User Manual

Tektronix

WFM700HD, WFM700A, & WFM700M Waveform Monitors

071-0916-05

This document applies to firmware version 2.2.X.

www.tektronix.com

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

WARRANTY

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

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

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

THIS WARRANTY IS GIVEN BY TEKTRONIX IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

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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.

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

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

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

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

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

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

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

Symbols and Terms

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

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

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

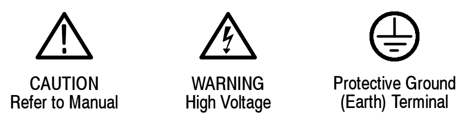
Terms on the Product. These terms may appear on the product:

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

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

CAUTION indicates a hazard to property including the product.

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



Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect Power. To avoid electric shock, switch off the instrument power, then disconnect the power cord from the mains power.

Use Care When Servicing With Power On. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Preface

This manual describes configuring and using the WFM700HD, WFM700A, and WFM700M multi-format, multi-standard waveform monitors.

Contents of This Manual

This manual consists of the following sections:

Getting Started briefly describes the capabilities of the waveform monitor. This section also includes the accessories list, the installation procedure for portable cabinet or rack, and the functional check.

Operating Basics discusses the operation of the user interface and describes the measurements, setups, displays, and reporting capabilities.

Reference provides details of how to perform video and audio measurement tasks, including those tasks specific to the Option DG audio module.

Appendix A: Specifications lists the performance specifications and environmental operating limits.

Appendix B: Supported Video Standards lists the signal formats that are supported. This section includes a table of compatible combinations of input signal formats and reference formats.

Appendix C: Remote Control describes how to use the ground-closure interface to provide remote notification of enabled alarms and how to use the Web Server interface to remotely control the instrument.

Appendix D: User Service describes instrument maintenance that can be performed by the user.

Appendix E: Firmware Upgrade describes how to install a new version of firmware in your instrument.

Appendix F: Cabinet and Rack Adapter Installation desribes how to install or remove the instrument from the WFM7F02 portable cabinet, the WFM7F03 plain cabinet, and the WFM7F05 rack adapter.

Appendix G: Module Installation describes how to install or remove an input module. These instructions are for qualified service personnel only.

Index provides page number references to topics in alphabetical order.

Related User Documents

The following related user documents are available:

- *WFM700 Release Notes* (Tektronix part number 061-4247-XX). This document describes new features provided by a firmware release and also describes problems or behaviors that you might encounter while using the waveform monitor. This document is provided as a standard accessory when you order a new instrument. If you upgrade your instrument firmware from the Tektronix, Inc. Web site, an updated version of this document is provided.
- *WFM700 Service Manual* (Tektronix part number 071-0915-XX). This document provides servicing information for qualified service personnel.

Related Reference Documents

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

- *Preventing Illegal Colors*. This application note describes how the Diamond, Arrowhead, and Lightning displays on the waveform monitor 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 on the waveform monitor can be used to help prevent the undesired impact of color gamut violations.
- *A Guide to Standard and High Definition Digital 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.

Contacting Tektronix

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

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

Getting Started

Getting Started

This section contains a list of accessories, an installation procedure, and a functional check to verify the primary functions of your waveform monitor. For instrument specifications, refer to *Appendix A: Specifications*.

Product Description

The WFM700 waveform monitor is designed to meet the multi-format monitoring and measurement needs of digital video for program production, post-production, and transmission. For a complete list of supported video input formats, refer to *Appendix B: Supported Video Standards*.

The WFM700 waveform monitor combines the features of traditional waveform monitors with the advantages of digital technology. Digital processing provides accuracy and repeatability of measurements.

The waveform monitor can be configured for different applications within a TV facility. Feature enhancements can be achieved by installing additional modules or by downloading software.

The waveform monitor has three base models:

- WFM700HD. Monitors high-definition (SMPTE 292M) video.
- WFM700A. Monitors standard-definition (ITU–R BT.601) and high-definition (SMPTE 292M) video.
- WFM700M. Measurement instrument for standard-definition (ITU–R BT.601), high-definition (SMPTE 292M), and hybrid serial digital operations.

Each waveform monitor includes:

- External Reference module
- One video module (with two inputs)

At the time of purchase or at a later date, you can add an additional video module and/or the optional AES audio module (Option DG) to any of the three base-model waveform monitors.

Platform Features

The waveform monitor platform provides the following features:

- Field-upgradable, modular platform accommodates SD (ITU-R BT.601) and HD (SMPTE 292M) standards in one product (refer to *Appendix B: Supported Video Standards* for a table of supported formats)
- Exclusive Diamond, Split Diamond, and Arrowhead displays offer unique insight into the gamut compliance of your video content
- Multi-mode display saves time and improves monitoring efficiency by providing two different measurement displays of the same input signal
- Fully digital signal processing for accurate, repeatable, and stable measurements
- Comprehensive error detection, reporting, and logging provide the capability to support signal monitoring, content QA, and service-level verification
- Fully configurable alarms with user-selectable thresholds allow you to select the level of monitoring required for your application
- Up to four video inputs (two inputs on each video module, up to two video modules allowed)
- Expansion slot available for adding optional modules
- TFT color LCD display, with integrated touch screen control
- Picture monitor and VGA display outputs
- Remote interface for access and control from any location
- Print function allows you to print the Diagnostic Log, the Event Log, and the instrument display to LPD-protocol printers on your network
- Available Eye Pattern and Jitter displays for both SD and HD video signals
- Available AES/EBU digital audio monitoring

Features by Module Type

The WFM700HD, WFM700A, and WFM700M provide specific features, as listed below. Also included is a list of features for the Option DG audio module.

WFM700HD

The WFM700HD monitors the high-definition digital signal path. The HD formats monitored are shown in *Appendix B: Supported Video Standards*. The WFM700 waveform monitor includes:

- Two terminating inputs for SMPTE 292M serial digital video
- Auto detection of input format
- Selectable colorimetry
- Integrated TFT color LCD display with touch screen
- VGA output that replicates the integrated display
- Picture monitor output, selectable RGB, YPbPr, with bright-up
- Picture monitor output for computer display (RGB H & V sync)
- Looping inputs for bi-level and tri-level sync reference
- Auto detection of external reference input format
- Waveform parade and overlay displays, RGB, YRGB, YPbPr, and composite display of component input
- Line select
- Component Vector display
- Lightning display for use with color difference signals
- Diamond display for RGB domain gamut limits
- Arrowhead display for NTSC/PAL composite domain gamut limits
- Freeze mode for comparing input signal levels
- Detection of embedded audio channels
- Error detection and reporting per SMPTE RP-165 for standard definition and SMPTE 292M for high definition
- Electronic graticules
- Digital timing and voltage cursors
- User-definable presets

- Alarms with adjustable thresholds
- One switched output, follows selected input (serial digital out)
- Thumbnail picture available on Waveform, Vector, Gamut, and Data displays
- Closed caption detection

WFM700A The WFM700A monitor includes all the features of the WFM700HD, with the added capability of monitoring ITU-R BT.601.

WFM700M The WFM700M monitor includes all the features of the WFM700A, plus:

- Data value waveform
- Eye pattern display of the selected input signal
- Eye pattern timing cursors
- Eye pattern voltage cursors
- Logic analyzer data word listing for detailed pixel analysis
- Jitter demodulator with numeric jitter readout and video correlated jitter waveform display

WFM7DG The Option DG audio module provides the following additional features to the WFM700HD, WFM700A, and WFM700M monitors:

- Monitoring of up to eight channels of embedded AES/EBU digital audio from any two audio groups of the selected video input
- Four AES/EBU inputs which can monitor up to eight channels of non-embedded AES/EBU digital-audio input or can supply up to eight channels of de-embedded, digital-audio output from one of the video inputs
- Support for multi-channel digital audio for surround and stereo pair signal formats
- Level Bar display of eight audio channels with true peak, PPM, and extended VU meter ballistics and adjustable scaling
- Lissajous display showing the phase relationships of the two signals on the selected channel pair, with X/Y or soundstage (L/R) axis orientation and optional automatic gain control (AGC)
- Single axis, phase correlation meter showing the phase relationship between signals on an audio channel pair

Options

You can order any of the following instrument options with your waveform monitor. Some of these instrument options are also available separately as optional accessories (refer to page 1-8).

Cabinets

Two cabinet options are available:

- Option 01. Adds the WFM7F02 Portable Cabinet, which is a portable carrying case with handle and feet. The front feet flip down to form a stand and the cabinet includes a protective cover for the front of the instrument. You can also order this cabinet as an optional accessory.
- Option 02. Adds the WFM7F05 Rack Adapter, which is a dual side-by-side adapter for installing your half-rack monitors in a rack. This adapter uses two types of sleeves: WFM7F00 and 1700F00A.

  The WFM7F00 sleeve is for the WFM700 waveform monitor only. The 1700F00A sleeve is for the following Tektronix half-rack instruments: 1700 Series, WFM601 Series, WFM300 Series, 760 Series, 1420 Series, 528A, and 764.

  You must select one of the following sleeve options when you order the WFM7F05 adapter:

  - WFM7F05 Option NN. Includes two WFM7F00 sleeves.
  - WFM7F05 Option ON. Includes one 1700F00A sleeve and one WFM7F00 sleeve. You can install either sleeve in either side of the WFM7F05 rack adapter.
  - Other WFM7F05 Options. You can also install a sleeve in one side of the WFM7F05 rack adapter and a blank panel (1700F06) or an accessory drawer (1700F07) in the other side to improve airflow and appearance.

CAUTION. *Do not install the WFM700 waveform monitor into the 1700F00, 1700F02, or 1700F05 cabinets. Attempting to do so can damage the waveform monitor and the cabinet. Only the WFM7F00, WFM7F02, WFM7F03, and WFM7F05 cabinets are designed to provide proper airflow to the WFM700 waveform monitor.*

Additional Inputs

You can add a video module to increase the number of inputs on a unit to four. You can have a maximum of two video modules in any one unit; you can mix them any way you want.

