

**WFM6120, WFM7020, WFM7120
WFM6100 Opt. MB, WFM7000 Opt. MB,
and WFM7100 Opt. MB
Waveform Monitors
Specifications and Performance Verification
Technical Reference**



077-0080-02

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Technical Reference**

This document applies to firmware version 5.0.X.

Warning

The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

www.tektronix.com

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Contacting Tektronix

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

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
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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.

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.

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 apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Power Disconnect. The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

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

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

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

Replace Batteries Properly. Replace batteries only with the specified type and rating.

Recharge Batteries Properly. Recharge batteries for the recommended charge cycle only.

Use Proper AC Adapter. Use only the AC adapter specified for this product.

Use Proper Fuse. Use only the fuse type and rating specified for this product.

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.

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.*

Symbols and 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.

The following symbol(s) may appear on the product:



CAUTION
Refer to Manual



Protective Ground
(Earth) Terminal

Environmental Considerations

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

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

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



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

Battery Recycling. This product may contain a Nickel Cadmium (NiCd) or lithium ion (Li-ion) rechargeable battery, which must be recycled or disposed of properly. Please properly dispose of or recycle the battery according to local government regulations.

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

Restriction of Hazardous Substances

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

Preface

This reference document provides technical information about using the WFM6120, WFM7020, and WFM7120 Series multi-format waveform monitors.

Related User Documents

The following related user documents are available:

- *WFM6120, WFM7020, and WFM7120 Waveform Monitors Release Notes* (Tektronix part number 077-0226-XX). This document describes any known problems or behaviors that you might encounter while using the waveform monitor.
- *WFM6120, WFM7020, and WFM7120 Waveform Monitors Quick Start User Manual* (Tektronix part numbers: English, 071-2223-XX; Japanese 071-2224-XX; Simplified Chinese, 071-2225-XX). This document is a printed Quick Start User Manual and contains the basic operating information for the instrument. Included in the manual is a CD-ROM containing PDFs of the user documents.
- *WFM6120, WFM7020, and WFM7120 Waveform Monitors Technical Reference* (Tektronix part number 077-0079-XX). This document contains the detailed operating information for the instrument.
- *WFM6120, WFM7020, and WFM7120 Waveform Monitors Service Manual* (Tektronix part number 077-0081-XX). This document provides servicing information for the waveform monitor and is intended for qualified service personnel only.

Related Reference Documents

The following related reference documents are available at the Tektronix, Inc. Web site (www.tektronix.com):

- *Preventing Illegal Colors*. This application note describes how the Diamond, Arrowhead, and Lightning displays can be used to help prevent the undesired impact of color gamut violations and to simplify the assessment of proper gamut compliance.
- *Understanding Colors and Gamut*. This poster provides a large visual display of how the Diamond, Arrowhead, and Lightning displays can be used to help prevent the undesired impact of color gamut violations.
- *A Guide to Standard and High Definition Digital Video Measurements*. This book is a primer for understanding the basics for making standard and high-definition, digital-video measurements.
- *Analog and Digital Audio Monitoring*. This application note describes how to monitor analog and digital audio signals. Also discussed are specific differences in the methods used to monitor analog audio versus digital audio, and how to plan the transition from monitoring analog audio to monitoring digital audio.
- *Audio Monitoring*. This application note describes balanced and unbalanced audio signals, and explains the physical and electrical characteristics and the specific strength and weaknesses of the different digital audio signal formats.
- *Monitoring Surround Sound Audio*. This application note describes the basics of 5.1-channel surround sound audio and how to use the Surround Sound display to visualize key audio-level and phase relationships in this audio format.

Specifications

The following tables list the specifications for the Tektronix WFM6120, WFM7020, and WFM7120 Waveform Monitors. Items listed in the Performance Requirement column are generally quantitative and can be tested by the *Performance Verification* procedure in Section 2 of this manual. Items listed in the Reference Information column are useful operating parameters that have typical values; information in this column is not guaranteed.

The specifications listed in the Electrical Specifications portion of these tables apply over an ambient temperature range of +0 °C to +40 °C. The rated accuracies are valid when the instrument is calibrated in an ambient temperature range of +20 °C to +30 °C.

NOTE. All HD specifications apply to 3 Gb/s unless noted otherwise.

Electrical Specifications

Table 1: SDI Input Waveform Vertical Characteristics

Characteristic	Performance requirement	Reference information
Vertical Measurement Accuracy		Using graticule or cursor. Measure in YPbPr mode.
	1X	± 0.5% of 700 mV full scale mode
	5X	± 0.2% of 700 mV full scale mode
Gain	X1, X2, X5, and X10	
Variable Gain Range, Typical		0.25X to 1.8X, typical (variable gain multiplied by fixed gain to get total gain).
Frequency Response - HD	Luminance Channel (Y)	50 kHz to 30 MHz, ± 0.5%
	Chrominance Channels (Pb, Pr)	50 kHz to 15 MHz, ± 0.5%
Frequency Response - SD	Luminance Channel (Y)	50 kHz to 5.75 MHz, ± 0.5%
	Chrominance Channels (Pb, Pr)	50 kHz to 2.75 MHz, ± 0.5%
YPbPr to RGB Conversion Accuracy		0.1%, nominal

Table 1: SDI Input Waveform Vertical Characteristics (cont.)

Characteristic	Performance requirement	Reference information
Step Response, Typical	Preshoot	Sine-squared bars
	SD	≤ 0.3% peak (2T5 bar)
	HD	≤ 0.5% peak (2T30 bar)
	Overshoot	
	SD	≤ 0.3% peak (2T5 bar)
	HD	≤ 0.5% peak (2T30 bar)
	Ringing	
	SD	≤ 0.8% peak-peak (2T5 bar)
	HD	≤ 0.8% peak-peak (2T30 bar)
		Most of the error seen on the display comes from the inherent ringing in the digital data. The response of the monitor is close to the theoretical limit of a perfect $\sin x/x$ reconstruction filter.
Pulse Response, Typical		Blackman pulse
	Baseline Ringing	
	SD	≤ 0.6% peak-peak (2T5)
	HD	≤ 0.7% peak-peak (2T30)
		Pulse-to-bar ratio 0.995:1 to 1.005:1 on appropriate Sine Squared or Blackman 2T pulse.
		A sine-squared pulse near Nyquist is not band-limited and so inherently has ringing much larger than the waveform monitor filter. A three term Blackman pulse with the same HAD has much less inherent ringing, so it is a better choice for most testing. See <i>Digital to Analog Conversion, Data and Filter Requirements</i> , SMPTE Journal Mar 1995, Vol. 104, Fibush, Baker, Penny.
Tilt, Typical	Field Rate	0.1%
	Line Rate	0.1%
Off Screen Recovery, Typical		0.1% variation in baseline of a 5 MHz modulated pulse when positioned anywhere on screen at any gain setting.

Table 2: Composite Analog Input Waveform Vertical Characteristics

Characteristic		Performance requirement	Reference information
Vertical Measurement Accuracy			Measured using cursors or graticules
	1X	$\pm 1\%$	
	5X	$\pm 1\%$	
Gain			X1, X2, X5, and X10
Variable Gain Range, Nominal			0.25X to 1.8X
Frequency Response		Flat to 5.75 MHz, $\pm 1\%$	
Delay Variation over Frequency		± 10 ns to 5.75 MHz	Typically ± 2.5 ns
Transient Response on Sine Squared 2T4 Pulse			Pulse to bar ratio 0.99:1 to 1.01:1
	Preshoot	$\leq 1\%$	
	Overshoot	$\leq 1\%$	
	Ringing	$\leq 1\%$	
Field Rate Tilt		$< 0.5\%$	With DC Restore Fast or Off
Line Rate Tilt		$< 0.5\%$	With DC Restore Fast or Off
Off Screen Recovery			$\leq 0.5\%$ variation in baseline of a Chroma modulated pulse when positioned anywhere on screen. Signal must meet specification for Video Maximum Operating Amplitude. Any gain setting.
SNR			60 dB _{RMS} minimum, relative to 700 mv for PAL or 714 mv for NTSC.

Table 3: Composite Analog Inputs A and B Physical Layer

Characteristic	Performance requirement	Reference information
Formats Supported		NTSC, NTSC no setup, and PAL, I, B, D, G, H. Complies with RS170A & ITU-R BT.471 Manual or auto detect of input standard
Internal Reference		Proper horizontal and vertical synchronization with a composite signal of appropriate line and field rate
Input Dynamic Range, Typical		± 6 dB range
Video Maximum Operating Amplitudewith Clamp Off (DC Coupled), Typical		-1.8 V to +2.2 V (all inputs) DC +peak AC
Maximum Absolute Video Input Voltage		-6.0 V to +6.0 V (DC + peak AC)
Input Type		Passive loop-through 75 Ω compensated
DC Input Impedance		20 k Ω
Return Loss		Typically > 46 dB to 6 MHz, > 40 dB to 10 MHz. Typically 35 dB with power off for standard amplitude video

Table 3: Composite Analog Inputs A and B Physical Layer (cont.)

Characteristic	Performance requirement	Reference information
Video Input Crosstalk Between Channels		≥ 60 dB to 6 MHz
Loop through Isolation		≥ 70 dB to 6 MHz
DC Offset with Restore Off, Typical		≤ 20 mV Measured in full screen mode at X5 Gain
DC Restore Modes		Fast, Slow, and Off modes Slow has a typical bandwidth of 10 Hz Fast has a typical bandwidth of 500 Hz
DC Restore Offset Error		≤ 2 mV Registration between back porch and 0 V graticule
DC Offset Between Inputs With Restore Off		≤ 7 mV
DC Restore		
50 Hz and	Fast Mode	> 95% attenuation
60 Hz Attenuation	Slow Mode	< 10% attenuation, < 10% peaking
Blanking Shift with 10% to 90% APL Change		≤ 1 IRE (7 mV PAL)
Blanking Shift with Presence and Absence of Burst		≤ 1 IRE (7 mV PAL), Typically 0 mV
Lock Range		± 50 ppm, remains locked Vector typically OK to ± 80 ppm. waveform display typically locked to ± 200 ppm
Lock in Presence of Hum		700 mV _{p-p} , on full amplitude 100% color bar signal, remains locked
Lock in Presence of White Noise		Signal/Noise ratio of 32 dB, 5 MHz bandwidth on black burst, remains locked
Color Framing		Correct color framing detected for signals having < 45 SCH phase error with burst present

Table 4: Waveform Sweep (Horizontal) Deflection

Characteristic	Performance requirement	Reference information
Sweep		
	Accuracy	± 0.5%, all rates Line sweeps for 1080P 60/59/50 dual link formats are shown with image scanning time scale. In these formats, each link operates at 1/2 the image scanning rate, so link time scale is twice the indicated time per division.
	Linearity	0.2% of time displayed on screen Fully digital system

Table 4: Waveform Sweep (Horizontal) Deflection (cont.)

Characteristic	Performance requirement	Reference information
Timing Cursor Delta Readout Accuracy, Typical		$\pm 0.5\%$ of sweep time displayed on screen
Rates		1, 2, 3, or 4 line, or field depending on mode
Line Select		In 2-line sweep, the selected line is the first displayed line.

Table 5: Eye Pattern Display

Characteristic	Performance requirement	Reference information
Type		Equivalent Time Sampler
Formats		SD and HD. (See Table 48 on page 38.)
Signal Bandwidth	100 MHz to 2.5 GHz at -3 dB point	
Time Base		
Jitter, Typical	SD	60 ps _{p-p} in 1 kHz high-pass filter mode
	HD	20 ps _{p-p} in 1 kHz high-pass filter mode
Eye Clock Bandwidth Settings		Clock bandwidth can be set to 10 Hz, 100 Hz, 1000 Hz, 10 kHz, or 100 kHz high pass filter
Eye Clock Bandwidth Accuracy		Actual -3 dB frequency within 10% of nominal
Jitter Attenuation Error	HD	
	10 Hz High Pass Filter	Within 0.3 UI + 10% for jitter frequencies above five times bandwidth selection
	100 Hz to 100 kHz High Pass Filter	Within 0.05 UI + 10% for jitter frequencies above five times bandwidth selection
	SD	
	All High Pass Filter settings	Within 0.05 UI + 10% for jitter frequencies above five times bandwidth selection

Table 5: Eye Pattern Display (cont.)

Characteristic	Performance requirement	Reference information
Display Modes		
	SD	
	Overlay	Overlays all bits to form each eye opening. Useful for observing peak jitter
	10 Eye	Displays eye relative to the parallel clock. Useful for observing jitter correlated to word clock
	HD	
	Overlay	Overlays all bits to form each eye opening. Useful for observing peak jitter
	20 Eye	Displays eye relative to the parallel clock. Useful for observing jitter correlated to word clock
Vertical Scale Accuracy	800 mV $\pm 5\%$ with an 800 mV _{p-p} input signal	
Horizontal Scale Accuracy		Indicated time per division $\pm 1\%$, fully digital system
Eye Derived Measurements		
	Rise Time / Fall Time, Typical	Measurements only valid on a clean signal. Excess jitter, overshoot, or other aberrations will reduce the accuracy. Limited by inherent rise time of eye display
	Amplitude, Typical	$\pm 10\text{mV}$ Measurements only valid on a clean signal. Excess jitter, overshoot, or other aberrations will reduce the accuracy. Limited by inherent rise time of eye display
Equalized Eye Display		Shows eye from input after it has gone through equalizer Allows limited use of eye at long cable length. Equalizer adds some jitter. Can bypass equalizer at short cable lengths to overcome this effect
Equalized Eye Amplitude, Typical		600 mv $\pm 80\text{mv}$ Amplitude of equalized eye is not related to input amplitude. This waveform is from the digital output of the equalizer. It is intentionally displayed at a smaller size to reduce the chance of it being confused with the input eye

Table 6: Jitter Display (Option EYE and PHY)

Characteristic	Performance requirement	Reference information
Type		Displays numerical and graphical readouts of peak-to-peak jitter. Jitter derived from demodulated recovered clock as described in SMPTE RP192 2003. If Opt. PHY is installed, then Jitter Waveform can also be displayed
High-Pass Filter Settings		Can be set to 10 Hz, 1 kHz, 10 kHz, or 100 kHz. High pass filter has type-3 response for low frequency rejection of 60 dB/decade below the filter setting. High pass filter also applies to digital readout, jitter waveform and Eye diagram display, but not the reference clock output. There are two independent Jitter demodulators which may be configured with different loop bandwidths. One is applied to the upper two tiles of the display, and the other applies to the lower two tiles
High-Pass Filter Attenuation Accuracy		Frequency at which response is -3dB is within 10% of nominal High-Pass Frequency Response also applies to readout and jitter waveform
High-End Frequency Response, Typical		-3 dB at $> 5\text{ MHz}$ Applies to digital readout, jitter waveform, and reference clock output

Table 6: Jitter Display (Option EYE and PHY) (cont.)

Characteristic	Performance requirement	Reference information
Maximum Jitter		Applies to digital readout, jitter waveform, and Reference Clock output
	Maximum is a function of jitter frequency and standard:	Maximum jitter is limited by measurement range at low frequencies, and by jitter tolerance of serial receiver at high frequencies
	10 Hz to 30 kHz, HD	20 UI _{p-p}
	10 Hz to 40 kHz, SD	10 UI _{p-p}
	30 kHz to 1 MHz, HD	Declines to 0.35 UI at 1 MHz
	50 kHz to 1 MHz, SD	Declines to 0.35 UI at 1 MHz
	>1 MHz, HD	0.35 UI
	1 MHz to 4 MHz, SD	0.35 UI
	>4 MHz, SD	0.25 UI
	Minimum (noise floor) is a function of bandwidth selection:	Applies to jitter waveform
10 Hz, HD	200 ps typical	
100 Hz, 1 kHz, 10 kHz, 100 kHz, HD	40 ps typical	
All HPF settings, SD	250 ps typical	
Digital Readout Type		Displays peak to peak value of jitter detected over the measurement period, as defined by selected high-pass filter setting. Indicates timing jitter or alignment jitter if appropriate

Table 6: Jitter Display (Option EYE and PHY) (cont.)

Characteristic	Performance requirement	Reference information
Digital Readout	Accuracy, Typical	For jitter frequencies from 5 times bandwidth selection to 4 MHz
	10 Hz, HD	<0.3 UI + 10% of reading
	100 Hz, 1 kHz, 10 kHz, 100 kHz, HD	<0.05 UI + 10% of reading
	All HPF settings, SD	<0.05 UI + 10% of reading
	Resolution	0.01 UI
Jitter Waveform	Gain Error, Typical	For jitter frequencies from 5 times bandwidth selection to 4 MHz Error for jitter frequencies between HPF setting and 5x HPF setting due to loop peaking: max of 1.5 dB
	10 Hz, HD	<0.4 UI + 10% of reading
	100 Hz, 1 kHz, 10 kHz, 100 kHz, HD	<0.1 UI + 10% of reading
	All HPF settings, SD	<0.1 UI + 10% of reading
	Scale	
	Horizontal Modes	1 Line, 2 Line, 1 Field, 2 Field
Vertical Modes	1 UI / div, 0.2 UI / div, 0.1 UI / div	
Reference Clock Output, Typical		1 V p-p into 75 Ω load SD frequency = 27 MHz HD frequency = 74.25 or 74.17852 MHz
Jitter Measurement Time		0.5 Sec Approximately 5,000,000 independent samples

Table 7: Jitter Display (Option JIT)

Characteristic	Performance requirement	Reference information
Type		Displays numerical and graphical readouts of peak-to-peak jitter. Jitter derived from demodulated recovered clock as described in SMPTE RP192 2003. If Opt. PHY is installed, then Jitter Waveform can also be displayed
High-Pass Filter Settings		Can be set to 10 Hz, 1 kHz, 10 kHz, or 100 kHz. High pass filter has type-3 response for low frequency rejection of 60 dB/decade below the filter setting. High pass filter also applies to digital readout, jitter waveform and Eye diagram display, but not the reference clock output. There are two independent Jitter demodulators which may be configured with different loop bandwidths. One is applied to the upper two tiles of the display, and the other applies to the lower two tiles
High-Pass Filter Attenuation Accuracy		Frequency at which response is -3dB is within 10% of nominal High-Pass Frequency Response also applies to readout and jitter waveform
High-End Frequency Response, Typical		-3 dB at > 5 MHz Applies to digital readout, jitter waveform, and reference clock output

Table 7: Jitter Display (Option JIT) (cont.)

Characteristic	Performance requirement	Reference information
Maximum Jitter		Applies to digital readout, jitter waveform, and Reference Clock output
	Maximum is a function of jitter frequency and standard:	Maximum jitter is limited by measurement range at low frequencies, and by jitter tolerance of serial receiver at high frequencies
	10 Hz to 30 kHz, HD	20 UI _{p-p}
	10 Hz to 40 kHz, SD	10 UI _{p-p}
	30 kHz to 1 MHz, HD	Declines to 0.35 UI at 1 MHz
	50 kHz to 1 MHz, SD	Declines to 0.35 UI at 1 MHz
	>1 MHz, HD	0.35 UI
	1 MHz to 4 MHz, SD	0.35 UI
	>4 MHz, SD	0.25 UI
	Minimum (noise floor) is a function of bandwidth selection:	Applies to jitter waveform
	10 Hz, HD	200 ps typical
	100 Hz, 1 kHz, 10 kHz, 100 kHz, HD	40 ps typical
	All HPF settings, SD	250 ps typical
Digital Readout Type		Displays peak to peak value of jitter detected over the measurement period, as defined by selected high-pass filter setting. Indicates timing jitter or alignment jitter if appropriate

Table 7: Jitter Display (Option JIT) (cont.)

Characteristic	Performance requirement	Reference information
Digital Readout	Accuracy, Typical	For jitter frequencies from 5 times bandwidth selection to 4 MHz
	10 Hz, HD	<0.3 UI + 10% of reading
	100 Hz, 1 kHz, 10 kHz, 100 kHz, HD	<0.05 UI + 10% of reading
	All HPF settings, SD	<0.05 UI + 10% of reading
	Resolution	0.01 UI
Jitter Waveform	Gain Error, Typical	For jitter frequencies from 5 times bandwidth selection to 4 MHz Error for jitter frequencies between HPF setting and 5x HPF setting due to loop peaking: max of 1.5 dB
	10 Hz, HD	<0.4 UI + 10% of reading
	100 Hz, 1 kHz, 10 kHz, 100 kHz, HD	<0.1 UI + 10% of reading
	All HPF settings, SD	<0.1 UI + 10% of reading
	Scale	
	Horizontal Modes	1 Line, 2 Line, 1 Field, 2 Field
Vertical Modes	1 UI / div, 0.2 UI / div, 0.1 UI / div	
Reference Clock Output, Typical		1 V p-p into 75 Ω load SD frequency = 27 MHz HD frequency = 74.25 or 74.17852 MHz
Jitter Measurement Time		0.5 Sec Approximately 5,000,000 independent samples

Table 8: Component Vector Mode

Characteristic	Performance requirement	Reference information
Vertical Bandwidth, Typical	SD	800 kHz
	HD	3.4 MHz (6.8 MHz for 1080P 60/59/50 dual link formats)
Vertical Gain Accuracy	$\pm 0.5\%$	Fully digital system
Horizontal Gain Accuracy	$\pm 0.5\%$	Fully digital system
Display to Graticule Registration	$\pm 0.5\%$	Fully digital system limited by sample resolution
Vector Display		P_B is displayed on horizontal axis and P_R is displayed on vertical axis

Table 9: Waveform Mode Filter Characteristics

Characteristic	Performance requirement	Reference information
Low Pass Filter Gain	SD, component only	$1 \pm 0.1\%$ relative to flat gain
	HD, component only	$1 \pm 0.1\%$ relative to flat gain
Low Pass Filter Frequency Response	SD, component only	≤ 3 dB attenuation at 800 kHz ≥ 32 dB attenuation at 3 MHz Filter meets IEEE STD-205
	HD, component only	≤ 3 dB attenuation at 4.5 MHz ≥ 25 dB attenuation above 15 MHz, Noise bandwidth is approximately 8 MHz Stopband null at 18 MHz
Luma Filter Gain, composite only	$1 \pm 0.1\%$ relative to flat gain at 50 kHz	
Luma Filter Frequency Response, composite only	≤ 3 dB attenuation at 800 kHz 32 dB attenuation at F_{SC} Same as SD serial component low pass filter	
Chroma Filter Gain, composite only	$1 \pm 0.1\%$ relative to flat gain	
Chroma Filter Response, composite only	3 dB bandwidth $1\text{MHz} \pm 0.2$ MHz F_{SC} autoselected based on input standard, implemented digitally, centered on F_{SC}	
Chroma Filter Attenuation at $2x F_{SC}$, composite only	≥ 25 dB Implemented digitally. Typically 28 dB for NTSC, 53 dB for PAL	

Table 10: SDI Lightning and Diamond Modes

Characteristic		Performance requirement	Reference information
Vertical Gain Accuracy		$\pm 0.5\%$	Fully digital system
Electronic Graticule Display	Diamond		RGB deflection axis indicated. Upper and lower halves are separated, to see negative signals
	Lightning		Displays signal components as follows: Y vertically Pb horizontally on top half of display P _r horizontally on bottom half of display
Detection Level	High Limit	+630 mV to +756 mV in 1 mV steps	
	Low Limit	-50 mV to +35 mV in 1 mV steps	
Detection Level Accuracy		± 3.5 mV	
Diamond Area Threshold Range			0% to 10%

Table 11: Data Mode

Characteristic		Performance requirement	Reference information
Digital Waveform			Non-interpolated waveform display. Cursor identifies selected sample value (hex, decimal, binary). Cursor inserted on picture monitor output shows selected line
Digital List			Sequential list of sample values in table format. Cursor identifies selected sample
Display Format			HEX, DEC, BIN

Table 12: Composite Vector Mode

Characteristic		Performance requirement	Reference information
Displayed Horizontal and Vertical Gain Accuracy	X1 Gain	$\pm 1\%$	
	X5 Gain	$\pm 1\%$	
Display to Graticule Registration		Centered in target, +0.5 box diameter With the color bar black/white display dot centered in target. Boxes are 2% targets	
Vector Display			B-Y is displayed on horizontal axis and R-Y is displayed on vertical axis
Bandwidth, Typical			360 kHz
Horizontal to Vertical Bandwidth Matching		$< 0.5^\circ$ at 500 kHz and 2 MHz	
Composite Vector Dot Reference			Shows "true" zero subcarrier reference
R-Y B-Y Axis Orthogonality, Typical			$\pm 0.1^\circ$, implemented digitally

Table 13: Arrowhead Mode (NTSC/PAL composite limit display)

Characteristic	Performance requirement	Reference information
Signal to Graticule Accuracy	$\pm 1\%$, 100 IRE (700 mV), and 131 IRE (900 mV)	(PAL values in parenthesis)
Composite Limit Cursor Accuracy	$\pm 1.0\%$ at 100 IRE, 110 IRE, 120 IRE, and 131 IRE (700 and 950 mV)	(PAL values in parenthesis)
	$\pm 1.0\%$ at -24 IRE, -33 IRE, and -40 IRE (-230 and 300 mV)	(PAL values in parenthesis)
Detection Level, nominal		Adjustable thresholds, 1% steps
Composite Limit Detection Level Accuracy	Detection Level = ± 7 mV of cursor level	Upper detection level can be set to 100, 110, 120 or 131 IRE (700 mV or 950 mV PAL)
		Lower detection level can be set to -24, -33, and -40 IRE (-230 mV or -300 mV PAL)
Composite Limit Area Threshold Range		0% to 10%
Luma Limit Detection Range	High	90 to 108%, 0.5% steps
	Low	+5 to -6%, 0.5% steps
Luma Limit Detection Level Accuracy		Detection level = ± 7 mV of cursor level, nominal
Luma Limit Area Threshold Range		0% to 10%

Table 14: Bowtie Mode

Characteristic	Performance requirement	Reference information
Common Mode Rejection Ratio	SD	≥ 34 dB at 2.5 MHz
	HD	≥ 34 dB at 5 MHz
Interchannel Timing Match	± 0.5 ns	
Functional Description		Displays Y minus Pr and Y minus Pb signals. Requires bowtie signal to be useful. Null in center indicates the channels are time aligned

Table 15: Timing Display

Characteristic	Performance requirement	Reference information
Input Timing Relative to External Reference		Display of Vertical and Horizontal timing offset graphically and numerically. One clock cycle resolution Patented proprietary display. Display Timing difference between input and Ref at rear panel or relative to an offset saved by the user

Table 15: Timing Display (cont.)

Characteristic	Performance requirement	Reference information
Timing Display Zero Definition		<p>For vertical timing, conforms to SMPTE 168-2002</p> <p>For horizontal timing, zero delay analog signals have coincident syncs. For digital signals, timing is such that if converted to analog by a WFM601A, then the resultant analog signal is coincident with the reference</p> <p>Timing zero is equivalent to nominal zero delay on TG700. Also agrees with signal that shows minimal shift on the waveform display when going from internal to external</p> <p>Vertical timing, according to SMPTE 168, specifies that the lines with the start of the broad pulses are aligned</p>
Operation with input and reference being different formats		<p>Compatible with any combination of frame and field rates. (See Table 45.)(See Table 46.)(See Table 47.). In cases where there are multiple ways to interpret the phase relationship, multiple indicators of the phase will be shown. The numeric display will follow the smallest phase offset</p>
Link B to Link A		<p>Display of dual link timing skew. Uncertainty of ± 1.5 clocks or 20 ns.</p>
Input Timing Reference to Other Input		<p>For Simultaneous inputs, allows selection of other channel as reference.</p>

Table 16: Picture Mode

Characteristic	Performance requirement	Reference information
Format (XGA)		<p>Allows viewing picture in all formats</p> <p>In SD formats, full screen picture occupies the central portion of the XGA raster area. For tile mode, the image is downsampled to fit the 512 x 350 size</p> <p>In HD formats, picture is downsampled to fit in 1024 x 768 size (512 x 350 in 4-tile mode). In 1080P 60/59/50 dual link formats, picture is formed by averaging two lines, one from each link, then downsampling as required for display</p> <p>In Low Frame Rate formats, frames are repeated as needed to achieve XGA frame rate; similar to 3:2 pulldown on some frame rates</p>

Table 16: Picture Mode (cont.)

