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Automated Video Measurement Set

▶ VM5000



The VM5000 automates video testing of consumer HDTV and PC graphics devices such as digital set-top boxes, multi-media PCs, graphics cards and video semiconductors. It addresses the needs of engineers developing and deploying the next generation of video devices for the digitally connected home. Unrivaled performance in terms of speed, accuracy and reliability has made the VM5000 the choice of industry leaders for design validation, quality control and ATE applications.

Unlike conventional instruments, the VM5000 integrates acquisition hardware, optimized video measurement algorithms, test signal files and accessories into a cohesive test system solution. 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 video output signal quality. The conformance of signals to specifications is reported with obvious pass or fail results, with signal distortions clearly identified for further analysis.

The VM5000 stands alone as the only automatic video analyzer capable of supporting SD, HDTV and PC graphics signal formats. Offering a full 1 GHz bandwidth and 5 GS/s sample rate, the VM5000 is well suited to the demands of measuring high-resolution HDTV and high-frequency PC graphics video signals. Traditional DTV formats from 480i through 1080i and either RGB or YPbPr color space are supported in Options SD and HD. Option VGA supports common analog RGBHV signal resolutions from 640x480p through 2048x1536p, and pervasive refresh rates from 50 Hz through 100 Hz.

The ultimate solution for component analog video signal analysis, the VM5000 delivers comprehensive characterization of video fidelity, signal quality and standards compliance. With available options, the instrument automatically assesses conformance of video signals to applicable EIA-770.x, SMPTE-274M, 296M and VESA standards. Traditional “TV” signal fidelity is evaluated utilizing industry-accepted parameters, making 150 individual measurements automatically in less than 15 seconds. PC graphics signal fidelity is assessed via comprehensive RGB video and HV sync measurement parameters made in accordance with VSIS test procedures. Preloaded reference and limit files enable

▶ Features & Benefits

Automates Test of Consumer HDTV Video Devices

Automates VESA Compliance Test for PC Graphics Devices

Fast, Accurate and Reliable Video Measurements

Comprehensive Component Analog Video Signal Analysis

SD, HDTV and RGBHV Component Analog Format Support

Picture, Vector and Waveform Displays

Companion Test Signal Packages

Time Saving Test Utilities

Pass-fail Limit Testing

Automatic Report Generator

Video Measurement Accessories

Complete DPO Functionality

1 GHz Bandwidth, 4 Channels

Bright 10.4" Display

GPIB Remote Control

LAN Connectivity

CD-RW Drive

▶ Applications

Design Validation

Standards Compliance Testing

Quality Control

Installation and Troubleshooting

Automated Manufacturing Test

Off-air Video Systems Test

Tektronix

Enabling Innovation

► Format Support

Option	Signal Format	Vertical Refresh Frequency	Color Space RGB	Color Space YPbPr
SD	480i	59.94/60 Hz	X	X
	576i	50 Hz	X	X
	480p	59.94/60 Hz	X	X
	576p	50 Hz	X	X
HD	720p	50/59.94/60 Hz	X	X
	1080i	50/59.94/60 Hz	X	X
	1080p	24 Hz	X	X
VGA	640x480p	60, 72, 75, 85, 100, 120 Hz	X	
	800x600p	60, 72, 75, 85, 100, 120 Hz	X	
	1024x768p	60, 72, 75, 85, 100, 120 Hz	X	
	1280x1024p	60, 70, 75, 85, 100, 120 Hz	X	
	1600x1024p	60, 70, 75, 76, 85, 100 Hz	X	
	1920x1080p	50, 60, 75, 85, 100 Hz	X	
	1920x1200p	60, 75, 76, 85, 100 Hz	X	
	1920x1440p	60, 75, 85 Hz	X	
	2048x1536p	60, 75, 85 Hz	X	
	2048x2048p	60 Hz	X	
	Other progressive RGBHV formats and vertical frequencies supported via signal configuration utility		X	

► Sync Options

Signal Format	Sync on Y/G	Separate Composite Sync on Ch4	Separate H&V Sync
SD Component	X	X	X*1
HD Component	X	X	X*1
Analog RGBHV – Option VGA			X

*1 Requires VGA to BNC sync combiner accessory, excludes HV sync measurements.



► Summary Pass-fail Test Results Display.

go-no go evaluation to applicable DMT, CVT or GTF timing standards.

As an integrated signal analyzer, the VM5000 can be reliably deployed as a stand-alone QA station in manufacturing. Unlike modular test systems, extensive programming, complicated system debugging or costly test engineering support is not required with the VM5000.

Integrated pass-fail limit testing and documentation utilities link distributed design, supply and manufacturing organizations with standardized test capability. Product quality is enhanced because accurate test results can be reliably generated, easily replicated and readily communicated across a global engineering, manufacturing or sales organization.

These unique capabilities enable in-depth signal analysis, speed product development and ensure new designs comply with applicable standards. Fast, accurate and objective video measurements enable manufacturers to ensure that HDTV or PC graphics video signal quality is up to the challenge of today's high-performance displays, as well as providing clear differentiation between input signal and display device impairments.

Easy to Configure and Operate

The VM5000 offers intuitive Windows-based configuration and measurement menus for easy operation and minimal training. A 10.4-inch (264 mm) color display provides a bright, clear and crisp display of waveforms and measurement results. Users can easily navigate through logically arranged menus and make selections via radio buttons with a mouse or optional touch screen.

▶ VM5000 Automated Measurements

Measurement Parameters

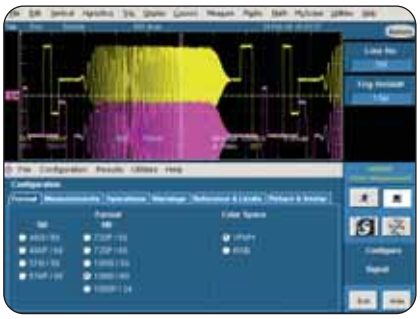
TV Signals Options SD & HD	PC Graphics Signals Option VGA
Color Bars (Levels)	Color Bars Luma Levels*1
Sync Amplitude and Timing	H & V Timing*1 H & V Sync*1 H Sync Jitter*1
Noise	Noise Injection Ratio*1
Non-linearity	Integral and Differential Linearity, Monotonicity*1
Inter-channel Timing	Channel-to-Channel Skew*1
Transient Response, K2T	Video Transient Response
Multiburst	—
Frequency Response	—
—	Resolution*1

*1 VESA Parameters.

Complicated instrument setups, algorithm selection, programming and other undesirable aspects of making video measurements are eliminated with the VM5000. Configuration is as simple as selecting the video format and measurement parameters from an on-screen menu, eliminating complicated instrument setups, tedious manual measurements and time-consuming results correlation. These test configuration settings can be readily saved, recalled or copied, further simplifying test of multi-format video devices. Users wanting to make manual measurements can exit the automated measurement application and then access a full-featured oscilloscope.

