"---"` if no valid measurement is currently available.

Examples `VARIable:VALue? "ColorBarsmVCh1"`

Query may return:
`"ColorBarsmVCh1 699.76 650.52 552.75 501.98 201.89 150.74 52.11 0.49"`

ColorBarsmVCh[1..3]Val[1..8]?

Query the value (in mV) resulting from Color Bars measurement for the specified channel and value.

Syntax `VARIable:VALue? "ColorBarsmVCh[1..3]Val[1..8]"`

Group Results

Arguments None

Related Commands ColorBarsmVCh[1..3]

Returns Returns the specified Color Bars value (in mV).

Values must be in the range: 1..8
Values must designate the following colors:
1-White 2-Yellow 3-Cyan 4-Green 5-Magenta 6-Red 7-Blue 8-Black.

Returns `"---"` if no valid measurement is currently available

Examples `VARIable:VALue? "ColorBarsmVCh2Val6"`

Query may return: `"ColorBarsmVCh2Val6 –78.89"`

ColorBarsSet < setting >

Set or query whether Color Bars is to be measured upon Execute.

Syntax

```
VARIable:VALue "ColorBarsSet", "< setting >"
VARIable:VALue? "ColorBarsSet"
```

Group

Configuration

Arguments

`< setting >` specifies whether to perform Color Bars measurement upon Execute. Valid values are: OFF, ON, 0, 1

Related Commands

Execute
ReportMeasurements

Returns

Query returns 0 or 1 depending on whether ColorBarsSet measurement is selected.

Examples

```
VARIable:VALue "ColorBarsSet", "ON"
VARIable:VALue? "ColorBarsSet"
```

Query may return: `"ColorBarsSet 1"`

ColorSpace < colorspace >

Set or query video color space to use for measurement.

Syntax

```
VARIable:VALue "ColorSpace", "< colorspace >"
VARIable:VALue? "ColorSpace"
```

Group

Configuration

Arguments

`< colorspace >` specifies color space that is to be set. Valid color spaces are: YPbPr, RGB

Returns

Query returns the current specified color space

Examples

```
VARIable:VALue "ColorSpace", "YPbPr"
VARIable:VALue? "ColorSpace"
```

Query may return: `"ColorSpace YPbPr"`

DefaultSettings

Command restores default (factory) settings.
Query returns “OK” unless the command is still being processed, in which case it returns “1”.

Restores default (factory) settings.

Syntax

```
VARIable:VALue "DefaultSettings", "1"
VARIable:VALue? "DefaultSettings"
```

Group

Settings

Arguments

Valid value is 1.

Returns

Query returns "OK” unless the command is still being processed, in which case it returns "1".

Examples

```
VARIable:VALue "DefaultSettings", "1"
VARIable:VALue? "DefaultSettings"
```

Query may return: "DefaultSettings OK"

Error < setting >

Command can be used to reset Error to “0”.
Query returns the most recent error reported by the application, or “0” if no errors have occurred since Error was last reset.

Initialized to “0” on startup.

Syntax

```
VARIable:VALue "Error" < setting >
VARIable:VALue? "Error"
```

Group

Miscellaneous

Arguments

`< setting >` resets Error to “0”.
Valid values are: OFF, 0.

Returns

Returns the most recent error reported by the application. Returns “0” if no error has occurred since the Error command was last reset. For a listing of all possible errors, refer to Table C–9 on page C–71.

Examples

```
VARIable:VALue "Error", "OFF"
VARIable:VALue? "Error"
```

Query may return: `"Error No Measurement Selected"`

Execute < setting >

Execute/stop the current set measurement(s), or query whether any measurement is currently being executed. If the measurement is already in the mode specified by the setting, the command has no effect. For example, if a measurement is already running and "VARIable:VALue "Execute", "1" is received, the measurement will continue to run.

Syntax

```
VARIable:VALue "Execute", "< setting >"
VARIable:VALue? "Execute"
```

Group

Run

Arguments

`< setting >` Valid settings are: OFF, 0, ON, 1.
OFF is the same as 0, and ON is the same as 1.

Related Commands

ChannelDelaySet
ColorBarSet
MultiburstSet
NoiseSet
NonLinearitySet
SyncSet

Returns

Query returns 1 if any measurement is currently being executed, otherwise it returns 0.

Examples

```
VARIable:VALue "Execute", "1"
VARIable:VALue? "Execute"
```

Query may return: `"Execute 1"`

Format < format >

Set or query video format to use for measurement. No defaults.

If you get the error message, “Invalid Argument”, make sure that you specified a valid format.

Syntax

```
VARIable:VALue "Format", "< format >"
VARIable:VALue? "Format"
```

Group

Configuration

Arguments

`< format >` specifies format that is to be set.
Valid formats are: HD480P60, HD576P50, HD720P60, HD1080I50, HD1080I60, SXGAP60

Returns

Query returns the current specified format.

Examples

```
VARIable:VALue "Format", "HD480P60"
VARIable:VALue? "Format"
```

Query may return: `"Format HD1080I60"`

ID?

Query the ID/Version of the application.

Syntax `VARIable:VALue? "ID"`

Group Miscellaneous

Arguments None

Returns Returns the application's ID

Examples `VARIable:VALue? "ID"`

Query may return: `"ID Tek/VM5000HD FV:1.0"`

MultiburstAmpdBCh[1..3]?

Query all six amplitude values (in dB) resulting from Multiburst measurement for the specified channel.

Syntax `VARIable:VALue? "MultiburstAmpdBCh[1..3]"`

Group Results

Arguments None

Related Commands MultiburstAmpdBCh[1..3]Val[1..6]

Returns Returns all six amplitude values (in dB) in burst order.

Returns `"---"` if no valid measurement currently available.

Examples `VARIable:VALue? "MultiburstAmpdBCh2"`

Query may return:
`"MultiburstAmpdBCh2 –0.09 –0.18 –0.14 –0.13 –0.08 –0.02"`

MultiburstAmpdBCh[1..3]Val[1..6]?

Query the amplitude (in dB) resulting from Multiburst measurement for the specified channel and value.