Characteristic	Performance requirement	Reference information
Pix Border On/Off		Allows user to mask or show the inactive portions of the raster such as ANC area for digital and sync for analog. When the border is on, the image is scaled to correct the aspect ratio. When the border is off, the image is either mapped pixel to pixel (full screen SD), or minimally decimated to reduce the artifacts
Synchronization		Picture mode always uses internal timing; it is not affected by external sync
Aspect Ratio		Allows choice of 16:9 or 4:3 for SD, to support widescreen

Table 17: Signal Level / Cable Length Detector

Characteristic	Performance requirement	Reference information
Cable Length Measurement Error	15m \pm 10% for cable types listed at end of table	Requires clean SD signal with rise time <1 ns for full accuracy. Excessive ringing or slower rise time may appear as increased cable length
Cable Length Measurement Resolution		2 meters, nominal
Cable Length Measurement Range, Typical		Cable loss range of 0 to 30 dB at 1/2 serial bit rate Typically runs to 40 dB, but with reduced accuracy Equivalent to 0 to 300 m Belden 8281 for SD, 0 to 120 m Belden 8281 for HD
Launch Amplitude Measurement Accuracy, Typical		\pm 40 mV at 800 mV level, 0 to 100 m Belden 8281 cable
Launch Amplitude Measurement Resolution, Typical		10 mV
Launch Amplitude Measurement Dynamic Range, Typical		\pm 50% from 800 mV
Cable Types		Belden 1694A/1505A/8281/1855A Canare L-5CFB Image 1000
Cable loss measurement		Displays loss around 160 MHz minus loss around 18 MHz

Table 18: Data error detection (EDH / Status, Under STATUS Button)

Characteristic	Performance requirement	Reference information
Data Integrity	SD Active picture and full field. Field rate resolution Complies with SMPTE RP165	Uses CRC check-word system. System is known as EDH (Error Detection and Handling) in industry literature Error icon asserted for 1 second after any error
	HD Field rate Resolution, separate reporting for errors in Y or Color Difference data streams	Error icon asserted for 1 second after any error

Table 19: ANC Data and ARIB

Characteristic	Performance requirement	Reference information
Displays		Detects ANC data in SDI streams, displays data from user specified DID and SDID. Displays Audio Control Packet. Decodes data for ARIB types B39, B37, B35, TR-B22, and TR-B23.
Alarms		Allows Alarms to be set for : ANC Parity ANC Checksum B39 Absence B37 Absence B35 Absence TR-B22 Absence TR-B23 Absence

Table 20: Audio Bar Displays

Characteristic	Performance requirement	Reference information
Modes		The user may configure the response dynamics (ballistics), reference levels, peak hold, offset, and scale of the meters to suit the monitoring needs of the particular installation or situation
Channel Mode		Any 10 channels configured into 5 pairs with phase correlation meters between pairs; analog audio inputs have a 6 channel maximum
Surround Mode		Left, Right, Center Lfe, Left surround, Right surround meters, and an extra channel pair. Phase correlation meters between L-R, L-C, C-R, Ls-Rs, L-Ls, R-Rs and the extra pair In Dolby mode, the bar configuration is automatically set by metadata
Dual Audio Display Mode		For Simultaneous inputs, Dual Audio Displays are available. A total of 8 bars may be allocated between the two displays. Dolby decoding may be enabled for either display, but not for both

Table 20: Audio Bar Displays (cont.)

Characteristic	Performance requirement	Reference information
Audio Sources		<p>Monitoring the signal levels and stereo phase of AES/EBU digital audio, digital audio embedded in serial digital video, and Analog Audio inputs</p> <p>Digital Audio (direct and embedded) may be PCM, Dolby digital, or Dolby E</p>
Level Meter Resolution		<p>0.056 dB steps at 30 dB scale, from full scale to -20 dB FS</p> <p>XGA Full Screen mode = 510 steps XGA 4-tile mode = 255 steps VGA Full or 4-tile mode = 260 steps</p>
Correlation Meter Speed		<p>User selectable 1 to 20. Factory default is set to 8.</p> <p>Speed 1 averages over 0.04 sec. Speed 2 averages over 0.04 sec. Speed 3 averages over 0.08 sec. Speed 4 averages over 0.12 sec. Speed 5 averages over 0.28 sec. Speed 6 averages over 0.52 sec. Speed 7 averages over 1.0 sec. Speed 8 averages over 1.5 sec. Speed 9 averages over 2.0 sec. Speed 10 averages over 2.5 sec. Speed 11 averages over 3.0 sec. Speed 12 averages over 3.5 sec. Speed 13 averages over 4.0 sec. Speed 14 averages over 4.5 sec. Speed 15 averages over 5.0 sec. Speed 16 averages over 5.5 sec. Speed 17 averages over 6.0 sec. Speed 18 averages over 6.5 sec. Speed 19 averages over 7.0 sec. Speed 20 averages over 7.5 sec.</p> <p>The Phase Correlation Meter Speed setting determines how quickly the meter reacts to changes in phase relationship. The meter reading is actually an average of correlation over time, and this setting determines how many samples are used to calculate the average. The instrument uses the fewest samples when this setting is 1, and the meter reacts almost instantaneously. The instrument uses the most samples when the setting is 20, and the meter reacts much more slowly. Experiment to find the setting that best fits your application</p>

Table 20: Audio Bar Displays (cont.)

Characteristic	Performance requirement	Reference information
Metering Ballistic Types		Selectable from true peak, PPM Type 1, PPM Type 2, and Extended VU
Peak Program Meter (PPM) Ballistic Response		PPM Type I (IEC Type I, essentially the same as DIN 45406 and Nordic N-9) PPM Type II (IEC Type II, the same as IEEE std. 152-1991) PPM Type I has a slightly faster attack time and a faster return time, 1.7 seconds to fall 20 dB as opposed to 2.8 seconds for Type II
True Peak Ballistic Response		PPM Type II decay characteristics, no attack delay, factory default ballistic
Extended VU Ballistic Response		VU meter as defined in IEEE 152-1991, but with an extended dB-linear scale. The meter bars also contain true peak indicators when VU is selected
Peak Hold		True peak indicator remains at the most recent peak for a user selectable time of 1 to 10 seconds
Clip Indication Delay Count		Consecutive FS samples for Clip Indication, user selectable Off or 1 to 100. Factory default is set to 1. A setting of 0 is equivalent to "Off"
Mute Indication Delay Count		Consecutive "0" samples for Mute Indication, user selectable Off or 1 to 100. Factory default is set to 10. A setting of 0 is equivalent to "Off"
Clip/Mute Error Readout Hold Time		1 to 30 seconds, user selectable. Factory Default set to 2
Silence Indication Threshold		Audio level below which the signal will be considered "silent" Used to trigger on-screen indication and alarms
Silence Indication Delay		Off or 1 to 60 seconds, user selectable Indication and alarm will not be asserted until signal stays below the silence threshold for this number of consecutive seconds. Factory default is set to 10. A setting of 0 is equivalent to "Off"
Over Indication Threshold		Audio level above which the signal will be considered "over" Used to trigger on-screen indication and alarms

Table 20: Audio Bar Displays (cont.)

Characteristic	Performance requirement	Reference information
Over Indication Delay		Off or 1 to 30 seconds, user selectable Indication and alarm will not be asserted until signal stays above the Over Indication Threshold for this number of consecutive seconds. Factory default is set to 2. A setting of 0 is equivalent to "Off"
Adjustable Peak Program Level		Peak Program level is the level, relative to digital full scale, that the user chooses as the maximum desired level for monitored programs. The meter bars change to red above Peak Program level
	Digital	Range 0 to -30 dBFS
	Analog	Range 24 to -6 dBu
Adjustable Test Level		Test level is the level, relative to digital full scale, that the user chooses as the test or "line up" level for monitored programs. The meter bars change to yellow between the Test and Peak Program levels
	Digital	Range 0 to -30 dBFS
	Analog	Range 24 to -6 dBu
Set 0 dB Mark	Selections are 0 dBFS or 0 dBu, Peak Program Level (dB), or Test Level (dB)	Use this item to number the meter scale relative to Digital Full scale with digital sources, or relative to 0 dBu with analog sources, or to one of the two user-adjustable levels. When the zero mark is set to either Peak Program or Test level, the scale units are dB, relative to the 0 dB level; units above the selected 0 dB mark are positive, while units below it are negative
Analog Audio Scale Types		Selection of DIN, Nordic, or PPM preset the scale, test, and reference levels to match these defined meter types

Table 21: Audio Bar and Lissajous/Surround Display

Characteristic	Performance requirement	Reference information
Description		In combination with Bar mode can have Lissajous or Surround Display in one tile. (See Table 20.)
Automatic Gain Control (AGC)	Lissajous gain control may be on or off	AGC time constant: 0.5 second to expand display after a 0 to -40 dB level transition, 0.05 second to reduce gain after a -40 to 0 dB level transition

Table 21: Audio Bar and Lissajous/Surround Display (cont.)

Characteristic	Performance requirement	Reference information
Manual Scaling		When AGC is off, level at perimeter of display follows Peak Program Level on Bar display
Surround Display Frequency Weighting Filter		Frequency weighting can be A-weighting or Linear (Flat Response) as described in IEC 651 Dominant sound indicator can be turned on and off

Table 22: AV Delay display (Option AVD)

Characteristic	Performance requirement	Reference information
Audio Video Delay measurement		Displays the delay of embedded audio relative to SDI video. Shows delay in milliseconds and in fields. Requires SDI signal from TG700 in AV Timing mode.
Measurement Range		At least -2 to +2 seconds: a negative reading indicates audio is advanced with respect to video; a positive reading indicates it is delayed. Range depends on the repetition rate of the test signal. Specification applies for TG700 AV Timing mode, which has a nominal 5 second repetition rate.
Measurement Accuracy	+/- 1/2 video field.	

Table 23: AES Audio Inputs

Characteristic	Performance requirement	Reference information
Inputs		2 sets with 8 channels each, 32-192 kHz, 24 bit, meets requirements of AES-31D and SMPTE 276M-1995
Input Connector		BNC, terminated, unbalanced
Input Impedance		75 Ω
Input Return Loss		Typically better than 30 dB to 24 MHz Input A has passive terminations, so they are the same with power on or off. Input B has active terminations that go to a higher impedance with the power off
Input Amplitude Range		0.1 V to 2 V peak-to-peak
Input Sample Rate	32k to 192k samples/sec	
Input Lock Frequency Range		>± 5%. If input sample rate changes more than 5%, then the instrument may search again for a new lock point. Typically stays locked to 12.5%

Table 23: AES Audio Inputs (cont.)

Characteristic	Performance requirement	Reference information
Level Meter Accuracy Over Frequency	± 0.1 dB from 20 Hz to 20 kHz with 0 to -40 dBFS sine wave input, Peak Ballistic mode. Within 5 Hz of some submultiples of the sampling frequency it may be attenuated additionally, as shown below. Sampling frequency refers to the 192 kHz upsampled data used for the bar ballistics For example: $1/12^{\text{th}}$ of rate -0.30 dB (16 kHz \pm 5 Hz) $1/16^{\text{th}}$ of rate -0.17 dB (12 kHz \pm 5 Hz) $1/20^{\text{th}}$ of rate -0.11 dB (9.6 kHz \pm 5 Hz)	May not display full amplitude on fast transients due to sampled nature of digital signal
Audio Levels		Bars display signals up to 0 dBFS Must not exceed maximum power specification on analog outputs. Configure output attenuation if necessary

¹ The AES B connectors can be configured for input or output functionality.

Table 24: AES Audio Outputs (alternate function on second set of inputs)

Characteristic	Performance requirement	Reference information
Source		AES Line B outputs can be sourced from embedded, AES line A inputs (active loopthrough) or analog inputs If either Dolby option is installed, then the source may also be a repeat of the encoded Dolby stream, or decoded AES from a Dolby input. See the Dolby spec section for limitations
Number of Outputs		Up to 8 channels
Output Format		AES 3-ID Output, 48 kHz, 20 bit for embedded; 48 kHz, 24 bit for analog to AES. For AES to AES loogthrough, output format equals input format. Meets requirements of SMPTE 276M-1995 (AES 3-ID) For decoded Dolby Digital, output is 24 bits at a rate of 32, 44.1, or 48KHz. For decoded Dolby E the output is 24 bits at 48KHz, or 47.952KHz
Output Connector		BNC, terminated, unbalanced
Output Impedance		75 Ω
Output Return Loss		Typically better than 30 dB to 24 Mhz Tested in input mode
Output Amplitude Range	0.9 V to 1.1 V peak-to-peak into 75 Ω	

Table 24: AES Audio Outputs (alternate function on second set of inputs) (cont.)

Characteristic	Performance requirement	Reference information
Output Sample Rate		Locked to embedded sample rate (nominally 48 kHz) for embedded source, to AES incoming rate for AES source, and to 48 kHz for analog source
Output Jitter, Typical		3.5 ns peak with 700 Hz high pass filter per AES specification AES3 rev. 1997 specification is 4.1 ns peak for 48 kHz audio
Rise and Fall Time, Typical		37 ns from 10% to 90% as per AES3 for 48 kHz sampling < 12 ns for 96 kHz and 192 kHz sampling
Analog input to AES output levels, Typical		Analog input of +24 dBu translates to 0 dBFS digital signal Accuracy governed by analog input accuracy spec

¹ The AES B connectors can be configured for input or output functionality.

Table 25: Embedded Audio Extraction

Characteristic	Performance requirement	Reference information
Embedded Audio Formatting		24-bit Embedded audio is not supported (no AUX bits are extracted), only 20 most significant bits will be extracted. Supports SMPTE 272M Operation Level B only (48 kHz audio sampling rate synchronized with video)
	SD	Extract 20-bit audio formatted according to SMPTE 272M
	HD	Extract 20 or 24 bit audio formatting according to SMPTE299M
Channel Numbering		Channel numbers per SMPTE 272M (1 through 16) will be correctly shown on all displays
Audio Rates		No support for SMPTE 272M levels C through J
Number of Channels Monitored for Presence		16 channels are monitored for presence. With Simultaneous inputs or dual link formats, 16 channels of of each selected SDI input are monitored for presence.

Table 25: Embedded Audio Extraction (cont.)

Characteristic	Performance requirement	Reference information
Maximum Number of Channels Monitored for Activity		Monitoring done by audio board only. Can only monitor channels set up for display
Audio levels		Bars display signals up to 0 dBFS Must not exceed maximum power specification on analog outputs. Configure output attenuation if necessary

Table 26: Analog Audio Inputs

Characteristic	Performance requirement	Reference information
Number of Channels		Provides up to two sets of six channels of professional balanced differential inputs for each video input, 12 channels total
Input Connector		Balanced, unterminated via rear panel connector Use 62 pin, 3 row, DSUB connector, only 2 rows of 42 pins are connected
Level Meter Accuracy over Frequency	± 0.3 dB from 20 Hz to 20 kHz, 24 dBu to -16 dBu sine wave input, Peak Ballistic mode. Within 5 Hz of some submultiples of the sampling frequency it may be attenuated additionally, as shown below. Sampling frequency refers to the 192 kHz upsampled data used for the bar ballistics. For example: 1/12 th of rate -0.30 dB (16 kHz ± 5 Hz) 1/16 th of rate -0.17 dB (12 kHz ± 5 Hz) 1/20 th of rate -0.11 dB (9.6 kHz ± 5 Hz)	
Cross Talk, Typical		≤ -90 dB from 20 Hz to 20 kHz, inputs driven from $< 600 \Omega$ source impedance Defined as the displayed bar level in any channel that results from a full scale signal on a different input pair than that input
Maximum Input Levels	+ 24 dBu ± 0.3 dBu (see Level Meter Accuracy over Frequency above)	Must not exceed maximum power specification on analog outputs. Configure output attenuation if necessary
Resolution Sampling		24 bits at 48 kHz
Input Impedance		24 k Ω
Off Isolation		≤ -90 dB, from 20 Hz to 20 kHz. Unused input driven from $< 600 \Omega$ source impedance Defined as the displayed bar level that results from a full scale signal on any pair of the unused input
Analog Input to Digital Output Distortion (THD+N), Typical		$< 0.03\%$ from full scale to -30 dBFS, 20 Hz to 20 kHz

Table 27: Analog Audio Outputs

Characteristic	Performance requirement	Reference information
Audio Modes		<p><i>Balanced:</i> provides a full-scale output of 24 dBu and is designed for professional balanced applications</p> <p><i>Unbalanced:</i> Designed to drive the unbalanced inputs of consumer amplifiers, in which case the negative output pin must be grounded</p>
Audio Sources		The channels routed to the line outputs may include: Embedded audio source, AES audio source, Analog audio source, and Decoded Dolby
Number of Channels		Provides up to eight channels
Output Connections		<p>Balanced, unterminated via rear panel connector</p> <p>62 pin, 3 row, DSUB connector, but only 2 rows of 42 pins are connected</p> <p>Ground negative output to support unbalanced mode</p>
Maximum Output Levels	+24 dBu \pm 0.5 dBu	When one output is grounded to achieve unbalanced mode, the other output will be driven to a larger amplitude. You can reduce the level by adding attenuation in the Audio Settings menu. Do not exceed the maximum rated output power in either mode
Input to Output Gain		0 dB to -120 dB in 0.5 dB steps
Digital Input to Analog Output Gain Accuracy over Frequency	\pm 0.5dB, 20 Hz to 20kHz, 0 to -40 dBFS, 20 or 24 bit input	
Analog Input to Analog Output Gain Accuracy over Frequency	\pm 0.8dB, 20 Hz to 20 kHz, 24dBu to -16dBu	
Output Impedance		<p>50 Ω</p> <p>Intended to drive \geq600 Ω load. Drivers are capable of driving a minimum load impedance of 300 Ω but may overheat. DO NOT exceed maximum rated output power</p>
Digital Input to Analog Output Distortion (THD + N)		\leq -0.01% from full scale to -20 dBFS, 20 Hz to 20 kHz
Analog Input to Analog Output Distortion (THD + N)		\leq -0.02% from full scale to -20 dBFS, 20 Hz to 20 kHz
Digital Input to Analog Output Crosstalk, Typical		<p>\leq-90 dB, 20 Hz to 20 kHz, 24 dBu or 0 dBFS input</p> <p>\leq-100 dB, 20 Hz to 2 kHz, 24 dBu or 0 dBFS input</p> <p>Defined as cross talk within a pair</p>

Table 27: Analog Audio Outputs (cont.)

Characteristic	Performance requirement	Reference information
Output Power Capability, Typical		Capable of continuously driving a –10 dBFS sinewave into 600 Ω or –13 dB into 300 Ω This is 25 mW RMS in the load per output pair. Live audio may reach full voltage level as long as the duty cycle is such that the RMS power is less than 25 mW averaged over any 10 second period. If an overtemp condition is detected, the output attenuation may be increased automatically to prevent damage
Meter Level to Headphone Output Gain		0 dB to –63 dB in 0.5 dB steps relative to maximum output level
Digital Input to Headphone Output Gain Accuracy over Frequency	± 0.1 dB, 20 Hz to 20kHz, 0 to –40dBFS	
Digital Input to Headphone Output Distortion (THD + N), Typical		$\pm 0.05\%$ from full scale to –10 dBFS, 20 Hz to 20 kHz, into 32 Ω <0.2% at full scale into 32 Ω <2% at full scale into 16 Ω
Headphone Output Power Capability		Capable of continuously driving a 6.25 dBu sinewave into 32 Ω or 16 Ω

Table 28: Dolby Digital (AC-3) Compressed Audio Monitoring (Opt. DDE)

Characteristic	Performance requirement	Reference information
Compressed Audio Input Format		Decodes audio and metadata from Dolby data stream transported through AES or 48 kHz embedded audio source. Supports 32-bit professional and consumer modes on stream zero only
Decoded Audio Outputs		A single, selectable, Dolby Digital decoded channel pair may be output on AES B 1-2 and Analog Outputs 1 & 2 Limited to a single channel pair and line compression mode only, by license requirements
Dolby Audio Status Display		Displays basic Dolby D status and bit stream meta-data
Alarms		(See page 39, <i>Alarms</i> .)

Table 29: Dolby E and Extended Dolby Digital (AC-3) Compressed Audio Monitoring (Opt. DDE)

Characteristic	Performance requirement	Reference information
Compressed Audio Input Format		Decodes audio and metadata from Dolby data stream transported through AES or 48 kHz embedded audio source, streams 0 through 7. Supports 16-bit professional mode on Channel 1 or 2
Decoded Audio Outputs		Up to eight decoded channels including all surround sound channels plus down mix may be output on AES B or Analog Outputs
Dolby Audio Status Display		Displays extensive Dolby D and Dolby E status and bit stream meta-data
Alarms		(See page 39, <i>Alarms.</i>)

Table 30: Picture Monitor Outputs (VGA Pix Mon)

Characteristic	Performance requirement	Reference information
Signal Format VGA DSUB Outputs		Y, Pb, Pr with sync on Y, RGB with sync on all, HD and SD. HD sync is tri-level, also have TTL H and V drive. Component mode only available for SDI input mode. With 1080P 60/59/50 dual link formats, combined links are down-converted to the related 1080i format. 4:4:4 dual link formats are down-converted to 4:2:2 Does not support 720p 30, 720p 29.97, 720p 25, 720p 24 or 720p 23.98 formats No H and V sync outputs when sourcing 1080p sf 23.98 or 24, just tri-level sync on Green/Y
DAC Resolution		10 bit
Impedance, Typical		75 Ω unbalanced
Active Video Accuracy	700 mV ±5% peak-peak (Y-Pb-Pr mode)	
Black (blanking) Output Level	0 mV ±50 mV for HD and SD	
Frequency Response, Typical		Measure with a VM5000 and use “normal” VGA to BNC cable (such as Allied 796-9640)
	SD	±5% to 5.5 MHz, Y, G, B, and R
	HD	±8% to 30 MHz, Y, G, B, and R
Non-Linearity, Typical		≤1.5%
Rise and Fall Time, Typical		
	SD	250 ns for Y, R, G, B 500 ns for Pb, Pr
	HD	35 ns for Y, R, G, B 70 ns for Pb, Pr
Overshoot and Undershoot, Typical		1%
K Factor, Typical		1%

Table 30: Picture Monitor Outputs (VGA Pix Mon) (cont.)

Characteristic	Performance requirement	Reference information
Interchannel Timing Match, Typical	SD	Y-to-Pb and Y-to-Pr ± 5.0 ns
	HD	Y-to-Pb and Y-to-Pr ± 4.0 ns
Sync Amplitude Accuracy, Typical	SD	-300 mV
	HD	300 mV on positive and negative excursions
Signal to Noise Ratio, Typical	SD	70 dB to 5.5 MHz 58 dB to 100 MHz RMS noise on quiet line, relative to 700 mV
	HD	58 dB to 30 MHz 55 dB to 250 MHz RMS noise relative to 700 mV
Return Loss on BNCs, Typical		>20 dB to 30 MHz
Transcoder Accuracy		9 bit
Composite Mode		When using composite input only. Sourced on Green channel of connector
Composite Amplitude, Typical		1 V $\pm 5\%$ including sync and 100% white video
Composite Offset, Typical		± 100 mV
Composite mode SNR, Typical		60 dB RMS to 700 mV with 20 MHz BW

Table 31: LCD Display

Characteristic	Performance requirement	Reference information
Display Area	Horizontal	13 cm
	Vertical	10 cm
Resolution		1024 (H) x 768 (V) pixels
Color Palette		6 bits per component. LSB is dithered to improve picture
Pixel Defects	≤ 6 bad pixels	

Table 32: External XGA Output (EXT DISPLAY)

Characteristic	Performance requirement	Reference information
Content		Identical to front-panel LCD display
Output Levels		0.7 V or 1 V for RGB signals, selectable. Fixed 5 V for H and V sync signals
Resolution		1024 (H) x 768 (V) pixels

Table 32: External XGA Output (EXT DISPLAY) (cont.)

Characteristic	Performance requirement	Reference information
Color Palette		6 bits per component
Connector Pin Assignments		Pin 1: R Pin 2: G Pin 3: B Pin 4: NC Pin 5: GND Pin 6: GND Pin 7: GND Pin 8: GND Pin 9: NC Pin 10: NC Pin 11: NC Pin 12: NC Pin 13: HSync Pin 14: VSync Pin 15: NC

Table 33: LTC Time Code Input / Ground Closures

Characteristic	Performance requirement	Reference information
LTC Input Connector		Balanced, unterminated via rear-panel GC remote connector. (See Table 40.)
LTC Input Impedance		Greater than 10 k Ω
LTC Signal Characteristics		Longitudinal Time Code per IEC Publication 461
LTC Signal Amplitude Range, Typical		0.2 V _{p-p} to 5.0 V _{p-p} , balanced differential or single-ended

Table 33: LTC Time Code Input / Ground Closures (cont.)

Characteristic	Performance requirement	Reference information
Ground Closure Input Signaling (Preset Selection)		TTL thresholds, 5 V maximum input, –0.5 V minimum input. Pull low to assert Has internal 10 k Ω pull-up to 5 V on each input Direct or encoded inputs must be asserted and stable for at least 150 ms to be recognized reliably. Inputs that are stable for 75 ms or less will never be recognized Inputs are sampled every 16.6 ms. Five consecutive samples must all have the same code for the code to be accepted. It is possible to pulse the codes synchronously with the sampling process and trick the system. Users are encouraged to work within the intent of the specification to insure reliable operation
Ground Closure Output Characteristics		One open collector output Pulled up by 10 k Ω resistor in series with a diode to +5 V. Pull down current is limited by 10 Ω resistor. Maximum current allowed is 100 mA

Table 34: VITC Decoding

Characteristic	Performance requirement	Reference information
Sources		Composite input A or B, SDI input A or B No embedded time-code extraction

Table 35: Serial Digital Video Interface (Input A, Input B)

Characteristic	Performance requirement	Reference information
Video Inputs		Two inputs; only one input active at a time
Format		HD: compatible with SMPTE 292M/BTA-S004A SD: compatible with 270 Mb/s SMPTE 259M 3 Gb/s: compatible with SMPTE 424/M and SMPTE 425M
Input Type		75 Ω BNC, internally terminated

Table 35: Serial Digital Video Interface (Input A, Input B) (cont.)

Characteristic	Performance requirement	Reference information	
Cable Loss Accommodation	With 1/SQRT(f) characteristic at ½ of serial rate.		
	SD	0 to 30 dB attenuation	Equivalent to approximately 300 m of Belden 8281 at 270 Mb/s
	HD	0 to 20 dB attenuation	Equivalent to approximately 80 m of Belden 8281 at 1.485 Gb/s. Typical performance to 110 m
Launch Amplitude Accommodation, Typical	For Full Specification	800 mV ± 10%	
	Up to 20 dB Cable Loss	800 mV ± 30%	
Jitter Tolerance, Typical		0.35 UI _{p-p} above 2 MHz. Increases proportional to 1/f below 2 MHz	
Return Loss, Typical		> 15 dB to 1.5 GHz	
Isolation Between Inputs	> 45 dB to 1 GHz		
Time Base Range		>± 50ppm	

Table 36: Serial Video Output (Serial Out/SDI PixMon)

Characteristic	Performance requirement	Reference information
Format		1.485 Gb/s, 1.4835 Gb/s, or 270 Mb/s same as selected input. With Simultaneous inputs, configurable to be Channel 1 or Channel 2 With 1080P 60/59/50 dual link formats, combined links are down-converted to the related 1080i 4:2:2 single link format With other dual link formats, combined links are down-converted to the related 4:2:2 10-bit single link format
Content - Follows Active Input With Brightups		Selectable as loop out A or loop out B or Digital version of RGB/YPbPr analog pix monitor output. Gamut and/or line select brightups optionally displayable. For dual link formats, Pix Mon may be configured to display picture from link A alone, link B alone, or links A and B combined Gamut error brightups appear one line below error
Output Level	800 mV, ± 10% into 75 Ω load	

Table 36: Serial Video Output (Serial Out/SDI PixMon) (cont.)