Supports SD, HDTV and RGBHV Component Analog Video Formats

The VM5000 can be flexibly configured to support any combination of component analog SD, HDTV and RGBHV video formats with the available options. Broad format support enables automated test of digital set-top boxes, video semiconductors, DVD players, PC graphics cards and other consumer video devices.



▶ Signal Format Configuration Menu (Option SD and HD).

Bandwidth and Sample Rates Suitable for HDTV and High Resolution PC Graphics Signals

The VM5000 utilizes a digital phosphor oscilloscope platform as the basis for signal acquisition and analysis. Utilizing proven, high-speed measurement architecture, Tektronix surpasses the limitations of current video analyzers to address the evolving needs of the video industry. The VM5000 offers over 1 GHz of bandwidth and 1.25 GS/s maximum real-time sample rates per channel to easily meet stringent HDTV measurement demands – easily assessing frequency response for signals up to and well beyond 30 MHz. The high sample rates and low noise floor of the instrument enable noise measurement accuracy that was previously impossible on HDTV signals. A rise time of less than 400 ps and superior time-base performance are sufficient to make critical sync and rise time measurements as required by EIA-770 and SMPTE 274M and VESA. A large record length and high sample rates deliver measurement results with minimal time lag.

Comprehensive Component Analog Video Signal Analysis

The VM5000 incorporates an extensive set of automated video measurements that deliver comprehensive characterization of the fidelity and conformance of component analog signals. Approximately 150 individual measurements completely characterize video signal amplitudes, timing and noise distortions into parameter categories that are easily understood, facilitating trouble-shooting and design optimization.
Enabled by such broad and thorough signal analysis, the VM5000 is able to identify relevant video signal impairments, verify compliance with applicable standards and ensure operability with connected displays. Measurement parameters have been appropriately selected for testing TV signals (Options SD and HD) and PC graphics



► H Sync Measurement Results (Option VGA).



► Multiburst Measurement Results Display (Option SD and HD).



► Frequency Response Measurement Input Selections (Option SD and HD).

signals (Option VGA). These parameters vary by application because of differences in hardware technology, signal attributes, applicable standards and historical test methodology. TV test measurements are based on the de-facto industry standard VM700T and have been adapted to assess distortions unique to digital devices and HDTV signals. The PC graphics measurement set delivers fully automated VESA compliance testing and video measurements, as well as reporting other parameters commonly utilized to characterize PC graphics device performance.

Fast, Accurate and Reliable Automated Video Measurements

The VM5000 is differentiated from conventional oscilloscopes, waveform monitors or modular instruments by its automated video measurements. Automated measurements deliver benefits in terms of speed, accuracy and ease of use that almost obsolete manual approaches, and even user-developed programs. Automating signal configuration, signal acquisition and data analysis enables robust and reliable operation impervious to signal variations. The VM5000 applies optimized video measurement algorithms and extended data processing to deliver accuracy and reliability that outperforms even the most skilled expert user.

Auto Configuration – By selecting the applicable format and desired measurements from the configuration menu, the VM5000 automatically configures gain, offset and time scale based on the nominal signal values expected. Variations from nominal values are accommodated with auto range capabilities.

Auto Range – The auto range feature enhances accuracy and enables automated measurement of signals that vary from nominal levels. This feature automatically optimizes gain and offset based on the signal conditions, enabling the instrument to consistently present the best results possible.

Automatic Special Position – The VM5000's automatic special position function ensures that automated measurements are robust to temporal signal distortions, alternate test signals and alternate output display modes. Always active, this feature identifies appropriate test signal events and sets measurement cursor locations optimally to ensure consistent and meaningful test results. Measurement location selections made by the VM5000 can be analyzed or documented with the selectable feature included in the report generator.

Auto Mode – Enables users to instruct the instrument to make one, selected or all automated video measurements with a single run command. While functioning in Auto Mode, the instrument automatically selects the appropriate test signal line, utilizes pre-set measurement configurations and averaging selected by the user and completes each measurement.

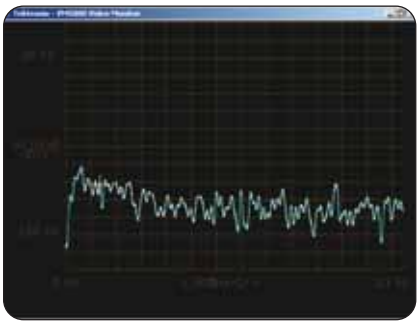
Option VGA includes multi-line measurements capability, enabling users to measure selected parameters on many or all lines in a frame with a single run command.

Measurement Cursors (Special Position) – Options SD and HD address requirements for custom signal analysis by enabling users to input customized measurement locations for the Frequency Response and Noise measurement parameters. For frequency response measurements, users can select either timing location input or frequency input to make response measurements anywhere within the supported video bandwidth utilizing a standard sweep signal. Input locations can be further toggled within YPbPr signals to accommodate either 4:2:2 or 4:4:4 video. This enables detailed analysis of roll-off, frequency distortion, identification of spurs and aliasing anywhere across the useful frequency spectrum.

Flexible Noise Measurement – Options SD and HD offer the capability to make both weighted and un-weighted noise measurements. Default selections for bandwidth cut-off filtering are automatically via the format configuration; however, users can enter other bandwidth cut-off filter selections if desired to clarify noise characteristics. Measurement locations may also be input by users for the noise measurement. This is most useful when used in conjunction with the Noise Spectrum display, simplifying identification of the frequency and relative magnitude of noise peaks in the video signal.

Automated VESA Compliance Testing for Analog RGBHV Signal Formats (Option VGA)

The emergence of IP broadcast video and convergence of traditional "TV" and "PC" video entertainment devices have resulted in PCs evolving into media gateways to



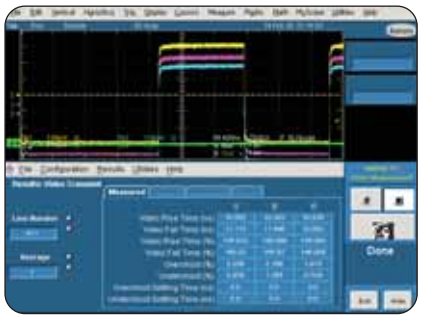
▶ Noise Spectrum Display (Option SD and HD).