You can add any of the following video or audio modules to a unit:

- Option 2HD. Adds the WFM7HD, which is a second video module for serial digital monitoring (SMPTE 292 M).
- Option 2A. Adds the WFM7A, which is a second video module for serial digital monitoring (ITU-RBT.601 and SMPTE 292M).
- Option 2M. Adds the WFM7M, which is a second video module for serial digital measurement (ITU-R BT.601 and SMPTE 292M).
- Option DG. Adds the WFM7DG, which is an AES audio module for digital audio measurements.

Services

You can order the following services:

- Option R3. Extends the instrument warranty to 3 years.
- Option C3. Provides calibration services for 3 years.
- Option D1. Provides test data.
- Option D3. Provides test data for 3 years.

Power Cord Options

Table 1–1 on page 1–7 lists the available power cords.

Standard Accessories

The following accessories are shipped with each waveform monitor:

Documents

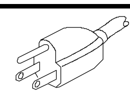
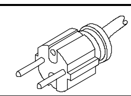
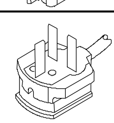
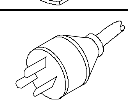
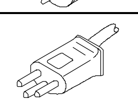
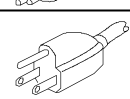
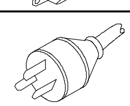
The following documents are standard accessories:

- *WFM700 User Manual*, Tektronix part number 071-0916-XX.
- *WFM700 Release Notes*, Tektronix part number 061-4247-XX.

Power Cords

All WFM700 waveform monitors are shipped with one of the following power cord options. Power cords for use in North America are UL listed and CSA certified. Cords for use in areas other than North America are approved by at least one authority acceptable in the country to which the product is shipped.

Table 1-1: Power cord options and identification

Plug configuration	Normal usage	Option number	Tektronix part number
	North America 120 V	Standard	161-0216-00
	Universal Euro	A1	161-0215-00
	United Kingdom	A2	161-0066-10
	Australia	A3	161-0066-11
	Switzerland	A5	161-0154-00
	Japan	A6	161-A005-00
	China	AC	161-0304-00
	No power cord supplied.	A99	------

Optional Accessories

You can order any of the following optional accessories to use with your waveform monitor. These can also be ordered as instrument options when you order a waveform monitor (refer to page 1–5).

Additional Inputs

You can add a second video module to increase the number of video inputs on an instrument to four. You can have a maximum of two video modules in any one unit, but you can mix them any way you want. In addition to the video modules, you can add an AES audio module.

You can add any of the following video or audio modules to a unit:

- WFM7HD. Serial digital video monitor module for HD (included in the WFM700HD).
- WFM7A. Serial digital video monitor module for SD and HD (included in the WFM700A).
- WFM7M. Serial digital video measurement module for SD and HD (included in the WFM700M).
- WFM7DG. AES digital audio measurement module.

Cabinets

You can order one of these cabinets (installation instructions are in *Appendix F*):

- WFM7F02 Portable Cabinet. Portable carrying case with handle and feet. The front feet flip down to form a stand. This cabinet includes a protective cover for the front of the instrument. You can also order this cabinet as Option 01 when you order the waveform monitor.
- WFM7F03 Plain Cabinet. Plain cabinet without any feet or carrying handle.
- WFM7F05 Rack Adapter. Dual side-by-side adapter for installing your half-rack monitors in a rack. This adapter uses two types of sleeves, one for the waveform monitor and one for other half-rack instruments. You can configure the adapter with any combination of two half-rack-width monitors. Refer to *Cabinets* on page 1–5 for a list of WFM7F05 options. You can also order this adapter as Option 02 when you order the waveform monitor.

CAUTION. *Do not install the WFM700 waveform monitor into the 1700F00, 1700F02, or 1700F05 cabinets. Attempting to do so can damage the waveform monitor and the cabinet. Only the WFM7F00, WFM7F02, WFM7F03, and WFM7F05 cabinets are designed to provide proper airflow to the WFM700 waveform monitor.*

Documents

The following documents are optional accessories:

- *WFM700 Service Manual*, Tektronix part number 071-0915-XX.

  The optional service manual includes procedures for qualified service personnel to verify that the instrument is operating within specifications and to troubleshoot the instrument to the module level.

- Japanese language *WFM700 User Manual*, Tektronix part number 071-1174-XX.

Installation and Power On

This section contains information about installing and powering on the waveform monitor.

Instructions for performing firmware upgrades are located in *Appendix E*.

Instructions for installing or removing the waveform monitor from the WFM7F02 portable cabinet, the WFM7F03 plain cabinet, or the WFM7F05 rack adapter are located in *Appendix F*.

Instructions for adding or removing a module are located in *Appendix G*.

Hardware Installation

When you unpack the waveform monitor, save the shipping carton and packing materials in case you need to ship the instrument. Packing instructions are on page 1–16.

The waveform monitor is shipped in a wrap-around chassis (see Figure 1–1) that covers the instrument bottom and two sides. A cover is installed on the chassis, and the rear panel is made up of the module rear panels.

You can operate the waveform monitor in the instrument chassis (be sure the cover is on) or installed in an approved portable cabinet (WFM7F02) or rack adapter (WFM7F05). You can also install the waveform monitor in a custom installation, such as a console.

CAUTION. *Do not install the waveform monitor in any cabinet except those that are listed in* Optional Accessories *on page 1–8. Attempting to do so can damage the waveform monitor and the cabinet.*

Allowing Airflow

If you install the waveform monitor in a custom application, such as a console, be sure to provide adequate airflow. Follow these guidelines:

- Do not block the ventilating holes shown in Figure 1-1.
- Adhere to the clearance requirements listed in Table A-35 on page A-22.

CAUTION. *Failure to provide adequate airflow to the waveform monitor could cause the instrument to shut down (refer to Table 2-1 on page 2-4 for LED fault codes). If the airflow is blocked and the instrument does not shut down, it could result in serious instrument damage.*

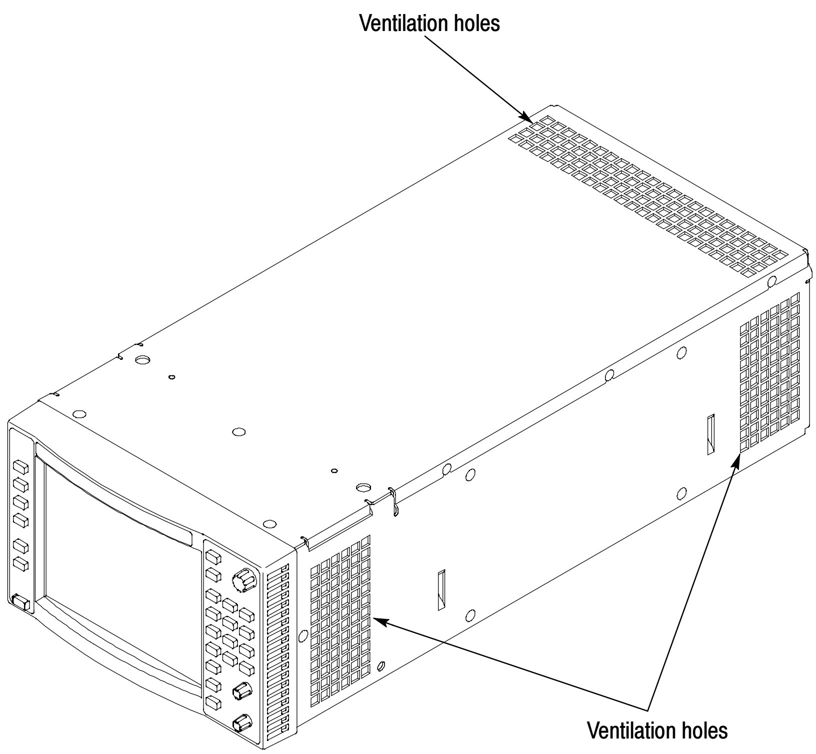


Figure 1-1: Waveform monitor chassis

WFM7F02 Portable Cabinet

You can install your waveform monitor into a WFM7F02 Portable Cabinet, shown in Figure 1–2. The WFM7F02 has a handle and four feet. The two rear feet are stationary and the two front feet flip down to provide a stand. A protective front cover is also provided. Instructions for installing the portable cabinet are located in *Appendix F*.

CAUTION. *Do not install the waveform monitor into the traditional 1700F02 Portable Cabinet, because it does not provide the correct ventilation. Additionally, there are keying pins to exclude this application.*

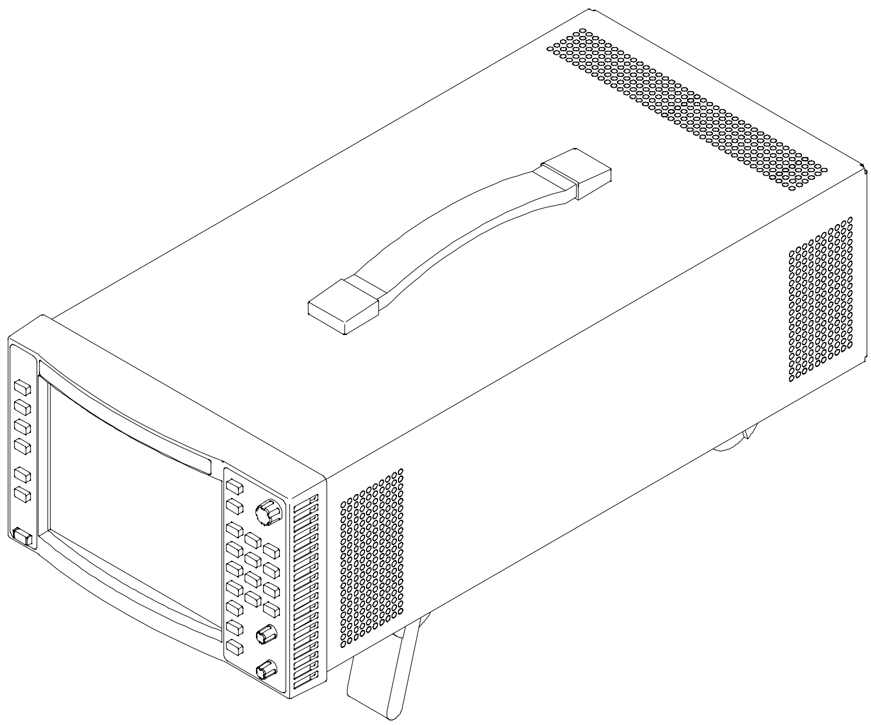


Figure 1-2: WFM7F02 portable cabinet

WFM7F03 Plain Cabinet

The WFM7F03 Plain Cabinet is designed to house any of the 1/2 rack-width, WFM700 waveform monitors. The cabinet does not have any feet, carrying handle, or protective front cover. Instructions for installing the cabinet are located in *Appendix F*.