Characteristic	Performance requirement	Reference information
Rise and Fall Time, Typical	SD	400 ps minimum, 800 ps maximum, 20% to 80%
	HD	220 ps maximum, 20% to 80%
Return Loss, Typical		15 dB to 1.5 GHz
		10 dB to 3.0 GHz (option 3G only)

Table 37: External Reference

Characteristic	Performance requirement	Reference information
Input Type		Passive loop-through, 75 Ω compensated
Operational		Locks to analog bi-level and tri-level signals of formats. (See Table 45.)(See Table 46.)(See Table 47.) Reference must have a frame rate compatible with input. WFM mode and Line Select derive timing from the external sync information Picture mode and Data mode do not use timing from the external reference With Simultaneous inputs, External Reference settings apply to both channels
Analog Sync Format	PAL	
	1080i 60 Hz	
	720p 59.94 Hz	
	NTSC	
	1080i 59.94 Hz	
	1080p 23.98 Hz	
	1080p 24 Hz	
	720p 50	
	720p 60	
	1080i 50	
1080sf 23.98		
1080sf 24		
Input Signal Level, Typical		-6 dB to +6 dB
DC Input Impedance		20 k Ω
Maximum Operating Input Voltage, Typical		\pm 5 V DC
Absolute Maximum Input Voltage, Typical		\pm 5 V DC
Inband Input Impedance, Typical		\pm 15 k Ω

Table 37: External Reference (cont.)

Characteristic	Performance requirement	Reference information
Return Loss, Typical		> 40 dB to 6 MHz >29 dB to 30 MHz
Hum Tolerance, Typical		Operates with 500 mV _{p-p} at 50 or 60 Hz
Signal/Noise Tolerance, Typical		Operates to 25 dB

Table 38: Ethernet

Characteristic	Performance requirement	Reference information
IP Address Mode		Supports manual and DHCP
SNMP		For instrument control and feedback of status. Complies with SNMP version 2
Connector Type		RJ-45 LAN connector supporting 10/100 Base-T

Table 39: USB

Characteristic	Performance requirement	Reference information
Type		Host
Speed		Complies with USB 1.1 and USB 2.0 full speed specification Full speed operation in accordance with USB 2.0 spec is 12 Mb/s.

Table 40: Remote Port

Characteristic	Performance requirement	Reference information
Alarm Output	Type	Open collector. Has weak pull-up with a diode to +5 V

Table 40: Remote Port (cont.)

Characteristic	Performance requirement	Reference information																																																			
Connector Pin Assignments		Pin # Signal 1 Out; GND 2 In; Time Code Positive (LTC input) 3 In; Time Code Negative (LTC input) 4 Out; GND 5 Out; Ground Closure Output 6 In; Preset Recall A1 7 In; Preset Recall A2 8 In; Preset Recall A3 9 In; Preset Recall A4																																																			
		<table border="1"> <thead> <tr> <th>Hex</th> <th>Binary Pins 9,8,7,6</th> <th>Direct mode selection</th> </tr> </thead> <tbody> <tr> <td>F</td> <td>1111</td> <td>none</td> </tr> <tr> <td>E</td> <td>1110</td> <td>Preset 1</td> </tr> <tr> <td>D</td> <td>1101</td> <td>Preset 2</td> </tr> <tr> <td>C</td> <td>1100</td> <td></td> </tr> <tr> <td>B</td> <td>1011</td> <td>Preset 3</td> </tr> <tr> <td>A</td> <td>1010</td> <td></td> </tr> <tr> <td>9</td> <td>1001</td> <td></td> </tr> <tr> <td>8</td> <td>1000</td> <td></td> </tr> <tr> <td>7</td> <td>0111</td> <td>Preset 4</td> </tr> <tr> <td>6</td> <td>0110</td> <td></td> </tr> <tr> <td>5</td> <td>0101</td> <td></td> </tr> <tr> <td>4</td> <td>0100</td> <td></td> </tr> <tr> <td>3</td> <td>0011</td> <td></td> </tr> <tr> <td>2</td> <td>0010</td> <td></td> </tr> <tr> <td>1</td> <td>0001</td> <td></td> </tr> <tr> <td>0</td> <td>0000</td> <td></td> </tr> </tbody> </table>	Hex	Binary Pins 9,8,7,6	Direct mode selection	F	1111	none	E	1110	Preset 1	D	1101	Preset 2	C	1100		B	1011	Preset 3	A	1010		9	1001		8	1000		7	0111	Preset 4	6	0110		5	0101		4	0100		3	0011		2	0010		1	0001		0	0000	
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9	1001																																																				
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6	0110																																																				
5	0101																																																				
4	0100																																																				
3	0011																																																				
2	0010																																																				
1	0001																																																				
0	0000																																																				

Table 41: Power Source

Characteristic	Performance requirement	Reference information
Electrical Rating	100 - 240 VAC \pm 10%, 50/60 Hz 115 Watts max.	
Supply Connection		Detachable cord set
Power Consumption, Typical		50 to 110 VA at 110 or 240 VAC
Surge, Typical		7.5 Amps at 90 V 10 Amps at 240 V
Fuse Rating		T3.5, 250 V Not operator replaceable. Refer servicing to qualified service personnel

Table 42: Miscellaneous

Characteristic	Performance requirement	Reference information
Real-time Clock Battery Life		>10 year

Physical Specifications

Table 43: Physical Characteristics

Characteristic	Standard	
Dimensions	Height	5 1/4 inches (133.4 millimeters)
	Width	8 1/2 inches (215.9 millimeters)
	Depth	18 1/8 inches (460.4 millimeters)
Weight	Net	12 pounds (5.5 kilograms)
	Shipping	21 pounds (9.6 kilograms), approximate

Table 44: Environmental Performance

Category	Standards or description	
Temperature	Operating	0 °C to +40 °C
	Non Operating	-20 °C to +60 °C
Humidity	Operating	20% to 80% relative humidity (% RH) at up to +40 °C, non-condensing
	Non Operating	5% to 90% RH (relative humidity) at up to +60 °C, non-condensing
Altitude	Operating	Up to 9,842 feet (3,000 meters)
	Non Operating	Up to 40,000 feet (12,192 meters)
Cooling	Variable Fan. Forced air circulation with no air filter.	
Required Clearances	Do not block the bezel or rear panel vent holes, or more than half the vent holes on the sides	

Supported Input Formats and Allowed References

An X in the following three tables indicates that this combination is supported and verified. Other combinations within each of these tables may work, but are unverified and only supported on a best effort basis.

Operation with an input from one of these three tables and a reference from another table is not supported (for example, a 1080i 50 input will not work with a 1080i 60 reference). Such mismatches may be reported on the display, and/or the display will “roll” due to the inherent incompatibility between the standards.

Table 45: 25 Hz and 50 Hz Frame and Field Rates

Input Format	Reference Format					
	PAL	720p 25	720p 50	1080p 25	1080sf 25	1080i 50
720p 25 Hz ¹	X		X			X
720p 50 Hz ¹	X		X			X
1080p 25 Hz ^{1 2}	X		X			X
1080sf 25 Hz ^{1 2}	X		X			X
1080i 50 Hz ^{1 2}	X		X			X
576i 50 Hz (625)	X		X			X
PAL 50 Hz ²	X					

Table 46: 59.94 Hz, 23.98 Hz, and 29.97 Hz Frame and Field Rates

Input Format	Reference Format								
	NTSC	720p 23.98	720p 29.97	720p 59.94	1080p 23.98	1080sf 23.98	1080p 29.97	1080sf 29.97	1080i 59.94
720p 23.98 Hz ¹	X			X	X	X			X
720p 29.97 Hz ¹	X			X					X
720p 59.94 Hz ¹	X			X	X	X			X
1080p 23.98 Hz ^{1 2}	X			X	X	X			X
1080sf 23.98 Hz ^{1 2}	X			X	X	X			X
1080p 29.97 Hz ^{1 2}	X			X					X
1080sf 29.97 Hz ^{1 2}	X			X					X
1035i 59.94 Hz ¹	X			X					X
1080i 59.94 Hz ^{1 2}	X			X					X
483i 59.94 Hz (525)	X			X					X
NTSC 59.94 Hz ³	X								

¹ WFM7020 and WFM7120 Opt. HD.

² Includes support dual-link standards with option DL.

³ Opt. CPS.

Table 47: 24 Hz, 30 Hz, and 60 Hz Frame and Field Rates

Input Format	Reference Format							
	720p 24	720p 30	720p 60	1080p 24	1080sf 24	1080p 30	1080sf 30	1080i 60
720p 24 ¹			X	X	X			X
720p 30 ¹			X					X
720p 60 ¹			X	X	X			X
1080p 24 ^{1 2}			X	X	X			X
1080sf 24 ^{1 2}			X	X	X			X
1080p 30 ^{1 2}			X					X
1080sf 30 ^{1 2}			X					X
1035i 60 Hz ¹			X	X	X			X
1080i 60 Hz ^{1 2}			X	X	X			X

¹ WFM7020 and WFM7120 Opt. HD.

² Includes support dual-link standards with option DL.

Table 48: Supported Standards

Image	System	Interface	Signal Type	Image system number for indicated field/frame rate								
				60	59.94	50	30	29.97	25	24	23.98	
274M	1920 x 1080/P	372M (dual link)	4:2:2 Y'C _B C _R	1	2	3						
			10-bit 4:4:4(:4) R'G'B' (A)				7	8	9	10	11	
	1920 x 1080/P, PsF	372M (dual link)	12-bit 4:4:4 R'G'B'				7	8	9	10	11	
			10-bit 4:4:4(:4) Y'C _B C _R (A)				7	8	9	10	11	
			12-bit 4:4:4 Y'C _B C _R				7	8	9	10	11	
			12-bit 4:2:2(:4) Y'C _B C _R (A)				7	8	9	10	11	
			292M	4:2:2 Y'C _B C _R				7	8	9	10	11
			1920 x 1080/I	372M (dual link)	10-bit 4:4:4(:4) R'G'B' (A)	4	5	6				
	12-bit 4:4:4 R'G'B'	4			5	6						
	10-bit 4:4:4(:4) Y'C _B C _R (A)	4			5	6						
	12-bit 4:4:4 Y'C _B C _R	4			5	6						
	12-bit 4:2:2(:4) Y'C _B C _R (A)	4			5	6						
	292M	4:2:2 Y'C _B C _R			4	5	6					

Table 48: Supported Standards (cont.)

Image	System	Interface	Signal Type	Image system number for indicated field/frame rate							
				60	59.94	50	30	29.97	25	24	23.98
274M	2048 x 1080/P, PsF	372M- proposed	10-bit 4:4:4(:4) R'G'B' (A)				X	X	X	X	X
			12-bit 4:4:4 R'G'B'				X	X	X	X	X
			10-bit 4:4:4(:4) Y'C _B C _R (A)				X	X	X	X	X
			12-bit 4:4:4 Y'C _B C _R				X	X	X	X	X
			12-bit 4:2:2(:4) Y'C _B C _R (A)				X	X	X	X	X
295M (1250/50)	1920 x 1080/I, P	Not supported									
240M 260M	1920 x 1035/I	292M	4:2:2 Y'C _B C _R	X	X						
296M		292M	4:2:2 Y'C _B C _R	1	2	3	4	5	6	7	8
ITU-R BT.601	720 x 576/I (625)	292M	4:2:2 Y'C _B C _R				X				
	720 x 483/I (525)	292M	4:2:2 Y'C _B C _R		X						
293M	720 x 480/P	Not supported									

Alarms

The following tables list the alarms that may be set for the waveform monitors.

Table 49: Common Alarms

Alarm	Description
HW Fault	Indicates a system fault occurred. May require service
SDI Input Missing	Indicates that no signal is detected on the selected SDI input
SDI Input Signal Lock	Indicates unable to lock to selected SDI input signal
Reference Missing	Indicates that no signal is detected on the Ref input when REF EXT is selected
Ref Lock	Indicates unable to lock to the Ref input signal when REF EXT is selected
Ref Fmt Mismatch	Indicates that the signal format detected on Ref input differs from the configured External Ref format
RGB Gamut Error	Indicates that the selected video input signal contains colors that violate the configured Diamond gamut thresholds
Composite Gamut Error	Indicates that the selected video input signal contains colors that violate the configured Arrowhead gamut thresholds

Table 49: Common Alarms (cont.)

Alarm	Description
Luma Gamut Error	Indicates that the selected video input signal contains luminance levels that violate the configured Luma gamut thresholds
Video Fmt Change	Indicates that a change occurred in the format of the selected video input signal
Video Fmt Mismatch	Indicates that the signal format detected on the selected video input differs from the configured Input Format or that the format detected differs from that indicated by the signal's SMPTE 352 payload identifier
Vid/Ref Mismatch	Indicates that the Ref signal format is not compatible with the Input signal format. (See Table 45.)(See Table 46.)(See Table 47.)
Line Length Error	Indicates that the length of a video line differs from that expected for the detected video format
Field Length Error	Indicates that the length of a video field differs from that expected for the detected video format
EAV Place Error	Indicates that the location of the EAV timing reference signal differs from that expected for the detected video format
SAV Place Error	Indicates that the location of the SAV timing reference signal differs from that expected for the detected video format
Timecode Vitc Missing	Indicates that a break or discontinuity in the VITC has occurred
Timecode Vitc Invalid	Indicates that the VITC was lost for one frame but has reappeared
Timecode Ltc Missing	Indicates that a break or discontinuity in the LTC has occurred
Timecode Ltc Invalid	Indicates that the LTC was lost for one frame but has reappeared
Timecode Anc Missing	Indicates that a break or discontinuity in the ANC timecode has occurred
Timecode Anc Invalid	Indicates that the ANC timecode was lost for one frame but has reappeared
Closed Caption Missing	Indicates that the configured Closed Caption Transport stream or streams are not present in the selected video input signal
CC Service(s) Missing	Indicates that one or more configured EIA 608 Required Services is not present in the closed caption data stream
EIA608 Caption Error	Indicates a data error in an EIA608 data stream, excluding Extended Data Services and EIA708 Caption Data Packet errors
V-Chip Presence Error	Indicates that no content advisory packet has been detected in the selected video input signal for at least 4 seconds
V-Chip Format Error	Indicates that a content advisory packet contained illegal data or was formatted incorrectly
Extended Data Services Error	Indicates a data error in Extended Data Services of an EIA608 data stream
Caption Data Packet Error	Indicates a Caption Data Payload error in the EIA708 stream carrying EIA608 data
Line 21 presence Error	Indicates no VBI caption signal was found on the configured Line and Timing of the selected video input signal
ANC CC Presence Error	Indicates no caption ancillary data (SMPTE334M) was found in the selected video input signal
TSID Missing	Indicates no Transmission Signal Identifier was found in the selected video input signal
TSID Format Error	Indicates detected Transmission Signal Identifier is not an allowed value

Table 50: HD Specific Alarms (WFM7120, WFM7020 Opt. HD)

Alarm	Description
Video Not HD	Indicates that the selected SDI video input signal is not an HD format
Line Number Error	Indicates that the encoded line number differs from the counted line number
Y Chan CRC Error	Indicates that the encoded CRC for a line's Y (luminance) samples differs from the calculated CRC
C Chan CRC Error	Indicates that the encoded CRC for a line's C (chrominance) samples differs from the calculated CRC
Y Anc Checksum Error	Indicates that the encoded checksum in a Y (luminance) ancillary data packet differs from the calculated checksum
C Anc Checksum Error	Indicates that the encoded checksum in a C (chrominance) ancillary data packet differs from the calculated checksum

Table 51: SD Specific Alarms

Alarm	Description
AP CRC Error	Indicates that encoded AP (active picture) CRC differs from the calculated CRC
FF CRC Error	Indicates that encoded FF (full field) CRC differs from the calculated CRC
EDH Error	Indicates that EDH (error detection and handling) has detected an error

Table 52: Composite Specific Alarms (Opt. CPS)

Alarm	Description
Cmpst Input Missing	Indicates that no signal is detected on the selected composite video input
Cmpst Lock	Indicates unable to lock to the selected composite video input

Table 53: Audio Alarms (Opts. AD and DDE)

Alarm	Description
Over	Indicates that the signal has exceeded the level specified by the Over Level setting for the period of time specified by the Duration for Over setting.
Silence	Indicates that the signal has fallen below the level specified by the Silence Level setting for the period of time specified by the Duration for Silence setting.
Clip	Indicates that the number of consecutive, full-scale digital audio samples monitored has exceeded the value specified by the Number of Samples for Clip setting.
Mute	Indicates that the number of consecutive, "0" digital audio samples monitored has exceeded the Number of Samples for Mute setting.
AES Unlocked	Indicates unlocked condition of an AES input.
CRC Error	Indicates that the AES channel status CRC as calculated by the instrument does not agree with the CRC embedded in the channel status bytes.
V Bit	Indicates that the Validity bit is set high for one or more AES audio samples. In the AES/EBU standard, a set validity bit indicates that the sample is not suitable for conversion to audio.
AES Parity	Indicates incorrect parity in one or more AES audio samples.

Table 53: Audio Alarms (Opts. AD and DDE) (cont.)

Alarm	Description
AES Sync Error	Indicates a timing error of greater than 25% of an audio frame between the monitored AES input and the selected AES reference input.
Emb. Audio Presence	Indicates that no embedded audio stream is detected in the selected SDI input.
(Embedded) Checksum	Indicates that the checksum present in the embedded audio stream does not match the calculated checksum.
(Embedded) Parity	Indicates incorrect parity in one or more embedded audio samples.
Emb. Group Sample Phase	Indicates embedded audio streams are not time-aligned due to asynchronous audio or data error.

Table 54: Additional Audio Alarms (Opt. DDE)

Alarm	Description
Dolby Format	Indicates Dolby audio Format is not as expected
Dolby E /Video Frame Rate Error	Indicates that the Dolby E stream frame rate is not the same as the video frame rate

Performance Verification

This section contains a collection of manual procedures for verifying that the following waveform monitor products perform as warranted:

- WFM7120 models and their options
- WFM7020 models and their options
- WFM6120 models and their options

This chapter is divided into two sections: *Incoming Inspection Procedures* and *Performance Verification Procedures*. The test procedures in this chapter provide for an extensive confirmation of performance and functionality.

NOTE. *Before performing any of the procedures and tests in this manual, the waveform monitor must have been operating for a warm-up period of at least 20 minutes and must be operating at an ambient temperature. (See Table 44 on page 36.)*

Test Records

Use the following tables to record the measured performance or Pass/Fail status for each step of the specified test procedure. In cases where a measurement is made in different units than specified in the manual, the actual measured values that correspond to the specification limits are shown in parentheses.

Test Record - Function Tests

Table 55: WFM6120, WFM7020, and WFM7120 Waveform Monitor Functional Test Record

Instrument Serial Number:	Certificate Number:		
Temperature:	RH %:		
Date of Calibration:	Technician:		
Functional Test (Incoming Inspection)	Incoming	Outgoing	Comments
Basic Turn On and Self Test			
Front Panel LEDs			
POST			
Front Panel Test			
LCD Pixel and Defects			
LCD Color Palette and Advanced Diagnostics Test			
LCD Color Palette Test			
Advanced Diagnostics			
Fan Test			
SDI Bit Integrity			
External Reference			
NTSC Lock			
Ref Missing			
EYE (Options EYE and PHY)			
Eye Waveform			
Jitter Waveform			
Composite Input (Option CPS)			
CMPST A, WFM with NTSC			
CMPST A, Vector with NTSC			
CMPST A, Picture with NTSC			
CMPST B, WFM with NTSC			
CMPST B, Vector with NTSC			
CMPST B, Picture with NTSC			
Analog Audio Input (Options AD, DD, & DDE)			
Analog Audio input A ports 1-6 display bar			

Table 55: WFM6120, WFM7020, and WFM7120 Waveform Monitor Functional Test Record (cont.)

Functional Test (Incoming Inspection)	Incoming	Outgoing	Comments
Analog Audio input B ports 1-6 display bar			
Analog Audio Output (Options AD, DD, & DDE)			
Digital Audio Input (Options AD, DS, DD, & DDE)			
AES Audio input A to Display Bar			
AES Audio input B to Display Bar			
Embedded Audio to Display Bar			
Embedded Audio to Lissajous Display			
Digital Audio Output (Options AD, DS, DD, & DDE)			
AES B 1-2 Audio Output			
AES B 3-4 Audio Output			
AES B 5-6 Audio Output			
AES B 7-8 Audio Output			
Dolby Decode (Options DD, & DDE)			
LTC Waveform and Decode			
LTC Waveform			
LTC Decode			
Ground Closure Remote			
Remote Input - Activate Preset			
Remote Output - Ground Closure			
Ethernet Functionality			
Simultaneous Input Operation (Option SIM)			
Dual Link Format (Option DL)			
3 Gb/s SDI Verification Test (Option 3G)			
Stability			
Jitter			
A/V Delay (Option AVD)			

Test Record - All Instruments

If you are testing a WFM6120 or a WFM7000 without Option HD, skip the HD entries in the record. Complete the other entries, which are common to all models.

Table 56: WFM6120, WFM7000, and WFM7120 Waveform Monitor Video Performance Test Record

Instrument Serial Number:	Certificate Number:			
Temperature:	RH %:			
Date of Calibration:	Technician:			
Performance Test	Minimum	Incoming	Outgoing	Maximum
HD SDI Input Level Low and High (HD)				
Input A, Low Level				90% (720 mV)
Input A, High Level	110% (880 mV)			
Input B, Low Level				90% (720 mV)
Input B, High Level	110% (880 mV)			
EDH and HD SDI Input Equalization Range (HD)				
EDH	Pass			
Input A	20 dB			
Input B	20 dB			
HD SDI Loop Through Isolation (HD)	Pass			
HD PixMon Frequency Response	-0.92 dB (-10%)			+0.82 dB (+10%)
HD Cable Meter (HD)				
SDI A Input (Short Cable)	0 m			17 m
SDI A Input (Long Cable)	76 m			127 m
SDI B Input (Short Cable)	0 m			17 m
SDI B Input (Long Cable)	76 m			127 m
HD Jitter Noise Floor and Bounce (HD)				
Jitter Noise Floor	Pass			
10 second 10 Hz Jitter Bounce	Pass			
HD Jitter Readout Accuracy (HD)				
Jitter Trace	Pass			
Jitter Readout	Pass			
External Reference Formats supported: Bi-Level	Pass			
External Reference Lock Range	-50 ppm			50 ppm
External Reference Formats supported: Tri-Level	Pass			
External Reference Lock in Presence of Hum: Bi-Level	Pass			
External Reference Lock in Presence of Hum: Tri-Level	Pass			

Table 56: WFM6120, WFM7000, and WFM7120 Waveform Monitor Video Performance Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
Recovered Sine Wave (Opt EYE and PHY)	Pass			
Recovered Sine Wave (Opt JIT)	Pass			
LTC Decoding Functionality	Pass			
Eye Gain				
SDI A Input	760 mV			840 mV
SDI B Input	760 mV			840 mV
Reference Clock Amplitude and Frequency				
Clock Amplitude	Pass			
Clock Frequency	Pass			
Eye Signal Bandwidth				
SDI A 2.5 GHz Response				
SDI A Minimum Response				
SDI B 2.5 GHz Response				
SDI B Minimum Response				

Test Record - All Instruments (SD)

The following test record covers tests of SD functionality. These tests are valid for all instruments with SD.