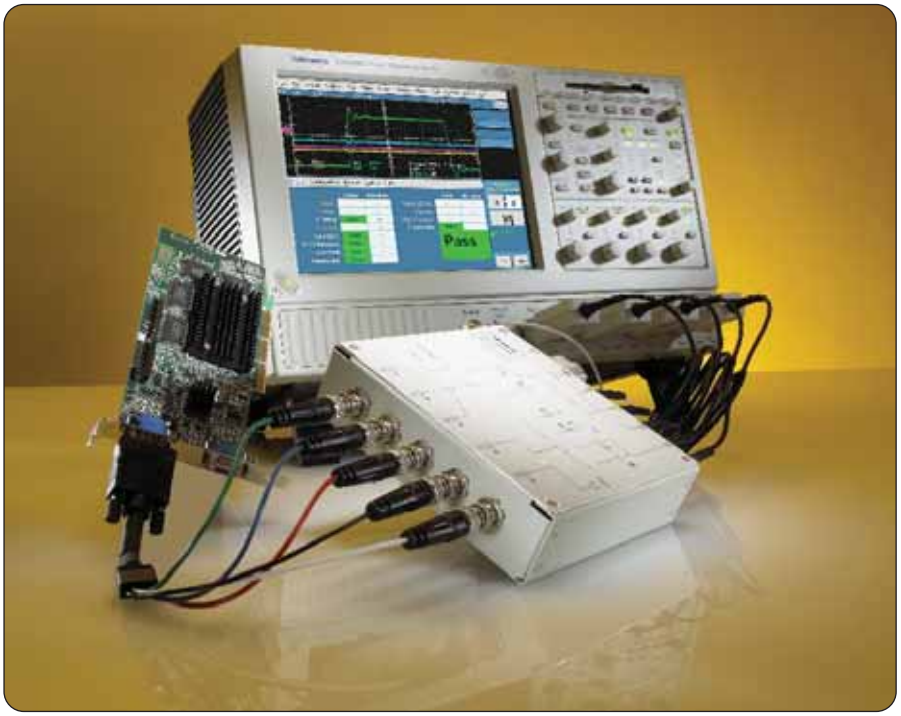
▶ Format Configuration Menu (Option VGA).



▶ Measurement Selection Menu (Option VGA).



▶ RGB Transient Response Measurement Results (Option VGA).



▶ VM5000 with Option VGA – VESA Compliance Test Solution.

the digitally connected home. As a result, assessing the fidelity and conformance of analog RGBHV signals has become more important to engineers involved in the design and manufacturing of PC graphics devices. This challenge has been further complicated by the emergence of digital interfaces, proliferation of supported output modes, and the persistence of analog RGBHV interfaces on PC graphics cards. Tektronix addresses these industry test requirements with VM5000 Option VGA, the first and only "VM" class solution for PC graphics signals and devices. Option VGA automates signal analysis and mandatory VESA standards compliance testing, speeding design validation testing that is typically performed with the release or modification of PC graphics hardware, software or integration of complete video system. Option VGA supports pervasive analog RGBHV signal formats typically communicated via VGA, DVI-I or DVI-A interfaces. Automated measurement is possible for 11 standard signal resolutions spanning from 640x480p (VGA) through 2048x1536p (QXGA), at selected vertical refresh frequencies from 50 to 120 Hz. Because non-standard signal resolutions, vertical refresh frequencies or blanking are common with analog RGBHV signals, Option VGA offers capability to automatically test unsupported video formats. A user-defined format configuration utility enables users to easily create, edit or recall custom modes and seamlessly access the full test automation of the VM5000 instrument.

Approximately 150 video measurements can be performed for each supported mode, delivering a comprehensive assessment of RGB video fidelity, HV sync quality and format conformance. Parameters and test methods are based on industry standard (VESA) test procedures, enabling easy comparison against the requirements of the Video Signal Standard (VSIS) and applicable DMT, GTF or CVT timing standards. Convenient averaging and configuration controls deliver the flexibility to perform either speedy or precise measurement in accordance with VESA sampling requirements. A full suite of comprehensive RGBHV video parameters can be measured in less than five minutes. Pre-loaded signal reference data and tolerance limit files simplify results analysis, eliminating laborious spreadsheet entry and computation. Test results, and even waveform screen captures, can be quickly documented with reports that can be automatically generated, printed and saved. An innovative set of PC graphics matrix test signals has been created to enable comprehensive signal characterization for the full range of supported formats. These signals, working in concert with a remote controlled measurement interface unit,

► Test Signal Files: File and Signal Formats of Test Signal Packages

Test Signal Format	HDTV Matrix 16x9	HDTV Matrix 4x3	PC Matrix & Full Fields	.bmp files	.png files	TG700 DNL AVG7/ AWVG7 DVG7/ HDVG7	ATSC Transport Stream	Compressed MPEG Elementary Stream	DVD
SD Formats	X	X		X		X*1, 2	X*3	X	X
HD Formats	X			X		X*1	X*3	X	
VGA Formats			X	X	X				

*1 Requires TG700 and appropriate module (AVG7, AWVG7, DVG7 and/or HDVG7).

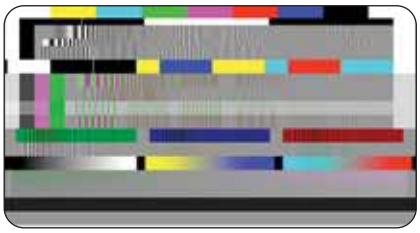
*2 SDI signal generation not supported for 576p format.

*3 ATSC transport stream not provided for 576i, 576p, 720p/50 and 1080i/50 formats.

enable fully automated testing with a single run command. The included measurement interface unit provides connectivity, signal termination, automated switching and variable loads for sync voltage tests. This approach eliminates the need for expensive FET probes and delivers optimized accuracy for both DC amplitude and high-frequency timing measurements. All the necessary elements for compliance or QC testing are integrated into a cohesive solution that delivers easily understood pass or fail test results. Comprehensive parametric signal analysis isolates product performance deficiencies, enables design optimization and ensures interoperability of connected display devices. With Option VGA, even unskilled operators can make reliable and repeatable assessments of VESA standards compliance. Extensive video knowledge, oscilloscope skills, complicated programming or system integration skills are no longer required to assess analog RGBHV signal integrity.

Companion Test Signal Packages

Each of options SD, HD and VGA includes a specific companion test signal package to speed and simplify testing of supported signal formats. These packages have been developed to enable comprehensive parametric analysis of signal fidelity without the inconvenience of switching test signals. Test signal packages eliminate potential video measurement set operability issues and minimize uncertainties regarding the quality of the input signal.