WFM7F05 Rack Adapter

You can use the WFM7F05 side-by-side rack adapter, shown in Figure 1-3, to install the waveform monitor and another half-rack width instrument into a rack. You can also install a drawer or blank panel in the unused side of the rack adapter. Instructions for installing the rack adapter are in *Appendix F*.

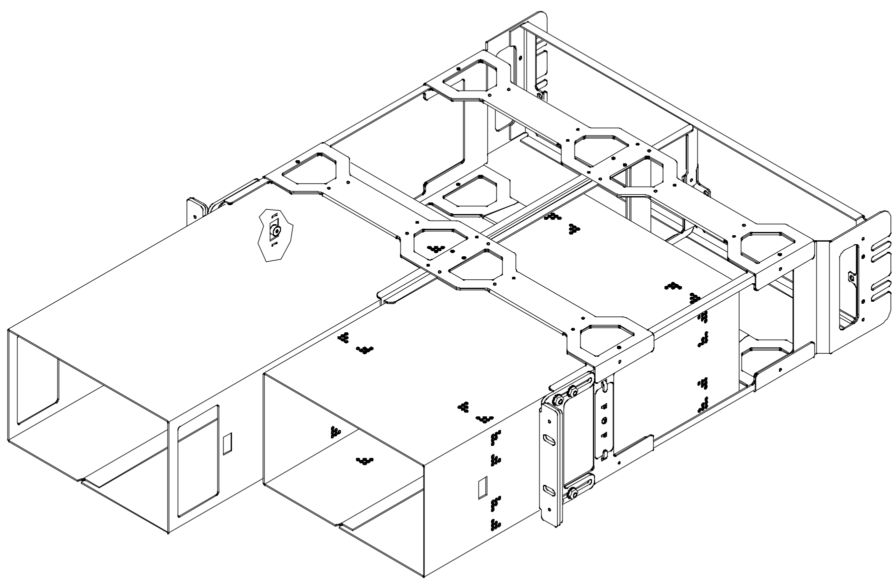


Figure 1-3: WFM7F05 rack adapter

Connecting Power

The waveform monitor operates from a single-phase power source with the neutral conductor at or near earth ground. The line conductor is fused for over-current protection. A protective ground connection through the grounding conductor in the power cord is essential for safe operation.

WARNING. *When power is supplied via the power cord, line voltage will be present inside the waveform monitor, even if the unit is in standby mode.*

AC Power Requirements

The waveform monitor operates from an AC line frequency of 50 or 60 Hz, over the range of 100–240 Volts, without the need for configuration, except the power cord. Refer to page 1–7 for the power cord options.

The typical power consumption is 100 W with one video module installed and 125 W with two video modules installed. Power consumption increases by a negligible amount when there is an Option DG audio module installed. Refer to *Appendix A: Specifications* for additional information on power and environmental requirements.

CAUTION. *Use only power cords that are approved for the country of use. Using non-approved power cords could result in fire or shock hazard.*

Powering On the Instrument

Follow these steps to power on the waveform monitor:

1. Plug the supplied power cord (IEC 320) into the back of the instrument. Refer to page 1–7 for a list of power cord options.
2. Plug the other end of the power cord into a standard wall outlet.
3. Press the ON/STBY button to bring the waveform monitor out of standby mode.

Packaging for Shipment

To ship the waveform monitor to a Tektronix Service Center for service, follow these instructions:

1. Contact Tektronix (see page xvii) to get an RMA and other instructions.
2. Attach a tag to the waveform monitor showing the name of the owner, the complete address, the phone number, the instrument serial number and a description of the required service.
3. Repackage the instrument in the original packaging materials. If the original packaging materials are not available, follow these instructions:
   a. Obtain a carton of corrugated cardboard having inside dimensions at least six inches greater than the dimensions of the instrument. Use a shipping carton that has a test strength of at least 275 pounds.
   b. Surround the instrument with a protective bag (anti-static preferred). For instruments that are not in a cabinet, wrap a cardboard piece around the bagged instrument to protect internal components.
   c. Pack dunnage or urethane foam between the instrument and the carton. If using Styrofoam kernels, overfill the box and compress when closing the lid. You need three inches of cushioning on all sides of the instrument.
4. Seal the carton with shipping tape or industrial staples.

Functional Check

The procedures in this section provide a basic operational check of the waveform monitor. Measurement quantities or specifications are not checked in this procedure. These procedures do not require you to remove the cover from the instrument.

WARNING. *To avoid personal injury, do not operate the waveform monitor with the chassis cover removed.*

If the Functional Check procedure reveals improper operation or an instrument malfunction, check the connections and the operation of the test equipment. If test equipment is operating normally and the failure is repeatable, contact qualified service personnel or Tektronix for repair or adjustment.

For a complete check of instrument performance to specifications, refer qualified service personnel to the Performance Verification procedure in the *WFM700 Service Manual*.

The functional check of the instrument is divided into the following procedures:

- *First Video Module Functional Check* is the procedure you should use to verify the overall basic operation of the instrument. Also included are procedures for checking the first video module installed in slot 2 of the instrument (see Figure G–1 on page G–2). The last step of this procedure checks the LCD display.
- *Second Video Module Functional Check* is an abbreviated version of the first video procedure and starts on page 1–33. In this procedure, you perform only the steps that are directly related to testing the video module and not the whole instrument system.
- *Audio Module Functional Check (Option DG Only)* is the procedure you should use to verify the operation of the optional audio module. This procedure starts on page 1–34.

If your instrument has two video modules and an audio module installed, you need to perform all three procedures to fully check the instrument.

Required Equipment

Listed below is the equipment you will need to verify the performance of the instrument.

Video Module

The following equipment is required to verify the basic performance of the instrument and the video module(s):

- Television Signal Generator with analog, digital SD, and digital HD capabilities.
  For example: Tektronix TG2000 Signal Generation Platform with AVG1, DVG1, and HDVG1 modules installed.
- Test signals: SD and HD color bar signal, HD and SD 10 bit shallow ramp matrix, HD or SD 0% flat field and 100% flat field signals
- VGA monitor
- 75 Ω terminator
- High quality 75 Ω BNC cables (3)

The following equipment can be used to test all outputs of the instrument while performing this procedure:

- HD CAV picture monitor
- SD serial digital picture monitor
- SD CAV picture monitor

Audio Module

The following equipment is required to verify the basic performance of the optional audio module:

- Television Signal Generator that is capable of providing serial SD with embedded audio and serial HD with embedded audio.
  For example: Tektronix TG2000 Signal Generation Platform with DVG1, and HDVG1 modules installed.
- AES Audio Signal Generator with 48 kHz, 24-bit word length signals.
  For example: Rohde & Schwarz UPL06; Tektronix AM70 and AM700.
- Oscilloscope
- 75 Ω terminator
- High quality 75 Ω BNC cables (3)

First Video Module Functional Check

Perform the following procedure to verify the overall basic operation of the instrument. Also included are procedures for checking the first video module installed in slot 2 of the instrument (see Figure G–1 on page G–2). The last step of this procedure checks the LCD display.

Verify the Type of the Video Module

1. Power on the instrument, and check the fans and installed modules:

a. Press the ON/STBY button to power on the waveform monitor. Check that the fans spin up. All front-panel lights except the Fault light should come on momentarily.

b. After about 20 seconds, the splash screen appears. This screen reports the status of the boot process and lists the installed modules. Check that the reported modules match the actual installed modules. Check that there are no fatal errors.

***NOTE**. Some of the steps in this procedure can be omitted depending on the type of video module you are testing: WFM7A, WFM7HD, or WFM7M.*

2. Verify the type of the first video module installed in the instrument:

a. Press the Help button. Touch the System Info soft key, and then touch the Installed Options soft key.

b. The display lists the type of module contained in each of the instrument slots. The type of module installed for video inputs 1A and 1B is shown in the Acq. 1 row, and the type of module installed for video inputs 2A and 2B is shown in the Acq. 2 row.

Initial Equipment Setup

3. For WFM7A and WFM7M modules only: Use the SD module of the test signal generator (for the TG2000 generator, use the DVG1 module). Connect an output signal to the rear-panel INPUT A on the waveform monitor module you will be checking (you can have up to two modules installed in the waveform monitor). Set the generator for a 525 format, 100% color bar signal with embedded audio and EDH enabled.

4. For WFM7HD, WFM7A, and WFM7M modules: Use the HD module of the test signal generator (for the TG2000 generator, use the HDVG1 module). Connect an output signal to INPUT B on the waveform monitor. Set the generator for a 1080i format, 100% color bar signal with embedded audio and CRC enabled.

Functional Checks

5. Check touch panel calibration:

a. Press the CONFIG button to open the Configure menu. You can change configuration settings in this step because you will return to default menu settings in step 6.

b. Touch the soft keys down the left side of the screen. Check that you are able to select each soft key and that the appropriate submenu appears on the right side of the screen.

c. Touch the General Alarms soft key on the left side of the screen.

d. Touch the Next Menu soft key.

e. Touch the buttons in the displayed table and check that you can select and deselect the buttons.

f. Press the CONFIG button or touch the Top Menu soft key to return to the top level of the Configure menu.