Table 57: WFM6120, WFM7020, and WFM7120 Waveform Monitor Video Performance Test Record

Instrument Serial Number:		Certificate Number:		
Temperature:		RH %:		
Date of Calibration:		Technician:		
Performance Test	Minimum	Incoming	Outgoing	Maximum
SD SDI Input Level Low and High				
Input A, Low Level				720 mV
Input A, High Level	880 mV			
Input B, Low Level				720 mV
Input B, High Level	880 mV			
SD SDI Input Equalization Range and EDH				
EDH	Pass			
Input A	30 dB			
Input B	30 dB			
SD PixMon Multiburst Frequency Response	-0.92 dB (-10%)			+0.82 dB (+10%)
Analog Pixmon Gain and Offset				

Table 57: WFM6120, WFM7020, and WFM7120 Waveform Monitor Video Performance Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
YPbPr	Pass			
RGB	Pass			
Composite	Pass			
SD SDI Serial Output Amplitude	760 mV			840 mV
SD VITC Decoding Functionality	Pass			
SD Cable Meter				
SDI A Input (Short Cable)	0 m			17 m
SDI A Input (Long Cable)	76 m			127 m
SDI B Input (Short Cable)	0 m			17 m
SDI B Input (Long Cable)	76 m			127 m
SD Equalized Eye Gain	Pass			
SD Jitter Noise Floor and Bounce				
Jitter Noise Floor	Pass			
SD Jitter Readout Accuracy				
Jitter Trace	Pass			
Jitter Readout	Pass			

Test Record - Option CPS

Table 58: WFM7120 Waveform Monitor Video Performance Test Record (Options CPS)

Instrument Serial Number:		Certificate Number:		
Temperature:		RH %:		
Date of Calibration:		Technician:		
Performance Test	Minimum	Incoming	Outgoing	Maximum
Composite Analog Frequency Response	99% (7 mV)			101% (-7 mV)
Composite Analog Delay Variation Over Frequency (Group Delay)	-10ns (-7.1 mV)			+10ns (7.1 mV)
Composite Analog Pulse to Bar Ratio	99% (-7 mV)			101% (7 mV)

Table 58: WFM7120 Waveform Monitor Video Performance Test Record (Options CPS) (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
Composite Analog Field Rate Tilt	-0.5% (-3.5 mV)			+0.5% (+3.5 mV)
Composite Analog Line Rate Tilt	-0.5% (-3.5 mV)			+0.5% (+3.5 mV)
Composite Analog Input DC Offset with Restore Off	-10 mV			10 mV
Composite Analog Input Clamp Off Check	Pass/Fail			
Composite Analog Input DC Restore Hum Attenuation				
DC Restore Off	Pass			
Fast Mode	(0mV)			5% (35 mV)
Slow Mode	90% (643 mV)			110% (785 mV)
Composite Analog Vertical Measurement Accuracy	707.71 mV			722.01 mV
External Reference Lock Range	-50 ppm			50 ppm
VITC Decoding Functionality	Pass			

Test Record - Options AD and DDE

Table 59: WFM7120 Waveform Monitor Audio Options AD and DDE Test Record

Instrument Serial Number:	Certificate Number:			
Temperature:	RH %:			
Date of Calibration:	Technician:			
Performance Test	Minimum	Incoming	Outgoing	Maximum
AES Audio Input Sample Rate				
AES A 1-2 In (96 kHz)	pass			
AES A 3-4 In (96 kHz)	pass			
AES A 5-6 In (96 kHz)	pass			
AES A 7-8 In (96 kHz)	pass			
AES A 1-2 In (35 kHz)	pass			
AES A 3-4 In (35 kHz)	pass			
AES A 5-6 In (35 kHz)	pass			

Table 59: WFM7120 Waveform Monitor Audio Options AD and DDE Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
AES A 7-8 In (35 kHz)	pass			
AES Audio Output Amplitude				
AES B 1-2 I/O	0.9 v			1.1 v
AES B 3-4 I/O	0.9 v			1.1 v
AES B 5-6 I/O	0.9 v			1.1 v
AES B 7-8 I/O	0.9 v			1.1 v
AES Audio Output Jitter				
AES B 1-2 I/O	Pass			
AES B 3-4 I/O	Pass			
AES B 5-6 I/O	Pass			
AES B 7-8 I/O	Pass			
AES Audio Level Meter Accuracy Over Frequency				
AES A 1 In (100 Hz)	Pass			
AES A 2 In (100 Hz)	Pass			
AES A 3 In (100 Hz)	Pass			
AES A 4 In (100 Hz)	Pass			
AES A 5 In (100 Hz)	Pass			
AES A 6 In (100 Hz)	Pass			
AES A 7 In (100 Hz)	Pass			
AES A 8 In (100 Hz)	Pass			
AES A 1 In (1 kHz)	Pass			
AES A 2 In (1 kHz)	Pass			
AES A 3 In (1 kHz)	Pass			
AES A 4 In (1 kHz)	Pass			
AES A 5 In (1 kHz)	Pass			
AES A 6 In (1 kHz)	Pass			
AES A 7 In (1 kHz)	Pass			
AES A 8 In (1 kHz)	Pass			
AES A 1 In (19 kHz)	Pass			
AES A 2 In (19 kHz)	Pass			
AES A 3 In (19 kHz)	Pass			
AES A 4 In (19 kHz)	Pass			
AES A 5 In (19 kHz)	Pass			
AES A 6 In (19 kHz)	Pass			
AES A 7 In (19 kHz)	Pass			
AES A 8 In (19 kHz)	Pass			
Headphone Level Accuracy Over Frequency				

Table 59: WFM7120 Waveform Monitor Audio Options AD and DDE Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
Left (100 Hz)	-0.75 dBu			1.25 dBu
Right (100 Hz)	-0.75 dBu			1.25 dBu
Left (1 kHz)	-0.75 dBu			1.25 dBu
Right (1 kHz)	-0.75 dBu			1.25 dBu
Left (19 kHz)	-0.75 dBu			1.25 dBu
Right (19 kHz)	-0.75 dBu			1.25 dBu
Analog Audio Level Meter Accuracy Over Frequency				
Analog Input A1 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input A2 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input A3 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input A4 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input A5 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input A6 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input A1 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input A2 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input A3 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input A4 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input A5 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input A6 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input A1 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input A2 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input A3 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input A4 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input A5 (19 kHz)	17.5 dBu			18.5 dBu

Table 59: WFM7120 Waveform Monitor Audio Options AD and DDE Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
Analog Input A6 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input B1 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input B2 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input B3 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input B4 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input B5 (100 Hz)	17.5 dBu			18.5 dBu
Analog Input B6 (100 Hz)	17.5 dBu			18.5 dBu
Analog Audio Level Meter Accuracy Over Frequency				
Analog Input B1 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input B2 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input B3 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input B4 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input B5 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input B6 (1 kHz)	17.5 dBu			18.5 dBu
Analog Input B1 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input B2 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input B3 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input B4 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input B5 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input B6 (19 kHz)	17.5 dBu			18.5 dBu
Digital Input to Analog Output Gain Accuracy Over Frequency				
Analog Output 1 (100 Hz)	17.5 dBu			18.5 dBu

Table 59: WFM7120 Waveform Monitor Audio Options AD and DDE Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
Analog Output 2 (100 Hz)	17.5 dBu			18.5 dBu
Analog Output 3 (100 Hz)	17.5 dBu			18.5 dBu
Analog Output 4 (100 Hz)	17.5 dBu			18.5 dBu
Analog Output 5 (100 Hz)	17.5 dBu			18.5 dBu
Analog Output 6 (100 Hz)	17.5 dBu			18.5 dBu
Analog Output 7 (100 Hz)	17.5 dBu			18.5 dBu
Analog Output 8 (100 Hz)	17.5 dBu			18.5 dBu
Analog Output 1 (1 kHz)	17.5 dBu			18.5 dBu
Analog Output 2 (1 kHz)	17.5 dBu			18.5 dBu
Analog Output 3 (1 kHz)	17.5 dBu			18.5 dBu
Analog Output 4 (1 kHz)	17.5 dBu			18.5 dBu
Analog Output 5 (1 kHz)	17.5 dBu			18.5 dBu
Analog Output 6 (1 kHz)	17.5 dBu			18.5 dBu
Analog Output 7 (1 kHz)	17.5 dBu			18.5 dBu
Analog Output 8 (1 kHz)	17.5 dBu			18.5 dBu
Analog Output 1 (19 kHz)	17.5 dBu			18.5 dBu
Analog Output 2 (19 kHz)	17.5 dBu			18.5 dBu
Analog Output 3 (19 kHz)	17.5 dBu			18.5 dBu
Analog Output 4 (19 kHz)	17.5 dBu			18.5 dBu
Analog Output 5 (19 kHz)	17.5 dBu			18.5 dBu
Analog Output 6 (19 kHz)	17.5 dBu			18.5 dBu

Table 59: WFM7120 Waveform Monitor Audio Options AD and DDE Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
Analog Output 7 (19 kHz)	17.5 dBu			18.5 dBu
Analog Output 8 (19 kHz)	17.5 dBu			18.5 dBu
Analog Input to Analog Output Gain Accuracy Over Frequency				
Analog Output 1 (100 Hz)	Pass			
Analog Output 2 (100 Hz)	Pass			
Analog Output 3 (100 Hz)	Pass			
Analog Output 4 (100 Hz)	Pass			
Analog Output 5 (100 Hz)	Pass			
Analog Output 6 (100 Hz)	Pass			
Analog Output 7 (100 Hz)	Pass			
Analog Output 8 (100 Hz)	Pass			
Analog Output 1 (1 kHz)	Pass			
Analog Output 2 (1 kHz)	Pass			
Analog Output 3 (1 kHz)	Pass			
Analog Output 4 (1 kHz)	Pass			
Analog Output 5 (1 kHz)	Pass			
Analog Output 6 (1 kHz)	Pass			
Analog Output 7 (1 kHz)	Pass			
Analog Output 8 (1 kHz)	Pass			
Analog Output 1 (19 kHz)	Pass			
Analog Output 2 (19 kHz)	Pass			

Table 59: WFM7120 Waveform Monitor Audio Options AD and DDE Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
Analog Output 3 (19 kHz)	Pass			
Analog Output 4 (19 kHz)	Pass			
Analog Output 5 (19 kHz)	Pass			
Analog Output 6 (19 kHz)	Pass			
Analog Output 7 (19 kHz)	Pass			
Analog Output 8 (19 kHz)	Pass			

Test Record - Option DS

Table 60: WFM7120 Waveform Monitor Audio Option DS Test Record

Instrument Serial Number:		Certificate Number:		
Temperature:		RH %:		
Date of Calibration:		Technician:		
Performance Test	Minimum	Incoming	Outgoing	Maximum
AES Audio Input Sample Rate				
AES A 1-2 In (96 kHz)	Pass			
AES A 3-4 In (96 kHz)	Pass			
AES A 5-6 In (96 kHz)	Pass			
AES A 7-8 In (96 kHz)	Pass			
AES B 1-2 I/O (96 kHz)	Pass			
AES B 3-4 I/O (96 kHz)	Pass			
AES B 5-6 I/O (96 kHz)	Pass			
AES B 7-8 I/O (96 kHz)	Pass			
AES A 1-2 In (35 kHz)	Pass			
AES A 3-4 In (35 kHz)	Pass			
AES A 5-6 In (35 kHz)	Pass			
AES A 7-8 In (35 kHz)	Pass			
AES B 1-2 I/O (35 kHz)	Pass			
AES B 3-4 I/O (35 kHz)	Pass			
AES B 5-6 I/O (35 kHz)	Pass			
AES B 7-8 I/O (35 kHz)	Pass			

Table 60: WFM7120 Waveform Monitor Audio Option DS Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
AES Audio Output Amplitude				
AES B 1-2 I/O	0.9 v			1.1 v
AES B 3-4 I/O	0.9 v			1.1 v
AES B 5-6 I/O	0.9 v			1.1 v
AES B 7-8 I/O	0.9 v			1.1 v
AES Audio Output Jitter				
AES B 1-2 I/O	Pass			
AES B 3-4 I/O	Pass			
AES B 5-6 I/O	Pass			
AES B 7-8 I/O	Pass			
AES Audio Level Meter Accuracy Over Frequency				
AES A 1 In (100 Hz)	Pass			
AES A 2 In (100 Hz)	Pass			
AES A 3 In (100 Hz)	Pass			
AES A 4 In (100 Hz)	Pass			
AES A 5 In (100 Hz)	Pass			
AES A 6 In (100 Hz)	Pass			
AES A 7 In (100 Hz)	Pass			
AES A 8 In (100 Hz)	Pass			
AES A 1 In (1 kHz)	Pass			
AES A 2 In (1 kHz)	Pass			
AES A 3 In (1 kHz)	Pass			
AES A 4 In (1 kHz)	Pass			
AES A 5 In (1 kHz)	Pass			
AES A 6 In (1 kHz)	Pass			
AES A 7 In (1 kHz)	Pass			
AES A 8 In (1 kHz)	Pass			
AES A 1 In (19 kHz)	Pass			
AES A 2 In (19 kHz)	Pass			
AES A 3 In (19 kHz)	Pass			
AES A 4 In (19 kHz)	Pass			
AES A 5 In (19 kHz)	Pass			
AES A 6 In (19 kHz)	Pass			
AES A 7 In (19 kHz)	Pass			
AES A 8 In (19 kHz)	Pass			
Headphone level accuracy over frequency				
Left (100 Hz)	-0.75 dBu			1.25 dBu

Table 60: WFM7120 Waveform Monitor Audio Option DS Test Record (cont.)

Performance Test	Minimum	Incoming	Outgoing	Maximum
Right (100 Hz)	-0.75 dBu			1.25 dBu
Left (1 kHz)	-0.75 dBu			1.25 dBu
Right (1 kHz)	-0.75 dBu			1.25 dBu
Left (19 kHz)	-0.75 dBu			1.25 dBu
Right (19 kHz)	-0.75 dBu			1.25 dBu

Incoming Inspection

This section contains functional/operational checks appropriate to an incoming inspection.

The waveform monitor must have been operating for a warm-up period of at least 20 minutes, and must be operating at an ambient temperature. (See Table 44 on page 36.)

Use the following procedures to check the basic functionality of WFM6120, WFM7020, and WFM7120 Waveform Monitors. The checks are arranged by model and option so that you can choose the sections that are appropriate for your instrument. The last two sections are for less critical waveform monitor features: the ground closure and Ethernet ports. You need only test these if you intend to use them. In general, you should test in the order presented, since later tests might depend on items checked in the earlier tests.

Required Equipment

The following equipment is required to perform the incoming inspection procedure.

Table 61: Required Test Equipment

Test Equipment	Requirements	Example
XGA Monitor	Computer monitor capable of 1024 x 768 x 60 Hz scan rate	
75 Ω coaxial cables (3 required)	General purpose digital video Male-to-male BNC connectors 1 or 2 meters long	Belden 8281. Tektronix part numbers 012-0159-00 or 012-0159-01
75 Ω Terminator for Analog Video	Male connector, Precision	Tektronix part number 011-0102-03
Analog audio breakout cable (required for Audio Options AD and DDE)	DB62 to XLR I/O	Tektronix part number 012-1688-00
Dolby bit-stream generator	Generate Dolby Digital, Dolby E and PCM bit streams at 48 kHz. AES3ID-1995/SMPTE 276M output (75 Ω BNC)	Dolby Laboratories DM100 Bitstream Analyzer. (Option DDE)

Table 61: Required Test Equipment (cont.)

Test Equipment	Requirements	Example
SDI serial digital video test generator, with embedded audio and composite signal source	NTSC Black	Tektronix TG2000 with BG1 and additional modules indicated in the next three rows
	1080i 59.94 HD signals required for WFM7120 or WFM7020 with Option HD: 100% color bars 10-bit shallow ramp SDI Matrix Split Field Pathological Signal 100% sweep	HDVG1 module for TG2000 (Embedded audio needed for audio options AD, DS, DDE)
	525/270 SD signals required: 100% color bars 10-bit shallow ramp SDI Matrix Split Field Pathological Signal 100% sweep	DVG1 module for TG2000 (Embedded audio needed for audio options AD, DS, DDE)
	Composite signals required for Option CPS: NTSC SMPTE bars	AVG1 module for TG2000
	Dual link signals required for Option DL AV Delay	TG700 with HDLG7 module TG700 with DVG7 module
AES Audio Signal Generator	48 kHz, 24 bit word length signals	Rohde & Schwarz UPL06, Tektronix AM700 and AM70.
AES Audio Signal Analyzer		Rohde & Schwarz UPL06, Tektronix AM700.
Analog Audio Signal Generator		Rohde & Schwarz UPL06, Tektronix AM700 and AM70.
Waveform Monitor	Used to test SDI Pixmon output	Tektronix WFM7120 or WFM700
Video Test Signals	SDI 525 10-bit shallow ramp SDI 525 100% sweep NTSC black NTSC SMPTE bars	Provided by Tektronix TG2000 as specified above
LTC generator		Horita TRG-50 or Adrienne AEC-Box-28
Voltmeter		Fluke 87 or equivalent
15-pin Dsub male connector and cable	Used to mate with the ground closure port	(See Figure 2 on page 98.)
Computer and Ethernet cable	Used to test Ethernet connection	Generic equipment
Dual Link Generator		Tektronix TG700
3 Gb/s HD SDI signal source		Tektronix WFM7120 with test signal capability (included with Option JIT)

Incoming Inspection Tests

Basic Turn On and Self Test

1. Connect an XGA monitor to the **EXT DISPLAY** connector on the rear of the waveform monitor.
2. Connect the AC line cord to the rear of the instrument and to a 100 to 240 VAC source. There is no power switch on the waveform monitor, so the instrument will turn on as soon as you apply power.
3. Look at the front panel immediately after you apply power. The **MAG**, **LINE SEL**, and **CURSOR** buttons should be lit. The other front-panel buttons will light one at a time, in sequence. Verify that all buttons do light. The sequence will repeat until the Boot Loader process completes (approximately 30 seconds).
4. Record pass or fail in the test record for Front Panel LEDs.
5. After about 50 seconds, the power-on diagnostic page should appear on the monitor.
6. Verify that all self tests pass. Any failures will be shown in red. The results of the power-on diagnostics are erased from the screen, but you can view the results by selecting **CONFIG > Utilities > View Diagnostics Log > SEL**.
7. After the diagnostics are finished, the instrument state is restored. When the progress indicator in the status bar is finished, the instrument has finished initializing.
8. Record Pass or Fail for the POST in the test record.
9. If it is still open, exit the Diagnostics Log.

Restore the Factory Presets

1. Follow these steps to reset the waveform monitor to the Factory Presets:
 - a. Press and hold the **PRESET** button.
 - b. Select **Recall Preset > Recall Factory Preset**.
 - c. Press the **SEL** button.

Front Panel Test

1. Set the waveform monitor to the Factory Presets (see above). Wait for the process to complete as indicated by the progress indicator. Record Pass or Fail in the test record.
2. Connect a 525/270 color bar signal from DVG1 to the SDI A input.
3. Press **FULL** to set the active tile to full screen.
4. Turn the **HORIZONTAL** and **VERTICAL** knobs and verify the waveform moves appropriately.
5. Press **HELP** to display the online help.
6. Press each of the front panel buttons.

Each button should flash as you press it. Most buttons will bring up help text related to that button in the right pane of the help screen. Some buttons, such as the presets, all bring up the same information, so you may need to alternate between preset buttons and another button to see the text change. The navigation keys (the four arrow keys and the SEL key) do not bring up help text. They are used to navigate the help panes and content.

7. Press the right arrow key until the Help Contents pane in the upper-left corner is highlighted.
8. Turn the **GENERAL** knob and verify the selector box moves up and down the list of topics.
9. Press **HELP** to exit help.
10. Record Pass or Fail for Buttons and Knobs in the test record.

LCD Pixel Defects

1. Set the waveform monitor to display a white screen:
 - a. Press the **CONFIG** button.
 - b. Select **Utilities > Screen Solid Color > Select Color > White**.
 - c. Press the **SEL** button.
2. Count any pixels stuck low (not white).
3. While the screen is all white, inspect for visible defects that exceed the limits. (See Table 62.)

NOTE. *Inspection should be done from 18" away from the display, under normal room lighting. Loose dust on the front of the screen does not constitute a defect.*

4. Press the **SEL** button to cancel the white screen.
5. Set the waveform monitor for an all black screen:
 - a. Select **Utilities > Screen Solid Color > Select Color > Black**.
 - b. Press the **SEL** button.
6. Count any pixels stuck high (not black).
7. Press the **SEL** button to cancel the black screen.
8. Check that the total number of pixels counted in steps 2 and 6 is less than six.

Table 62: LCD Visual Defects

Defect Type ¹	Allowable Defect	
Circular Defect ²	>0.020"	None
	0.015" to 0.020"	Maximum of two allowed within a 2l circle
Black Defect (opaque)	>0.005"	None
Linear Defect (Scratches)	>0.004" width	None
	0.003" to 0.004"wide	Max length 0.500"
	0.0021" to 0.0030"wide	Max length 1.000"
	0.0010" to 0.0020"wide	Max length 1.500"

Table 62: LCD Visual Defects (cont.)

Defect Type ¹	Allowable Defect
Stains, discolorations, streaks, scuffs	Allowed if they fade when backlit

¹ Defects should be visible from 18" under normal lighting. If you have to hold it closer or use special lighting to see the defect, it is not a rejectable defect.

² For irregular defects, use (LengthxWidth)/2.

9. Record pass or fail for Pixel Defect in the test record.

10. Press the **CONFIG** button to close the configuration menu.

LCD Color Palette and Advanced Diagnostics Test

1. Run the Advanced Diagnostics:
 - a. Press the **CONFIG** button.
 - b. Select **Utilities > Run Advanced Diags.**
 - c. Press the **SEL** button.
 - d. Select **Continue** in the Advanced Diagnostics message window.
 - e. Press the **SEL** button.

LCD Color Palette.

2. Verify the LCD Color Palette by observing the white and red ramps at the top of the screen, and the green and blue ramps at the bottom of the screen:
 - The topmost ramp is white. It should vary smoothly from black on the left side of the screen to white on the right side of the screen.
 - The ramp just below the white ramp is red. It should vary smoothly from black on the left side of the screen to bright red on the right side of the screen.
 - The bottom ramp is blue. It should vary smoothly from black on the left side of the screen to bright blue on the right side of the screen.
 - The ramp just above the blue ramp is green. It should vary smoothly from black on the left side of the screen to bright green on the right side of the screen.

For each of these ramps it is normal to have some discrete steps in the brightness. The width of these steps should not exceed 0.1 inches. Some very fine lines may be visible in the ramps. This is normal.

3. Record Pass or Fail in the test record for the LCD Color Palette test.

Advanced Diagnostics.

- Verify the following frequencies and pulse widths, shown in the diagnostics display, are within the limits listed in the following table.

Table 63: Diagnostics Limits

Readout	Nominal	Min	Max
VGA Clock Frequency	64.4475 MHz	64.4375 MHz	64.4575 MHz
QDR Clock Frequency	25.1750 MHz	25.1650 MHz	25.1850 MHz
SD Eye Frequency ¹	36.0204 MHz	35.9844 MHz	36.0564 MHz
HD Eye Frequency ^{1 2}	59.3700 MHz	59.3106 MHz	59.4924 MHz
Audio PLL 1 Frequency	12.2880 MHz	12.2780 MHz	12.2980 MHz
Audio PLL 2 Frequency	12.2880 MHz	12.2780 MHz	12.2980 MHz
Hsync PW	20.6 μs	20.4 μs	20.8 μs
Vsync PW	19074.9 μs	18974.9 μs	19174.9 μs
Lissajous Frequency ³	61.4400 MHz	61.3900 MHz	61.4900 MHz

¹ Options EYE and PHY.
² For WFM6120 this will display 0.000 MHz.
³ Options AD and DDE.

- Verify that all the tests in the middle section of the screen have a green Pass status.
- Press the **SEL** button to reboot the unit in normal operation. It may take some time before the button press has any effect. You can cycle the power instead.
- Record Pass or Fail for Advanced Diagnostics in the test record.

Fan Test

You should be able to hear the fans and feel air coming out the back of the instrument. At low temperatures the fans will turn slowly and be very quiet. Record Pass or Fail for Fan Test in the test record.

SDI Input - Check Output Validity and Bit Integrity

- Connect a 525/270 10-bit shallow ramp matrix signal from the DVG1 module to the SDI A input of the instrument under test.
- Set the waveform monitor to the Factory Presets. (See page 60, *Restore the Factory Presets.*)
- If the waveform is not already in Parade, perform the following steps to set the display style to Parade:

- a. Press and hold the **WFM** button to display the waveform menu.
 - b. Select **Display Style**.
 - c. Use the **SEL** button to select **Parade**.
 - d. Press the **WFM** button to dismiss the menu.
4. Turn off the Pb waveform:
 - a. Press and hold the **WFM** button to display the waveform menu.
 - b. Select **Pb**.
 - c. Use the **SEL** button to select **Off**.
 - d. Press the **WFM** button.
5. Set the display vertical gain:
 - a. Press and hold the **GAIN** button to display the gain menu.
 - b. Select **Gain Settings**.
 - c. Use the arrow keys to select **x10**.
 - d. Press the **GAIN** button once to close the Gain menu. The **GAIN** button should remain lit.
6. Press the **FULL** button to expand the waveform tile to full screen:
7. Connect the waveform monitor SDI OUT to a second, known good, waveform monitor SDI A input.
8. Repeat steps 2 through 5 for the second waveform monitor.
9. Perform steps 10 through 14, on both the instrument under test (to check the Serial Input), and the second waveform monitor (to check the Serial Output of the instrument under test).
10. Position the waveform so that you can check the ramps.
11. Check a major division of both ramps in the signals. Check for 11 to 13 even vertical steps over a major division (10 mV). The steps should always step upward in a monotonic ramp. On the second waveform monitor, check that there are no EDH errors (SD). If relevant, check that there are no CRC errors (HD) by pressing and holding the **STATUS** button and selecting **Video Session**.
12. Press the **GAIN** button on both waveform monitors so that the button is no longer lit, to return the instruments to x1 gain.
13. Change the input signal to a 100% sweep.
14. Verify the sine waves are uniform and do not have steps. Also verify the amplitude is 700 mV. Check that there are no EDH errors (SD) or CRC errors (HD) on the second waveform monitor.

15. Disconnect the signal from the SDI A input and reconnect it to the SDI B input and then press the Input **B** button.
16. Press the **CONFIG** button and then select **Outputs > SDI Output > Loopout B**.
17. Repeat steps 5 through 14.
18. Record Pass or Fail for SDI Bit Integrity in the test record.
19. Disconnect the second waveform monitor.

External Reference

1. Restore the Factory Preset. (See page 60, *Restore the Factory Presets*.)
2. Connect a 525/270 10-bit shallow ramp signal from a DVG1 module to the SDI A input of the instrument under test.
3. Apply an NTSC signal to the External Reference input from the Analog Signal Generator. Install a termination on the loopthrough.
4. Press **EXT REF** on the instrument front panel.
5. The status bar in the lower left-hand corner of the display should display Ref: NTSC.
6. Press the Display Select **4** button, then the **WFM** button, and then the **SWEEP** button.
7. Verify that both WFM tiles are stable.
8. Record Pass or Fail for NTSC Lock in the test record.
9. Remove the NTSC signal from the reference input.
10. Both WFM tiles should “unlock” and scroll.
11. The status bar in the lower left-hand corner of the display should display Ref: Ext. Missing.
12. Record Pass or Fail for Ref Missing in the test record.

Eye (Options EYE and PHY)

1. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
2. Connect a 525/270 color bars signal from a DVG1 module to the SDI A input of the instrument under test.
3. Press the **EYE** button.
4. Check for the presence of a stable eye diagram in tile 1. (The actual wave shape depends on the generator signal.)
5. Record Pass or Fail for Eye Waveform in the test record.
6. Proceed to the next step if option PHY is present. Otherwise, this test is complete.
7. Set the Eye waveform display to jitter display:
 - a. Press and hold the **EYE** button to display the Eye waveform menu.
 - b. Select **Display Type > Jitter Display > Jitter Display**.
8. Check for a flat line wave shape. (The residual jitter level depends on the quality of the generator signal.)
9. Record Pass or Fail for Jitter Waveform in the test record.

Composite Input (Option CPS)

1. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
2. Apply an NTSC SMPTE color bar signal from the TG2000 AVG1 module to the Composite A input (CMPST A). Install a termination on the loop through.
3. Press Input **C** to select the CMPST A input.
4. Observe the WFM display in tile 1, the signal should be aligned with the zero graticule.

NOTE. *Recalling the factory presets does not set the vertical position to zero. You may need to adjust the Vertical control to set the vertical position to zero.*

5. Record Pass or Fail for WFM with NTSC in the test record.
6. Observe the Vector in tile 2, the burst should be aligned with the burst marker that extends to the left of the vector center.
7. Record Pass or Fail for Vector with NTSC in the test record.
8. Observe the picture in tile 3. It should be stable and show the color bar signal.
9. Record Pass or Fail for Picture with NTSC in the test record.
10. If desired, move the input to input B and repeat steps 3 through 8.

**Analog Audio Input
(Options AD and DDE)**

1. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
2. Set the analog audio generator to output a 1 kHz, 18 dBu sine wave.
3. Press and hold the **Display Select** button **4** button to display the Audio pop-up menu.
4. Select **Analog Input** and then select **Analog A**.
5. Press the **AUDIO** button briefly to dismiss the menu.
6. Using the audio breakout cable or equivalent, connect the analog audio generator to the first Line A input pair and verify that the output level of the generator signal is 18 dBu, as indicated on the audio bars.
7. Repeat step 6 for the second and third line A input pair.
8. Record Pass or Fail in the test record.
9. Press and hold the **Display Select** button **4** button to display the AUDIO pop-up menu.
10. Select **Analog Input** and then select **Analog B**.
11. Press the **AUDIO** button briefly to dismiss the menu.
12. Repeat step 6 for all three Line B input pairs.
13. Record Pass or Fail in the test record.

**Analog Audio Output
(Options AD and DDE)**

1. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
2. Press and hold the **Display Select** button 4 button to display the AUDIO pop-up menu.
3. Select **Analog Input** and then select **Analog A**.
4. Press the **AUDIO** button briefly to dismiss the menu.
5. Using the audio breakout cable or equivalent, connect the first Line A input pair to the analog audio generator and verify that the output level of the generator is 18 dBu, as indicated on the audio bars.
6. Press **CONFIG** to display the **CONFIG** menu.
7. Select **Audio Inputs/Outputs > Atten Analog Out**.
8. Press **SEL** and use the GENERAL knob to adjust the value to 0db, then press SEL again to set the value.
9. While still in the Audio Inputs/Outputs submenu, select **Analog A > Analog Output Map**.
10. Press **SEL** to display the Analog Output to Analog “A” Bar Map.
11. Put an X in the first bar pair row for Analog Outputs 1&2, 3&4, 5&6, and 7&8.
12. Press **CONFIG** to exit the CONFIG menu.
13. Connect the first analog output pair on the breakout cable to the second line A input pair.
14. Verify on the level meter bars that the second set of bars is within 1 dB of the first set of bars.
15. Connect the second analog output pair on the breakout cable to the second line A input pair.
16. Verify on the level meter bars, that the second set of bars is within 1 dB of the first set of bars.
17. Connect the third analog output pair on the breakout cable to the second line A input pair.
18. Verify on the level meter bars, that the second set of bars is within 1 dB of the first set of bars.
19. Connect the fourth analog output pair on the breakout cable to the second line A input pair.
20. Verify, on the level meter bars, that the second set of bars is within 1 dB of the first set of bars.
21. Record Pass or Fail in the test record.