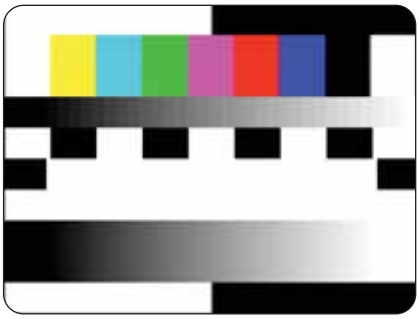


► HDTV Matrix Test Signal in 16x9 Aspect Ratio.

Because DTV has resulted in a proliferation in video source content and signal formats, test signals are provided in a variety of pervasive formats to enable easy generation and extended format testing. Since encoded test signals may contain artifacts that detract from measuring the analog signal fidelity, the matrix test signal is also provided in MPEG-2 encoded elementary and ATSC transport streams. To ensure the encoded signal is accurate, Tektronix has pre-qualified the matrix test signal for each native video format.

HDTV Matrix Test Signal – A specific matrix test signal has been created to enable efficient and comprehensive test of component analog video signal fidelity. The matrix signal includes a range of test signals on different lines to enable video test without the inconvenience of switching full field signals, and contents have been customized to exercise the full bandwidth capability of each format. One signal can be flexibly utilized for both RGB and YPbPr color spaces, thereby minimizing test signal proliferation.

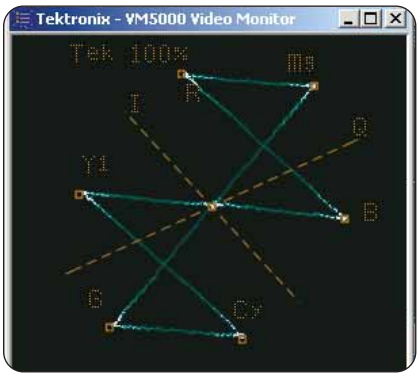
The HDTV matrix test signal is supplied in a variety of file and signal formats to enable convenient and comprehensive test of set-top boxes and other consumer video devices. High-quality encoded ATSC transport stream and compressed elementary stream files are supplied for easy play-out on a Tektronix MPEG player such as the MTX100A.



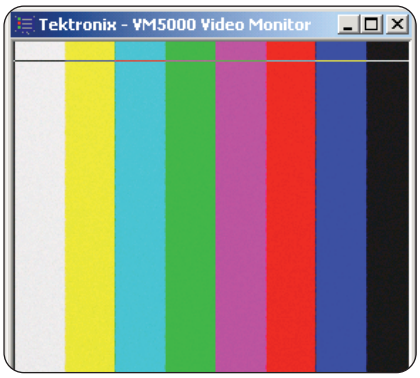
► PC graphics Matrix Test Signal (Option VGA).

PC Graphics Matrix Test Signal (Option VGA) – VESA compliance and certification testing requires that several different types of test signals be applied to the device under test. Option VGA includes test signal files for these patterns, in both full field and matrix forms for the full range of supported image resolutions. Test signal files are provided in .bmp and .png file formats.

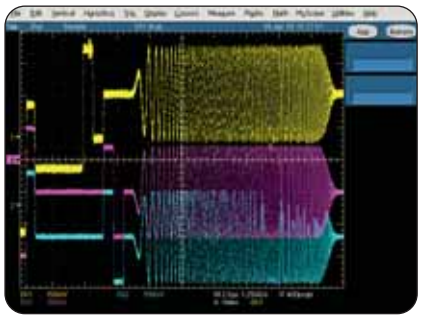
VESA compliance and certification testing requires that several different types of test signals be applied to the device under test. Option VGA includes test signal files for these patterns, in both full field and matrix forms for the full range of supported image resolutions. Test signal files are provided in .bmp and .png file formats. The .png files are beneficial because they enable HV timing measurement to be made without the border artifacts potentially introduced by bitmap files.



▶ Vector Display.



▶ Picture Mode.



▶ Full Screen Waveform Display.



▶ Summary Test Results Display with Pass-fail Indication.



▶ Color Bar Relative Results Display with Limit Testing Enabled.

Picture, Vector and Waveform Displays

Picture and Vector displays can be initiated with a single button push and deliver "at-a-glance" confidence checking that simplifies signal identification, troubleshooting and color conversion accuracy. Waveforms are simultaneously displayed with parametric test results to enable visualization of signal impairments.

By selecting Picture mode, a full color picture display is rendered on screen from the connected sub-sampled and down converted signals to the available picture area and resolution. Pictures by default appear in an appropriate 16x9 or 4x3 aspect ratio; however, users can resize, move or minimize the window as needed. Picture mode incorporates a user-enabled bright line select feature to facilitate test configuration. Live or full motion video signals can also be viewed at vertical refresh rates of 1 to 2 fps.

The Vector display, available with Option SD and HD, displays the waveform with targets for 75% or 100% color bars and accommodates either 601 or 709 colorimetry targets. Graticule targets and color space can be selected automatically or manually.

Waveforms for all channels are simultaneously viewable in different colors, and display can be zoomed both vertically and temporally for detailed examination and analysis. Users can selectively expand the waveform to the full display size by minimizing the measurement application.

Time-saving Test Utilities and Results Displays

The VM5000 offers a powerful combination of test utilities and custom displays to make HDTV video test faster, more robust, more convenient and more accurate. These utilities supplement basic automated measurement capabilities to deliver performance and value unmatched by any other solution. Combined with the extended documentation utilities, these powerful automated measurement utilities and features ensure that the VM5000 meets the demands of all application areas. Research and Development, Quality Control and Production Test personnel can tailor the instrument settings to meet their particular needs for robust acquisition, speed or accuracy. By automating measurement functions, video professionals are ensured that automatic measurements are robust, accurate, repeatable and completely objective.

Summary Test Results Display – For the ultimate in test progress and reporting, the VM5000 incorporates a summary test results display screen. This display enables operators to monitor test progress and acceptability of video signal parameters without having to delve into complicated individual test results. Each of the selected test parameters, measurement progress, pass or fail result per parameter and test errors, if any, are displayed. Upon completion, an overall green or red measurement result flag is displayed.

Integrated Pass-fail Limit Testing – The VM5000 incorporates user-selectable pass-fail limit testing. Acceptability of individual parameters or an entire DUT can be assessed without browsing hundreds of individual numerical results. Suitable for use in stand-alone applications, there is a PF summary screen that shows the progress and PF result of individual measurements and an overall DUT PF result based on the selected parameters and user-selected limits. When PF limit testing is enabled, measurement results for failed parameters are displayed in an intuitive GREEN-RED numerical result for easy identification of unacceptable or nonconforming signal conditions.



► Reference and Limit Test Configuration Menu.