Syntax `VARIable:VALue? "MultiburstAmpdBCh[1..3]Val[1..6]"`

Group Results

Arguments None

Related Commands MultiburstAmpdBCh[1..3]

Returns Returns the specified Multiburst value (in dB).

Returns `"---"` if no valid measurement is currently available.

Examples `VARIable:VALue? "MultiburstAmpdBCh1Val2"`

Query may return: `"MultiburstAmpdBCh1Val2 -0.26"`

MultiburstAverage < samples >

Set or query the number of samples over which to average the Multiburst measurement.

Syntax

```
VARIable:VALue "MultiburstAverage", "< samples >"
VARIable:VALue? "MultiburstAverage"
```

Group

Setup

Arguments

`< samples >` can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current number of samples for Multiburst measurement.

Examples

```
VARIable:VALue "MultiburstAverage", "1"
VARIable:VALue? "MultiburstAverage"
```

Query may return: `"MultiburstAverage 8"`

MultiburstFlagmVCh[1..3]?

Query the Flag value (in mV) resulting from Multiburst measurement for the specified channel.

Syntax

```
VARIable:VALue? "MultiburstFlagmVCh[1..3]"
```

Group

Results

Arguments

None

Returns

Returns the Flag value (in mV).

Returns `"---"` if no valid measurement currently available.

Examples

```
VARIable:VALue? "MultiburstFlagmVCh3"
```

Query may return: `"MultiburstFlagmVCh3 428.01"`

MultiburstFreqCh[1..3]?

Query all six frequency values (in MHz) resulting from Multiburst measurement for the specified channel.

Syntax `VARIable:VALue? "MultiburstFreqCh[1..3]"`

Group Results

Arguments None

Related Commands MultiburstFreqCh[1..3]Val[1..6]

Returns Returns all six frequency values (in MHz) in burst order.

Returns `"---"` if no valid measurement currently available.

Examples `VARIable:VALue? "MultiburstFreqCh1"`

Query may return:
“`MultiburstFreqCh1 10.00 12.00 14.00 16.00 18.01 20.00"`

MultiburstFreqCh[1..3]Val[1..6]?

Query the frequency (in MHz) resulting from Multiburst measurement for the specified channel and value.

Syntax `VARIable:VALue? "MultiburstFreqCh[1..3]Val[1..6]"`

Group Results

Arguments None

Related Commands MultiburstFreqCh[1..3]

Returns Returns the specified Multiburst frequency (in MHz).

Returns `"---"` if no valid measurement currently available.

Examples `VARIable:VALue? "MultiburstFreqCh1Val2"`

Query may return: `"MultiburstFreqCh1Val2 12.00"`

MultiburstLine < linenumber >

Set or query line number that is to be used for Multiburst measurement.

Syntax

```
VARIable:VALue "MultiburstLine", "< linenumber >"
VARIable:VALue? "MultiburstLine"
```

Group

Setup

Arguments

`< linenumber >` can be an integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current line number for Multiburst measurement.

Examples

```
VARIable:VALue "MultiburstLine", "200"
VARIable:VALue? "MultiburstLine"
```

Query may return: `"MultiburstLine 325"`

MultiburstSet < setting >

Set or query whether Multiburst is to be measured upon Execute.

Syntax

```
VARIable:VALue "MultiburstSet", "< setting >"
VARIable:VALue? "MultiburstSet"
```

Group

Configuration

Arguments

`< setting >` specifies whether to perform Multiburst measurement upon Execute. Valid values are: OFF, ON, 0, 1

Related Commands

Execute
ReportMeasurements

Returns

Query returns 0 or 1 depending on whether MultiburstSet measurement is selected.

Examples

```
VARIable:VALue "MultiburstSet", "ON"
VARIable:VALue? "MultiburstSet"
```

Query may return: `"MultiburstSet 1"`

NoiseAmpdBCh[1..3]?

Query amplitude value (in dB) resulting from Noise measurement for the specified channel.

Syntax `VARIable:VALue? "NoiseAmpdBCh[1..3]"`

Group Results

Arguments None

Returns Returns amplitude value (in dB).

Returns `"---"` if no valid measurement currently available.

Examples `VARIable:VALue? "NoiseAmpdBCh2"`

Query may return: `"NoiseAmpdBCh2 66.43"`

NoiseAmpmVCh[1..3]?

Query amplitude value (in mV) resulting from a Noise measurement for the specified channel.

Syntax `VARIable:VALue? "NoiseAmpmVCh[1..3]"`

Group Results

Arguments None

Returns Returns amplitude value (in mV).

Returns "`---`" if no valid measurement is currently available.

Examples `VARIable:VALue? "NoiseAmpmVCh2"`

Query may return: `"NoiseAmpmVCh2 0.33"`

NoiseAverage < samples >

Set or query the number of samples over which to average the Noise measurement.

Syntax

```
VARIable:VALue "NoiseAverage", "< samples >"
VARIable:VALue? "NoiseAverage"
```

Group

Setup

Arguments

`< samples >` Can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current number of samples for Noise measurement.

Examples

```
VARIable:VALue "NoiseAverage", "1"
VARIable:VALue? "NoiseAverage"
```

Query may return: `"NoiseAverage 8"`

NoiseBW < bandwidth >

Set or query bandwidth of noise filter that is to be used for noise measurement, if the unweighted noise filter is selected.

Syntax

```
VARIable:VALue "NoiseBW", "< bandwidth >"
VARIable:VALue? "NoiseBW"
```

Group

Setup

Arguments

`< bandwidth >` specifies bandwidth of unweighted noise filter, in Hz. Can be integer or floating point. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Related Commands

NoiseFilter

Returns

Query returns the current unweighted noise filter bandwidth, in Hz.

Examples

```
VARIable:VALue "NoiseBW", "30000000"
VARIable:VALue "NoiseBW", "3.2E7"
VARIable:VALue? "NoiseBW"
```

Query may return: `"NoiseBW 50000000"`

NoiseFilter < noisefilter >

Set or query type of noise filter that is to be used for noise measurement.