6. Restore factory presets:

a. Press the PRESET button. The Preset menu appears across the bottom of the screen.

b. Touch the soft key labeled –more– 1 of 2.

c. Touch the soft key labeled Restore Factory. This returns the instrument state to the factory settings.

7. For WFM7HD modules only: Change to active input:

a. Press the INPUT button.

b. Touch the soft key to select the B input of the module you are checking (either 1B or 2B).

c. Check that the HD color bar signal is displayed.

8. Check waveform signal and format:

a. Press the WFM button.

b. Check for the appropriate waveform display.

c. Check that the format readout for the input is:
WFM7A and WFM7M modules: 270Mb/s 525i 59.94
WFM7HD modules: 1.4835Gb/s 1080i 59.94

9. Verify VGA output:

a. Connect the waveform monitor EXT VGA output to the VGA monitor.

b. Verify that the image on the waveform monitor is the same as the image on the VGA monitor.

10. Check vector mode:

a. Press the VECTOR button to enter the vector mode.

b. Check for the appropriate vector display.

11. Check picture mode:

a. Press the PICTURE button to enter the picture mode.

b. Check for the appropriate picture display.

12. Check gamut mode:

a. Press the GAMUT button to enter the gamut mode.

b. Check for the appropriate gamut display.

13. For instruments without Option DG: Check audio mode:

NOTE*. For instruments with the Option DG audio module, skip this step and perform the* Audio Module Functional Check (Option DG Only) *procedure starting on page 1-34 after you finish checking the video module(s).*

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a. Press the AUDIO button to enter the audio mode.

b. Check the status of the audio channels. Verify that the correct channels are being detected.

14. Check audio de-embedding for HD:

a. Select the HD color bar signal from the generator.

b. Turn on the Embedded Audio. (For the TG2000 generator, from the signal select window, select Module Parameters and then select the Embedded Audio folder.)

c. Set the Number of Groups Enabled to 2.

d. Set the Starting Group to 1.

e. Press the STATUS button on the waveform monitor.

f. Touch the Audio/Video Session soft key.

g. Option DG only: Touch the Session soft key if necessary to select Video Session.

h. Check that the Embedded Audio status reads as follows:
Embedded Audio: PPPP PPPP – – – – – – – –

15. For WFM7A and WFM7M modules only: Check audio de-embedding for SD:

a. Select the SD color bar signal from the generator.

b. Turn on the Embedded Audio. (For the TG2000 generator, from the signal select window, select Module Parameters and then select Embedded Audio folder.)

c. Set the Number of Groups Enabled to 2.

d. Set the Starting Group to 1.

e. Press the STATUS button on the waveform monitor.

f. Touch the Audio/Video Session soft key.

g. Option DG only: Touch the Session soft key if necessary to select Video Session.

h. Check that the Embedded Audio status reads as follows:
Embedded Audio: PPPP PPPP – – – – – – – –

16. Check to see that there are no errors on EDH status.

17. For WFM7M modules only: Check eye and jitter modes:

a. Press the EYE button. It may take a few seconds before a stable eye display appears.

b. Check for a clean, stable eye signal.

c. Touch the Jitter soft key.

d. Check for a nominal trace. This will typically be a flat line unless you have jitter added to the generator signal.

e. Press the WFM button to clear the EYE mode.

18. Check knob operation:

a. Press the WFM button.

b. Turn the VERT POS and HORIZ POS knobs.

c. Check that the controls move the waveform horizontally and vertically.

d. Press the CONFIG button.

e. Turn the general purpose knob and check that it scrolls through the displayed menu options.

f. Check that all three front-panel knobs have about the same drag and feel; one knob should not be stiff if another knob is loose.

g. Press the CONFIG button again to exit the Configure menu.

19. Check vertical gain operation:

a. Press the GAIN button.

b. Touch the X5 soft key and check that the signal magnifies properly.

c. Touch the X10 soft key and check that the signal magnifies properly.

d. Touch the Var. Gain soft key. Turn the general-purpose knob and check for smooth control of the variable gain.

e. Touch the X1 soft key. Check that the gain is reduced by a factor of 10. Note that variable gain is still active.

f. Touch the Var. Gain soft key. Check that the signal returns to 1x gain.

20. Check freeze mode:

a. Press the FREEZE button.

b. Touch the Capture Screen soft key.

c. Touch the Display Both soft key.

d. Use the horizontal and vertical position controls to reposition the live signal.

e. Check for two waveforms, the live signal and the captured signal.

f. Touch the Delete Capture soft key.

21. Check line select mode:

a. Press the LINE SEL button to enter line select mode.

b. Use the general-purpose knob to set the active line to F1:50.

c. Check that you can see the waveform.

d. Press the LINE SEL button again to turn the function off.

22. Check external reference operation:

a. Press the INPUT button.

b. Touch the Reference soft key to select External.

c. Check for a readout that the reference is not present (unlocked). You will not see a stable display.

d. Connect the NTSC analog reference from the generator to the REF IN loop-through connector on the monitor.

e. Terminate the second REF IN connector in 75 Ω.

f. Check for a stable (locked) waveform display on the monitor and a readout indicating the reference type.

23. For WFM7A and WFM7M modules only: Check for missing bits in the SD signal path:

a. Adjust the generator to supply a 525 format, 10-bit shallow ramp matrix signal.

b. Press the Input button and touch the Input A soft key. Verify that the correct signal is displayed on the waveform monitor.

c. Press the WFM button.

d. Touch the Pr and Pb soft keys to turn them off.

e. Check the trace carefully; verify that the steps in the ramps are monotonic (all steps are in the same direction) and approximately one pixel high.

f. Press the GAIN button.

g. Touch the X10 Gain soft key.

h. Check the trace carefully. Check that the steps in the ramps are 0.7 mV to 0.9 mV high, which indicates that all 10 bits are working correctly. (You can use the voltage cursors for this check.) If the steps are 4 pixels high, it may be that the input signal has only 8 bits of resolution.

i. Press the WFM button.

j. Touch the Pb and Pr soft keys to turn those components back on.

k. Press the GAIN button.

l. Touch the X1 Gain soft key.

24. Select and verify the B input:

a. Press the INPUT button.

b. Touch the soft key to select the B input of the module you are checking (either 1B or 2B).

c. Check that the HD color bar signal is displayed. (It may take a second or so to appear.)

d. Press the WFM button.

e. Check that the 100% color bars are displayed correctly.

f. Check that the format readout for the input (1B or 2B) is: 1.4835Gb/s, 1080i 59.94

25. Check external reference operation:

a. Press the INPUT button.

b. Disconnect the reference signal and check that the waveform display is unlocked.

c. Touch the Reference soft key to select Internal.

d. Check that the waveform display is stable (locked).

26. For WFM7M modules only: Check jitter and eye modes:

a. Press the EYE button. The jitter display will come up because it was selected last in eye mode.

b. Check for a nominal trace. This will typically be a flat line unless you have jitter added to the generator signal.

c. Touch the Eye soft key.

d. Check for a clean, stable eye signal.

27. Check for missing bits in the HD signal path:

a. Adjust the generator to supply a 1080i, 10-bit shallow ramp matrix signal.

b. Press the WFM button.

c. Touch the Pr and Pb soft keys to turn them off.

d. Check the trace carefully; verify that the steps in the ramps are monotonic (all steps are in the same direction) and approximately one pixel high.

e. Press the GAIN button.

f. Touch the X5 Gain soft key.

g. Check the trace carefully. Check that the steps in the ramps are 0.7 mV to 0.9 mV high, which indicates that all 10 bits are working correctly. (You can use the voltage cursors for this check.) If the steps are 4 pixels high, it may be that the input signal has only 8 bits of resolution.

h. Press the WFM button.

i. Touch the Pb soft key to turn on the Pb component.

j. Touch the Y soft key to turn off the Y component.

k. Press the GAIN button.

l. Touch the X1 Gain soft key.

m. Check the trace carefully; verify that the steps in the ramps are monotonic (all steps are in the same direction) and approximately one pixel high.

n. Touch the X5 Gain soft key.

o. Check the trace carefully. Check that the steps in the ramps are 0.7 mV to 0.9 mV high, which indicates that all 10 bits are working correctly. (You can use the voltage cursors for this check.) If the steps are 4 pixels high, it may be that the input signal has only 8 bits of resolution.

p. Touch the X1 Gain soft key.

q. Press the WFM button.

r. Touch the Y and Pr soft keys to turn those components back on (make sure that Y, Pb, and Pr are turned on).

28. Check the display screen pixels using black and white screens:

a. Set the generator output signal to 0% flat field. Use HD for WFM7HD modules. Use SD for the WFM7A and WFM7M modules.

b. Press the PICTURE button on the waveform monitor.

c. Press the INPUT button and touch the soft key as required to display the 0% signal that you just set up on the generator. (This varies depending on which instrument you are checking.)

d. Press the CLR MENU button.

e. Count any bad pixels on the black screen.

f. Change the generator signal to 100% white field.

g. Count any bad pixels on the white screen.

h. Total all of the bad pixels. If there are more than 6 bad pixels, recount the bad pixels; this time if a pixel fails for both black and white signals, count it only once. If there are still more than 6 bad pixels, the LCD is faulty. Contact your Tektronix representative.

29. For WFM7A and WFM7M modules only: Check that both inputs accept SD and HD signals:

a. Set the SD generator for a 525 format, 100% color bar signal with embedded audio and EDH enabled.

b. Set the HD generator for a 1080i format, 100% color bar signal with embedded audio and CRC enabled.

c. Swap the inputs: connect the SD signal to INPUT B and the HD signal to INPUT A.

d. Check that the signal displays properly on INPUT B.

e. Press the INPUT button.

f. Touch the soft key to select the A input of the module you are checking.

g. Check that the signal displays properly on INPUT A.