Preloaded and User-definable Reference and Limit Files – Tektronix supplies a set of default reference and limit files for the supported video formats for "out of the box" test functionality. Option SD and HD have been preloaded with SMPTE/EIA standard reference values and Tektronix recommended tolerance limit files. Option VGA has been preloaded with VESA reference and tolerance limit values based on the applicable timing standards. The signal reference data boosts test productivity by minimizing the need to access separate standards or quality documents. Files can be edited with other spreadsheet programs to specify customized target values, conformance limits or go/no go manufacturing process limits. Reference and limit files can be auto selected by format (default), manually specified or loaded automatically via pre-set configuration files (.vmset).

Flexible Results Displays – To simplify test results analysis, the VM5000 features tabular results menus. Within each parameter group, users can easily browse measurement results, deviation from reference, nominal (reference) value and max/min tolerance limits for pass and fail. Reference information and calculations necessary to analyze and understand test results are logically organized and readily available. With limit testing enabled, non-conforming test results are highlighted in red, readily highlighting signal distortions for further analysis.

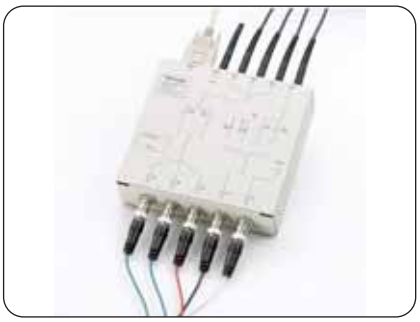
Save and Recall Measurement Configurations – Measurement configuration settings can be stored, instantaneously recalled or easily copied to other instruments. Factory default settings can also be recalled, if necessary. Reference and limit files are associated with configuration files, and are automatically pulled in with a recall configuration command. This feature speeds and simplifies device testing with multiple display output formats, as users can configure, store and recall a set-up for each individual format.



► VM5000 Test Report.

Reference Capture Utility – The output of a "golden" DUT or reference test signal generator can be conveniently captured and stored as a reference file. This utility enables current measurement results to be readily compared with other measurement results utilizing the tabular results display screens in the results menus.

Sync Load Testing – Per VESA standards, H and V Sync voltages must be measured under V1 and V0 conditions with ±8 mA current loads to ensure adequate power is available to handle impedance variations that may occur with connected displays. Option VGA automates this test by providing loads with the remote control MIU.



► Option VGA – Analog RGBHV Measurement Interface Unit (MIU).

Automatic Report Generator – A report generator utility speeds test documentation by creating an organized video measurement report with the touch of a single button. Test results, configuration settings and signal reference data details are summarized in the VM5000 test report. Reports created in .pdf and .rtf formats are organized and suitable for inclusion in certification test results. For data analysis, reports can be output in the form of a .csv file, easily imported into spreadsheet programs. Option VGA even includes the option to embed waveform screen captures into selected report formats.

Video Measurement Accessories For convenience and enhanced test performance, the VM5000 includes a logical set of complementary video measurement accessories that simplify connection, termination and measurement. Custom designed sync pick-off and sync combiner accessories simplify measurement of TV signals with Options SD and HD. Option VGA includes a custom measurement interface unit (MIU) that has been engineered to enable precision, VESA compliant and fully automated measurement for 5 channel analog RGBHV signals. The MIU provides termination, signal switching and a current source/ sink, eliminating the need for expensive FET probes or manual switching of cables during testing.

Addressing stringent requirements for measurement accuracy, the MIU incorporates an innovative dual input path for RGB and HV channels in order to deliver optimized accuracy for both DC amplitude

measurement and high frequency timing measurements. Utilizing RS-232 control, the VM5000 automatically selects either low frequency or wideband mode as required by the parameter being measured. Incorporating a full 1 GHz of bandwidth, with optimized return loss in wideband mode, the MIU delivers un-matched speed, accuracy and convenience in testing PC graphics signals.

Standard GPIB Remote Control and LAN Connectivity

A fast and reliable GPIB Port compliant to IEEE 488.2 is standard on the instrument with selectable controller or talk/listener modes. A fully documented oscilloscope GPIB remote command set and simplified video command set enable all of the instrument capabilities accessible via the user interface to be automated via GPIB remote control.

Network connectivity is provided with a LAN port supporting 10Base-T and 100Base-T. This enables video test reports or data stored on the hard drive to be accessed via the network. Network remote control can be accomplished via the Tektronix AD007 GPIB to LAN adapter accessory, available separately. TekVISA™ is functional for LAN remote control of the oscilloscope commands.

Complete Oscilloscope Functionality

Recognizing the need for flexibility, Tektronix has integrated complete digital phosphor oscilloscope functionality into the VM5000. Flexible and dedicated video triggering for NTSC, PAL, SECAM and analog HDTV is provided in the oscilloscope. Optional application software packages complement the standard oscilloscope functionality to further extend the return and value of a VM5000 platform investment. Oscilloscope functionality and specifications are detailed in the TDS5104B or appropriate application software data sheet(s).



▶ Oscilloscope Measurement Menu.

▸ Characteristics[*1]

Video Measurement Specifications

▸ Options SD and HD Video Measurements

Characteristic		Description
Color Bar Measurement Accuracy	±2 mV ±1.5% of reading	Measurement of all 8 bar levels, displayed in absolute (mV) values. YPbPr or RGB formats
Noise Measurement	*Range and Accuracy*	
Unweighted and Weighted	–20 to –60 dB ±1 dB –60 to –70 dB ±2 dB	Specification requires 30 MHz bandwidth filter setting. Trigger on CH 4 required for measurements below –60 dB. Noise measurement bandwidth selectable, 200 KHz to 250 MHz. Unified Weighting Filter
Noise Floor	<–76 dB, 30 MHz noise bandwidth	Typically <–80 dB, 30 MHz noise bandwidth
Multiburst and Frequency Response Measurements	*Accuracy*	
Flag Amplitude	±2 mV ±1.5% of reading	
1 MHz to 10 MHz Packets	±0.5 dB	Measurement relative to reference flag amplitude
10 to 30 MHz Packets	±0.75 dB	
Frequency Readout	±0.1 MHz	Multiburst packet frequency is measured and displayed
Non-linearity Measurement	*Accuracy*	
Non-linearity	±1.5%	Non-linearity measurement using a ramp test signal. Incremental linearity reported over five equally spaced intervals, as well as an overall linearity figure for each channel
Transient Response Measurement	*Accuracy*	
Rise Time and Fall Time	±5 ns	
K2T	±1%	
Overshoot and Undershoot	±1.5% of reading	
Rise and Fall Settle Times	±5 ns	

[*1] For VM5000 Instrument Characteristics, please refer to the TDS5104B datasheet.

chart continued on next page

► Options SD and HD Video Measurements (Continued)