Syntax

```
VARIable:VALue "NoiseFilter", "< noisefilter >"
VARIable:VALue? "NoiseFilter"
```

Group

Setup

Arguments

`< noisefilter >` specifies type of noise filter that is to be used for noise measurement. Valid noise filters are: Off, Unified, Unweighted.

Related Commands

NoiseBW

Returns

Query returns the current specified noise filter.

Examples

```
VARIable:VALue "NoiseFilter", "Unified"
VARIable:VALue? "NoiseFilter"
```

Query may return: `"NoiseFilter Off"`

NoiseLine < linenumber >

Set or query line number that is to be used for Noise measurement.

Syntax

```
VARIable:VALue "NoiseLine", "< linenumber >"
VARIable:VALue? "NoiseLine"
```

Group

Setup

Arguments

`< linenumber >` Can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current line number for Noise measurement.

Examples

```
VARIable:VALue "NoiseLine", "200"
VARIable:VALue? "NoiseLine"
```

Query may return: `"NoiseLine 325"`

NoiseSet < setting >

Set or query whether Noise is to be measured upon Execute.

Syntax

```
VARIable:VALue "NoiseSet", "< setting >"
VARIable:VALue? "NoiseSet"
```

Group

Configuration

Arguments

`< setting >` specifies whether to perform Noise measurement upon Execute. Valid values are: OFF, ON, 0, 1.

Related Commands

Execute
NoiseMeasurements

Returns

Query returns 0 or 1 depending on whether NoiseSet measurement is selected

Examples

```
VARIable:VALue "NoiseSet", "ON"
VARIable:VALue? "NoiseSet"
```

Query may return: `"NoiseSet 1"`

NonLinearityAverage < samples >

Set or query the number of samples over which to average the Non-Linearity measurement.

Syntax

```
VARIable:VALue "NonLinearityAverage", "< samples >"
VARIable:VALue? "NonLinearityAverage"
```

Group

Setup

Arguments

`< samples >` Can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current number of samples for Non-Linearity measurement.

Examples

```
VARIable:VALue "NonLinearityAverage", "1"
VARIable:VALue? "NonLinearityAverage"
```

Query may return: `"NonLinearityAverage 8"`

NonLinearityLine < linenumber >

Set or query line number that is to be used for Non-Linearity measurement.

Syntax

```
VARIable:VALue "NonLinearityLine", "< linenumber >"
VARIable:VALue? "NonLinearityLine"
```

Group

Setup

Arguments

`< linenumber >` Can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current line number for Non-Linearity measurement.

Examples

```
VARIable:VALue "NonLinearityLine", "200"
VARIable:VALue? "NonLinearityLine"
```

Query may return: `"NonLinearityLine 325"`

NonLinearityPctCh[1..3]?

Query all six non-linearity values (as a percentage) resulting from Non-Linearity measurement for the specified channel.

Syntax

```
VARIable:VALue? "NonLinearityPctCh[1..3]"
```

Group

Results

Arguments

None

Related Commands

NonLinearityPctCh[1..3]Max
NonLinearityPctCh[1..3]Val[1..5]

Returns

Returns all six non-linearity values (as a percentage) in this order: Maximum Step1 Step2 Step3 Step4 Step5.

Returns `"---"` if no valid measurement is currently available

Examples

```
VARIable:VALue? "NonLinearityPctCh3"
```

Query may return:

```
"NonLinearityPctCh3 0.82 0.00 0.82 0.69 0.21 0.28"
```

NonLinearityPctCh[1..3]Max?

Query the maximum non-linearity value (as a percentage) resulting from a Non-Linearity measurement for the specified channel.

Syntax `VARIable:VALue? "NonLinearityPctCh[1..3]Max"`

Group Results

Arguments None

Related Commands NonLinearityPctCh[1..3]
NonLinearityPctCh[1..3]Val[1..5]

Returns Returns maximum non-linearity value (as a percentage) for specified channel.

Returns `"---"` if no valid measurement currently available.

Examples `VARIable:VALue? "NonLinearityPctCh3Max"`

Query may return: `"NonLinearityPctCh3Max 0.82"`

NonLinearityPctCh[1..3]Val[1..5]?

Query the non-linearity value (as a percentage) resulting from a Non-Linearity measurement for the specified channel and step.

Syntax `VARIable:VALue? "NonLinearityPctCh[1..3]Val[1..5]"`

Group Results

Arguments None

Related Commands NonLinearityPctCh[1..3]
NonLinearityPctCh[1..3]Max

Returns Returns non-linearity value (as a percentage) for specified channel and step.

Returns `"---"` if no valid measurement is currently available.

Examples `VARIable:VALue? "NonLinearityPctCh3Val4"`

Query may return: `"NonLinearityPctCh3Val4 0.21"`

NonLinearitySet < setting >

Set or query whether Non-Linearity is to be measured upon Execute.

Syntax

```
VARIable:VALue "NonLinearitySet", "< setting >"
VARIable:VALue? "NonLinearitySet"
```

Group

Configuration

Arguments

< setting > specifies whether to perform Non-Linearity measurement upon Execute.

Valid values are: OFF, ON, 0, 1.

Returns

Query returns 0 or 1 depending on whether NonLinearitySet measurement is selected.

Examples

```
VARIable:VALue "NonLinearitySet", "ON"
VARIable:VALue? "NonLinearitySet"
```

Query may return: `"NonLinearitySet 1"`

OPComplete < setting >

OPComplete is set to “1” whenever a VM5000HD GPIB command has been received and processed and a new command is ready to be processed (except for the resetting of OPComplete itself, which sets OPComplete to “0”).

OPComplete can only be reset to “0” by the user, and it can only be set to “1” when a command has been sent and the next command is ready to be input.

OPComplete is designed to control VM5000HD GPIB scripts by ensuring that the previous command is ready before either (1) querying it’s value or (2) calling the next command. It should therefore be checked and reset in between each command, and before querying the new setting.