**Digital Audio Input
(Options AD, DS, and
DDE)**

1. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
2. Set the digital audio generator to output a 1 kHz, –6 dBFS sine wave.
3. Press and hold the **Display Select** button 4 to display the AUDIO pop-up menu.
4. Select **Audio Input > AES A.**
5. Connect the unbalanced output of the digital audio generator to the AES A 1-2 input.
6. Press the **AUDIO** button to dismiss the menu.
7. Verify that the first set of level meter bars indicates –6 dBFS.
8. Repeat steps 5 and 7 for AES A 3-4, AES A 5-6, and AES A 7-8.
9. Record Pass or Fail for AES A in the test record.
10. Press and hold the **Display Select 4** button to display the AUDIO pop-up menu.
11. Select **Audio Input > AES B.**
12. Press the **AUDIO** button to dismiss the menu.
13. Connect the output of the digital audio generator to the AES B 1-2 input.
14. Verify that the first set of level meter bars indicates –6 dBFS.
15. Repeat steps 13 and 14 for AES B 3-4, AES B 5-6, and AES B 7-8.
16. Record Pass or Fail for AES B in the test record.
17. Set the DVG1 module in the signal generator to 525/270 color bars.
18. Set the generator for embedded audio in 2 groups, starting with group 1, and then access and set its audio channels:
 - a. Press **Modules** and select DVG1.
 - b. Press **Test Signals** and select **Module Parameters.**
 - c. Select **Audio** and set the audio channels as follows:
 - Channel 1: 50 Hz, –35 dB
 - Channel 2: 100 Hz, –30 dB
 - Channel 3: 150 Hz, –25 dB
 - Channel 4: 200 Hz, –20 dB
 - Channel 5: 250 Hz, –15 dB
 - Channel 6: 300 Hz, –10 dB
 - Channel 7: 400 Hz, –5 dB

- Channel 8: 500 Hz, 0 dB

19. Connect the output of the DVG2 to the SDI A input of the instrument under test.
20. Press and hold the **Display Select** button **4** to display the AUDIO pop-up menu.
21. Select **Audio Input > Embedded**.
22. Press the **AUDIO** button.
23. Verify that the level meter bars have a stair step pattern from -35 dB on channel 1 to 0 dB on channel 8.

NOTE. *If level-meter bars indicate that audio is not present, set the TG700 module number of groups to 2 even if it appears to be set already.*

24. Record Pass or Fail for Embedded Display in the test record.
25. Press and hold the **Display Select** button **4** to display the AUDIO pop-up menu.
26. Select **Phase Pair > 1 & 2**.
27. Go through the other phase pairs (3 & 4, 5 & 6, 7 & 8) and verify that the phase display changes in each one.
28. Record Pass or Fail for Embedded to Lissajous in the test record.

**Digital Audio Output
(Options DS, AD, and DDE)**

1. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
2. If you have just finished testing the Digital Audio Inputs, proceed to step 3, otherwise do steps 18 through 23 of the Digital Audio Input test.
3. Press **CONFIG** to display the configuration menu.
4. Select **Audio Inputs/Outputs > AES B Config Port As > Output.**
5. Briefly press the **CONFIG** button to close the menu.
6. Connect the AES B 1-2 output to the Audio Signal Analyzer input.
7. Verify on the analyzer that the signal levels are at -35 dBFS for the left channel and -30 dBFS for the right.
8. Connect the AES B 3-4 output to the Audio Signal Analyzer input.
9. Verify on the analyzer that the signal levels are at -25 dBFS for the left channel and -20 dBFS for the right.
10. Connect the AES B 5-6 output to the Audio Signal Analyzer input.
11. Verify on the analyzer that the signal levels are at -15 dBFS for the left channel and -10 dBFS for the right.
12. Connect the AES B 7-8 output to the Audio Signal Analyzer input.
13. Verify on the analyzer that the signal levels are at -5 dBFS for the left channel and 0 dBFS for the right.
14. Record Pass or Fail for each output in the test record.

Dolby Decode

1. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
2. Press and hold **Display Select** button **4** to display the AUDIO pop-up menu.
3. Select **Audio Input > AES A**.
4. Press the **Display Select** button **4** again to dismiss the pop-up.
5. Set the Dolby generator for a Dolby D output using the following steps:
 - a. Press Gen to display the Gen Stream Sel message.
 - b. Press the Up/Down buttons to select a Dolby D stream as indicated by the leading “D” in the bit stream name.
 - c. Press **Enter** to activate the selected signal.
6. Connect the Digital Output of the Dolby generator to the AES A1-2 In BNC with a 75 Ω cable.
7. Check for the “DOLBY D” message in bars 1 and 2 of the Audio display.
8. Press and hold the **Display Select** button **4** to display the AUDIO pop-up menu.
9. Select **Audio Input > Dolby 2**. (Factory preset configured Dolby 2 to decode Dolby from the AES A1-2 input.)
10. Press the **Display Select** button **4** again to dismiss the pop-up.
11. Check that the audio display shows the decoded Dolby signal.
12. Check that the Dolby program type shown in the top line of the audio display, for example “D 3/2 L”, agrees with the Dolby generator setting.
13. Change the Dolby generator to a Dolby E output:
 - a. Press the Up/Down buttons to select a Dolby E stream as indicated by the leading “E” in the bit stream name.
 - b. Press **Enter** to activate the selected signal.
14. If option DDE is present, check that the audio display shows the decoded Dolby signal and that the Dolby program type shown in the top line of the audio display, for example “E 2+2”, agrees with the Dolby generator setting.
15. If option DDE is not present, check for the “DOLBY E” message in bars 1 and 2 of the Audio display.
16. Record Pass or Fail for Dolby Decode in the test record.

LTC Waveform and Decode Test

1. Restore to Factory Presets. (See page 60, *Restore the Factory Presets.*)
2. You will need a custom cable for this step. (See Figure 2 on page 98.)
 - a. Solder wires to each of the pins of a male db9 connector, and strip the insulation back approximately 1/4 inch on each of the wires.
 - b. Make a shielded coaxial cable with a male RCA connector on one end. On the other end, connect the center coaxial conductor to pin 2 of the male db9 connector and the outer (shield) conductor to pin 1 of the male db9 connector.

NOTE. *This is the same cable used to check Ground Closure functionality.*

3. Connect the RCA connector on the custom cable to the output of the Timecode generator. Connect the custom cable 9-pin connector to the REMOTE connector on the waveform monitor rear panel.
4. Select any NTSC signal for the AVG1.
5. Connect the TG2000 AVG1 composite output to the video input of the Timecode generator.
6. Connect a 525/270 color bar signal from the DVG1 module to the SDI A input of the instrument under test.
7. Press **CONFIG**.
8. Select **Aux Data Settings > Timecode Display if present > LTC**.
9. Press the **OTHER** button to display the LTC waveform.
10. The LTC waveform should be displayed in the active tile. The amplitude will depend on the source. The sync packet should remain at a constant horizontal location on the sweep.
11. Record Pass or Fail for the LTC waveform in the test record.
12. In the lower-right corner of the screen, the time from the LTC input should be shown. It may be necessary to reset the LTC generator by using the reset switch.
13. Record Pass or Fail for LTC Decode in the test record.
14. Disconnect the LTC generator.

Ground Closure Remote

1. Connect a 525/270 color bar signal to the SDI A input.
2. You will need a custom cable for this step. (See Figure 2 on page 98.)

NOTE. *This is the same cable used to check LTC functionality.*

- a. Solder wires to pins 1, 2, 5, 6, 7, 8, and 9 of a male db9 connector, and strip the insulation back approximately 1/4 inch on each of the wires.
 - b. Make a shielded coaxial cable with a male RCA connector on one end. On the other end, connect the center coax conductor to pin 2 of the male db9 connector and the outer (shield) conductor to pin 1 of the male db9 connector.
3. Connect the DSUB connector to the REMOTE connector on the waveform monitor.

Test Preset Recall.

4. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)

NOTE. *This test overwrites presets A1 through A4. Save any existing presets to USB flash memory before doing this procedure.*

5. Set the waveform monitor to display a picture in tile 1 and a waveform in the the remaining tiles:
 - a. Press the **Display Select** button **1** button and then press the **PICT** button.
 - b. Press the **Display Select** button **2** and then press the **WFM** button.
 - c. Press the **Display Select** button **3** and then press the **WFM** button.
 - d. Press the **Display Select** button **4** and then press the **WFM** button.
6. Save the current settings as preset A1:
 - a. Press and hold the **PRESET** button to display the Preset Menu.
 - b. Select **Save Preset > Select Group A > Save A1**.
 - c. Save the preset as Preset **A1**.
 - d. Briefly press the **PRESET** button to close the Preset menu.
7. Repeat steps 5 and 6 to create a preset with picture in tile 2 and waveform in tiles 1, 3, and 4. Save as Preset **A2**.
8. Repeat steps 5 and 6 to create a preset with picture in tile 3 and waveform in tiles 1, 2, and 4. Save as Preset **A3**.

9. Repeat steps 5 and 6 to create a preset with picture in tile 4 and waveform in tiles 1, 2, and 3. Save as Preset **A4**.
10. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets*.)
11. Short pins 1 and 6 together on the remote cable.
12. Preset **A1** should be restored so that a picture is displayed in tile 1. It may take several seconds for the display to change.
13. Short pins 1 and 7 together on the remote cable.
14. Preset **A2** should be restored so that a picture is displayed in tile 2. It may take several seconds for the display to change.
15. Short pins 1 and 8 together on the remote cable.
16. Preset **A3** should be restored so that a picture is displayed in tile 3. It may take several seconds for the display to change.
17. Short pins 1 and 9 together on the remote cable.
18. Preset **A4** should be restored so that a picture is displayed in tile 4. It may take several seconds for the display to change.
19. Record Pass or Fail for Activate Preset in the test record.
20. Restore saved presets from the USB flash memory device (if saved before this procedure).

Test Ground Closure Out.

21. Connect a voltmeter or oscilloscope to monitor pin 5 of the DSUB connector.
22. Verify the voltage is greater than 4.5 V. This indicates the output is not asserted.
23. Connect a 525/270 color bar signal from DVG1 to the SDI A input.
24. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
25. On a 15-pin, male DSUB connector, solder wires or strip back insulation to gain access to pins 2, 5, and 9.
26. Connect the DSUB connector to the ground closure remote connector on the waveform monitor.
27. Press the **CONFIG** button to display the CONFIG menu.
28. Select **Alarms > SDI Input**, then press the **SEL** button.
29. Use the arrow keys to move the selection highlighting to the **Ground Closure** column of the **SDI Input Missing** row, and then press **SEL** to put an X in the box. This instructs the waveform rasterizer to assert the ground closure if the input is not present.
30. The voltmeter should read about 4.7 V on pin 9.
31. Remove the input signal from the SDI connector on the rear panel to assert ground closure.
32. The voltmeter should now read a low voltage, below 0.5 V.
33. Record Pass or Fail for Ground Closure in the test record.

Ethernet Test

1. Connect an Ethernet cable from the rear of the unit to a computer. The computer must have a Web browser installed.
2. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
3. Press the **CONFIG** button to display the Configuration menu.
4. Select **Network Settings > IP Configure Mode**.
5. Verify that the IP Config Mode is set to **Manual**.
6. Select **Network Settings > IP Address**.
7. Set the IP Address to be compatible with the computer:
 - a. Use the left/right arrow keys to move the highlight to each box in the address.
 - b. Use the up/down arrow keys to change the number in each box as required.
 - c. To accept your changes, move the highlight to the Accept box and press **SEL**.
 - d. Enable the ethernet connection from the Configuration menu by selecting **Network Settings > Web Enable > On**.
8. Open a Web browser on the computer.
9. From the computer, enter the IP address of the waveform monitor into the Web browser address line (for example, <http://192.182.256.23>).
10. You should see a Web page titled “Tektronix WFM6120/WFM7120 Remote Interface” or something similar. This means that the Ethernet function is working.
11. Record Pass or Fail for Ethernet Functionality in the test record.

NOTE. *While in Simultaneous Input mode, certain displays can be displayed either on the left or on the right, but not both at the same time.*

NOTE. *This test exercises the ability to simultaneously display signals from two inputs. The two input signals may be of any type and format supported by installed options (HD, CPS, DL). This procedure assumes Option HD is installed. If Option HD is not installed, then any supported signal type may be used in its place with similar results.*

Simultaneous Input Operation Test (Option SIM)

1. Set up a signal generator with an HDVG1 module and a DVG1 module. Connect an output from the HDVG1 module to the SDI A input of the instrument under test.
2. Connect an output from the DVG1 module to the SDI B input of the instrument under test.
3. Set the HDVG1 module format to 1080 59.94i 100% color bars.
4. Set the DVG1 module format to 525-270 SMPTE color bars.
5. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
6. Press the **CONFIG** button.
7. Select **Input Mode > Simultaneous**.
8. Press the **CONFIG** button again to remove the menu.
9. Press **DISPLAY SELECT 2** to select tile 2.
10. Press the **WFM** button to select the waveform display in tile 2.
11. Press **DISPLAY SELECT 4** to select tile 4.
12. Press the **PICT** button to select the picture display.
13. Check that the left two tiles (tiles 1 and 3) show the signal from the SDI A input. Check that the right two tiles (tiles 2 and 4) show the signal from the SDI B input.
14. Check that the left portion of the Status Bar displays the status of the SDI A signal input. Check that the right portion of the Status Bar displays the status of the SDI B signal input.
15. Enter pass or fail in the test record.

Dual Link Format Verification Test (Option DL)

1. Set up a dual link signal generator with an HDLG7 module. Connect the Link A output on the module to the SDI A input of the instrument, and the Link B output to the SDI B input of the instrument.
2. Perform the following steps to set the HDLG7 module format to 1080 59.94i:
 - a. Press the **MODULE** button until HDLG7 appears.
 - b. On the signal generator, press the **FORMAT** button until 1080 59.94i appears and then press the **ENTER** button.
 - c. Press the **CANCEL** button.
 - d. Press the up/down arrows until Sample Structure/Depth appears.
 - e. Press the left/right arrows until YCbCr+A 4:4:4 10 bits appears.
 - f. Press the **ENTER** button.
 - g. Press the **COLOR BAR** button until 75% color bars appears.

3. Restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
4. Press **DISPLAY SELECT 2** to select tile 2.
5. Press and hold the **STATUS** button.
6. Select **Display Type > Video Session**.
7. Press **DISPLAY SELECT 4** to select tile 4.
8. Press and hold the **VECTOR** button to display the Vector map and the Vector menu.
9. Select **Display Type > Lightning**.
10. Press the **VECTOR** button to close the menu.
11. Verify that the following are true in the specified tile or area:
 - Tile 1: YPbPrA parade waveform displayed
 - Tile 2: Format indicates Auto 1080 59.94i-YCbCrA 4444 10 bit
 - Tile 3: Color bars picture displayed
 - Tile 4: Endpoints of Lightning display land within targets
 - Status Bar: SDI Input DL-AB is displayed
12. On the signal generator, check that HDVG7 is displayed. Press the **CANCEL** button and then press the arrow button to select Sample Structure/Depth. Next, press the right arrow button to change the HDVG7 color space from YPbPr to GBR 4:4:4 10 bit.
13. Press the **ENTER** button.
14. Verify that the following are true for the specified tile or area:
 - Tile 1: YPbPr parade waveform displayed and automatically converted from RGB input signal
 - Tile 2: Format indicates RGB 4:4:4 10 bit
 - Tile 3: Color bars picture displayed
 - Tile 4: Endpoints of Lightning display land within targets
15. Record pass or fail in the test record.

**3 Gb/s SDI Verification Test
(Option 3G)**

1. Restore the Factory preset. (See page 60.)
2. Configure a 3 Gb/s test signal source using the following steps:

NOTE. *If the unit under test includes Option JIT, then configure it to provide the test signal by performing the following procedure. If the unit under test does not include Option JIT, then use a second WFM7120 with option JIT, configured as follows.*

- a. If you are using a second instrument as the signal source, restore the Factory preset in the test signal source unit. (See page 60.)
- b. On the test signal source unit, press the **CONFIG** button and select Outputs > SDI Output > Loop Out Test Signal.
3. Connect the SDI OUT of the unit configured for the test signal to the SDI A input of the instrument under test.
4. Press **DISPLAY SELECT 4** to select tile 4.
5. Press and hold the **STATUS** button.
6. Select Display Type > Video Session.
7. Press the **STATUS** button briefly to dismiss the menu.
8. Check that the third line in the Video Session display indicates “Effective: Auto 1080p 59.94 – YcbCr 422 10b – 425M-A 2.970/M Gbps”.
9. Check that the display in Tile 1 shows a stable waveform.
10. Check that the display in Tile 3 shows a stable picture.
11. Record pass or fail in the test record.
12. Perform the following steps if Option JIT is installed. Otherwise, this test is complete.
13. Press **DISPLAY SELECT 2** to select tile 2.
14. Press the **EYE** button to show the Jitter Waveform display.
15. Press and hold the **GAIN** button.
16. Select Gain Settings > x10.
17. Briefly press the **GAIN** button to dismiss the menu.
18. Check that the jitter waveform is active. (Measured jitter is typically less than 0.15 UI when driven from the instrument’s own SDI OUT; less than 0.25 UI when driven from another WFM7120).
19. Record pass or fail in the test record.

NOTE. *The test signal bit rate in generator mode can be checked by connecting SDI OUT to SDI A input, enabling the Test Signal, and measuring the frequency of the recovered clock available at the CLOCK OUT connector. The clock out frequency is the bit rate divided by 20.*

**A/V Delay Test (Option
AVD)**

1. Connect an SDI video signal from a SIGNAL output of the DVG7 to the SDI A input of the WFM instrument.
2. Set the signal generator for AV Timing Mode as follows:
 - Press the **MODULE** button until **TG700:PRESET** appears and then press **ENTER**.
 - Press < to display **Factory Default**, then press **ENTER**.
 - Press **MODULE** until DVG7 appears.
 - Press ^ until **VIDEO** appears and then press **ENTER**.
 - Press ^ until **AV Timing Mode** appears.
 - Press > to select **ON** and then press **ENTER**.
 - Press **CANCEL** to return to the previous menu.
 - Press ^ until **AUDIO (EMBEDDED)** appears.
 - Press < until **GROUP 1** appears and then press **ENTER**.
 - Press > until **STATUS: ENABLED** appears and then press **ENTER**.
3. On the WFM instrument, restore the Factory Preset. (See page 60, *Restore the Factory Presets.*)
4. Press and hold the **MEAS** button to display the Measure menu.
5. Select **Display Type > AV Delay**.
6. Press the < navigation button to return to the previous menu level and then set **AV Delay Enable** to **On**.
7. Briefly press the **MEAS** button to dismiss the menu.
8. Check that the AV Delay readout is green and that it indicates less than .005 s. The number in the Fields readout will depend on the video standard in use.
9. Enter Pass or Fail in the test record.

Video and General Performance Verification Procedures

This performance verification includes procedures that verify standard and option-equipped instruments.

Required Equipment

Table 64: Required Test Equipment (Video and General Performance)

Test Equipment	Requirements	Example
XGA Monitor	Computer monitor capable of 1024 x 768 x 60 Hz scan rate	
SDI serial digital video test generator with embedded audio and composite signal source	NTSC Black	Tektronix TG2000 with BG1 and additional modules indicated below:
	1080i 59.94 HD signals required for WFM7120: <ul style="list-style-type: none"> ■ 75% and 100% color bars ■ SDI Matrix Split Field Pathological Signal ■ SDI Equalizer ■ VM5000 Matrix 	HDVG1 module for TG2000 (Embedded audio needed for audio options DG, AD, DS, DDE)
	HD signal with adjustable SDI amplitude required for WFM7120	HDST1 module for TG2000
	1080i 59.94 analog tri-level sync required for WFM7120	AWVG1 module for TG2000
	525/270 SD signals required: <ul style="list-style-type: none"> ■ 75% and 100% color bars ■ SDI Matrix Pathological Signal ■ SDI Equalizer ■ Adjustable SDI amplitude ■ VM5000 Matrix 	DVG1 with option S1 module for TG2000 (Embedded audio needed for audio options DG, AD, DS, DDE)
	Composite signals required for Option CPS: <ul style="list-style-type: none"> ■ NTSC 0% flat field ■ NTSC 100% color bars 	AVG1 module for TG2000
Precision calibration signals for Option CPS and for Eye Gain test ¹	Tektronix part number 067-0465-00 (AVC1) module for TG2000 ²	
HD Cable-clone cable simulator	Simulate 10 to 150 meters of 1694A equivalent in 10 m steps	Faraday FFE Kit

Table 64: Required Test Equipment (Video and General Performance) (cont.)

Test Equipment	Requirements	Example
SD Cable-clone cable simulator	Simulate 0 to 400 meters of 8281 equivalent in 25 meters steps.	Faraday SC75A800B-G
75 Ω coaxial cables (3 required)	General purpose digital video Male-to-male BNC connectors 1 or 2 meters long	Belden 8281 Tektronix part numbers 012-0159-00 or 012-0159-01
75 Ω Terminator for Analog Video	Male connector, precision	Tektronix part number 011-0102-03
75 Ω term for SDI signal. (2)	Male, wideband	Tektronix part number 011-0163-00
Video Measurement Set	Measure 1080i/60 RGB Multiburst PIXMON output	Tektronix VM5000
Sync pickoff adapter		Tektronix part number 012-1680-00
Test oscilloscope	>2 GHz bandwidth with 75 Ω input	Tektronix TDS7404B with TCA75 adapter
75 Ω calibration kit		Maury 8580A 75 Ω BNC
VITC Generator		Horita VG-50 or Adrienne AEC-Box-28
LTC Generator		Horita TG-50 or Adrienne AEC-Box-28
NTSC to SDI Converter		Grass Valley 8960DEC or AJA model D5D
RCA to 15 pin header custom cable	15-pin male Dsub connector, Tektronix part number 131-1164-00, RCA plug Allied 932-1098, and wire. (See Figure 2.)	
VGA to 5x BNC adapter cable	15 pin VGA connector input, 5 BNC connector outputs	Tektronix part number 174-5126-00
1 to 2 VDC voltage source (Required for Option CPS)	1.5 V battery or power supply	
BNC to retractable hook tip (Required for Option CPS)		Tektronix part number 013-0076-01
BNC barrel connector		
3 Gb/s test signal source		Tektronix WFM7120 with Option JIT Option JIT includes test signal generation capability
3 Gb/s clone cable	Simulate 10 to 150 meters of 1694A equivalent in 10 m steps	Faraday FFE Kit

¹ The required custom signals are provided on the User Documents CD. These signals are also provided for an AVG1 module, if an 067-0465-00 (AVC1) is not available. Download the PVCUSTOMsignals.zip file, unzip it, and install the signals on your TG2000.

² Note that the 067-0465-00 (AVC1) is not available outside of Tektronix. Other equipment can be substituted but it might not have sufficient accuracy to guarantee the specifications. For hum insertion, a general-purpose sine wave generator can be used to terminate and drive back into the video signal through appropriate impedance matching.

Basic Setup

Use the following setup for all tests unless otherwise specified.

1. Connect the power cord to the rear of the waveform monitor.
2. Connect an XGA monitor to rear of instrument.
3. Connect the power cord to the AC mains and allow at least 20 minutes for the waveform monitor to warm up before beginning any procedures.

Instrument Tests

The following procedures apply to all base instruments except where labeled for specific models. Do all tests except those that exclude your model.

HD SDI Input Level Low and High (Option HD)

This test uses the serial output with adjustable level to verify that the waveform monitor can accept serial signals of various amplitudes.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect a 75 Ω cable from a TG2000 HDVG1 output (Output 2) to the HDST1 video input.
3. Connect a 75 Ω cable from the HDST1 STRESS output to the SDI A input on the waveform monitor.
4. On the TG2000 HDVG1, set the output to the SDI Matrix signal.
5. You should see a stable picture and waveform on the waveform monitor display. Select a tile, press and hold the **STATUS** button, and select **Video Session** to display the status screen. The status screen should display OK for Y Chan CRC, C Chan CRC, Y Anc Checksum, and C Anc Checksum errors.
6. Press the **STATUS** button to close the menu.
7. Press **FULL** to display the status screen full tile.
8. On the TG2000 HDST1, adjust the serial amplitude downward to find the lowest level that does not generate any CRC errors in a 10 second period.
9. Record the HDST1 Amplitude Level in the test record.
10. Increase the HDST1 Amplitude Level to 130 %.
11. If any EDH errors are generated, reduce the amplitude until no errors are generated for a 10 second period.
12. Record the HDST1 Amplitude Level in the test record.
13. Move the input cable from the SDI A input to the SDI B input.
14. Repeat steps 8 through 12 for the SDI B input.
15. Record this level in the test record.

**EDH and HD SDI Input
Equalization Range
(Option HD)**

This test uses a cable clone to simulate cable. This verifies that the waveform monitor can receive signals that have passed through long cables.

EDH.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the TG2000 HDVG1 output to the TG2000 HDST1 input.
3. Connect the TG2000 HDST1 output to the waveform monitor SDI A input.
4. If you do not have the video status screen displayed, press the **Display Select 4** button, press and hold the **STATUS** button, select Video Session, and press the **FULL** button to display the tile full screen.
5. Press the **STATUS** button to close the menu.
6. Select the 1080i59.94 “SDI Equalizer Test” signal from the TG2000 HDVG1.
7. Set the TG2000 HDST1 SDI parameters for a 1.0 error rate.
8. Check that the Y Chan and C Chan CRC Error readouts, Err Seconds column, shown in the Video Session display, are incrementing at a rate of one per second.
9. Record Pass or Fail in the test record.

Cable Length Accommodation.

10. Connect a cable from an output of the TG2000 HDVG1 to the 80 m section of the HD Cable clone.
11. Use a second cable to connect the other port of the cable clone section to the SDI A connector on the waveform monitor.
12. On the TG2000 HDVG1, set the output to the SDI Matrix signal.
13. Press the **FULL** button to return to 4-tile view.
14. You should see a stable picture and waveform on the waveform monitor display.
15. You should see that all of the CRC Error indicators in the Video Session screen read OK.
16. Connect additional sections of the HD Cable Clone into the signal path to find the longest length of “cable” that does not generate any CRC errors in a 10-second period.
17. Add the HD Cable Clone section lengths to get the total length in meters of Belden 8281 cable. Divide by 4 to calculate the attenuation in dB at 750 MHz.
18. Record the value in the test record.
19. Repeat the test using SDI B input on the waveform monitor.
20. Record this level in the test record.

**3 Gb/s SDI Input
Equalization Range
(Option 3G)**

1. Connect a cable from the output of the 3Gb/s test signal source to the 3Gb/s Cable Clone with sections assembled totaling 70 meters of 1694A.

NOTE. *A WFM7120 with option JIT can be configured as a test signal source. (See page 80, 3 Gb/s SDI Verification Test (Option 3G).)*

2. Use a second cable to connect the other port of the Cable Clone assembly to the SDI A connector on the waveform monitor.
3. Check that the CRC Error indicators in the Video Session screen read OK.
4. Assemble the Cable Clone sections to simulate longer lengths to find the longest length that does not generate any CRC errors in a 10 second period.
5. Divide the simulated length in meters by 4 to calculate the attenuation in dB at 1.5 GHz.
6. The attenuation value is typically greater than 17.5 dB.
7. Repeat the test using the SDI B input on the waveform monitor.