Characteristic	Description	
Sync Measurement	*Accuracy*	
Sync Amplitude	±2 mV ±1.5% of reading	Blanking interval measurements, including sync amplitude, width and rise time
Sync Timing	(0.06/sample rate + 15 ppm x |Reading|) RMS	
Rise Time and Fall Time	±5 ns	
Channel Delay		CH 1 to CH 2, CH 1 to CH 3, CH 2 to CH 3; readouts in ns
	Range	Accuracy
Measurement	±35 ns	±5 ns
Delay Match Error	Less than 1 ns	Any two channels

► Option VGA Video Measurements[*2]

Characteristic	Accuracy	Description
Amplitude Measurements		
Luma Level, Max and Min	±8 mV ±2.0% of reading	VESA 6.1
Color Bars	±3 mV ±1.8% of reading	Channel voltage levels measured relative to back porch
Ch-Ch Mismatch (mV)	±3 mV ±3.6% of reading	32-step staircase signal. VESA 6.5 Channel voltage levels measured relative to back porch
Ch-Ch Mismatch (%)	±0.4% ±(3.6%) x (Luma Level)/(Max Luma Level); maximum ±4%	
H & V sync Logic "0" and "1"	± [8mV ±(0.0085) x (p-p sync amplitude)] ±1.8%	VESA 7.1 (p-p sync amplitude)=(logic 1 voltage)–(logic 0 voltage)
Linearity, Resolution, Monotonicity		
Integral Linearity (%)	±2%	VESA 6.4. Requires step response compliant to VESA limits for overshoot/undershoot, amplitude and settle time
Differential Linearity	±0.25 LSB (8 bit) ±0.5 LSB (10 bit)	
RGB Video Monotonicity	±0.25 LSB (8 bit) ±0.5 LSB (10 bit)	Monotonicity checks every step on the ramp to ensure signal is always rising
Resolution Measurement Range	5 to 10 bits	Resolution measured in bits
HV Sync Monotonic Rise and Fall	Detects monotonicity errors as small as 1% of p-p sync amplitude	Checks sync for always rising and always-falling characteristic. Requires VESA compliant amplitude, noise, rise and fall
Noise		
Noise (mV) Measurement Range 8 to 15 mV	±5.25 mV	Measurement of RGB noise on constant pedestal, 0 to 700 mV. Output in mV peak to peak, dB below 700 mV, VESA Sec 6.6. Displayed value corrected for instrument noise. Specification applies with 500 MHz bandwidth filter and 10 averages selected
Noise (mV) Measurement Range 15 to 25mV	The lesser of ±7 mV or ±35%	
Noise Injection Ratio (%) Measurement Range 1.1% to 2.1%	±.75%	
Noise Injection Ratio (%) Measurement Range 2.1% to 3.6%	±1%	
Timing		
Channel Skew Measurement Range ±35 ns	±500 ps	Alternate implementation of VESA 6.7; Any two channels
H Timing (ns) – Front and Back Porch, Left and Right Border, Addressable Video	360 ps ±15 ppm x Reading	
H Sync Period, H and V Sync Pulse width (ns)	80 ps ±15 ppm x Reading	
V Sync Period (µs)	20 ns ±15 ppm x Reading	Read out (precision) is 1 µs

Hardware Accessory
Specifications

▶ Option VGA Video Measurements*2 (Continued)

Characteristic	Accuracy	Description
Timing		
V Timing (lines) – Front and Back Porch, Top and Bottom Border, Addressable Lines		Read out (precision) is 1 line. Functions within ±10 lines of VESA reference value
Frequency		
H and V sync, Pixel Clock Frequency	±0.01% of reading	
Transient Response		
Video Rise and Fall Time Measurement Range >1.3 ns	±5% of reading	VESA 6.8 Video Transient Response: Utilizes Course grille, VESA Section 6.2, 6.3, 6.8 Displayed results corrected for RGB measurement system bandwidth limitations
Video Rise and Fall Time Measurement Range 800 ps to 1.3 ns	±10% of reading	
Video Rise and Fall Time Measurement Range 450 ps to 800 ps	±20% of reading	
RGB System Rise Time	350 ps (typical)	
Sync Rise and Fall Time Measurement Range	>5 ns	±5% VESA Section 7.1-7.4 Displayed results corrected for H/V measurement system bandwidth limitations
Sync Rise and Fall Time Measurement Range 2 ns to 5 ns	±11%	
RGB and HV Sync Overshoot and Undershoot Amplitude %, Settle Time: 0 to 1 ns	±2% of reading (typical)	
RGB and HV Sync Overshoot and Undershoot Amplitude %, Settle Time: 1 to 10 ns	±1% of reading (typical)	
RGB and HV Sync Overshoot and Undershoot Settling Time, Amplitude >5%	±T rise (typical)	VESA 6.3
Jitter		
H Sync Jitter (ns)	100 ps ± 15 ppm x H-Sync period ± 14% of reading	VESA 7.5 Requires VESA compliant amplitude, noise, rise and fall characteristics
H Sync Jitter (% of Pixel Clock Period) Measurement Range: <200 MHz PCF	<4%	
H Sync Jitter (% of Pixel Clock Period) Measurement Range: 200 to 400 MHz PCF	<7.5%	

*2 Specifications apply with use of Measurement Interface Unit (MIU).

▸ RGBHV Measurement Interface Unit (MIU)

Characteristic	Specification Wideband Mode	Specification Precision LF Mode	Reference Information
DC Gain			
RGB Channels	0.1 ±3% (typical)	1.0 ±0.002%	VM5000 automatically compensates for Wideband mode gain
HV Channels	0.01 ±5% (typical)	1.0 ±0.002%	
DC Termination			
RGB Channels	75 Ω nominal	75 Ω ±0.3%	
HV Channels	2.2 kΩ ±3%	2.2 kΩ ±1.5%	
Bandwidth			
RGB Channels	<3 dB down at 1,500 MHz	DC to 10 MHz (typical)	
HV Channels	<3 dB down at 320 MHz	DC to 10 MHz (typical)	
RGB Channels Input Return Loss			
1 MHz to 100 MHz	>27 dB		27 dB RL is equivalent to ±7.5 Ω variation from 75 Ω
100 MHz to 250 MHz	>21 dB		21 dB RL is equivalent to ±15 Ω variation from 75 Ω
HV Channels Input Capacitance	3 pF (typical)		
Current Source Loads (HV Channels)		+8mA ±2.5% -8mA ±2.5%	Current sources provide loads for V0H and V0L testing of H&V sync signals