If a command sets its value to the same value that it is currently set to, OPComplete will not be set to “1”. To avoid this, either set Header to “ON”, or use all lowercase arguments for text (such as “hd480p60”and “on”), and floating-point input for numeric values (such as 21.0 instead of 21). This will always cause OPComplete to be set.

Initialized to “0” on startup.

Syntax

```
VARIable:VALue "OPComplete", "< setting >"
VARIable:VALue? "OPComplete"
```

Group

Miscellaneous

Arguments

< setting > – resets OPComplete so it is ready for the next command.
Valid values are: OFF, 0.

Returns

Query returns “1” if a command has been completed since OPComplete was last reset, otherwise it returns “0”

Examples

```
VARIable:VALue "OPComplete", "OFF"
VARIable:VALue? "OPComplete"
```

Query may return: `"OPComplete 1"`

A typical general-case usage of OPComplete might be:

```
VARIable:VALue "OPComplete", "OFF"
// reset first so we know it is set to "0"

VARIable:VALue "Command1", "Argument1"
// call first command

While ((VARIable:VALue? "OPComplete") == "0") (
                          Wait;
)
// wait till first command is ready before calling next command

// Now repeat the same process for the next command:
VARIable:VALue "OPComplete", "OFF"

// reset first so we know it is set to "0"
VARIable:VALue "Command2", "Argument2"
// call next command

While ((VARIable:VALue? "OPComplete") == "0") (
                          Wait;
)
// wait till this command is ready before calling next command
// and so on for subsequent commands
```

RecallSettings < pathstring >

Command recalls settings stored in the specified path/filename.
Query returns “OK” unless the command is still being processed, in which case it returns the current pathstring argument.

If you only specify the filename, the default path “c:\VM5000HD” is used. The file specified in pathstring must have the default extension “.vmset”, or else it will be appended.

If you get the error message, “Invalid Filename”, confirm that you typed the correct path and that your path is no more than 60 characters.

Syntax

```
VARIable:VALue "RecallSettings", "< pathstring >"
VARIable:VALue? "RecallSettings"
```

Group

Settings

Arguments

<pathstring> specifies the path/filename where the setup file is stored. Can either be (1) the full path and filename, or (2) just the filename, and the default path “c:\VM5000HD” will be used. The default extension “.vmset” will be appended if it is not specified. The pathstring must be less than 60 characters in length, otherwise the command may not be completed successfully.

Related Commands

SaveSettings

Returns

Query returns “OK” unless the command is still being processed, in which case it returns the current pathstring argument.

Examples

```
VARIable:VALue "RecallSettings", "c:\VM5000HD\Tek1.vmset"
VARIable:VALue "RecallSettings", "Tek2.vmset"
VARIable:VALue? "RecallSettings"
```

Query may return: `"RecallSettings OK"`

ReportGenerate < pathstring >

Command generates a measurement report of the specified type (if a measure has been run and results are available), and saves it in the file specified by pathstring. The type of file (.rtf, .csv or .pdf) is determined by the file extension in the pathstring. If the extension does not match one of these endings, a .pdf file is created by default and ".pdf" is appended to the end of the pathstring.

Query returns "OK" unless the command is still being processed, in which case it returns the current pathstring argument.

If you get the error message "Invalid Filename," confirm that you typed the correct path and that your path is no more than 60 characters.

Syntax

```
VARIable:VALue "ReportGenerate", "< pathstring >"
VARIable:VALue? "ReportGenerate"
```

Group

Reports

Arguments

<pathstring> path/filename where file is to be stored. Can either be (1) the full path and filename, or (2) just the filename, and the default path "c:\VM5000HD" will be used. The default extension ".pdf" will be appended if it is not specified. The specified directory will be created if it doesn't currently exist. The pathstring must be less than 60 characters in length, otherwise the command may not be completed successfully.

Related Commands

ReportString
ReportMeasurements

Returns

Query returns "OK" unless the command is still being processed, in which case it returns the current pathstring argument.

Examples

```
VARIable:VALue "ReportGenerate", "J:\netpath\colorbars.csv"
VARIable:VALue "ReportGenerate", "noise02"
VARIable:VALue? "ReportGenerate"
```

Query may return: `"ReportGenerate OK"`

ReportMeasurements < setting >

Set or query the measurements to write to the report when ReportGenerate is called.

Set to ”All” when application starts.

Syntax

```
VARIable:VALue "ReportMeasurements", "< measuremode>"
VARIable:VALue? "ReportMeasurements"
```

Group

Reports

Arguments

`< measuremode >` specifies the measurements that are to be written to the report when ReportGenerate is called. Valid measuremode values are All and Selected. All reports all current valid measurements results, while Selected reports only those measurements that are currently set.

Related Commands

ChannelDelaySet
ColorBarsSet
MultiburstSet
NoiseSet
NonLinearitySet
ReportGenerate
SyncSet

Returns

Query returns the current specified report measurement mode.

Examples

```
VARIable:VALue "ReportMeasurements", "All"
VARIable:VALue? "ReportMeasurements"
```

Query may return: `"ReportMeasurements Selected"`

ReportString < string >

Set or query user-specified information to write to the report when ReportGenerate is called.

Initialized to empty string "" on startup.

Syntax

```
VARIable:VALue "ReportString", "< string >"
VARIable:VALue? "ReportString"
```

Group

Reports

Arguments

`< string >` can be up to 46 characters in length. The comma and double quote characters are not permitted and their usage may result in unexpected program behavior. All other printable characters are permitted.

Related Commands

ReportGenerate

Returns

Query returns the currently specified report string.