30. For WFM7HD modules only: Check that both inputs function properly:

   a. Set the HD generator for a 1080i format, 100% color bar signal with embedded audio and CRC enabled.

   b. Move the HD generator connection to INPUT A.

   c. Press the INPUT button.

   d. Touch the soft key to select the A input of the module you are checking.

   e. Check that the signal displays properly on INPUT A.

31. For WFM7A and WFM7M modules only: Check the SD picture monitor out connections:

   a. Press the INPUT button.

   b. Touch the soft key to select the B input of the module you are checking.

   c. Connect the waveform monitor PIX G/Y, B/Pb, and R/Pr outputs to the SD RGB monitor.

   d. Check that the proper color bar signal is displayed on the monitor. If it is not correct, press the CONFIG button, touch the Video Inputs/Outputs soft key, and then touch the Next Menu soft key.

   e. Touch the Output Active for SD soft key. In the Output Active for SD submenu, touch the RGB soft key.

   f. Connect the waveform monitor SD PIX MON output to the SD serial monitor.

   g. Check that the proper signal is displayed on the monitor.

32. Check the HD picture monitor out connections:

   a. Connect the waveform monitor PIX G/Y, PIX B/Pb, and PIX R/Pr outputs to the HD RGB or VGA monitor.

   b. Press the Input button.

   c. Touch the Input #1A soft key to select the HD input.

   d. Check that the proper color bar signal is displayed on the monitor. If the colors look wrong, press the CONFIG button, touch the Video Inputs/Outputs soft key, and then touch the Next Menu soft key.

   e. Touch the Output Active for HD. In the Output Active for HD submenu, touch the RGB soft key.

33. Run diagnostics and Check the display screen bits:

a. Press the Config button.

b. Select System from the first level menu.

c. Touch the Next Menu soft key to get to the second level.

d. Select Diagnostics.

e. Select View Diagnostic Log, and then touch Erase NVRAM Log to clear the log file.

f. Touch the Back to Diags Menu soft key.

g. Select Run Full Powerup Diagnostics on the touch screen.

h. Verify that there are no red fail messages.

i. Touch the Back to Diags Menu soft key.

j. Select Run Internal Digital Path Diagnostics on the touch screen.

k. Read the screen text, and then touch the Continue soft key to acknowledge that a reboot will be required. The diagnostic test will run.

l. At the end of the diagnostic test, four ramp patterns will appear on the LCD to check the bits on the waveform monitor display. Verify that there are steps about 1/16 inch wide on the left side of the ramps.

m. Verify that there are no color bands in the gray ramp.

n. If the steps in the ramp are wider than about 1/16 inch or if there are bands in the picture, it may indicate a bad bit in the LCD drive path. The width of the steps and bands indicates which bit is bad.

o. Press the flashing SELECT button to return to the Diagnostic Menu.

p. Touch the View Diagnostics Log soft key.

q. Page through the log to verify that there are no red FAIL messages.

r. Cycle the power to reboot the waveform monitor.

34. Check the Ethernet port connections:

***NOTE**. This step will test the Ethernet port, which is used for printing and for remote control, by connecting to the instrument using a Web browser. To perform this test, the instrument must be connected to an IP network using the Ethernet port. You will need to set the IP Config Mode, IP Address, Subnet Mask, and possibly the Gateway Address for the instrument depending on your network configuration. Talk with your network administrator to determine the proper settings. Refer to* Communications *on page 2-48 for information about using the Configure menu to set these parameters.*

Refer to Appendix C: Remote Control *for information about the system and software requirements of the PC you will use to remotely connect to the instrument using the Remote Web Interface.*

This procedure assumes you have already connected the instrument to your local Ethernet network and have set the appropriate network configuration settings on the instrument.

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a. On the waveform monitor, press the CONFIG button to display the Configure menu.

b. Touch the Communications soft key to display the current settings in the submenu.

c. If the Remote Web Interface is disabled, perform the following steps to enable the interface:

- Touch the Communications submenu display, which opens the Network Setup menu.
- Touch the Remote Web Interface soft key, and then touch the Enabled soft key.
- Touch the Top Menu soft key to return to the Configure menu.

d. Note the IP address of the instrument displayed in the Communications submenu.

e. From your PC, launch a Web browser such as IE (Internet Explorer) or Netscape.

f. Type the network address of the waveform monitor into the URL entry box like this:

http://123.123.123.123/

NOTE. *If the IP address assigned to your instrument contains a number less than 100, such as 123.123.076.032, enter the URL address in the Web browser without the "0" character. I.E.: 123.123.76.32.*

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g. Check that the WFM700 remote interface appears. See Figure 1–4.

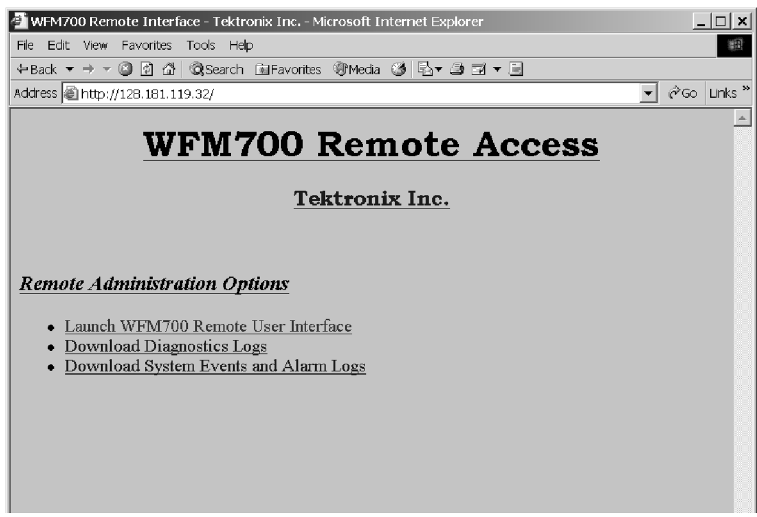


Figure 1-4: Accessing the remote interface with a Web browser

h. Exit the Web browser.

This completes the *First Video Module Functional Check* procedure. If you need to check a second video module, use the *Second Video Module Functional Check* procedure on page 1–33.

If you need to check the optional audio module, use the *Audio Module Functional Check (Option DG Only)* procedure starting on page 1–34.

Second Video Module Functional Check

When you perform a functional check on a second video module, it is not necessary to repeat steps that verify general instrument operation, such as knob function.

Perform the following steps from the *First Video Module Functional Check*, which begins on page 1–19, to verify the operation of the second video module installed in slot 3 of the instrument (see Figure G–1 on page G–2).

Step 2. Verify the type of the video module.

Step 3. Connect an SD test signal (WFM7A and WFM7M modules only)

Step 4. Connect an HD test signal (WFM7HD, WFM7A, and WFM7M modules)

Step 6. Recall the factory presets

Step 7. Change to input B (WFM7HD modules only)

Step 8. Check waveform signal and format

Step 16. Check EDH status

Step 17. Check eye and jitter modes (WFM7M modules only)

Step 23. Check for missing bits in the SD signal path (WFM7A and WFM7M modules only)

Step 24. Select and verify the B input

Step 26. Check jitter and eye modes

Step 27. Check for missing bits in the HD signal path

Step 29. Check that both inputs accept SD and HD signals (WFM7A and WFM7M modules only)

Step 30. Check that both inputs function properly (WFM7HD modules only)

Step 31. Check the SD picture monitor out connections (WFM7A and WFM7M modules only)

Step 32. Check the HD picture monitor out connections

This completes the *Second Video Module Functional Check* procedure. If you need to check the optional audio module, use the *Audio Module Functional Check (Option DG Only)* procedure starting on page 1–34.

Audio Module Functional Check (Option DG Only)

Refer to *Required Equipment* on page 1–18 for a list if the equipment you will need to perform this procedure.

Perform the following procedure to verify the operation of the audio module installed in slot 4 of the instrument (see Figure G–1 on page G–2).

Verify the Type of the Installed Modules

1. Some of the steps in this procedure can be omitted depending on the following two factors:

   - The number of video modules installed in the instrument (one or two)
   - The type of video module you are testing (WFM7A, WFM7HD, or WFM7M)

2. To verify the number and type of module installed in the instrument, perform the following steps:

   a. Press the Help button.

   b. Touch the System Info soft key, and then touch the Installed Options soft key.

   c. The Installed Options display lists the type of module contained in each of the instrument slots (Empty is displayed when there is no module installed in a slot):

      - The type of video module installed for video inputs 1A and 1B is shown in the Acq. 1 row
      - The type of video module installed for video inputs 2A and 2B is shown in the Acq. 2 row
      - The audio module is shown in the Aux row as module type WFM7DG

***NOTE**. If the WFM7DG module does not appear in the Aux slot of the Installed Options display, you do not need to perform this functional check procedure for the audio module. Either there is no WFM7DG audio module installed (check the rear panel) or the instrument does not recognize that the audio module is installed because the module has failed and needs repair.*

Initial Equipment Setup

3. For WFM7A and WFM7M modules only: Use the SD module of the test signal generator (for the TG2000 generator, use the DVG1 module). Connect an output signal to the rear-panel INPUT A on the waveform monitor module you will be checking (you can have up to two modules installed in the waveform monitor). Set the generator for a 525 format, 100% color bar signal with embedded audio and EDH enabled.

4. Set the SD television signal generator controls for a signal output as follows:

   - 525-format color bars signal
   - Embedded audio: 2 groups starting with group 1
   - 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

5. For WFM7HD, WFM7A, and WFM7M modules: Use the HD module of the test signal generator (for the TG2000 generator, use the HDVG1 module). Connect an output signal to INPUT B on the waveform monitor. Set the generator for a 1080i format, 100% color bar signal with embedded audio and CRC enabled.