▸ HDTV Matrix Test Signal Details

Signal	Format	Signal Details
Color Bars	All	100% Color Bars with 100% White
Multiburst	720p, 1080i and 1080p	5, 10, 15, 20, 25, 30 MHz for Y, G, B, R 2.5, 5, 7.5, 10, 12.5, 15 MHz for Pb and Pr
	480p and 576p	2, 4, 6, 8, 10, 12 MHz for Y, G, B, R 1, 2, 3, 4, 5, 6 MHz for Pb and Pr
	480i and 576i	1, 2, 3, 4, 5, 6 MHz for Y, G, B, R 0.5, 1, 1.5, 2, 2.5, 3 MHz for Pb and Pr
Sweep	720p, 1080i and 1080p	5 to 35 MHz for Y, G, B, R 2.5 to 15 MHz for Pb and Pr
	480p and 576p	2 to 12 MHz for Y, G, B, R 1 to 6 MHz for Pb and Pr
	480i and 576i	0.5 to 6 MHz for Y, G, B, R0.5 to 3 MHz for Pb and Pr
Sweep Parade	All	Windowed Areas (Chirp)
Flat Field – Black	All	Near Black – 7.5 mV
Flat Field – Gray	All	Gray – 350 mV on RGB
Flat Field – White	All	White – 700 mV on RGB
Valid Ramp	All	Ramp 0 to 700 mV on RGB
Shallow Ramp	All YPbPr	Ramp 350 mV ±35 mV on Y, G, B, R Ramp 0 mV ±35 mV on Pb and Pr
Pulse and Bar	YPbPr and RGB	2T Pulse Response with equivalent bar rise and bar fall. Pb and Pr are twice the duration of Y, G, B, R

Display Characteristics

Display Type –
10.4-inch Liquid crystal active-matrix color display.
Display Resolution –
640 horizontal x 480 vertical pixels.
Waveform Styles –
Vectors, Dots, Intensified Samples, Variable Persistence, Infinite Persistence.
Display Format – YT, XY, XYZ.

Computer System and Peripherals

Operating System – Microsoft Windows 2000.
CPU – Intel Celeron Processor, 2.0 GHz.
PC System Memory – 512 MB.
Internal Hard Disk Drive – ≥80 GB capacity.
Floppy Disk Drive –
Front panel 3.5-inch floppy disk drive, 1.44-MB capacity.
CD-RW Drive –
Side panel CD-RW drive, ≥24X read and write speed.
Mouse – Optical wheel mouse, USB interface.

Input/Output Ports

Video Input –
Front panel BNC connectors (3) for 3-wire CAV. A fourth BNC for separate composite sync or H sync input on RGBHV signals. A fifth BNC (auxiliary input) for V sync on RGBHV signals. Trigger level range is adjustable from +8 V to –8 V. The maximum input voltage is ±20 V (DC + peak AC) and input resistance is ≥1.5 kΩ.
External Reference In –
Rear-panel BNC connector. 9.8 MHz to 10.2 MHz.
Parallel Port – IEEE 1284, DB-25 connector.
Audio Ports –
Miniature phone jacks for stereo microphone input and stereo line output.
USB Port –
Two USB 2.0 ports allow connection or disconnection of USB keyboard and/or mouse while oscilloscope power is on.
Keyboard Port – PS-2 compatible.
Mouse Port – PS-2 compatible.
LAN Port –
RJ-45 connector, supports 10Base-T and 100Base-T.
Serial Port – DB-9 COM1 port.
Video Port –
DB-15 female connector; connect a second monitor to use dual-monitor display mode. Supports basic requirements of PC99 specification and display resolutions up to 1,920x1,440.
GPIB Port –
IEEE 488.2 standard, can be configured for talk/listen or controller mode.
Oscilloscope VGA Video Port –
DB-15 female connector, connect to show the oscilloscope display on an external monitor or projector.

Power Source

Power –
100 to 240 V_{RMS} ±10%, 47 to 63 Hz; CAT II, or 115 V_{RMS} ±10%, 360 to 440 Hz.
Power Consumption – <220 W.

Physical Characteristics

Benchtop Configuration

Dimensions	**mm**	**in.**
Height	361	14.2
Width	447	17.6
Depth	288	11.35
Weight	**kg**	**lbs.**
Net	11.23	24.75
Shipping	25.63	56.5

Rackmount Configuration

Dimensions	**mm**	**in.**
Height	267	10.5
Width	483	19
Depth	288	9.1*[1]
Weight	**kg**	**lbs.**
Net	13.53	29.75
Cooling		
Cooling Clearance	3 inches (76 mm) required on left side	

*[1] From rack mounting ear to back of instrument.

Environmental

Temperature

Operating – +5 ºC to +45 ºC.
Nonoperating –
–20 ºC to +60 ºC without diskette in floppy drive.

Humidity

Operating –
20% to 80% relative humidity with a maximum wet bulb temperature of +29 ºC at or below +45 ºC, noncondensing. Upper limit derates to 30% relative humidity at +45 ºC.
Nonoperating –
Without diskette in floppy disk drive. 5% to 90% relative humidity with a maximum wet bulb temperature of +29 ºC at or below +60 ºC, noncondensing. Upper limit derates to 20% relative humidity at +60 ºC.

Altitude

Operating – 10,000 ft. (3,048 m).
Nonoperating – 40,000 ft. (12,190 m).

Random Vibration

Operating –
0.1 GRMS from 5 to 500 Hz, 10 minutes each axis, 3-axes, 30 minutes total.
Nonoperating –
2.0 GRMS from 5 to 500 Hz, 10 minutes each axis, 3-axes, 30 minutes total.

Regulatory Certifications

Electromagnetic Compatibility – 89/336/EEC.
Safety –
UL61010, CSA-22.2 No. 1010.1, EN61010-1, IEC61010-1.

► Ordering Information

VM5000 – Automatic Video Measurement Set. Includes: 1 GHz, 5 GS/s, 4 channel digital phosphor oscilloscope, Accessory Pouch (016-1935-00), Front Cover (200-4651-00), Mini Keyboard (118-9402-00), Mouse (119-6936-00), Terminations 75 Ω BNC (Qty 4) (011-0102-03), BNC T's (Qty 4), (103-0030-00), VM5000 User Manual (071-1522-01), TDS5000 Quickstart Manual (071-1355-02) VM5000 Product software CD-ROM (020-2565-01), VM5000 Programmers manual (.pdf file). TDS5000B Series Product Software CD-ROM (063-3692-03), TDS5000B Series Operating System Restoration CD-ROM (063-3759-00), GPIB Programmer's Reference, Optional Applications Software CD-ROM (020-2450-17), *Getting Started with OpenChoice®* book and Software Developer's Kit CD (020-2513-00), and LabVIEW (020-2476-02), Performance Verification Procedure PDF file, Calibration Certificate Documenting NIST Traceability, Z540-1 Compliance, and ISO9001 Registration, Option key sticker, Power Cord.