Examples

```
VARIable:VALue "ReportString", "Tested by Joe B - DUT A1"
VARIable:VALue? "ReportString"
```

Query may return: `"ReportString Tested by Joe B - DUT A1"`

If assigning consecutive long strings to ReportString, truncation of the second string may occur if the length of the consecutive strings exceeds a limit (67 characters if Header is ON). For example:

```
VARiable:VALue "ReportString", "This is a long string which has
45 characters"

VARiable:VALue? "ReportString"
  "ReportString This is a long string which has 45 characters"

VARiable:VALue "ReportString", "This string will be truncated, it
is 45 chars"

VARiable:VALue? "ReportString"
  "ReportString This string will be tr"
```

To avoid this truncation, send a short string to ReportString prior to sending the second string.

```
VARiable:VALue "ReportString", "This is a long string which has
45 characters"
VARiable:VALue? "ReportString"
  "ReportString This is a long string which has 45 characters"

VARiable:VALue "ReportString", "short"
VARiable:VALue? "ReportString"
  "ReportString short"

VARiable:VALue "ReportString", "This string won't be truncated,
it is 46 chars"
VARiable:VALue? "ReportString"
  "ReportString This string won't be truncated, it is 46 chars"
```

RunMode < runmode >

Set or query the run mode to use for measurement.

Syntax

```
VARIable:VALue "RunMode", "< runmode >"
VARIable:VALue? "RunMode"
```

Group

Configuration

Arguments

`< runmode >` specifies the run mode that is to be used. Valid run modes are: Once, Continuously.

Returns

Query returns the currently specified run mode.

Examples

```
VARIable:VALue "RunMode", "Once"
VARIable:VALue? "RunMode"
```

Query may return: `"RunMode Continuously"`

SaveSettings < pathstring >

Command saves current settings in the specified path/filename.
Query returns “OK” unless the command is still being processed, in which case it returns the current pathstring argument.

If you only specify the filename, the default path “c:\VM5000HD” is used. The file will be saved using the default extension “.vmset”.

If you get the error message “Invalid Filename,” confirm that you typed the correct path and that your path is no more than 60 characters.

Syntax

```
VARIable:VALue "SaveSettings", "< pathstring >"
VARIable:VALue? "SaveSettings"
```

Group

Settings

Arguments

<pathstring> specifies the path/filename where the file is to be stored. Can either be (1) the full path and filename, or (2) just the filename, and the default path “c:\VM5000HD” will be used. The default extension “.vmset” will be appended if it is not specified. The specified directory will be created if it doesn’t currently exist. The pathstring must be less than 60 characters in length, otherwise the command may not be completed successfully.

Related Commands

RecallSettings

Returns

Query returns "OK" unless the command is still being processed, in which case it returns the current pathstring argument.

Examples

```
VARIable:VALue "SaveSettings", "c:\VM5000HD\Tek1.vmset"
VARIable:VALue "SaveSettings", "Tek2.vmset"
VARIable:VALue? "SaveSettings"
```

Query may return: "SaveSettings OK"

SetupAndOrRun < setuprunmode >

Set or query the setup run mode to use for measurement.

Syntax

```
VARIable:VALue "SetupAndOrRun", "< setuprunmode >"
VARIable:VALue? "SetupAndOrRun"
```

Group

Configuration

Arguments

`< setuprunmode >` specifies how to perform setup when performing a measurement. Valid modes are: SetupAndRun, SetupOnly, RunOnly.

Returns

Query returns the current specified setuprunmode.

Examples

```
VARIable:VALue "SetupAndOrRun", "SetupAndRun"
VARIable:VALue? "SetupAndOrRun"
```

Query may return: `"SetupAndOrRun SetupAndRun"`

SyncAverage < samples >

Set or query the number of samples over which to average the Sync measurement.

Syntax

```
VARIable:VALue "SyncAverage", "< samples >"
VARIable:VALue? "SyncAverage"
```

Group

Setup

Arguments

<samples > can be integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current number of samples for Sync measurement.

Examples

```
VARIable:VALue "SyncAverage", "1"
VARIable:VALue? "SyncAverage"
```

Query may return: "SyncAverage 8"

SyncLevelsmV?

Query all synchronization levels (in mV) resulting from a Sync measurement.
For Tri-Level Sync, this returns three levels.
For Bi-Level Sync, this returns two levels.

Syntax `VARIable:VALue? "SyncLevelsmV"`

Group Results

Arguments None

Related Commands SyncLevelsmVVal[1..3]

Returns Returns all synchronization levels (in mV) in this order:
For Tri-Level: FrontPorchLevel NegativeSyncLevel PositiveSyncLevel.
For Bi-Level: FrontPorchLevel SyncLevel.

Returns `"---"` if no valid measurement currently available.

Examples `VARIable:VALue? "SyncLevelsmV"`

Query may return: `"SyncLevelsmV 0.89 –298.31 299.11"`

SyncLevelsmVVal[1..3]?

Query the specified synchronization level (in mV) resulting from a Sync measurement.

Syntax `VARIable:VALue? "SyncLevelsmVVal[1..3]"`

Group Results

Arguments None

Related Commands SyncLevelsmV

Returns Returns specified synchronization level (in mV).

Values must be in the following ranges:
For Tri-Level, 1..3
For Bi-Level, 1..2
Values must designate the following levels:
For Tri-Level: 1-FrontPorchLevel, 2-NegativeSyncLevel, 3-PositiveSyncLevel.
For Bi-Level: 1-FrontPorchLevel, 2-SyncLevel.

Returns "`---`" if no valid measurement currently available

Examples `VARIable:VALue? "SyncLevelsmVVal3"`

Query may return: `"SyncLevelsmVVal3 299.11"`

SyncLine < linenumber >

Set or query line number that is to be used for Sync measurement.

Syntax

```
VARIable:VALue "SyncLine", "< linenumber >"
VARIable:VALue? "SyncLine"
```

Group

Setup

Arguments

`< linenumber >` can be an integer or floating point, but will be rounded to the next lowest integer. Values outside the range will be adjusted to be within range. Floating point notation is allowed.

Returns

Query returns the current line number for Sync measurement.

Examples

```
VARIable:VALue "SyncLine", "200"
VARIable:VALue? "SyncLine"
```

Query may return: `"SyncLine 325"`

SyncSet < setting >

Set or query whether Sync is to be measured upon Execute.

Syntax

```
VARIable:VALue "SyncSet", "< setting >"
VARIable:VALue? "SyncSet"
```

Group

Configuration

Arguments

`< setting >` specifies whether to perform Sync measurement upon Execute. Valid values are: OFF, ON, 0, 1.