HD SDI Loop- through Isolation (Option HD)

This test looks for crosstalk between the two SDI inputs. One input is driven by a signal straight from the generator; the second input is driven through the cable clone, which simulates a long cable. The two sources are set to different rates to allow transitions of the serial signal to hit all possible phases. If the isolation is sufficient, the crosstalk will not introduce errors.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. If you do not have the video status screen displayed, press the **DISPLAY SELECT 4** button, press and hold the **STATUS** button, and select Video Session.
3. Press the **STATUS** button to close the menu.
4. Connect a cable to any output on the TG2000 HDVG1.
5. Connect the other end of the cable to the 80 m section of the HD Cable clone.
6. Connect a second cable to the other port of the cable clone section.
7. Connect a cable from the cable clone to the SDI A input connector.
8. Connect an output from the DVG1 to the SDI B input connector.
9. Set the signal driving the SDI B input to 100% color bars.
10. Set the time base on the second signal to 1 ppm high.
11. Verify that there are no CRC errors on the SDI A input.
12. Record a Pass or Fail as appropriate in the test record.
13. Disconnect the test setup.

HD Pixmon Multiburst Frequency Response (Option HD)

This test uses a VM5000 to test the frequency response at the Pixmon output.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the TG2000 HDVG1 output to the waveform monitor SDI A input.
3. Select the VM5000 Matrix (1080i 59.94) test signal from the HDVG1. This signal is provided on the User Documentation CD.
4. Press **CONFIG > Output > HD Alg PixMon > RGB**.
5. Connect the waveform monitor PIXMON output to the VM5000, as described in the VM5000 manual or online help.
6. Start the VM5000 HD and SD application and set the number of Averages to 4.
7. On the Format tab, select 1080i/60, RGB.
8. On the Measurement tab, select Multiburst and clear any other measurement selections.

9. Run the measurement.



Figure 1: VM5000 HD Frequency Response display

- 10. Check that the Burst dB values in the AmpY/G, AmpPb/B, and AmpPr/R columns are between -0.92 dB (-10%) and $+0.82$ dB ($+10\%$).
- 11. Record Pass or Fail in the test record.

HD Cable Meter (WFM7120 Option EYE or PHY)

This test uses a short (1-2 m) length of Belden 8281 cable and a long (100 m) length of Belden 8281 cable to check the Cable Meter. A cable clone may be used instead of the long cable.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Press and hold the **STATUS** button and select SDI Status.
3. Press the **STATUS** button to close the menu.
4. Using the short cable, connect a color bar signal from the HDVG1 to the SDI A input on the waveform monitor.
5. Check that the cable length reading is between 0 m and 17 m.
6. Record the results in the test record.
7. Using the long cable, or the cable clone set to 100 m, connect a color bar signal from the HDVG1 to the SDI A input on the waveform monitor.
8. Check that the cable length reading is between 76 m and 127 m.
9. Record the results in the test record.
10. Repeat steps 4 through 9 for the SDI B input.

**HD Jitter Noise Floor
(WFM7120 Option EYE or
PHY)**

This test checks the jitter noise floor of the **waveform monitor**. Since some jitter may be introduced by the signal source, you may need to characterize the TG2000 output jitter with an oscilloscope. Most HDVG1 generators have an output noise floor in the 80 ps range.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets*.)
2. Connect the TG2000 HDVG1 output to the HDST1 input, and connect the HDST1 STRESS output to the SDI A input on the waveform monitor.
3. Reset the HDST1 to default on all SDI parameters.
4. Select the 1080i 59.95 75% color bar signal from the HDVG1.
5. Press the **Input A** button.
6. Press the **FULL** button to set the WFM tile to full screen.
7. Set the waveform monitor to the jitter display:
 - a. Press the **EYE** button to view the Eye display.
 - b. Press and hold the **EYE** button.
 - c. Select **Display Type** and then **Jitter Display**.
8. Set the jitter high pass filter to 100 Hz:
 - a. In the **EYE** menu, select **Jitter1 HP Filter**.
 - b. Select **100 Hz**.
9. Set the vertical gain to x10:
 - a. Press and hold the **GAIN** button.
 - b. Select **Gain Settings** and then **x10**.
 - c. Press the **GAIN** button to remove the pop-up menu.
10. Using the graticule or the cursors, measure the jitter amplitude.
11. Check that the jitter amplitude is approximately 80 ps (0.119 UI), depending on the TG2000 output jitter.
12. Record Pass or Fail in the test record.
10 second 10 Hz jitter bounce.
13. Set the jitter high pass filter to 10 Hz:
 - a. Press and hold the **EYE** button, and select **Jitter1 HP Filter**.
 - b. Select **10 Hz**.
14. Watch the display for at least 10 seconds. The trace may jump occasionally.
15. Check that any trace jump is ≤ 200 ps (0.297 UI).
16. Record Pass or Fail in the test record.

HD Jitter Readout Accuracy (WFM7120 Option EYE or PHY)

1. Press the **FULL** button to return to the 4-tile display.
2. Set the upper left tile to the Eye display:
 - a. Press the **DISPLAY SELECT 1** button.
 - b. Press and hold the **EYE** button for the menu.
 - c. Select **Display Type** and then **Eye Display**.
3. Set the upper right tile to be the Jitter display:
 - a. Press the **DISPLAY SELECT 2** button.
 - b. Press the **EYE** button to view the Eye display.
 - c. Press and hold the **EYE** button for the menu.
 - d. Select **Display Type** and then **Jitter Display**.
4. Press and hold the **MAG** button, and select x50 magnification.
5. Press and hold the **EYE** button, select **Jitter1 HP Filter**, and then select **100 Hz**.
6. Press and hold the **SWEEP** button and select **2 Field** to show two fields in the Jitter display.
7. Press the **SWEEP** button to close the menu.
8. Adjust the HDST1 module as follows:
 - a. Set the jitter (LF) frequency to 9950 Hz.
 - b. Slowly increase the jitter (LF) amplitude while watching the Eye display.

 As the jitter amplitude increases, the transitions start to get wider and fill in the space between the transitions. As the jitter amplitude approaches one UI, the space between transitions disappears (the eye display will begin to close).

 At one UI of jitter, the eye diagram will have ‘closed’, and a darkening, or shadow, on an eye trace will appear out of the smeared background. Continue increasing the jitter until another shadow of an eye appears. You now have 2 UIs of jitter.

 Continue increasing jitter to 3 UIs. Don’t adjust for 3 UIs on the generator; adjust instead for the sharpest narrow eye shadow on the display which indicates that the applied jitter is precisely 3UI. This may not be 3 UI on the generator, since the HDST1 module may be as accurate.
9. The jitter display should show a stationary sine-wave 3 UI in height. Check the sine portion of the jitter trace, ignoring the small random noise component, with the graticule marks and the cursors to see that it is 3 UI $\pm 10\%$ (between 2.7 UI and 3.3 UI).
10. Record Pass or Fail for the Jitter Trace functional test on the test record.

11. Check that the jitter readout shows the jitter to be between 2.65 UI and 3.35 UI.
12. Record Pass or Fail for the Jitter Readout functional test on the test record.
13. Reset the generator.

**External Reference
Formats Supported:
Bi-Level**

Check that the unit under test can reference to NTSC and PAL while viewing digital signals.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Press the **EXT REF** button to select the external reference mode.
3. Connect a 525/270 color bars signal from a DVG1 module to the SDI A input of the instrument under test.
4. Apply an NTSC 0% Flat Field signal from the AVG1 output to the Reference input of the waveform monitor. Terminate the other Reference input with a precision termination.
5. Check that the lower-left corner of the waveform monitor display shows the proper standard for the reference.
6. Check that the Waveform and Vector displays are locked.
7. Log either Pass or Fail in the test record.
8. Leave test setup as is for the next test.

**External Reference Lock
Range**

Vary the time base of the reference to measure lock range.

1. Adjust the AVG1 time base offset to -50 ppm. Verify that the readout in the lower-left corner of the waveform monitor display does not indicate an unlocked signal. It is normal for the system to momentarily lose lock when the time base is changed.

NOTE. *The waveform display will not be stable because the SDI time base is not in sync with the reference.*

2. Increase the negative time base offset until the waveform monitor cannot sustain lock. Record the maximum offset capability in the test record.
3. Repeat steps 1 and 2, but use positive offsets to test the positive end of the lock range.
4. Reset the AVG1 Module parameters to remove the timebase offset.

**External Reference
Formats Supported:
Tri-Levels (WFM7020 and
WFM7120 only)**

Check that the unit under test can reference to NTSC and PAL while viewing digital signals.

1. Disconnect the AVG1 signal from the Reference input, and connect a 1080i 59.94 Tri-Level Sync signal from the AWVG1.
2. Check that the lower-left corner of the waveform monitor display shows the proper standard for the reference.
3. Check that the Waveform and Vector displays are locked.
4. Log either Pass or Fail in the test record.
5. Disconnect the 1080i 59.94 Tri-Level Sync signal from the reference input.

**External Reference Lock in
Presence of Hum, Bi-Level**

Apply a 0 dB hum signal to the Reference and verify that the waveform monitor still locks correctly.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the TG2000 black burst signal to the video input of the AVC1. Route the video output of the AVC1 (not the precision video output) to one of the waveform monitor REF inputs. Terminate the other REF input.
3. Connect either a digital or composite signal from the TG2000 to the waveform monitor and select the appropriate input to display the signal.

NOTE. *For instruments without Option CPS you must use a digital signal. For Option CPS instruments, you can use an analog signal for more sensitivity to external reference performance.*

4. Set the AVC1 for 0 dB of 60 cycle hum.
5. Press the **EXT REF** button to select the external reference mode.
6. Check that the signal is locked and the WFM and VECTOR displays are stable.
7. Record Pass or Fail in the test record.

External Reference Lock in Presence of Hum, Tri-Level (WFM7020 and WFM7120 only)

Apply a 0 dB hum signal to the Reference and verify the waveform monitor still locks correctly.

1. Disconnect the black-burst signal from the AVC1 input, and apply a 1080i 59.94, Tri-Level Sync signal from the AWVG1 instead.
2. Set the AVC1 for -0 dB of 60 Hz hum.
3. Check that the signal is locked and the WFM and VECTOR displays are stable.
4. Record Pass or Fail in the test record.
5. Disconnect the AVC1.

**Recovered Sine-wave
Fidelity (Option EYE and
PHY)**

This test checks that the SD or HD recovered clock signal has no fidelity issues (such as stuck bits), after it has been filtered into a sine-wave and digitized.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect an SD signal to the waveform monitor.
3. Turn on the Recovered Sine-wave function:
 - a. Press the **CONFIG** button.
 - b. Select **Utilities, Calibration**, and then press the **SEL** button.
 - c. Use the down arrow key to scroll through the Calibration status screen and select **Eye Recovered Clock Test**.
 - d. Press the **SEL** button to start the calibration.
4. Check to see that the sine-wave is smooth and undistorted. There should be one cycle displayed.
5. Press the **Display Select 1** button to activate the upper-left tile.
6. Press the **FULL** button.
7. Press and hold the **GAIN** button, select **VAR Gain**, and set the **Gain Setting** to **x5**.
8. Press the **GAIN** button to dismiss the pop-up menu and use the **GENERAL** knob to adjust the vertical gain to **x10.0**.
9. Check the waveform. There should be no discontinuities or jagged edges. Use the **VERTICAL** knob to view the entire waveform.
10. Connect an HD signal and repeat step 9 (if instrument is equipped with Option HD).
11. When the process is complete, press **CONFIG** and select **Utilities > Calibration**. Navigate to **Eye Recovered Clock Test** and select **Off**.
12. Record Pass or Fail in the test record.

Recovered Sine-wave Fidelity (Option JIT)

This test checks that the 3 Gb/s recovered clock signal has no fidelity issues (such as stuck bits), after it has been filtered into a sine-wave and digitized.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Press the **CONFIG** button, then select Outputs > SDI Output and select Loop Out Test Signal.
3. Use a cable to connect the SDI OUT to the SDI A input.
4. Turn on the Recovered Sine-wave function:
 - a. Press the **CONFIG** button.
 - b. Select **Utilities, Calibration**, and then press the **SEL** button.
 - c. Use the down arrow key to scroll through the Calibration status screen and select **Eye Recovered Clock Test**.
 - d. Press the **SEL** button to start the calibration.
5. Check to see that the sine-wave is smooth and undistorted. There should be one cycle displayed.
6. Press the **Display Select 1** button to activate the upper-left tile.
7. Press the **FULL** button.
8. Press and hold the **GAIN** button, select **VAR Gain** and press the right arrow to highlight **Enable**. Then set the **Gain Setting** to **x5**.
9. Press the **GAIN** button to dismiss the pop-up menu and use the **GENERAL** knob to adjust the vertical gain to **x10.0**.
10. Check the waveform. There should be no discontinuities or jagged edges. Use the **VERTICAL** knob to view the entire waveform.
11. When the process is complete, press **FULL** to return to 4-tile view.
12. Press the **Display Select 4** button to activate the lower-right tile.
13. When the calibration process is complete, press the **SEL** button to turn off the Eye Recovered Clock Test.
14. Press and hold the **STATUS** button and select **Exit** to exit calibration.
15. Record Pass or Fail in the test record.

LTC Decoding Functionality

Apply an LTC signal and verify it is correctly decoded.

An LTC is input through the 9-pin REMOTE connector on the rear panel. To input an LTC signal, you need to construct a cable as shown in the following figure. This cable has seven wires from the Remote connector, with two of them also connected to an RCA connector. Pin 2 of the Remote connector is connected to

the center pin of the RCA connector, and pin 3 is connected to the shield of the RCA connector.

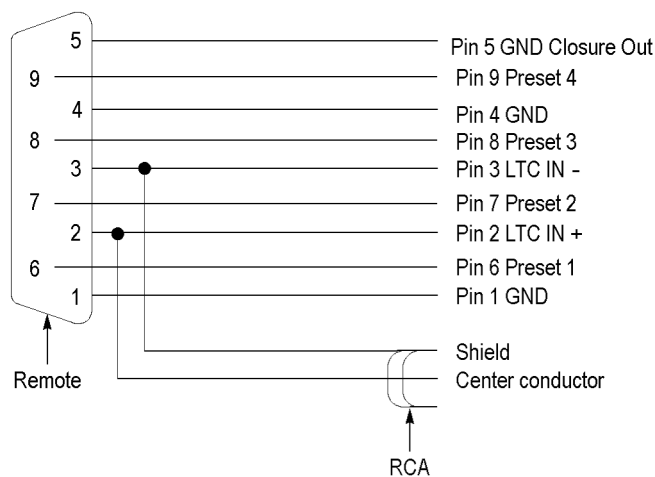


Figure 2: Wiring diagram for LTC input/Ground Closure cable

NOTE. Apply a signal to only one connector at a time.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the RCA connector on the custom cable to the output of the Timecode generator. Connect the custom cable 9-pin connector to the REMOTE connector on the waveform monitor rear panel.
3. Set the timecode source to LTC:
 - a. WFM6120 Opt CPS: Select **Audio Inputs/Outputs** and then **Analog Input A**. Proceed to step b.
 - b. Press the **CONFIG** button, select **Aux Data Settings > Timecode Display if present > LTC**.
4. If using a Horita TRG50 LTC generator, set the switches to:

Control or Setting	Value
V-Size	LRG
V-Pos	TOP
Mode	GEN

Control or Setting	Value
Data	TC

5. It may be necessary to reset the LTC generator via the mode switch. Momentarily move the Mode switch to SET, and back to GEN.
6. Verify that the Decoded LTC is displayed in the lower right corner of the display.
7. Record Pass or Fail in the test record.

Eye Gain (Option EYE or PHY)

This test uses an 800 mV, 1 MHz square wave to check the Eye Gain. This requires a 1 MHz square wave signal from the TG2000 AVC1 module. This signal is provided on the User Documentation CD. Use a precision cable to connect the AVC1 to the waveform monitor.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Set the waveform monitor to Bandwidth test mode:
 - a. Press the **CONFIG** button.
 - b. Select **Utilities, Calibration**, and then press the **SEL** button.
 - c. Use the down arrow key to scroll through the Calibration status screen and select **Eye Gain Adjust SDI A**.
 - d. Press the **SEL** button to start the calibration.
3. Connect the AVC1 Precision Video output to the SDI A input on the waveform monitor, and then select the 1 MHz squarewave signal.
4. **Option PHY:** Check that the digital amplitude reading is between 760 mV and 840 mV.
5. Using the cursors and graticule lines, check that the waveform is between 760 mV and 840 mV. Record this level in the test record.
6. From the Calibration Status screen, select **Eye Gain Adjust SDI B**.
7. Repeat steps 3 through 5 for the SDI B input.
8. When the calibration process is complete, press and hold the **STATUS** button and select **Exit** to exit calibration.

Reference Clock Amplitude and Frequency (Option EYE and PHY)

This test uses an oscilloscope to verify the reference clock output.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect an SD or HD signal, as appropriate to the instrument under test, to the waveform monitor SDI A input.
3. Verify that the display shows the signal.
4. Connect one of the CLOCK OUT BNCs to the test oscilloscope, using a 75 Ω cable. The test oscilloscope must have a 75 Ω input.
5. Check that the amplitude of the CLOCK OUT signal is between 0.8 V_{p-p} and 1.2 V_{p-p} .
6. Record Pass or Fail for the Clock Amplitude functional test on the test record.
7. Check that the frequency of the CLOCK OUT signal is 27 MHz $\pm 5\%$ (when using a 1080i 60 SD signal); 74.25 MHz $\pm 5\%$ (when using a 1080i 60 HD signal) or 74.17582 MHz $\pm 5\%$ (when using a 1080i 59.94 HD signal).
8. Record Pass or Fail for the Clock Frequency functional test on the test record.

Reference Clock Amplitude and Frequency (Option 3G)

This test uses an oscilloscope to verify the reference clock output.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect a 3Gb/s signal to the waveform monitor SDI A input. (See page 80, *3 Gb/s SDI Verification Test (Option 3G).*)
3. Verify that the display shows the signal.
4. Connect one of the CLOCK OUT BNCs to the test oscilloscope, using a 75 Ω cable. The test oscilloscope must have a 75 Ω input.
5. Check that the amplitude of the CLOCK OUT signal is between 0.8 V_{p-p} and 1.2 V_{p-p} .
6. Record Pass or Fail for the Clock Amplitude functional test on the test record.
7. Check that the frequency of the CLOCK OUT signal is 148.5 MHz $\pm 5\%$ (when using a 1080p 60 signal) or 148.35165 MHz $\pm 5\%$ (when using a 1080p 59.94 signal).
8. Record Pass or Fail for the Clock Frequency functional test on the test record.

Eye Signal Bandwidth (Option EYE or PHY)

NOTE. *The level accuracy of the RF generator and the frequency response of the cable and matching pad directly affect the following check. To accurately verify this specification with the recommended equipment, the combination of generator, pad, and cable must be characterized. (See page 126, *Signal Source Characterization for Eye Signal Bandwidth.*)*

1. Assemble the signal source set-up as characterized in Signal Source Characterization for Eye Signal Bandwidth Verification. (See page 126, *Signal Source Characterization for Eye Signal Bandwidth*.)
2. Set the RF generator frequency to 100 MHz.
3. Set the RF generator level as indicated in the characterization table. (See Table 66 on page 127.)
4. Connect the signal source output to the waveform monitor SDI A input.
5. Press the **Input A** button.
6. Check that the RF generator's RF output is on, with no modulation.
7. Press the **Display Select 1** button and then the **EYE** button.
8. Press the **FULL** button.
9. Press the **SWEEP** button to see the **10 Eye** readout on the display screen.
10. Select the Bandwidth Test:
 - a. Press the **CONFIG** button.
 - b. Select **Utilities, Calibration**, and then press the **SEL** button.
 - c. Use the down arrow key to scroll through the Calibration status screen and select **Eye Gain Adjust SDI A**.
 - d. Press the **SEL** button to start the calibration.
11. Use the cursors to measure the waveform amplitude, and note this as the reference amplitude. (If Option PHY is installed, the Eye Amplitude readout may be used instead of the cursors.)
12. Set the RF generator frequency to 2.5 GHz.
13. Set the RF generator output level to the corresponding setting. (See Table 66 on page 127.)
14. Measure the 2.5 GHz waveform amplitude using cursors. (If Opt. PHY is present, the Eye amplitude readout value may be used in place of the cursor measurement.)
15. Calculate the 2.5 GHz response as follows:

$$Response = 20 \times \log \left(\frac{2.5 \text{ GHz Amplitude}}{Reference Amplitude} \right)$$

This value must be greater (more positive) than -3 dB.

16. Record the 2.5 GHz response in the test record.
17. Set the RF Generator to 100 MHz.
18. Set the RF generator output level to the corresponding setting. (See Table 66 on page 127.)
19. While observing the waveform, increase the RF generator frequency in 10 MHz steps to 2.5 GHz. Find the frequency that results in the minimum waveform amplitude.
20. Set the RF generator level to the nearest corresponding setting. (See Table 66 on page 127.)
21. If the waveform amplitude falls below that measured in step 11, calculate the response in dB, as follows:

$$Response = 20 \times \log \left(\frac{Smallest\ Amplitude}{Reference\ Amplitude} \right)$$

Record this result in the test record as “minimum response”. This value must be greater (more positive) than –3.0 dB.

22. Move the signal source output to the SDI B input.
23. From the Calibration status screen, select **Eye Gain Adjust SDI B**.
24. Set the RF Generator to 100 MHz.
25. Set the RF generator output level to the corresponding setting. (See Table 66 on page 127.)
26. Repeat steps 11 through 21 for the Digital B input.
27. When the calibration process is complete, press and hold the **STATUS** button and select **Exit** to exit calibration.

SD Video Tests

SD SDI Input Level Low and High

This test uses the serial output with adjustable level to verify that the waveform monitor can accept serial signals of various amplitudes.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect a cable to the Opt S1 output of the TG2000 DVG1. The Opt S1 output is typically the second BNC from the top of that module.
3. Connect the other end of the cable to the SDI A input connector on the waveform monitor.
4. On the TG2000 DVG1, set the output to the SDI Matrix signal.
5. Press the **Display Select 4** button and then press the **FULL** button.
6. You should see a stable picture and waveform on the waveform monitor display.
7. Press the **FULL** button again to return to the 4-tile display view.
8. Press and hold the **STATUS** button and select **Display Type > Video Session**.
9. In the Status Display, you should see OK for all the EDH parameters.
10. On the TG2000, adjust the serial amplitude downward to find the lowest level that does not generate any EDH errors in a 10 second period.
11. Record the DVG1 amplitude level in the test record.
12. Increase the serial amplitude to 115%.
13. If any EDH errors are generated, reduce the amplitude until no errors are generated for a 10 second period.
14. Record the DVG1 amplitude level in the test record.
15. Repeat the steps 10 to 14, using the SDI B input on the waveform monitor.

SD SDI Input Equalization Range and EDH

This test uses a cable clone to simulate a long cable. This verifies that the waveform monitor can receive signals that have passed through long cables.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)

EDH.

2. Connect the TG2000 DVG1 Normal output (not the Opt S1 output) to the Cable Clone input. Typically the Normal output is the top BNC on the DVG1 module.
3. Connect the Cable Clone output to the waveform monitor SDI A input.
4. Set the waveform monitor to display a Video Session status screen:
 - a. Press **Display Select 4** to activate that tile.
 - b. Press and hold the **STATUS** button.
 - c. Select **Display Type** and then **Video Session**.
 - d. Press the **STATUS** button to dismiss the menu.
5. Select the 525 270 “SDI Equalizer Test” signal from the TG2000 DVG1.
6. Set all switches on the Cable Clone to the ‘out’ position.
7. While watching the EDH Error display Statistics column on the Video Session screen, rapidly toggle the +1 switch on the Cable Clone between the out and the in position until errors are observed.
8. The EDH Error display on the Video Session screen should indicate an EDH Error on at least one of the switch transitions.
9. Record Pass or Fail in the test record.

Cable Length Accommodation.

10. Set the cable clone for minimum cable length (all switches to the “out” position.)
11. On the TG2000 DVG1, set the output to the SDI Matrix signal.
12. You should see a stable picture and waveform on the waveform monitor display. All the EDH parameters on the Video Session Status screen should read OK.
13. Adjust the cable clone to find the longest length of “cable” that does not generate any EDH errors in a 10 second period.
14. Divide the length of Belden 8281 cable by 10 to calculate the attenuation in dB at 135 MHz.
15. Record the value in the test record.
16. Repeat the test using SDI B input on the waveform monitor.
17. Record this level in the test record.

**SD Pixmon Multiburst
Frequency Response**

This test uses a VM5000 to test the frequency response at the Pixmon output.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the TG2000 DVG1 output to the waveform monitor SDI A input.
3. Select the VM5000 Matrix (525 59.94) test signal from the DVG1.
4. Press Input A.
5. Set the SD Alg PixMon to RGB:
 - a. Press the **CONFIG** button.
 - b. Select **Outputs, SD Anlg PixMon**, and then **RGB**.
6. Connect the waveform monitor PIXMON output to the VM5000, as described in the VM5000 manual.
7. Start the VM5000 HD and SD application, and set the number of Averages to 4.
8. Set the format to 480i/60, RGB.
9. Set the Measurement to Multiburst.
10. Run the measurement.

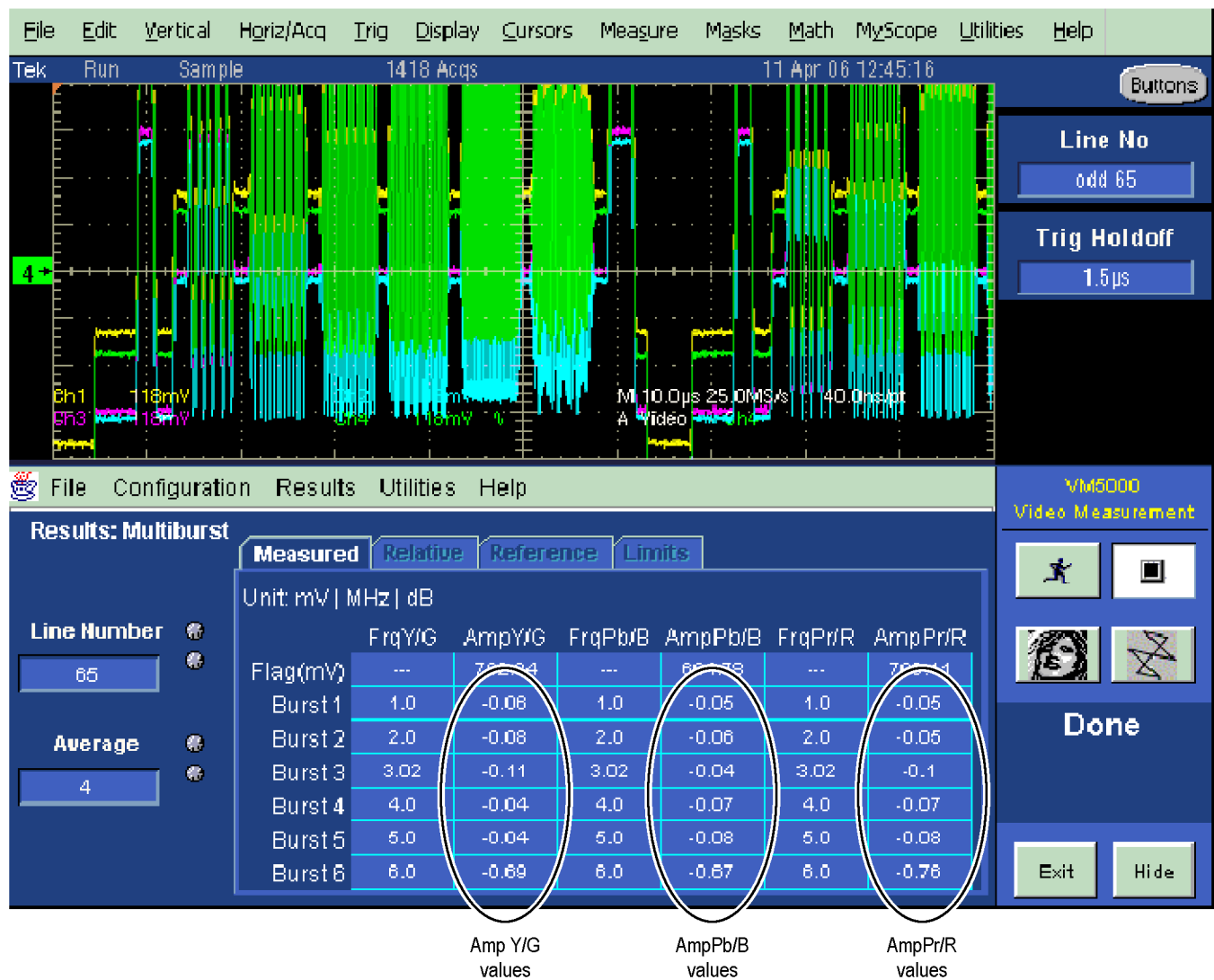


Figure 3: VM5000 SD Frequency Response display

11. Check that the Burst dB values in the AmpY/G, AmpPb/B, and AmpPr/R columns are between -0.92 dB (-10%) and $+0.82$ dB ($+10\%$).
12. Record the results in the test record.