6. Set the HD television signal generator controls for a signal output as follows:

   - 1080i, 59.94 MHz color bars signal
   - Embedded audio: 2 groups starting with group 1
   - Set the audio channels as follows:

     Channel 1: 50 Hz, 0 dB
     Channel 2: 100 Hz, -5 dB
     Channel 3: 150 Hz, -10 dB
     Channel 4: 200 Hz, -15 dB
     Channel 5: 250 Hz, -20 dB
     Channel 6: 300 Hz, -25 dB
     Channel 7: 400 Hz, -30 dB
     Channel 8: 500 Hz, -35 dB

7. Second video module only: Connect a second output from the serial SD television signal generator to INPUT A on the second video module.
8. Second video module only: Connect a second output from the serial HD television signal generator to INPUT B on the second video module.
9. Connect the AES generator output to the AES 1–2 I/O input on the audio module using a 75 Ω cable.
10. Set the AES audio signal generator output controls for a 1 kHz tone at –20 dB FS amplitude. Set the sample rate to 48 kHz.
11. Press the ON/STBY button to power on the waveform monitor. Wait for completion of the power-up sequence.

Audio Functional Checks

12. Restore the factory instrument setting and select the Audio display mode:

a. Press the PRESET button.

b. Touch the –more– 1 of 2 soft key, and then

c. Touch the Restore Factory soft key.

d. Press the AUDIO button.

13. Check the Level Meters display from the HD embedded audio:

a. Press the INPUT button.

b. Touch the Input #1B soft key.

c. Check that the eight displayed level meter bars show the following levels and indicators:

L:	Full scale, red CLIP indication above bar
C:	–10 dB
R:	–5 dB, yellow OVER indication above bar
Ls:	–20 dB
Rs:	–25 dB
LFE:	–15 dB
Lo:	–30 dB, SILENCE indication in bar
Ro:	–35 dB, SILENCE indication in bar

14. WFM7A and WFM7M video modules only: Check level meters display from SD embedded audio:

a. Press the INPUT button.

b. Touch the Input #1A soft key.

c. Check that the eight displayed level meter bars show the following levels and indicators:

L:	–35 dB, SILENCE indication in bar
C:	–25 dB
R:	–30 dB, SILENCE indication in bar
Ls:	–15 dB
Rs:	–10 dB
LFE:	–20 dB
Lo:	–5 dB, yellow OVER indication above bar
Ro:	Full scale, red CLIP indication above bar

15. Second video module only: Check level meters display from HD embedded audio:

a. Press the INPUT button.

b. Touch the Input #2B soft key.

c. Check that the eight displayed level meter bars show the following levels and indicators:

L: Full scale, red CLIP indication above bar
C: –10 dB
R: –5 dB, yellow OVER indication above bar
Ls: –20 dB
Rs: –25 dB
LFE: –15 dB
Lo: –30 dB, SILENCE indication in bar
Ro: –35 dB, SILENCE indication in bar

16. Second video module and WFM7A and WFM7M video modules only: Check level meters display from SD embedded audio:

a. Press the INPUT button.

b. Touch the Input #2A soft key.

c. Check that the eight displayed level meter bars show the following levels and indicators:

L: –35 dB, SILENCE indication in bar
C: –25 dB
R: –30 dB, SILENCE indication in bar
Ls: –15 dB
Rs: –10 dB
LFE: –20 dB
Lo: –5 dB, yellow OVER indication above bar
Ro: Full scale, red CLIP indication above bar

17. Check the Lissajous display:

a. Press the INPUT button.

b. Touch the Input #1B soft key.

c. Press the AUDIO button.

d. Touch the Display: soft key.

e. Touch the Level Meters + Lissajous soft key, and then touch the Done soft key.

f. Touch the Lissajous Pair: soft key.

g. Touch each of the four standard Audio Lissajous Pair selection soft keys and check that a different Lissajous pattern is displayed for each pair.

h. Touch the Configure Custom Pair soft key.

i. Touch the Lissajous Channel A: soft key, and then use the general purpose knob to select an audio channel.

j. Touch the Lissajous Channel B: soft key, and then use the general purpose knob to select an audio channel.

k. Touch the Done soft key.

l. Touch the Custom Pair: soft key and check that the two custom audio channels you selected are now shown in the Lissajous display.

18. Check the external AES inputs:

a. Press the INPUT button.

b. Touch the Audio In: soft key to select Ext AES.

c. Check that the L and R bars indicate –20 dB.

d. Move the AES generator output to the AES 3–4 I/O input.

e. Check that the C and LFE bars indicate –20 dB.

f. Move the AES generator output to the AES 5–6 I/O input.

g. Check that the Ls and Rs bars indicate –20 dB.

h. Move the AES generator output to the AES 7–8 I/O input.

i. Check that the Lo and Ro bars indicate –20 dB.

j. Disconnect the AES generator.

19. Check AES outputs:

a. Press the CONFIG button.

b. Touch the Audio Inputs/Outputs soft key.

c. Touch the Next Menu soft key.

d. Touch the AES Connectors soft key.

e. Touch the Outputs soft key.

f. Press the AUDIO button to return to the audio view.

g. Connect AES 1–2 I/O to the oscilloscope input using a 75 Ω cable and 75 Ω feed-through terminator.

h. Set the oscilloscope for 500 mV/div, 100 ns/div, 0 V trigger level.

i. Check for the presence of a signal of approximately 1 V amplitude.

j. Move the oscilloscope input to AES 3–4 I/O, AES 5–6 I/O, and AES 7–8 I/O connectors and check for the presence of a signal of approximately 1 V amplitude.

k. Disconnect the oscilloscope.

20. Restore factory settings:

a. Press the PRESET button.

b. Touch the soft key labeled –more– 1 of 2.

c. Touch the soft key labeled Restore Factory.

21. Run the audio path diagnostics:

a. Press the CONFIG button.

b. Touch the System soft key.

c. Touch the Next Menu soft key.

d. Touch the Diagnostics soft key.

e. Touch the Run Audio Path Diagnostics soft key.

f. Read the message on the screen and then touch the Continue soft key to acknowledge that rebooting will be required. The diagnostics will run.

g. Wait for the Diagnostics Completed message and check the screen for no red FAIL messages.

h. Cycle power to reboot the waveform monitor.

This completes the *Audio Module Functional Check (Option DG Only)* procedure.

Operating Basics

Functional Overview

The instrument is controlled through a combination of front-panel controls (buttons and knobs) and touch-screen controls (soft keys), as described on the following pages.

Front Panel Interface

The waveform monitor front panel is shown in Figure 2-1.

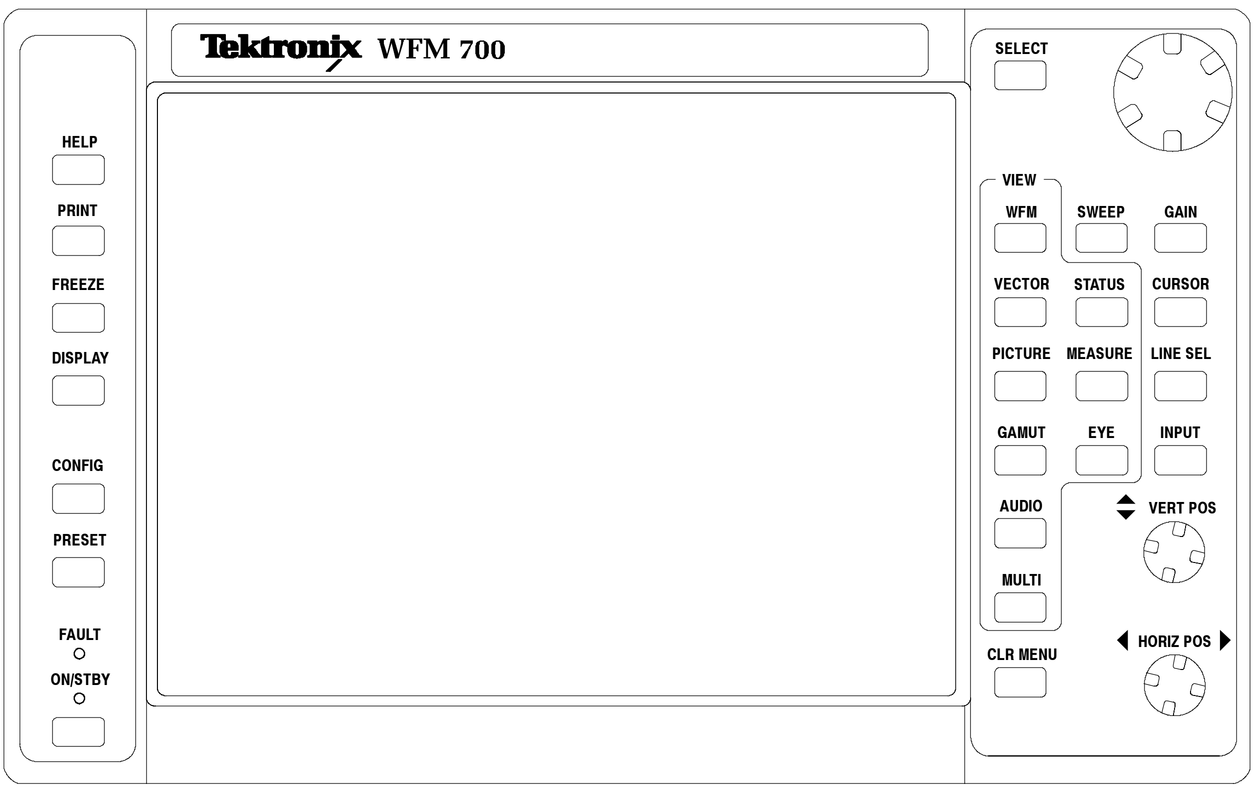


Figure 2-1: Waveform monitor front panel

Front Panel Knobs and Indicators

The waveform monitor has the following knobs and indicators:

General Purpose Knob

The general purpose knob is located in the upper right corner of the front panel. You can use the general purpose knob to navigate among choices or to change values, depending on the feature you are currently using. In general, the knob continues to perform the assigned function until you select a different feature.