Related Commands

Execute
ReportMeasurements

Returns

Query returns 0 or 1 depending on whether SyncSet measurement is selected.

Examples

```
VARIable:VALue "SyncSet", "ON"
VARIable:VALue? "SyncSet"
```

Query may return: `"SyncSet 1"`

SyncTimes?

Query all synchronization times (in nanoseconds) resulting from a Sync measurement.

For Tri-Level Sync, this returns seven times.
For Bi-Level Sync, this returns five times.

Syntax `VARIable:VALue? "SyncTimes"`

Group Results

Arguments None

Related Commands SyncTimesVal[1..7]

Returns Returns all synchronization times (in nanoseconds) in the order:
For Tri-Level: FrontPorch NegativeSyncFall NegativeSyncWidth SyncRise PositiveSyncWidth PositiveSyncFall BackPorch.
For Bi-Level: FrontPorch NegativeSyncFall NegativeSyncWidth SyncRise BackPorch.

Returns `"---"` if no valid measurement currently available

Examples `VARIable:VALue? "SyncTimes"`

Query may return:
`"SyncTimes 3822.39 59.03 592.01 52.61 590.40 55.24 1995.19"`

SyncTimesVal[1..7]?

Query the specified synchronization time (in nanoseconds) resulting from Sync measurement.

Syntax

```
VARIable:VALue? "SyncTimesVal[1..7]"
```

Group

Results

Arguments

None

Related Commands

SyncTimes

Returns

Returns specified synchronization time (in nanoseconds).

Values must be in these ranges:
For Tri-Level 1..7
For Bi-Level 1..5

Values must designate the following times:
For Tri-Level: 1-FrontPorch, 2-NegativeSyncFall, 3-NegativeSyncWidth, 4-SyncRise, 5-PositiveSyncWidth, 6-PositiveSyncFall, 7-BackPorch.
For Bi-Level: 1-FrontPorch, 2-NegativeSyncFall, 3-NegativeSyncWidth, 4-SyncRise, 5-BackPorch.

Returns `"---"` if no valid measurement currently available.

Examples

```
VARIable:VALue? "SyncTimesVal2"
```

Query may return: `"SyncTimesVal2 59.03"`

Trigger < trigger >

Set or query video trigger to use for measurement.

Syntax

```
VARIable:VALue "Trigger", "< trigger >"
VARIable:VALue? "Trigger"
```

Group

Configuration

Arguments

< trigger > specifies trigger that is to be used.
Valid triggers are: Ch1, Ch4.

Returns

Query returns the current specified trigger.

Examples

```
VARIable:VALue "Trigger", "Ch4"
VARIable:VALue? "Trigger"
```

Query may return: `"Trigger Ch4"`

WarningReportingMeasure < setting >

Set or query whether the instrument displays a measurement setup problem warning dialog on the instrument screen.

Syntax

```
VARIable:VALue "WarningReportingMeasure", "< setting >"
VARIable:VALue? "WarningReportingMeasure"
```

Group

Configuration

Arguments

`< setting >` Valid settings are: OFF, ON, 0, 1.
OFF is the same as 0, and ON is the same as 1.

Related Commands

WarningReportResults
WarningReportSignal

Returns

Query returns the current specified setting.

Examples

```
VARIable:VALue "WarningReportingMeasure", "ON"
VARIable:VALue? "WarningReportingMeasure"
```

Query may return: `"WarningReportingMeasure 0"`

WarningReportingResults < setting >

Set or query whether the instrument displays a measurement results warning dialog on the instrument screen.

Syntax

```
VARIable:VALue "WarningReportingResults", "< setting >"
VARIable:VALue? "WarningReportingResults"
```

Group

Configuration

Arguments

`< setting >` valid settings are: OFF, 0, ON, 1.
OFF is the same as 0, and ON is the same as 1.

Related Commands

WarningReportingMeasure
WarningReportingSignal

Returns

Query returns the current specified setting.

Examples

```
VARIable:VALue "WarningReportingResults", "ON"
VARIable:VALue? "WarningReportingResults"
```

Query may return: `"WarningReportingResults 0"`

WarningReportingSignal < setting >

Set or query whether the instrument displays an input signal problem warning dialog on the instrument screen.

Syntax

```
VARIable:VALue "WarningReportingSignal", "< setting >"
VARIable:VALue? "WarningReportingSignal"
```

Group

Configuration

Arguments

`< setting >` valid settings are: OFF, 0, ON, 1.
OFF is the same as 0, and ON is the same as 1.

Related Commands

WarningReportingMeasure
WarningReportingResults

Returns

Query returns the current specified setting.

Examples

```
VARIable:VALue "WarningReportingSignal", "ON"
VARIable:VALue? "WarningReportingSignal"
```

Query may return: `"WarningReportingSignal 0"`

Warning < setting >

Command can be used to reset Warning to “0”. Query returns the most recent warning reported by the application, or “0” if no warning have occurred since Warning was last reset. All warnings (Measurement, Signal, and Results) will be reported.

Initialized to “0” on startup.

Syntax

```
VARIable:VALue "Warning" < setting >
VARIable:VALue? "Warning"
```

Group

Miscellaneous

Arguments

`< setting >` resets Warning to 0.
Valid values are: OFF, 0.

Returns

Returns the most recent warning reported by the application. Returns “0” if no warning has occurred since the Warning command was last reset. For a listing of all possible warnings, refer to Table C–8 on page C–70.

Examples

```
VARIable:VALue "Warning", "OFF"
VARIable:VALue? "Warning"
```

Query may return:

```
"Warning Color Bars: Back Porch Reference Questionable"
```

Warning and Error Messages

Tables C–8 and C–9 list the warning and error messages you could see.