Analog Pixmon Gain and Offset

This test uses an oscilloscope to check the active video gain and black (blanking) levels at the Pixmon output, for the YPbPr, RGB, and Composite modes.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the TG2000 DVG1 output to the waveform monitor SDI A input.
3. Select a 525 270 MB/s 100% color bar signal from the TG2000 DVG1.
4. Connect a VGA to 5x BNC adapter cable to the waveform monitor PIX MON output.

YPbPr.

5. Set the SD Alg PixMon to YPbPr:
 - a. Press the **CONFIG** button.
 - b. Select **Outputs, SD Anlg PixMon**, and then **YPbPr**.
6. Set the test oscilloscope to view the waveform. The following oscilloscope settings normally provide a usable display:

Control or Setting	Value
Vertical Scale	100 mV/div
Vertical Position	-3.5 div
Horizontal Scale	5 us/div
Horizontal Trigger Position	50%
Trigger Slope	Rising edge

Control or Setting	Value
Trigger Level	500 mV

7. Connect the Y/G channel of the VGA to 5x BNC adapter cable to the test oscilloscope.
8. Check that the Y waveform is $1 V_{p-p} \pm 5\%$, from sync tip to white level (first color bar).
9. Check that the blanking (black) level is $0 mV \pm 50 mV$.
10. Connect the Pb/B channel of the VGA to 5x BNC adapter cable to the test oscilloscope.
11. Check that the Pb waveform is $700 mV_{p-p} \pm 5\%$, from the blanking (black) level to the top of the waveform.
12. Check that the blanking (black) level is $0 mV \pm 50 mV$.
13. Connect the Pr/R channel of the VGA to 5x BNC adapter cable to the test oscilloscope.
14. Check that the Pr waveform is $700 mV_{p-p} \pm 5\%$, from the blanking (black) level to the top of the waveform.
15. Check that the blanking (black) level is $0 mV \pm 50 mV$.
16. Record Pass or Fail in the test record.

RGB.

17. Set the SD Alg PixMon to RGB by selecting **RGB** from the Outputs menu.
18. Connect the Y/G channel of the VGA to 5x BNC adapter cable to the test oscilloscope.
19. Check that the G waveform is $1 V_{p-p} \pm 5\%$, from sync tip to white level.
20. Check that the blanking (black) level is $0 mV \pm 50 mV$.
21. Connect the Pb/B channel of the VGA to 5x BNC adapter cable to the test oscilloscope.
22. Check that the B waveform is $700 mV_{p-p} \pm 5\%$, from the blanking (black) level to the top of the waveform.
23. Check that the blanking (black) level is $0 mV \pm 50 mV$.
24. Connect the Pr/R channel of the VGA to 5x BNC adapter cable to the test oscilloscope.
25. Check that the R waveform is $700 mV_{p-p} \pm 5\%$, from the blanking (black) level to the top of the waveform.
26. Check that the blanking (black) level is $0 mV \pm 50 mV$.
27. Record Pass or Fail in the test record.

Composite.

28. Connect the TG2000 AVG1 output to the waveform monitor CMPST A input, and terminate the loopthrough in 75Ω .
29. Select an NTSC 100% Color Bar from the AVG1.
30. Select **Composite PixMon** from the **Outputs** menu.
31. Press the right arrow key to highlight **On**.
32. Press the Input **C** button.
33. Connect the Y/G channel of the VGA to 5x BNC adapter cable to the test oscilloscope.
34. Check that the G waveform is $1 V_{p-p} \pm 5\%$, from sync tip to white.
35. Check that the blanking (black) level is $0 mV \pm 100 mV$.
36. Record Pass or Fail in the test record.

Serial Output Amplitude

This test verifies that the Serial Output is within specifications.

1. Connect the TG2000 DVG1 output to the SDI A input on the waveform monitor.
2. Set the DVG1 to provide a 525 270 Mb/s 100% color bar signal.
3. Press the Input A button.
4. Connect the waveform monitor SDI OUT to the oscilloscope CH 1 input. Make sure that the TCA75 is installed in CH 1.
5. Set the oscilloscope for the measurement. (See Table 65 on page 110.)

Table 65: Oscilloscope Settings for Serial Output Amplitude

Ch 1 Vertical	200 mV/Div
Horizontal	1.0 ns/Div
Trigger Mode Source Pulse Width Upper Limit Lower Limit Trigger Type Trigger if Width Polarity	CH 1 Inside 10.0 s 30.0 ns Width Occurs Pos
Acquisition Mode	FastAcq

6. Set the oscilloscope cursor 1 to the top of the displayed waveform.

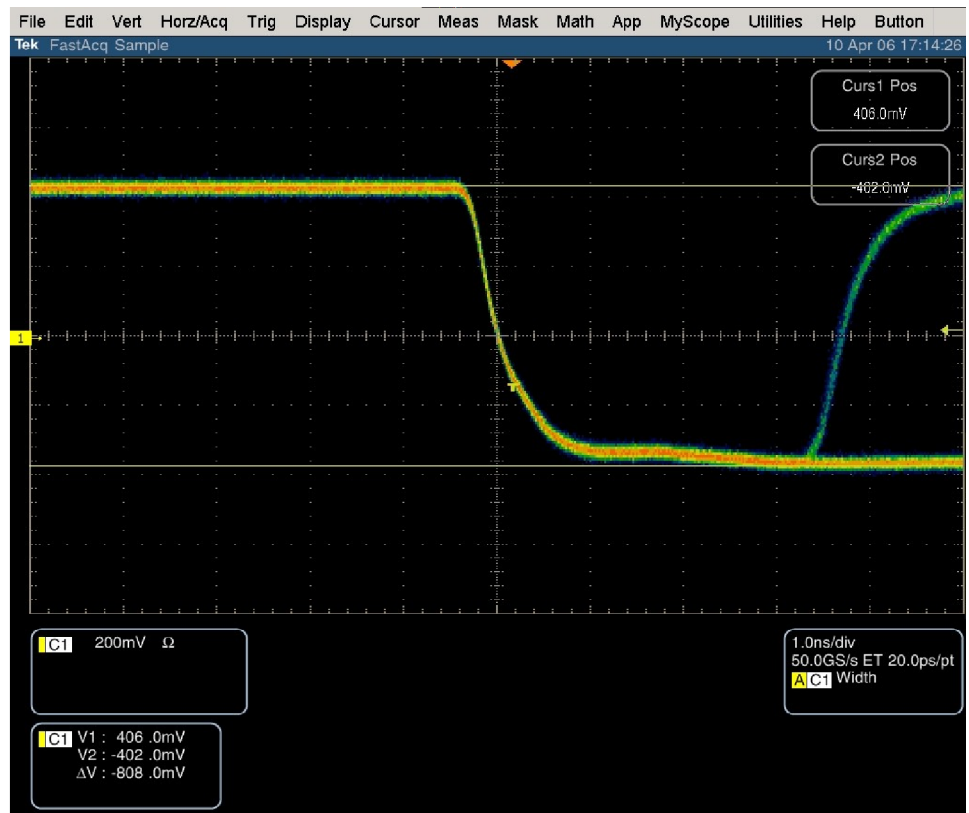


Figure 4: Trigger polarity positive

7. Change the oscilloscope trigger polarity to Neg.
8. Set the oscilloscope cursor 2 to the bottom of the displayed waveform. (See Figure 5.)
9. Record the amplitude (ΔV) in the test record.

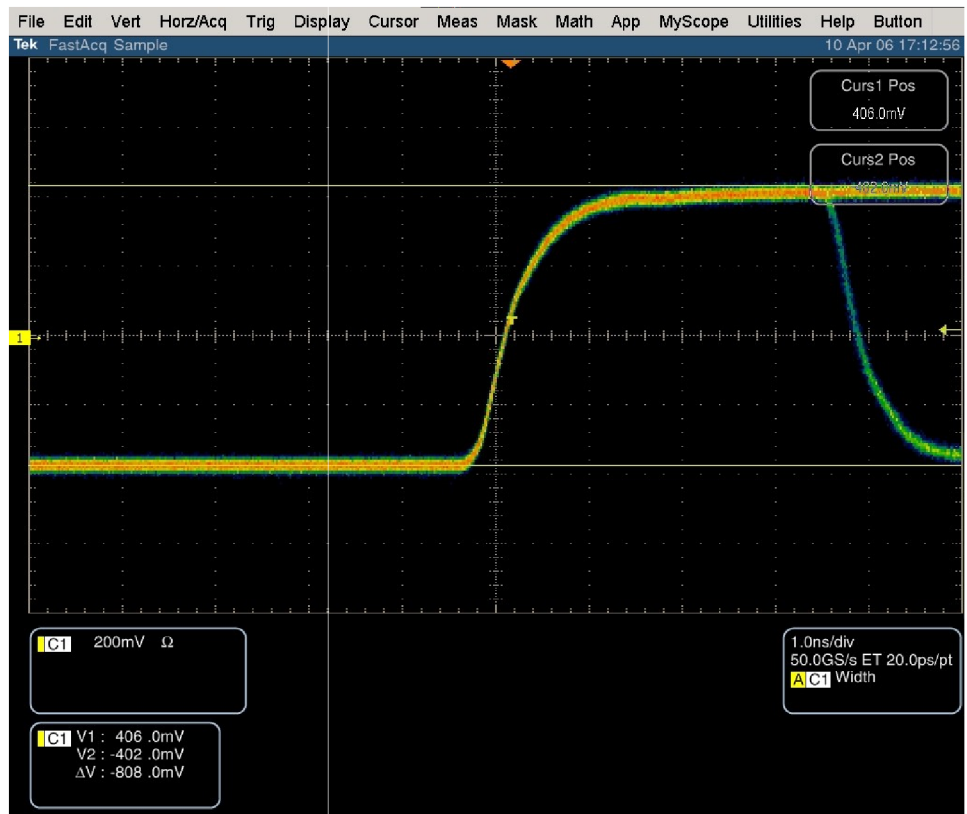


Figure 5: Trigger polarity negative

**SD VITC Decoding
Functionality**

Apply an SDI signal, that was converted from an NTSC signal, with VITC and verify the VITC is correctly decoded.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Route the NTSC signal from the AVG1 to the VITC encoder.
3. Connect the output of the VITC encoder to the NTSC to SDI converter.
4. Connect the SDI from the converter the SDI A input of the DUT.
5. Set the waveform monitor for VITC timecode:
 - a. Press the **CONFIG** button.
 - b. Select **AUX Data Settings**.
 - c. Select **Timecode Display Channel** and then **VITC**.
 - d. Press **CONFIG** to remove the menu.
6. Verify that a decoded VITC is displayed in the lower-right corner of the waveform monitor display.
7. Verify the VITC is correct and record Pass or Fail in the test record.

**SD Cable Meter (Options
EYE and PHY)**

This test uses a short (1-2 m) length of Belden 8281 cable and a long (100 m) length of Belden 8281 cable to check the Cable Meter. A cable clone may be used instead of the long cable.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Select the SDI Status display:
 - a. Press and hold the **STATUS** button.
 - b. Select **Display Type** and then **SDI Status**.
 - c. Press the **STATUS** button again to close the menu.
3. Using the short cable, connect a color bar signal from the DVG1 to the SDI A input on the waveform monitor.
4. Check that the cable length reading is between 0 m and 17 m.
5. Record the results in the test record.
6. Using the long cable, or the cable clone set to 100 m, connect a color bar signal from the DVG1 to the SDI A input on the waveform monitor.
7. Check that the cable length reading is between 76 m and 127 m.
8. Record the results in the test record.
9. Repeat steps 3 through 8 for the SDI B input.

**SD Equalized Eye Gain
(Options EYE and PHY)**

This test checks the amplitude of an internally generated eye signal.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the DVG1 to the waveform monitor SDI A input.
3. Press the **EYE** button.
4. Select the Equalized Eye signal:
 - a. Press the **CONFIG** button.
 - b. Select **Physical Layer Settings** and then **Eye Display Mode**.
 - c. Press the right arrow key to select **Equalized**.
 - d. Press the **CONFIG** button to close the configuration menu
5. Using the graticule, check that the waveform is 600 mV \pm 80 mV.
6. Record Pass or Fail in the test record.

**SD Jitter Noise Floor
(Options EYE and PHY)**

This test checks the jitter noise floor of the waveform monitor. Since some jitter may be introduced by the signal source, you may need to characterize the TG2000 output jitter with an oscilloscope. Most DVG1 generators have an output noise floor in the 200 ps range.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the TG2000 DVG1 upper (Clean) output to the SDI A input on the waveform monitor.
3. Select the 525 75% color bar signal from the DVG1.
4. Press the Input A button.
5. Press the **Display Select** button for the WFM display and press **FULL** to set the WFM tile to full screen.
6. Set the waveform monitor to the jitter display:
 - a. Press the **EYE** button to view the Eye display.
 - b. Press and hold the **EYE** button to display the menu.
 - c. Select **Display Type** and then **Jitter Display**.
7. Set the jitter high pass filter to 100 Hz:
 - a. Select **Jitter1 HP Filter** from the Eye menu.
 - b. Select **100 Hz**.
8. Set the vertical gain to x10:
 - a. Press and hold the **GAIN** button.
 - b. Select **Gain Settings** and then select **x10**.
9. Verify that the jitter trace is displayed and stable.
10. Using the graticule or the cursors, measure the jitter amplitude.
11. Check that the jitter amplitude is approximately 250 ps (0.068 UI), depending on the TG2000 output jitter.
12. Record Pass or Fail in the test record.

SD Jitter Readout Accuracy (Options EYE and PHY)

1. Set the waveform monitor to a four-tile display by pressing the **FULL** button.
2. Disconnect the TG2000 DVG1 Clean output from the waveform monitor, and connect the TG2000 DVG1 Opt S1 output (typically the 2nd output) to the SDI A input.
3. Press the **GAIN** button twice to set the Gain to **x1**.
4. Set the upper left tile to the Eye display:
 - a. Press the **Display Select 1** button.
 - b. Press the **EYE** button to view the Eye display.
 - c. Press and hold the **EYE** button to display the menu.

Tests for Instruments with Option CPS

Composite Analog Frequency Response (Option CPS)

Use Cursors to measure the reference, and the largest and smallest packets on a multi-burst signal. The greatest deviation from reference is the frequency response.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets*.)
2. Connect the precision video generator to one of the CMPST A input connectors and terminate the other connector with the precision terminator.
3. Set the precision generator for 700 mV Multiburst. This signal is provided on the User Documentation CD.
4. Press the **Input C** button.
5. Press the **FULL** button to make the WFM tile the full screen.
6. Adjust cursors to be near the top and zero portions of the waveform. Press the **CURSORS** button and use the **GENERAL** knob to adjust the **Volt1** or **Volt2** readouts. Use the arrow keys to select between them.
7. Press and hold the **GAIN** button, select **Gain Settings** and then **x5**.
8. Press the **GAIN** button to close the menu.
9. Adjust the lower cursor to align with the bottom of the reference step of the waveform.
10. Use the **Vertical** knob to move the top of the waveform to the 0 IRE graticule. The second cursor should also be near the zero graticule mark.
11. Use the **General** knob to adjust the upper cursor to align with the top of the reference step of the waveform.
12. Check the cursor delta readout of the magnitude of the reference step. Note this number. It should be near 98 IRE.
13. Next, adjust the upper cursor to align with the top of the largest packet of the waveform.
14. Use the **Vertical** knob to move the baseline of the waveform to the 0 IRE graticule. The other cursor should also be near the zero graticule mark.
15. Use the **General** knob to adjust the lower cursor to align with the bottom of the largest packet of the waveform.
16. Note the cursor delta value for the amplitude of the largest packet.
17. Adjust the lower cursor to align with the bottom of the smallest packet of the waveform.
18. Use the **Vertical** knob to adjust the vertical position to align the top of the waveform to the 0 IRE graticule.

19. Use the **General** knob to adjust the upper cursor to align with the top of the smallest packet of the waveform.
20. Note the cursor delta value for the amplitude of the smallest packet.
21. In the test record, record the deviation from reference that has the largest magnitude, either largest-reference or smallest-reference.

Adjust.. If the Frequency Response is outside the specification, press the **CONFIG** button, select **Calibration**, and then press the **SEL** button. Use the down arrow to navigate to **Composite Freq Peak**, and then follow the on-screen instructions to adjust the response. Follow the instructions at the bottom of the screen to Save and Exit calibration mode. Afterwards, repeat the above test for Analog Frequency Response and record the new value in the test record.

**Composite Analog Delay
Variation Over Frequency
(Group Delay) (Option
CPS)**

Use a 5.75 MHz 5T multi-pulse signal and cursors to measure group delay. This signal is provided on the User Documents CD.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the precision video generator to one of the CMPST A input connectors and terminate the other connector with the precision terminator.
3. Set the precision generator for 5.75 MHz multi-pulse. This is a custom test signal with more packets for better coverage.
4. Press the Input **C** button to select the Composite A input.
5. Press the **FULL** button to make the WFM tile the full screen display.
6. Press the **CURSORS** button to turn on the cursor controls.
7. Use the arrow keys to navigate to Volt1 and Volt2. Adjust the cursors to be near the zero portions of the waveform using the **GENERAL** knob.
8. Press and hold the **GAIN** button, select **Gain Settings**, and then select **x10**.
9. Press the **GAIN** button to close the menu.
10. Use the cursors to measure the peak-to-peak deviation in the baseline of the multipulse packets. Use the arrow keys to navigate between **Volt1** and **Volt2** and use the **GENERAL** knob to adjust them.
11. The peak-to-peak deviation of the baseline is 0.1% per ns. For example, for a 10 ns deviation on a 100 IRE signal yields a deviation of 1 IRE. Record the measured value in the test record.

Composite Analog Pulse to Bar Ratio (Option CPS)

Apply a pulse and bar signal and use cursors to measure the difference between the two.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the precision video generator to one of the CMPST A input connectors and terminate the other connector with the precision terminator.
3. Set the precision generator for a 2T Pulse and Bar.
4. Press the Input C button to select the Composite A input.
5. Press the **FULL** button to make the WFM tile the full screen display.
6. Press the **CURSORS** button to turn on the cursor controls.
7. Use the arrow keys to navigate between **Volt1** and **Volt2** and adjust the cursors to be near the top portions of the waveform. Use the **GENERAL** knob to adjust them.
8. Use the vertical knob to move the top of the waveform to the zero graticule.
9. Press and hold the **GAIN** button, select **Gain Settings**, and then **x10**.
10. Press the **GAIN** button to close the menu.
11. Place one cursor on the top of the “Bar.” Use the **GENERAL** knob to adjust **Volt1** in the WFM tile.
12. Use the horizontal knob to put the “pulse” on the dotted line at the center of the screen.
13. Press and hold the **MAG** button and select **x50** to expand the pulse horizontally.
14. Press the **MAG** button to close the menu.
15. Position the second cursor on the top of the pulse. Select **Volt2** using the arrow keys and use the **GENERAL** knob to adjust it.
16. Record the cursor delta in the test record.

**Composite Analog Field
Rate Tilt (Option CPS)**

Apply a field rate square wave and use cursors to measure the tilt.

1. Set the waveform monitor to the factory presets. (See page 60, *Incoming Inspection Tests*.)
2. Connect the precision video generator to one of the CMPST A input connectors and terminate the other connector with the precision terminator.
3. Set the precision generator for Field Square Wave.
4. Press the **Input C** button to select the Composite A input.
5. Press the **FULL** button to make the WFM tile the full screen display.
6. Press the **CURSORS** button to turn on the cursor controls.
7. Use the arrow keys to select **Volt1** and **Volt2** and adjust the cursors to be near the top of the waveform using the **GENERAL** knob.
8. Use the vertical knob to move the top of the waveform to the zero graticule.
9. Press and hold the **GAIN** button, select Gain Settings, and then select **x5**.
10. Press the **GAIN** button to close the menu.
11. Press the **LINE SEL** button use the left and right arrow keys to select **ALL**.
12. Use the **GENERAL** knob to set the line select to a line number between 72 and 202.
13. Use the arrow keys to select **Volt1** and **Volt2** and use cursors to measure the tilt in the waveform using the **GENERAL** knob to adjust them.
14. Record the value in the test record.

**Composite Analog Line
Rate tilt (Option CPS)**

Apply a field rate square wave and use cursors to measure the tilt.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the precision video generator to one of the CMPST A input connectors and terminate the other connector with the precision terminator.
3. Set the precision generator for 100% Flat Field.
4. Press the Input C button to select the Composite A input.
5. Press the **FULL** button to make the WFM tile the full screen display.
6. Press the **CURSORS** button to turn on the cursor controls.
7. Use the arrow keys to select **Volt1** or **Volt2** and adjust cursors to be near the top of the waveform using the **GENERAL** knob.
8. Use the **VERTICAL** position knob to move the top of the waveform to the zero graticule.
9. Press and hold the **GAIN** button, select **Gain Settings**, and then select **x5**.
10. Press the **GAIN** button to close the menu.
11. Use the cursors to measure the tilt in the waveform, excluding the first and last 5 μ s of the bar.
12. Record the value in the test record.

**Composite Analog Input
DC Offset Restore Off
(Option CPS)**

Measure the displayed offset when the input is not driven and DC Restore is off.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Apply an NTSC signal from the AVG1 output to the CMPST A input of the waveform monitor. Terminate the other CMPST A input with a precision termination.
3. Terminate one side of the Composite B input with a precision termination.
4. Switch DC Restore off:
 - a. Press the **CONFIG** button.
 - b. Select **Composite Input, DC Restore**, and then select **Off**.
5. Press the Input **C** button to select the Composite A input
6. Press the **FULL** button to make the WFM tile the full screen display.
7. Press the Input **D** button to select the Composite B input.
8. Press and hold the **GAIN** button, select **Gain Settings**, and then select **x5**.
9. Press the **GAIN** button to close the menu.
10. Press the **CURSORS** button to turn on the cursor controls.
11. Set the cursor to the center of the flat-line waveform. Note the waveform offset indicated by the cursor readout.
12. Connect the NTSC signal from the AVG1 output to the Composite B input.
13. Press the Input **C** button to select the Composite A input.
14. Set the cursor to the center of the flat-line waveform. Note the waveform offset indicated by the cursor readout.
15. Record the larger of the two waveform offset values in the test record.

Adjust. If the Offset is outside the specification, press the **CONFIG** button, select **Calibration**, and then press the **SEL** button. Use the down arrow to navigate to **Composite** and follow the on-screen instructions to automatically adjust the offset. Follow the instructions at the bottom of the screen to Save and Exit calibration mode. Afterwards, repeat the above test for and record the new value in the test record.

**Composite Analog Input
Clamp Off Check (Option
CPS)**

Apply a small DC voltage and verify it is not clamped to zero.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Disconnect all cables and terminators from the Composite inputs.
3. Connect a cable from a CMPST A input connector to the retractable hook clip.
4. Switch DC Restore off:
 - a. Press the **CONFIG** button.
 - b. Select **Composite Input, DC Restore**, and then select **Off**.
5. Press the **Input C** button to select the Composite A input.
6. Press the **FULL** button to make the WFM tile the full screen display.
7. Press the **Input C** button.
8. Press and hold the **GAIN** button.
9. Select **VAR Gain** and press the right arrow key to select **Enable**.
10. Press the **GAIN** button to close the menu.
11. Use the **GENERAL** knob to reduce the gain to 0.5X.
12. Hold the hook tips on a battery (D, C, or AA), red to positive, black to negative.
13. Verify that the waveform is offset up by about 1.5 volts and is not being clamped to ground.
14. Record Pass or Fail in the test record.

**Composite Analog
Input DC Restore Hum
Attenuation (Option CPS)**

Apply hum, then measure the attenuation with clamp in all three modes.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect an NTSC color bar signal to the video input of the AVC1. Route the video output of the AVC1 (not the precision video output) to the CMPST A input of the waveform monitor, and terminate the loopthrough in 75 Ω .
3. Press the **Input C** button.
4. Press the **FULL** button to make the WFM tile the full screen display.
5. Set the AVC1 for 0 dB of 60 Hz hum.
6. Press and hold the **SWEEP** button and select **2F**. If you cannot get 2 field, make sure the display style is set to Overlay (press and hold the WFM button and select Overlay).
7. Select input and switch DC Restore off:

- a. Press the **CONFIG** button.
 - b. Select **Composite Input, DC Restore**, and then select **Off**.
 - c. Press the **CONFIG** button to close the menu.
8. Press the **CURSORS** button to turn on the cursor controls.
9. Use the arrow keys to select **Volt1** or **Volt2** and measure the peak-to-peak hum with the cursors. Use the **GENERAL** knob to adjust them. The measurement should be about 100 IRE. Record Pass or Fail in the test record.
10. Switch DC Restore to Fast:
 - a. Press the **CONFIG** button.
 - b. Select **Composite Input, DC Restore**, and then select **Fast**.
11. Press and hold the **GAIN** button, select **GAIN Settings** and then **x10**. Then select **VAR Gain**, press the right arrow key to highlight **Enable**, and use the **GENERAL** knob to adjust the gain to **x4.00**.
12. Use the arrow keys to select **Volt1** or **Volt2** and measure the peak-to-peak hum with the cursors. Use the **GENERAL** knob to adjust them. The measurement should be less than 5% of the measurement in step 9 (less than ~5 IRE).
13. Record the value in the test record.
14. Press and hold the **GAIN** button, select **Gain Settings**, and then select **x2**.
15. Select **VAR Gain**, press the right arrow key to highlight **Enable**, and use the **GENERAL** knob to adjust the gain to **x1.25**.
16. Switch DC Restore to Slow:
 - a. Press the **CONFIG** button.
 - b. Select **Composite Input, DC Restore**, and then select **Slow**.
17. Measure the peak-to-peak hum with the cursors. Touch the **Volt1** or **Volt2** touchable readout in the WFM tile and use the **GENERAL** knob to adjust them. It should be between 90% and 110% of the measurement in step 9.
18. Record the value in the test record.

**Composite Analog Vertical
Measurement Accuracy
(Option CPS)**

Use 100% white and cursors to measure gain.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the precision video generator to one of the CMPST A input connectors and terminate the other connector with the precision terminator.
3. Set the Precision generator for a 100% Flat Field.
4. Press the Input C button to select the Composite A input.
5. Press the **FULL** button to make the WFM tile the full screen display.
6. Press the **CURSOR** button.
7. Use the arrow keys to select **Volt1** or **Volt2**. Use the **GENERAL** knob to adjust the cursors to be near the top and zero portions of the waveform.
8. Press and hold the **GAIN** button, select **Gain Settings**, and then select.
9. Position the lower cursor on to the backporch of the waveform.
10. Press and hold the **GAIN** button, select **Gain Settings**, and then **x2** and adjust the vertical position to locate the top of the waveform at the 0 mV graticule. The second cursor should also be near the zero graticule.
11. Position the upper cursor to be centered on the top of the waveform.
12. Cursor delta displays the magnitude of the waveform. It should be within 1% of nominal 714.86 mV. Record the amplitude in the test record.