Please specify power plug and manual version when ordering. Requires at least one of Option SD, HD or VGA with each new instrument ordered.

Option HD – Test signal files (ATSC transport, TG700 DNL, Bitmap) on CD-ROM (020-2611-00); Sync pick-off accessory (012-1680-01), Option key enabling HD format support.

Option SD – Test signal files on DVD (020-2610-00); Sync pick-off accessory (012-1680-01); Option key enabling SD format support.

Option VGA – PC graphics test signal files on CD-ROM (020-2634-00), RGBHV Measurement Interface Unit (012-1685-00), VGA to 5x BNC cable, 6 in. (174-5147-00), VGA to 5x BNC cable, 1 m (174-5126-00), Termination accessory kit, RS232 Cable (012-1692-00), BNC elbow (Qty 2) (103-0031-00), Option key enabling VGA option.

VM5UP, VM5HDUP – Quick Start User Manual with Translations (020-2643-00), VM5000 User Manual (071-1522-01), VM5000 Product software CD-ROM (020-2565-01), VM5000 Programmers manual (.pdf file).

VM5UP SD, VM5UP HD, VM5HDUP SD – Test signal files (ATSC transport, TG700 DNL, Bitmap) on CD-ROM (020-2611-00), Test signal files on DVD (020-2610-00); Option key adding newly ordered format support, Sync pick-off accessory (012-1680-01).

VM5UP VGA – PC graphics test signal files on CD-ROM (020-2634-00), RGBHV Measurement Interface Unit (012-1685-00), VGA to 5x BNC cable, 6 in (174-5147-00), VGA to 5x BNC cable, 1m (174-5126-00), Termination accessory kit, RS232 Cable (012-1692-00), BNC elbow (Qty 2) (103-0031-00), Option key sticker adding VGA support.

Recommended Probes

P5050 – 500 MHz, 10x passive probe.

Recommended Accessories

Service Manual – Order 071-1362-00.

Transit Case – Order 016-1937-00.

Probe Calibration, Compensation and Deskew Adapter – Order 067-0405-xx.

Power Deskew Fixture – Order 067-1478-00.

Video Display Clamp – Order 013-0278-xx.

GPIB Cable (1 m) – Order 012-0991-01.

GPIB Cable (2 m) – Order 012-0991-00.

Instrument Options

Opt. 18[*1] – Touch-screen interface.

Opt. 1R – Rackmount kit.

Opt. SM – Communication mask testing.

Opt. CP2[*2] – TDSCPM2: ANSI/ITU telecom pulse compliance testing software.

Opt. ET3 – TDSET3: Ethernet compliance test software.

Opt. HD[*3] – HD Component analog video measurements and format support.

Opt. J2 – TDSDDM2: Disk drive measurements software.

Opt. J3E – TDSJIT3E: Jitter and timing analysis software essentials.

Opt. JA3 – TDSJIT3 v2.0: Advanced Jitter and timing analysis software.

Opt. JE3 – TDSJIT3 v2.0; Essentials Jitter and timing analysis software.

Opt. JT3 – TDSJIT3: Jitter and timing analysis software.

Opt. PW3 – TDSPWR3: Power measurements software.

Opt. SD[*3] – SD component analog video measurements and format support.

Opt. SM – Communication mask testing.

Opt. USB – TDSUSBS: USB 2.0 Compliance test software only.

Opt. VGA[*3] – RGBHV Video Measurements and VESA Compliance Tests.

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

[*2] Requires Option SM.

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

Power Plug Options

Opt. A0 – North America Power.

Opt. A1 – Universal EURO Power.

Opt. A2 – United Kingdom Power.

Opt. A3 – Australia Power.

Opt. A4 – 240 V, North America Power.

Opt. A5 – Switzerland Power.

Opt. A6 – Japan Power.

Opt. A10 – China Power.

Opt. A99 – No Power Cord or AC Adapter.

Manual Options

Opt. L0 – English Manual.

Opt. L1 – French Manual.

Opt. L3 – German Manual.

Opt. L4 – Spanish Manual.

Opt. L5 – Japanese Manual.

Opt. L7 – Simplified Chinese Manual.

Opt. L8 – Traditional Chinese Manual.

Opt. L9 – Korean Manual.

Opt. L10 – Russian Manual.

Service Options

Opt. C3 – Calibration Service 3 Years.

Opt. C5 – Calibration Service 5 Years.

Opt. D1 – Calibration Data Report.

Opt. D3 – Calibration Data Report 3 Years (with Option C3).

Opt. D5 – Calibration Data Report 5 Years (with Option C5).

Opt. R3 – Repair Service 3 Years (including warranty).

Opt. R5 – Repair Service 5 Years (including warranty).

Instrument Upgrades (VM5UP)

Opt. 1R – Rackmount kit.

Opt. 3EA – TDSJIT3 v2.0; upgrade from J3E; requires JE3.

Opt. 3EE – TDSJIT3 v2.0; essentials; upgrade from J3E; requires JE3.

Opt. CP2*2 – TDSCPM2 – ANSI/ITU telecom pulse compliance testing software.

Opt. E3A – TDSJIT3 v2.0; upgrade from JE3; requires JT3.

Opt. ET3 – TDSET3; Ethernet compliance test software.

Opt. HD – HD Component analog video measurements and format support.

Opt. IF – Upgrade installation service.

Opt. J2 – TDSDDM2: Disk drive measurements software.

Opt. JE3 – TDSJIT3 v2.0 Essentials; Advanced Jitter and timing analysis software.

Opt. JA3 – TDSJIT3 v2.0; Advanced Jitter and timing analysis software.

Opt. JTA – TDSJIT3 v2.0; Advanced Jitter and timing analysis software; requires JT3.

Opt. PW3 – TDSPWR3: Power measurements software.

Opt. SD – SD component analog video measurements and format support.

Opt. SM – Communication mask testing.

Opt. USB – TDSUSBS; USB 2.0 Compliance test software only.

Opt. VGA – RGBHV Video Measurements and VESA Compliance Tests.

*2 Requires option SM.

Upgrades equivalent to original options can be ordered to extend instrument performance after initial purchase. Users can install upgrades without opening the instrument case or requiring on-site service. To upgrade a VM5000, order a VM5UP with one or more of the options listed above. Factory installation is available by specifying Option IF. For older VM5000HD instrument upgrades order VM5HDUP with one or more of the following options: 2A, 3EE, 3EA, E3A, IF, J2, JA3, JE3, JTA, PW3, SD, USB, VGA. Additional or replacement test signals and other standard accessories can be ordered separately via part number.

Automated Video Measurement Set

► VM5000

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www.tektronix.com

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