In the Configure menu, a knob icon appears in the upper left corner when it can be used to scroll through the menu or to change values. In most other menus, the item being modified by the knob is highlighted.

A clockwise turn:

- Increases a value
- Moves a graphical selection, such as a cursor, to the right or up
- Scrolls down through text

A counterclockwise turn:

- Decreases a value
- Moves a graphical selection, such as a cursor, to the left or down
- Scrolls up through text

You can use this knob with the following functions:

- Select button. You can use the Select button with the general purpose knob. For example, in the Configure menu, use the knob to scroll through the list of submenus, and then press the Select button to open the selected submenu.

  In some modes of operation, the Select button LED will stay illuminated. This indicators that you can press the Select button to toggle the general purpose knob between controlling two items. For example, you can toggle between selecting a line or selecting a sample in Line Select mode.
- Line Select. The general purpose knob is used to select the line in Line Select mode. In some cases, the knob will automatically return to Line Select mode after being assigned to another function.
- Sample Select. Used in data view mode.
- Cursor Position
- Intensity control for waveform, graticule, readouts, and backlight
- Selecting items in the Configure menu

Vertical Position Knob

Moves the waveform vertically on the screen.

Horizontal Position Knob

Moves the waveform horizontally on the screen.

ON / STBY LED Indicator

This green LED is illuminated whenever the instrument is powered on.

FAULT LED Indicator

This red LED is illuminated when a hardware fault is detected within the instrument, such as under/over voltage of a power supply.

The green ON/STBY LED and the red FAULT LED indicate instrument status. The ON/STBY LED LED is illuminated whenever the instrument is on. The FAULT LED is illuminated when the environment controller detects a fault within the instrument, such as under/over voltage of a power supply. The LEDs indicate instrument status and do not report input signal problems.

Table 2–1 shows the LED conditions and what they indicate.

Table 2-1: LED fault codes

State	ON/STBY LED	Fault LED	Main power relay	Description / suggested action
Standby	Off	Off	Off	
On	On	Off	On	
Cold	Flashing	Off	On	The LCD may be damaged if operated at low temperatures. If the internal temperature sensors detect a low temperature, this fault code will be asserted. Let the unit warm up and cycle the power or press the ON/STBY switch for normal operation to occur.
Momentary fault	On	On	On	This is a transient state. It should never last more than one second. It occurs when the internal sensors detect that one of the internal supplies is out of the allowable range. In this state, the instrument will be reset. This state can occur due to an intermittent problem that requires service or from a drop-out on the AC line. If the fault persists for more than one second, then the instrument will go to the Power Supply Fault state. It is normal for the momentary fault state to be asserted when the AC line is removed while the instrument is running.
Power supply fault	Off	On	Off	If the internal monitors detect that one of the internal power supplies is out of its allowed range, the instrument will shut down and the Power Fault LED code will be asserted. This can be triggered by multiple drop-outs on the AC power supply to the instrument. If this fault code is present, press the ON/STBY switch to reset the instrument. If the fault code reoccurs, refer the instrument to qualified service personnel. If the waveform monitor seems to be operating properly, monitor the AC power supply to be sure there are no problems in the power source.
Overtemp fault	Off	Flashing	Off	The internal temperature sensors will shut down the instrument at 75 °C to prevent damage to the components if the ambient temperature is too high or if the airflow is blocked. If this occurs, the Overtemp fault code will be asserted. Let the instrument cool down and cycle the power or press the ON/STBY switch to resume normal operation.
EC self test failed	Flashing	Flashing	Off	This is asserted if the Environmental Controller is not able to test the temperature sensors and fan circuits. If this occurs, refer the instrument to qualified service personnel.

Front-Panel Buttons

For more information about these functions, refer to the *Menus* section beginning on page 2–15.

Major Mode Buttons

These buttons change the entire context and content of the LCD display, and generally function as follows:

- Pressing a button selects a mode and opens a menu (for example, pressing WFM selects the Waveform display mode and opens the Waveform menu).
- The button illuminates to show that the mode is activated.

The major mode front-panel buttons consist of the following:

- WFM (Waveform)
- VECTOR
- PICTURE
- GAMUT
- AUDIO
- MULTI
- STATUS
- MEASURE
- EYE (functional on the WFM700M only)
- HELP
- CONFIG (Configuration)

Minor Mode Buttons

The minor mode front-panel buttons activate a function that works with one or more major modes. The minor mode front-panel buttons generally function as follows:

- Pressing a button activates a function (if that function is supported in the currently selected major mode) and displays the menu for that function.
- The front-panel button illuminates to show that the mode is activated.
- Pressing the CLR MENU button clears the function menu from the screen, leaving the function active. The major mode button LED will be on, and the minor one will be off.
- Some minor modes like Line Select, Sweep, and Cursor remain active and modify the display when their menu is not displayed. In this case, press the front panel button once to bring the menu back and then again to exit the mode.
- Settings selected in Sweep can only be turned off by pressing the SWEEP button and using the menu to change modes. The only exception is that when Eye display mode is selected, if the instrument is in 2 Line or 2 Field sweep, the sweep setting is changed to 1 Line or 1 Field respectively and does not revert back when you exit the Eye display mode.

The minor mode front-panel buttons consist of the following:

- SWEEP
- GAIN
- CURSOR
- LINE SEL (Line Select)
- FREEZE
- DISPLAY

Additional buttons

Additional buttons are:

- SELECT
- INPUT
- PRINT
- PRESET
- CLR MENU (Clear Menu)

Touch Screen (Soft Keys)

Use the touch screen to select choices from a menu and to access additional instrument menus. “Buttons” that appear on screen are referred to as soft keys. Soft keys vary depending on the instrument mode. The soft keys function as follows:

- Some soft keys toggle between two settings or between enable and disable.
- Some soft keys are presented as a linked group in which only one button can be selected at a time (mutually exclusive).

Readouts

Various on-screen readouts and icons inform you of instrument settings and conditions. For more information about the readouts, refer to the section about the mode in which you are operating. For example, information about the Cursor readouts would appear in the section on Cursors on page 2–53.

There are a number of readouts that may appear on the the screen, depending on the current state of the instrument. When a menu is displayed, the readouts on the lower part of the screen move up above the menu. When CLR MENU is pressed, these readouts move down to the bottom of the screen.

Readouts that may appear on the waveform monitor:
(listed in the order that they appear on screen, top to bottom, left to right)

1. Current reference (Ref). (Location = Lower left) Text indicates the current source of the video reference. May include INT(active input signal) or EXT (signal applied on the external reference connector). Also displays the type and status of the reference. See also *Input Menu* on page 2–70.
2. Vector graticule type (Bars:). (Location = Lower Left) Text indicates the current setting of the Vector Graticule, 75% or 100%.
3. Horizontal Gain (HGain). (Location = Lower Left) Text displays the variable horizontal gain value in yellow to indicate that it is not standard. See also *Gain Menu* on page 2–64.
4. Vertical Gain (VGain). (Location = Lower left) Text displays which calibrated vertical gain you have selected, such as X1 or X5. If you select variable gain, the readout displays the gain value in yellow to indicate that it is not standard. See also *Gain Menu* on page 2–64.

5. Selected input / input format. (Location = Lower left) Text indicates the currently selected input (1A, 1B, 2A, or 2B), followed by the input format. For example, 2A: 1.4835 Gb/s 1080sf:29.97 would indicate that the A input of the module in slot 2 is selected, it is receiving an HD signal, and that the format of the signal is 1080sf at a frame rate of 29.97 Hz. See also *Input Menu* on page 2–70.

6. Color standard. (Location = Lower Center) Text indicates the current colorimetry standard. Not present in all modes.

7. Audio channels. (Location = Lower center) When enabled, 16 characters indicate embedded audio channel status; one character for each channel. The codes are as follows:
   P = Present
   – = Not Present

8. Waveform components. (Location = Lower center) The currently displayed waveform color components are listed. Non-displayed components are indicated by dashes. For example, an RGB display with G deselected would appear as R–B. See also *Waveform Menu* on page 2–105.

9. Magnification (Mag). (Location = Lower center) Text indicates the mag setting. If mag is on, the text appears in yellow to indicate that the signal is not being displayed in the normal time scale. See also *Sweep Menu* on page 2–99.

10. Sweep rate. (Location = Lower center) A readout indicates the selected sweep rate. See also *Sweep Menu* on page 2–99.

11. Closed Caption Presence. (Location = Upper left) When the instrument detects the presence of a closed caption signal, CC is displayed on the screen.

12. Timecode. (Location = Upper left) Text indicates the type of timecode (VITC or ATC) and the decoded time. A semicolon between the seconds readout and the frame readout indicates that the timecode is of the “drop-frame” variety. If no timecode is present, no text appears.

13. Ancillary Data. (Location = Upper left) Indicates the presence of ancillary data packets in the video stream, excluding packets for embedded audio and RP165 EDH. Possible messages are as follows:
    Blank – No ancillary data packets present
    Anc Present – Indicates that one or more ancillary data packets are present, and that no parity or checksum errors were detected.
    Anc Error – Indicates that one or more ancillary data packets are present, and that one or more parity or checksum errors were detected.

14. Current date and time. (Location = Upper right) The current date and time is displayed. Use the System submenu of the Configure menu to set the date and time and to select the format of the date and time displays.

15. Field and line. (Location = Upper right) When Line Select is active and Line is selected, on-screen text shows the displayed field and line number. It also indicates in which portion of the video signal the selected line occurs. See also *Line Select Menu* on page 2–72.

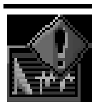
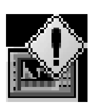
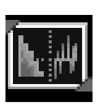
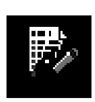
16. Sample. (Location = Upper right) When Line Select is active and Sample is selected, text displays the selected sample number, followed by the portion of the video signal that the sample is in, such as Y, Cb, Cr, EAV, HB, or SAV. See also *Line Select Menu* on page 2–72.