**External Reference Lock
Range (Option CPS)**

Vary the time base of the reference to measure lock range.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Connect the TG2000 AVG1 to one of the CMPST A inputs, and loop the other CMPST A input to the Ref input. Terminate the other side of the Reference loop through.
3. Press the Input C button to select the Composite A input.
4. Press the **EXT REF** button to activate external reference mode.
5. Adjust the AVG1 time base offset to -50 ppm. Confirm the VECTOR and WFM displays are stable and that the readout in the upper-left corner of the display does not indicate an unlocked signal. (It is normal for the system to momentarily lose lock when the time base is changed.)
6. Increase the negative time base offset until the system cannot sustain lock. Record the maximum offset capability in the test record.
7. Repeat steps 5 and 6 for positive time base offsets.

**VITC Decoding
Functionality (Option
CPS)**

Apply an NTSC signal with VITC and verify the VITC is correctly decoded.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. Route the NTSC signal from the AVG1 to the VITC encoder.
3. Connect the output of the VITC encoder to one of the CMPST A input connectors and terminate the other connector.
4. Press the Input C button to select the Composite A input.
5. Press the FULL button to make the WFM tile the full screen display.
6. Set the timecode source to VITC:
 - a. Press the CONFIG button.
 - b. Select **Aux Data Settings**.
 - c. Select **Timecode Display**.
 - d. Select **VITC**.
7. Verify that Decoded VITC is displayed in the lower-right corner of the waveform monitor display.
8. Verify that the VITC is correct and record Pass or Fail in the test record.

Signal Source Characterization for Eye Signal Bandwidth

Measuring eye signal bandwidth requires a 75 Ω RF sine wave signal source that can be connected to the 75 Ω BNC input, and is either characterized or automatically leveled. The results of characterization must be applied at each measurement frequency, either by adjusting the generator level setting, or by applying a correction to the amplitude reading from the unit under test.

The method described here uses a 50 Ω generator, 50 to 75 Ω min loss pad, and appropriate adapters and cables to connect to the 75 Ω female BNC input of the unit under test. The exact sequence of adapters, min-loss pad, and cables is not critical as long as correct impedance is maintained in each section, and as long as the complete setup is used exactly as characterized when measuring Eye bandwidth.

The absolute signal level should be chosen to give between 750 and 850 mV_{p-p} at the reference frequency, as viewed on the unit under test when in Eye BW check mode. With a setup consisting of a 50 Ω generator, a 5.7 dB min loss pad and appropriate adapters and cables, a base generator setting of 6.3 dBm normally gives this result.

Characterization Process

Characterize the test setup as follows to give a table of level setting vs frequency setting for the signal source, resulting in constant signal level at the connection point to the unit under test.

1. Connect the generator and the required converter, adapters, and cables to the wideband power detector.
2. Set the generator to the reference frequency, 100 MHz, and the base level, typically 6.3 dBm.
3. Enter '100 MHz' into the power meter, to apply the appropriate internal correction.
4. Record the measured power level as the reference level, in the following table.
5. For each frequency listed, adjust the generator level for a reading closest to the reference level from step 4. Be sure to enter the frequency into the power meter at each step so that it applies the appropriate internal correction.

Table 66: Generator Characterization

Frequency setting (MHz)	Level setting	Frequency setting (MHz)	Level setting
100 (Reference Level)	6.3 dBm ¹	1600	
200		1700	
300		1800	
400		1900	
500		2000	
600		2100	
700		2200	
800		2300	
900		2400	
1000		2500	
1100		2600	
1200		2700	
1300		2800	
1400		2900	
1500		3000	

¹ 6.3 dBm is a typical level, and may be different depending on your setup.

Audio Performance Verification Procedures

Required Equipment

Table 67: Required Test Equipment (Audio)

SDI serial digital video test generator with embedded audio	Generates the following signals:	Tektronix TG2000 with the following modules:
	WFM7120/WFM7020 with option HD: 1080i 59.94 100% color bars with two or more groups of embedded audio	HDVG1 module for TG2000
	All instruments with SD: 525/270 100% color bars with two or more groups of embedded audio	DVG1 module for TG2000
Sine wave generator	Capable of 0.8 Vp-p at 6 MHz into a 50 Ω load	Rohde & Schwarz SMT03 Opt. SM-B2
Test Oscilloscope	Amplitude measurements of a 6 Mhz sine wave	Tektronix TDS7404B
Analog/Digital audio generator/analyzer	35 kHz to 96 kHz sample rate range, jitter measurement per AES-3 (1997)	Rohde & Schwarz UPL06 Opt B22, B29
Precision 75 Ω -to-50 Ω adapter	1.5% impedance and attenuation accuracy	Tektronix AMT75
75 Ω coaxial cables (2 required)	General purpose digital video Male-to-male BNC connectors 3' long	Belden 8281
50 Ω coaxial cables (2 required)	Male-to-male BNC connectors 36 inches long	Tektronix part number 012-0482-00
75 Ω terminator	Male connector	Tektronix part number: 011-0055-02
Audio test cable	1/4 inch phono to 2 XLR	Sound Professionals SP-XLRM-MINI-1 with adapter SP-PHONE-MINI-ST
Audio breakout cable	DB62 to XLR I/O required for Audio Options AD and DDE	Tektronix part number 012-1688-00
Calculator	Logarithmic function	
Dolby (R) digital audio generator	Generates Dolby D and Dolby E bit streams Required for Option DDE	Dolby Laboratories DM100

The following tests verify that the Audio module for the WFM6120, WFM7020, and WFM7120 waveform monitors meets the warranted characteristics listed in the Specifications chapter. Characteristics with typical specifications (not warranted) are also checked with pass/fail criteria.

Tests for Waveform Monitors Equipped with Audio Options

The tests in this section apply to instruments with Audio options installed. The tests will note when tests or their steps apply only to specific audio options; otherwise, they apply to all the audio options.

AES Sample Rate Range

This test verifies that each AES input locks to an input signal.

Typical Operation Check. This test checks for typical operation. Typical values are not guaranteed characteristics and are listed in the test record as pass / fail.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. If the audio display is not selected, press the **Display Select 4** button.
3. Connect the digital audio generator unbalanced (UNBAL) output to the AES A 1-2 In BNC connector using a 75 Ω cable.
4. Set the digital audio generator as follows:

Control or Setting	Value
Frequency	1 kHz
Output Level	-20 dB FS Audio Tone
Sample Frequency	96 kHz

Control or Setting	Value
Unbalanced $V_{p,p}$	1.000 V (Carrier Level)

5. Select the AES A input:
 - a. Press and hold the **AUDIO** button, select Audio Input, and then select **AES A**.
 - b. Press the **AUDIO** button to close the menu.
6. Press the **FULL** button to make the audio tile the full screen display.
7. Check for an indication of -20 dB FS and no error messages in the corresponding bars, and record Pass or Fail in the test record.
8. Move the audio generator output to each of the remaining AES A In connectors and repeat step 7 for each connector.
9. Set the digital audio generator Sample Frequency to 35 kHz.
10. Check for an indication of -20 dB FS and no error messages in the corresponding bars, and record Pass or Fail in the test record.
11. Move the audio generator output to each of the remaining AES A In connectors and repeat step 10 for each connector.
12. Disconnect the test setup.

AES Output Amplitude

This test verifies the amplitude of each AES output.

Performance Requirement. The AES output amplitude test verifies performance characteristics and is listed in the test record.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets*.) This sets **Audio Input** to **Follow Video, Embedded**.
2. If the audio tile is not selected, press the Display Select 4 button.
3. Select the AES B output:
 - a. Press the **CONFIG** button.
 - b. Select **Audio Inputs/Output**, then select **AES B**.
 - c. Select **Configure port as** and press the right arrow key to highlight **Output**.
 - d. Press the **CONFIG** button to close the menu.
4. Connect a 525/270 color bars signal from a DVG1 module to the SDI A input of the instrument under test.
5. Set the generator for embedded audio in 2 groups starting with group 1. Audio settings in the TG2000 are accessed as follows:
 - a. Press Modules.
 - b. Select the appropriate module icon, HDVG1 or DVG1.
 - c. Press Test Signals.
 - d. Select Module Parameters.
 - e. Select Embedded Audio, and make sure Audio is on.
6. Check that "PPPP PPPP — —" is displayed in the lower right area of the status bar, indicating the presence of two groups of embedded audio.

NOTE. *If the status bar indicates that embedded audio is not present, set the number of groups to 2 for the TG2000 module, even if it appears to be set to 2 already.*

7. Connect the AES B 1-2 I/O output to the 75 Ω input of the test oscilloscope using a 75 Ω cable. Use a 75 Ω -to-50 Ω adapter on the input of the test oscilloscope if necessary.
8. Set the test oscilloscope to view the signal. The following oscilloscope settings normally provide a usable display.

Control or Setting	Value
Vertical Scale	200 mV/div
Horizontal Scale	100 ns/div
Horizontal Trigger Position	30%
Trigger Slope	Rising edge

Control or Setting	Value
Trigger Level	0 mV

9. Check that the amplitude of the waveform displayed on the oscilloscope is between 0.9 V and 1.1 V and record the value in the test record.
10. Move the cable to each of the remaining AES B I/O connectors and repeat step 9.
11. Disconnect the test setup.

AES Output Jitter

This test measures jitter at each AES output.

Typical Operation Check. This test checks for typical operation. Typical values are not guaranteed characteristics and are listed in the test record as pass / fail.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. If the audio tile is not selected, press the Display Select 4 button.
3. Select the AES B output:
 - a. Press the **CONFIG** button.
 - b. Select **Audio Inputs/Outputs**.
 - c. Select **Configure port as** and press the right arrow key to highlight **Output**.
 - d. Press the **CONFIG** button to close the menu.
4. Connect a 525/270 color bars signal from a DVG1 module to the SDI A input of the instrument under test.
5. Set the generator for embedded audio in 2 groups starting with group 1. Audio settings in the TG2000 are accessed as follows:
 - a. Press **Modules**.
 - b. Select the appropriate module icon, HDVG1 or DVG1.
 - c. Press **Test Signals**.
 - d. Select **Module Parameters**.
 - e. Select **Embedded Audio**, and make sure Audio is on.
6. Check that "PPPP PPPP — —" is displayed in the upper right area of the status bar, indicating presence of two groups of embedded audio.

NOTE. *If status bar indicates that embedded audio is not present, set the number of groups to 2 for the TG2000 module, even if it appears to be set to 2 already.*

7. Connect the AES B 1-2 I/O connector to the digital audio analyzer unbalanced (UNBAL) input using a 75 Ω cable.
8. Set the audio analyzer for measurement of jitter per AES3-1992 (or 1997). To configure the R&S UPL06 Opt B22, B29 for jitter measurement:
 - a. Press ANLR to display and configure the analyzer screen.
 - b. Use the up/down arrow keys, keypad, and SELECT button to set the parameters in the ANALYZER panel as follows:

Control or Setting	Value
INSTRUMENT	DIGITAL
Meas Mode	JITTER/PHAS
Input	UNBAL (BNC)

Control or Setting	Value
Jitter Ref	48.0 (PLL)
START COND	AUTO
Delay	0.0000s
INPUT/PHAS	OFF
FREQ/PHAS	OFF
FUNCTION -	PEAK & S/N
Meas Mode	PK abs
Intv Time	0.5000s
Unit	s
Reference	GEN TRACK
Filter	JITTER wtd
SPEAKER -	OFF

9. Allow the jitter reading to settle for a few seconds.
10. Check for a typical Jitter Peak absolute reading of less than 3.5 ns over an interval of at least 5 seconds, and record Pass or Fail in the test record.
11. Move the cable to each of the remaining AES B I/O connectors and repeat steps 9 and 10 for each AES B I/O connector.
12. Disconnect the test setup.

AES Audio Level Meter Accuracy Over Frequency

This test measures AES level meter accuracy over the audio frequency range.

Typical Operation Check. This test checks for typical operation. Typical values are not guaranteed characteristics and are listed in the test record as pass / fail.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. If the audio tile is not selected, press the Display Select 4 button.
3. Set the digital audio generator as follows:

Control or Setting	Value
Sample Frequency	48 kHz
Output Level	-6 dB FS Audio Tone
Frequency	100 Hz

4. Select the AES A input:
 - a. Press and hold the **AUDIO** button, select **Audio Input**, and then select **AES A**.
 - b. Press the **AUDIO** button to close the menu.
5. Connect the digital audio generator unbalanced (UNBAL) output to the AES A 1-2 In connector using a 75 Ω cable.
6. Check for an indication of -6 dB FS 0.2 dB in the corresponding bars and record Pass or Fail in the test record.
7. Move the audio generator output to each of the remaining AES A In connectors and repeat step 6 for each connector.
8. Set the digital audio generator as follows:

Control or Setting	Value
Sample Frequency	48 kHz
Output Level	-6 dB FS Audio Tone
Frequency	1 kHz

9. Repeat steps 5 through 7.
10. Set the digital audio generator as follows:

Control or Setting	Value
Sample Frequency	48 kHz
Output Level	-6 dB FS Audio Tone
Frequency	19 kHz

11. Repeat steps 5 through 7.
12. Disconnect the test setup.

Headphone Output Level This test measures the output level accuracy of the headphones.

Performance Requirement. This test verifies performance characteristics and is listed in the test record.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*)
2. If the audio tile is not selected, press the Display Select **4** button.
3. Set the digital audio generator as follows:

Control or Setting	Value
Sample Frequency	48 kHz
Output Level	-6 dB FS Sine
Frequency	100 Hz

4. Set the parameters in the ANALYZER panel as follows:

Control or Setting	Value
INSTRUMENT	ANLG 22 kHz
Min Freq	10 Hz
Ref Imped	100000 W
Channel	1
Ch1 Coupl	AC
Ch1 Input	BAL
Ch1 Imped	200 kΩ
Ch1 Common	FLOAT
Ch1 Range	AUTO
START COND	AUTO
Delay	0.0000 s
INPUT DISP	OFF
FUNCTION	RMS & S/N
S/N Sequ	OFF
Meas Time	AUTO
Unit Ch1	DBu
Reference	VALUE: 1.0000 V
Sweep Mode	NORMAL
Notch (Gain)	OFF
Filter	OFF
Filter	OFF

Control or Setting	Value
Filter	OFF

5. Press and hold the **AUDIO** button, select **Audio Input**, and then select **AES A**.
6. Press the **AUDIO** button to close the menu.
7. Connect the digital audio generator unbalanced (UNBAL) output to the waveform monitor AES A IN 1-2 connector, using a 75 Ω cable.
8. Verify that the numbers 1,2 are visible under the headphone icon, in the audio tile.
9. Set the headphone output volume to maximum by turning the **Horz** (VOLUME) knob clockwise.
10. Connect the 1/4I male phono connector from the headphone test cable to the waveform monitor headphone jack.
11. Connect the XLR corresponding to the ‘Left’ channel to the analyzer balanced (BAL) analog input.
12. Check for 0.25 dBu ±1 dB RMS on the analog analyzer. Record the result in the test record.
13. Connect the XLR corresponding to the ‘Right’ channel to the analyzer balanced (BAL) analog input.
14. Check for 0.25 dBu ±1 dB RMS on the analog analyzer. Record the result in the test record.
15. Set the digital audio generator as follows:

Control or Setting	Value
Sample Frequency	48 kHz
Output Level	-6 dB FS Audio Tone
Frequency	1 kHz

16. Repeat steps 9 through 12.
17. Set the digital audio generator as follows:

Control or Setting	Value
Sample Frequency	48 kHz
Output Level	-6 dB FS Audio Tone
Frequency	19 kHz

18. Repeat steps 9 through 12.

Additional Tests for Instruments Equipped with Options AD and DDE

Analog Audio Level Meter Accuracy Over Frequency

This test measures the Analog Input Level Meter Accuracy over the audio frequency range.

Performance Requirement. This test verifies performance characteristics and is listed in the test record.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*) Press the Display Select **4** button.
2. Press the **FULL** button to make the audio tile the full screen display.
3. Select the Analog A input:
 - a. Press and hold the **AUDIO** button, select **Audio Input**, and then select **Analog A**.
 - b. Press the **AUDIO** button to close the menu.
4. Install the audio breakout cable to the Analog Audio I/O connector.
5. Connect the generator balanced (BAL) analog output to the Input A1 XLR connector of the breakout cable.
6. Set the audio generator as follows:

Control or Setting	Value
Channel	2=1
Frequency	100 Hz
Output Level	18 dBu audio tone
Output Impedance	10 Ω

7. Check for an indication of 18 dBu ± 0.5 dB in the corresponding bar and record the value in the test record.
8. Change analog audio generator Frequency to 1 kHz.
9. Check for an indication of 18 dBu ± 0.5 dB in the corresponding bar and record the value in the test record.
10. Change analog audio generator Frequency to 19 kHz.
11. Check for an indication of 18 dBu ± 0.5 dB in the corresponding bar, and record the value in the test record.
12. Repeat steps 6 through 11 for each of the other five Input A XLR connectors in the breakout cable.
13. Select the Analog B input:
 - a. Press and hold the **AUDIO** button, select **Audio Input**, and then select **Analog B**.
 - b. Press the **AUDIO** button to close the menu.

14. Repeat steps 5 through 12 for the Input B XLR connectors on the audio breakout cable.

If any of the Analog A Inputs failed to meet the specification, (or even if they are off by more than a few tenths of a dB) an input adjustment can be performed.

15. To perform an analog input adjust, follow steps 16 through 20; otherwise skip to step 21.
16. Set the analog audio generator as follows:

Control or Setting	Value
Frequency	1 kHz
Output Level	18 dBu Audio Tone
Output Impedance	10 Ω

17. Connect the generator balanced (BAL) analog output to the Analog A input that requires adjustment.
18. Access the Calibration routine by pressing the **CONFIG** button, selecting **Utilities**, and then **Calibration**.
- Press the **SEL** button.
 - Use the down arrow key to navigate to **Analog Audio Channel**.
 - After the calibration process finishes, follow the directions on the screen and press the **STATUS** button to save and exit Calibration.
19. Check for an indication of -18 dBu in the newly adjusted audio bar.
20. If multiple inputs require adjustment, repeat steps 17 through 19 for each input.
21. Disconnect the test setup.

Digital Input to Analog Output Gain Accuracy Over Frequency

This test measures the Analog Output level meter accuracy over the audio frequency range, when using an AES or embedded input as the audio source.

Performance Requirement. This test verifies performance characteristics and is listed in the test record.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*) If the audio tile is not selected, press the Display Select 4 button.
2. Set the generator to Digital.
3. Set the Audio Output Attenuation to 0 dB:
 - a. Press and hold the **AUDIO** button.
 - b. Select **Analog Out Atten.**
 - c. Press the right arrow button to select the attenuation setting.
 - d. Use the **GENERAL** knob to set the attenuation to **0 dB**.
 - e. Press the **AUDIO** button to close the menu.
4. Map Bar 1,2 to all Analog Audio Outputs:
 - a. Press the **CONFIG** button.
 - b. Select **Audio Inputs/Outputs.**
 - c. Select **AES A, Analog Output Map**, and then press the **SEL** button.
 - d. Use the arrow keys to navigate to the **Analog 1,2; Analog 3,4; Analog 5,6; and Analog 7,8** boxes across from **Bars 1,2**.
 - e. Press the **SEL** key to place a check mark in those boxes.
 - f. When finished, navigate to the **Return** box and press the **SEL** button to exit the mapping menu.
5. Set the audio Input to AES A:
 - a. Press and hold the **AUDIO** button, select **Audio Input**, and then select **AES A**.
 - b. Press the **AUDIO** button to close the menu.
6. Install the audio breakout cable on the Analog Audio I/O connector.
7. Set the analog audio analyzer to measure RMS level in dBu, and for an input impedance of 200 k Ω . This is done on the Rohde & Schwarz UPL06 as follows:
 - a. Press ANLR to display and configure the ANALYZER panel.
 - b. Set the parameters in the ANALYZER panel as follows:

Control or Setting	Value
INSTRUMENT	ANLG 22 kHz
Min Freq	10 Hz
Ref Imped	100000 W
Channel	1

Control or Setting	Value
Ch1 Coupl	AC
Ch1 Input	BAL
Ch1 Imped	200 k Ω
Ch1 Common	FLOAT
Ch1 Range	AUTO
START COND	AUTO
Delay	0.0000 s
INPUT DISP	OFF
FUNCTION	RMS & S/N
S/N Sequ	OFF
Meas Time	AUTO
Unit Ch1	DBu
Unit Ch2	DBu
Reference	VALUE: 1.0000 V
Notch (Gain)	OFF
Filter	OFF
Filter	OFF
Filter	OFF

8. Connect the Rohde & Schwarz UPL06 Opt B22, B29 digital generator unbalanced (UNBAL) output to the AES A 1-2 In BNC using a 75 Ω cable.
9. Set the digital audio generator for a -6 dBFs, 100 Hz audio tone at 48 kHz sample rate. This is done on the Rohde & Schwarz UPL06 as follows:
 - a. Press GEN to display and configure the GENERATOR panel.
 - b. Set the parameters in the GENERATOR panel as follows:

Control or Setting	Value
INSTRUMENT	DIGITAL
Channel	2 = 1
Unbal Out	AUDIO OUT
Cable Sim	OFF
Sync To	GEN CLK
Sample Freq	48 kHz
Sync Out	GEN CLK
Type	WORD CLK
Ref Out	REF GEN

Control or Setting	Value
Data	ALL ZERO
Audio Bits	24
Unbal Vpp	1.0000 V
Bal Vpp	4.0000 V
Max Volt	1.0000 FS
Ref Freq	1000.0 Hz
Ref Volt	1.0000 FS
PROTOCOL	STATIC
Ch Stat. L	FILE + CRC
Filename	R&S_AES3.PGC
Ch Stat. R	EQUAL L
AUX GEN	OFF
FUNCTION -	SINE
Frq Offset	OFF
DC Offset	OFF
Dither	OFF
Equalizer	OFF
SWEEP CTRL	OFF
FREQUENCY	100.0 Hz
VOLTAGE	0.5000 FS

10. Connect the Output 1 XLR of the breakout cable to the analyzer balanced (BAL) analog input.
11. Check for an indication of 18 dBu \pm 0.5dB on the analog analyzer and record the result in the test record.
12. Change the digital audio generator FREQUENCY to 1000 Hz.
13. Check for an indication of 18 dBu \pm 0.5dB on the analog analyzer and record the result in the test record.
14. Change the digital audio generator FREQUENCY to 19000 Hz.
15. Check for an indication of 18 dBu \pm 0.5dB on the analog analyzer and record the result in the test record.
16. Repeat steps 8 through 15 for each of the other Output XLR connectors.
17. Disconnect the test setup.

Analog Input to Analog Output Gain Accuracy Over Frequency

This test measures the Analog Audio Output level accuracy over the audio frequency range, when using an Analog Input as the audio source.

Typical Operation Check. This test checks for typical operation. Typical values are not guaranteed characteristics and are listed in the test record as pass/fail.

1. Set the waveform monitor to the factory presets. (See page 60, *Restore the Factory Presets.*) If the audio tile is not selected, press the Display Select 4 button.
2. Set the Audio Output Attenuation to 0 dB:
 - a. Press and hold the **AUDIO** button.
 - b. Select **Analog Out Atten**, and press the SEL button.
 - c. Use the **GENERAL** knob to set the attenuation to 0 dB.
 - d. Press the **AUDIO** button to close the menu.
3. Map Bar 1,2 to all Analog Audio Outputs:
 - a. Press the **CONFIG** button.
 - b. Select **Audio Inputs/Outputs**.
 - c. Select **Analog A, Analog Output Map**, and then press the **SEL** button.
 - d. Use the arrow keys to navigate to the **Analog 1,2; Analog 3,4; Analog 5,6; and Analog 7,8** boxes across from **Bars 1,2**.
 - e. Press the **SEL** key to place a check mark in those boxes.
 - f. When finished, navigate to the **Return** box and press the **SEL** button to exit the mapping menu.
4. Set the Audio Input to Analog Audio A:
 - a. Press and hold the **Audio** button.
 - b. Select **Audio Inputs/Outputs**, then select **Analog A**.
 - c. Press the **Audio** button to close the menu.
5. Set the analog audio generator as follows:

Control or Setting	Value
Frequency	100 Hz
Output Level	18 dBu
Output Impedance	10 Ω

6. Connect the audio break out cable to the Analog Audio I/O connector.
7. Connect the generator balanced (BAL) analog output to the Input A1 XLR of the breakout cable.

8. Check for an indication of 18 dBu in the corresponding bar.
9. Connect the Output 1 XLR of the breakout cable to the analyzer balanced (BAL) analog input.
10. Check for an RMS indication of 18 dBu 1.0 dB on the analog analyzer, and record Pass or Fail in the test record.
11. Repeat step 10 for Output 3, Output 5 and Output 7.
12. Connect the generator balanced (BAL) analog output to the Input A2 XLR of the breakout cable.
13. Check for an indication of 18 dBu in the corresponding bar.
14. Connect the Output 2 XLR of the breakout cable to the analyzer balanced (BAL) analog input.
15. Check for an RMS indication of 18 dBu 1.0 dB on the analog analyzer, and record Pass or Fail in the test record.
16. Repeat step 15 for Output 4, Output 6, and Output 8.
17. Set the analog audio generator as follows:

Control or Setting	Value
Frequency	1 kHz
Output Level	18 dBu
Output Impedance	10 Ω

18. Connect the generator balanced (BAL) analog output to the Input A1 XLR of the breakout cable.
19. Check for an indication 18 dbu in the corresponding bar.
20. Connect the Output 1 XLR of the breakout cable to the analyzer balanced (BAL) analog input.
21. Check for an RMS indication of 18 dBu 1.0 dB on the analog analyzer and record Pass or Fail the result in the test record.
22. Repeat step 21 for Output 3, Output 5, and Output 7.
23. Connect the generator balanced (BAL) analog output to the Input A2 XLR of the breakout cable.
24. Check for an indication of 18 dBu in the corresponding bar.
25. Connect the Output 2 XLR of the breakout cable to the analyzer balanced (BAL) analog input.
26. Check for an RMS indication of 18 dBu 1.0 dB on the analog analyzer and record Pass or Fail in the test record.
27. Repeat step 26 for Output 4, Output 6, and Output 8.

28. Set the analog audio generator as follows:

Control or Setting	Value
Frequency	19 kHz
Output Level	18 dBu Audio Tone
Output Impedance	10 Ω

29. Connect the generator balanced (BAL) analog output to the Input A1 XLR of the breakout cable.

30. Check for an indication of 18 dbu in the corresponding bar.

31. Connect the Output 1 XLR of the breakout cable to the analyzer balanced (BAL) analog input.

32. Check for an RMS indication of 18 dBu 1.0 dB on the analog analyzer and record Pass or Fail in the test record.

33. Repeat step 32 for Output 3, Output 5, and Output 7.

34. Connect the generator balanced (BAL) analog output to the Input A2 XLR of the breakout cable.

35. Check for an indication of 18 dbu in the corresponding bar.

36. Connect the Output 2 XLR of the breakout cable to the analyzer balanced (BAL) analog input.

37. Check for an RMS indication of 18 dBu 1.0 dB on the analog analyzer, and record Pass or Fail in the test record.

38. Repeat step 37 for Output 4, Output 6, and Output 8.

This completes the Performance Verification procedures.