Table C- 8: Warning messages

Number	Text	Possible causes	Operation where it may occur
1	Acquisition Problem	The instrument cannot trigger or the signal levels are out of range.	All measurements
2	Channel Delay: Channel <x> & <y>, Correlation Too Low	You may have the wrong line in the matrix signal, a distorted signal, or an inappropriate input signal with too few transitions.	Measuring Channel Delay
3	Channel Delay: Disjoint Correlations Among Channels...	There is a possible group delay mismatch among channels, or there is an inappropriate signal source.	Measuring Channel Delay
4	Color Bars: <Color> Bar Not Found	You may have the wrong line in the matrix signal, a distorted signal, an incorrect format selected, channels connected in the wrong order, the wrong colorimetry, or excessive cropping of the signal.	Measuring Color Bars
5	Color Bars: Back Porch Reference Questionable	The signal is distorted.	Measuring Color Bars
6	Multiburst: Signal Change: <freq1> -> <freq2> MHz	You may have low signal levels, an incorrect signal, or a change in the signal.	Measuring Multiburst
7	Multiburst: Individual Channel Errors: Channel <x>: Flag <= 0 mV	The signal is distorted or a flag is missing in the signal.	Measuring Multiburst
8	Multiburst: Individual Channel Errors: Channel <x>: burst <n>: not detected	You may have low signal levels, distorted signals, an input signal with less than six frequency packets, or excessive cropping of the signal.	Measuring Multiburst
9	Multiburst: Invalid results for all channels	You may have the wrong line in the matrix signal, an inappropriate input signal, or an incorrect configuration.	Measuring Multiburst
10	Noise: Signal Change: Chan <x>	The signal changed during measurement.	Measuring Noise
11	Noise: Invalid results for all channels.	You may have the wrong line in the matrix signal, an inappropriate input signal, or an incorrect configuration.	Measuring Noise
12	Nonlinearity: Invalid Results: Channel <x>: No ramp or step signal found	You may have the wrong line in the matrix signal or an inappropriate input signal.	Measuring NonLinearity
13	Nonlinearity: Signal Change: Channel <x>: ...	The signal changed during measurement.	Measuring NonLinearity
14	Sync Measurements Inconclusive	The instrument could not find a proper sync, the wrong format was selected, or the signal is distorted.	Measuring Sync

Table C-8: Warning messages (Cont.)

Number	Text	Possible causes	Operation where it may occur
15	Sync Measurement: <n> Not Found	The instrument could not find a proper sync.	Measuring Sync
16	Writing over file <filename>	The instrument is writing over a file that previously existed.	Recalling settings; Generating a report

Table C-9: Error messages

Number	Text	Possible causes	Operation where it may occur
1	File Name Error: File doesn't exist: <filename>	The selected .vmset file doesn't exist. (You need to use the full path if the file is not in the directory C:\VM5000HD.)	Recalling settings
2	Cannot write directory: file already exists: <filename>	You need to rename <filename> so that the directory can be written.	Saving settings; Generating a report
3	File Name Error. Invalid character(s) in file name	There are invalid characters in the filename. (Refer to the command structure description on page C-1.)	Saving settings; Generating a report
4	No Measurement Selected	No measurements are selected in the Configuration > Measurements menu.	Executing a measure; Generating a report
5	Cannot create Report. Not all selected measures have been Run	Need to run a measurement and wait until it completes before generating a report.	Generating a report
6	Invalid Filename	An invalid or non-existing file was used when performing the operation. Refer to the command structure description on page C-1. Also, you need to use the full path if the file is not in the directory C:\VM5000HD.	RecallSettings; SaveSettings; ReportGenerate (only when called via GPIB)
7	Invalid Argument	An inappropriate argument was used for the particular GPIB command.	All GPIB commands
8	Command Overflow	The GPIB commands were sent in too rapidly to the instrument. Increase the delay time between commands to prevent this problem (recommended 100 milliseconds), or use handshaking with OPComplete.	Any time GPIB commands are sent in too rapidly
9	Command Missed	Under certain configurations, a command can occasionally fail to be processed by the instrument. This error suggests that a command sent in the last second may not have been processed, so you should return to a recent (known) configuration and re-send the most recent commands.	Sending a GPIB command

Appendix D: 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 E: 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, 063-3509-XX.
2. Follow the directions in the CD jewelcase booklet to install the TDS5000 product software CD, 063-3508-XX.
3. Install the VM5000HD application CD, 063-6353-XX.
4. Follow the online instructions.

   When asked, enter your option key information from the sticker on the back of your instrument.

Appendix F: Signal Source Files (Option SS)

Option SS consists of four CDs and two DVDs that contain Matrix test pattern signal source files in a number of video formats. See page 2–6 for information on the Matrix test pattern. Table F–1 lists the Option SS discs.

Table F-1: Option SS discs

Title	Tektronix part number
Baseband Test Signals	063-3660-XX
ATSC Transport Streams	063-3661-XX
Advanced TV Elementary Streams	063-3662-XX
Standard Definition TV Elementary Streams	063-3663-XX
480 Line DVD	063-3664-XX
576 Line DVD	063-3665-XX

Baseband Test Signals CD

The Baseband Test Signals disc (Tektronix part number 063-3660-XX) contains files for generating baseband test signals. There are two directories:

- The PC directory contains an SXGA sub-directory that contains a 1280 X 1024 bitmap image file, which you can open with MS Paint on a PC and display the Matrix test pattern at 1280 x 1024 resolution at a 60 Hz horizontal refresh rate. See page 1–15 for instructions on how to use the SXGA Matrix bitmap file.
- The TG700 directory contains setup (.dnl) files for generating Matrix test signals using the Tektronix TG700 TV Signal Generator Platform. Table F–2 lists the available image format standard .dnl setup files.

Table F-2: Available TG700 DNL signal format files

Image format	Field rate	TG700 module	Color space	Signal file name
480p (525 total lines)	59.94	AVG7	RGB	525PSGBR.DNL
			YP_bP_r	S525PY.DNL
576p (625 total lines)	50	AVG7	RGB	625PSGBR.DNL
			YP_bP_r	S625PY.DNL

Table F-2: Available TG700 DNL signal format files (Cont.)

Image format	Field rate	TG700 module	Color space	Signal file name
720p	59.94	AWVG7	RGB	72059PG.DNL
			YP_bP_r	72059PY.DNL
1080i	50	AWVG7	RGB	108050IG.DNL
			YP_bP_r	108050IY.DNL
1080i	59.94	AWVG7	RGB	108059TG.DNL
			YP_bP_r	108059IY.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 F–1 shows a typical test signal setup using the TG700 instrument as the signal source.

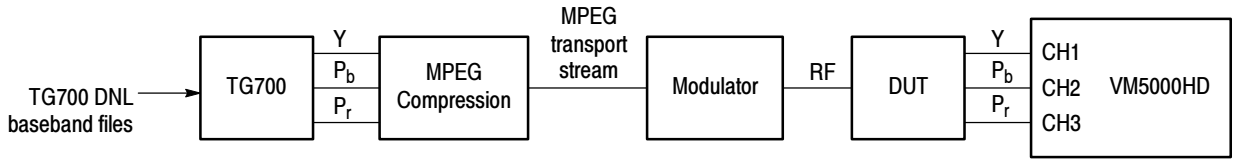

Figure F-1: Using TG700 baseband test signals

ATSC Transport Stream CD

The ATSC Transport Streams disc (Tektronix part number 063-3661-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 F–3 lists the available image format standard .trp setup files.

Table F-3: Available MXT100 .trp signal setup files

Image format	Field rate	MTX100 setup file(s)	Associated VM5000HD setup file
480p	59.94	Tek480pMatrix.trp Tek480p16x9Matrix.trp	Tek480pMatrix.vmset
720p	59.94	Tek720pMatrix.trp	Tek720pMatrix.vmset
1080i	59.94	Tek1080iMatrix.trp	Tek1080iMatrix.vmset

The disc also contains some or all of the following:

- Readme files that contain detailed information on each signal setup file. You should view the readme files before using a signal setup file.
- The .vmset files that you recall into the VM5000HD instrument to configure the correct default line number values for each measurement. See page 2–16 for instructions on how to recall VM5000HD instruments setups.

***NOTE**. You must use the associated .vmset file to configure the VM5000HD before taking measurements from test signals generated using a .trp setup file.*

- WFM700 directories that contain .bmp-format screen captures from the Tektronix WFM700 series 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 F–2 shows a typical test signal setup using the MTX100 instrument as the signal source.

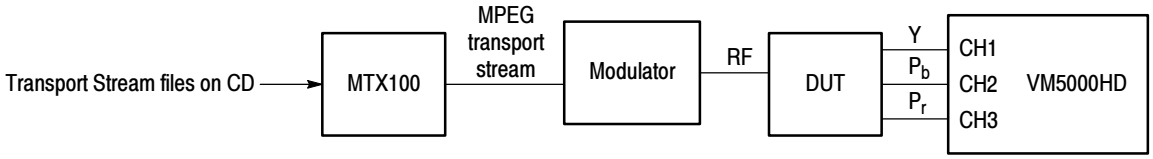

Figure F-2: Using ATSC transport stream signals

Advanced TV Elementary Streams CD
Standard Definition TV Elementary Streams CD

The Advanced TV Elementary Streams disc (Tektronix part number 063-3662-XX) and the The Standard Definition TV Elementary Streams disc (Tektronix part number 063-3663-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 F–4 and F–5 list the available elementary stream formats.

Table F-4: Available Advanced TV Elementary Streams

Image format	Field rate	File	Ratio	Associated VM5000HD setup file
480p	59.94	Tek480pMatrix.mpg	4:3	Tek480pMatrix.vmset
		Tek480p16x9Matrix.mpg	16:9	
720p	59.94	Tek720pMatrix.mpg		Tek720pMatrix.vmset
1080i	50	Tek1080i50Matrix.mpg		Tek1080iMatrix.vmset
	59.94	Tek1080iMatrix.mpg		

Table F-5: Available Standard DefinitionTV Elementary Streams

Image format	Field rate	File	Ratio	Associated VM5000HD setup file
480i	59.94	Tek480iMatrix.mpg	4:3	none
		Tek480i16x9Matrix.mpg	16:9	
576i	59.94	Tek576iMatrix.mpg	4:3	none
		Tek576i16x9Matrix.mpg	16:9	

The disc also contains some or all of the following:

- Readme files that contain detailed information on each signal setup file. You should view the readme files before using a signal setup file.
- The .vmset files that you recall into the VM5000HD instrument to configure the correct default line number values for each measurement. See page 2-16 for instructions on how to recall VM5000HD instruments setups.

***NOTE**. You must use the associated .vmset file that is on the same disc to configure the VM5000HD before taking measurements that use the elementary stream signals.*

To use the elementary stream files, copy the appropriate files into your transport stream multiplexor. Figure F-3 shows a typical elementary stream test setup.

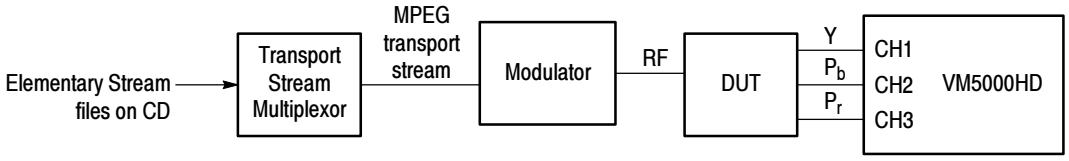

Figure F-3: Using elementary stream signals

480 & 576 Line DVDs

The 480 Line DVD (Tektronix part number 063-3664-XX) and 576 Line DVD (Tektronix part number 063-3665-XX), both generate 60-second Matrix pattern test signals for use with the VM5000HD instrument. The DVD files are available in the formats listed in Table F–6.

Table F-6: 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 F–4 shows the typical setup for testing DVD players.

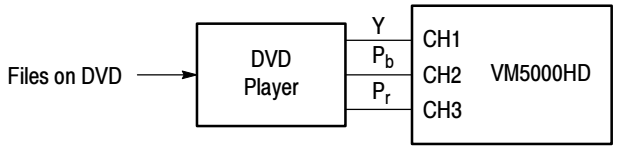

Figure F-4: Using DVD signals

***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 VM5000HD instrument.*

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