17. Cursor. (Location = Upper right) When cursors are active, the text displays the time or voltage (depending upon mode) at their location and the difference in time or voltage between them (delta). See also *Cursor Menu* on page 2–53.

18. Gamut error. (Location = Top center) When gamut errors occur, the readout (if enabled) will display either “RGB Err” or “Cmpst Err” for RGB and composite gamut errors, respectively. See also *Gamut Menu* on page 2–65.

Icons

On-screen icons inform you that an error condition exists or an instrument operation is in progress. The icons are:

Icon	Name	Description
	Video Alarm / Error Indicator (Red)	Appears at the top-middle of the screen when video alarms have triggered and remains until just after the last alarm or error condition is resolved (cleared).
	Hardware Fault Indicator (Yellow)	Appears when there are hardware issues, such as high temperature or a blocked fan, and remains until the condition is resolved.
	Freeze Indicator (Green)	Appears at the left-middle of the screen when a capture is available, whether or not it is currently displayed. Refer to *Freeze Mode* on page 3–27.
	Event Logging Indicator (White)	Appears at the top-middle of the screen when event logging is active.

Context-Sensitive Help

When the instrument is in a major mode, such as Waveform or Vector, pressing the HELP button displays help about that mode.

Rear Panel Connectors

The rear-panel connectors are shown in Figure 2–2 and are described in the following text.

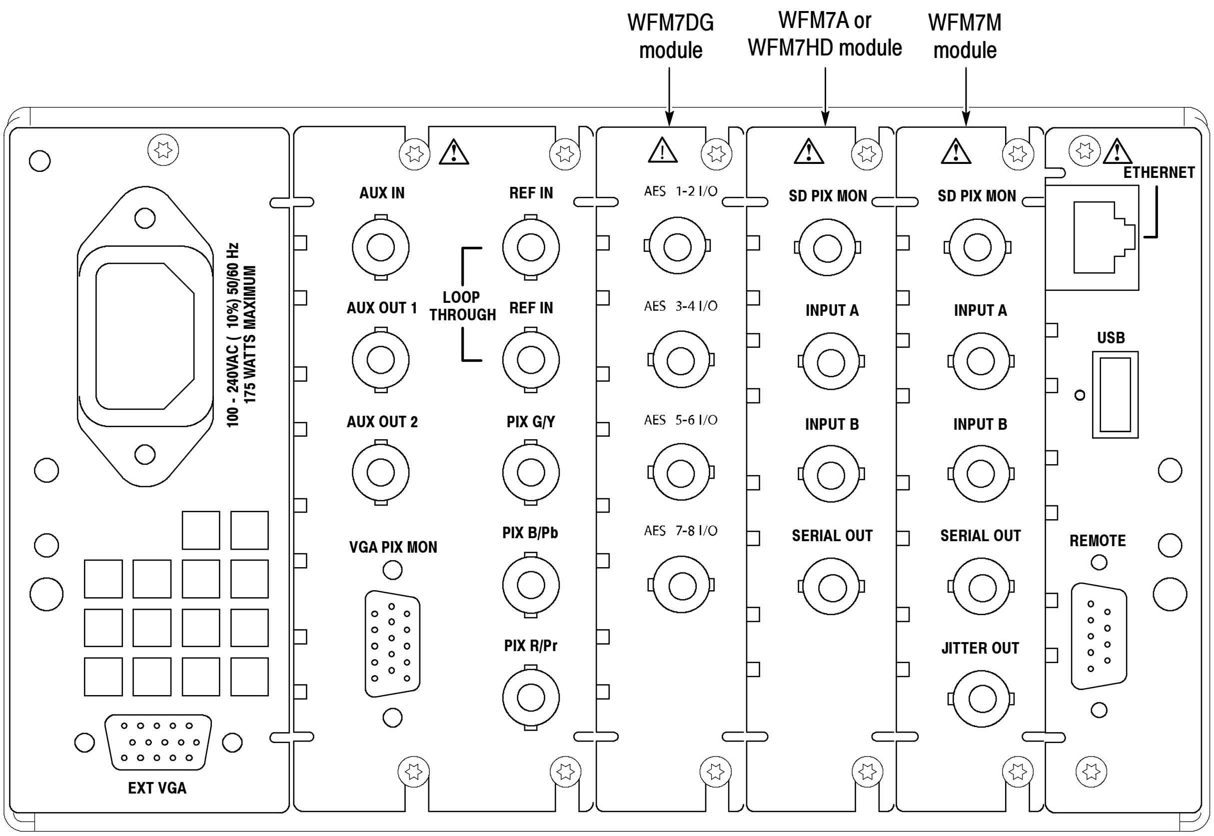


Figure 2-2: Rear panel view showing the WFM7M, WFM7A/HD, and WFM7DG input modules installed

Power Connector

This instrument is intended to operate from a single-phase power source with one current-carrying conductor at or near earth ground (the neutral conductor). Only the Line conductor is fused for over-current protection. The fuse is internal, on the Power circuit board. Systems that have both current-carrying conductors live with respect to ground (such as phase-to-phase in multiphase systems) are not recommended as power sources. Mains frequency is 50 or 60 Hz. Operating voltage range is continuous from 100 to 240 VAC, ±10%.

Video Inputs

The waveform monitor provides the following video input connectors:

***NOTE**. Input A and Input B are separate signal inputs and cannot be used as a loop-through signal path.*

- INPUT A. Digital input for signal to be monitored. For WFM700HD, this can only accept 1.485 Gb/s High Definition serial video. For the WFM700A and WFM700M, this input can accept HD and 270 Mb/s Standard Definition video. This is a 75 Ω terminating input.
- INPUT B. Digital input for signal to be monitored. For WFM700HD, this can only accept 1.485 Gb/s High Definition serial video. For the WFM700A and WFM700M, this input can accept HD and 270 Mb/s Standard Definition video. This is a 75 Ω terminating input.
- REF IN LOOP-THROUGH. Compensated for 75 Ω impedance; requires proper termination at one end of the loop-through connector or at the receiver in a monitored system. Provides for connection of an external synchronization signal such as black burst or composite video.
- AUX IN. Future capability.

Audio Inputs / Outputs (Option DG Only)

When your instrument has the optional WFM7DG audio module installed, the waveform monitor provides BNC connectors that function either as inputs for external AES/EBU audio (not necessarily associated with any video) or as outputs of the de-embedded AES audio associated with the selected video input. You can use the Audio Inputs/Outputs submenu of the Configure menu to configure these connectors to output the embedded audio channels in the selected video signal.

Multi-Pin Connectors

The waveform monitor provides the following multi-pin connectors:

- VGA PIX MON. A copy of the PIX G/Y, B/Pb, R/Pr pix mon outputs. This allows using an inexpensive VGA monitor for non-critical HD applications. Most computer monitors will not lock to 50 Hz vertical rates or to Standard Definition line rates, so this may not work in all applications.
- EXT VGA. Provides an exact copy of the LCD screen to drive an external monitor.
- REMOTE. 9-pin subminiature D-type connector used as a Ground Closure interface for remote control. Refer to *Appendix C: Remote Control* for more information.
- USB. Intended for interfacing with USB printers. Future capability.
- ETHERNET. (10/100 Base T). 10/100 Mbit/sec Ethernet interface. Used for for web-based remote control of the instrument and for downloading firmware upgrades. Refer to *Appendix C: Remote Control* and *Appendix E: Firmware Upgrade* for more information.

Coaxial Outputs

The waveform monitor provides the following coaxial outputs:

- PIX G/Y, B/Pb, R/Pr. Provides three 75 Ω component signal outputs to drive a component picture monitor. You can set the output format to YPbPr or RGB. Out of gamut input signals cause the affected areas to be highlighted on the monitor display. This gamut error highlight or “bright-up” signal is controlled in the CONFIG menu.
- SD PIX MON. This output is a copy of the PIX G/Y, B/Pb, R/Pr pix mon output, but is reclocked in SD serial digital format. It is operational only for SD format input signals, and only while the SD signal is being displayed on the screen of the waveform monitor. In addition, there is no signal output from this connector on a module while an input signal from a second module is being displayed on the screen.
- SERIAL OUT. Provides a version of the selected signal input (Video Input A or B). There is no signal output from this connector on a module while an input signal from a second module is being displayed on the screen.
- JITTER OUT. (WFM700M only) Provides a 75 Ω output signal from the jitter demodulator. This signal is only valid when the instrument is in Jitter mode. Any signal present on this output at other times is not a calibrated jitter signal. The jitter filter selection does not affect this signal.

  This signal is used as an input to an oscilloscope or spectrum analyzer to do additional analysis on the jitter. You can view the same jitter waveform on the waveform monitor using the Jitter display mode.
- AUX OUT 1 / AUX OUT 2. Future capability.

Menus

This section contains a diagram for each instrument menu, starting with the major instrument modes. Refer to Table 2–2 for diagram page numbers. This table also lists page numbers of related information in the *Reference* section, beginning on page 3–1.

Table 2-2: Menu diagram and reference information locator

Button name	Menu	Diagram / info.	Reference info.
AUDIO	Audio menu	page 2-19	page 3-6, page 3-79 (Option DG only)
CLR MENU	- - - - - -	page 2-25	
CONFIG	Configure menu	page 2-25	
CURSOR	Cursor menu	page 2-53	
DISPLAY	Display menu	page 2-56	
EYE[1]	Eye menu	page 2-59	page 3-14
FREEZE	Freeze menu	page 2-62	page 3-27
GAIN	Gain menu	page 2-64	
GAMUT	Gamut menu	page 2-65	page 3-28
HELP	Help menu	page 2-69	
INPUT	Input menu	page 2-70	
LINE SEL	Line Select menu	page 2-72	page 3-39
MEASURE	Data menu Measure menu	page 2-74	page 3-7 page 3-44
MULTI	Multi menu	page 2-78	page 3-44
PICTURE	- - - - - -	page 2-80	
PRESET	Preset menu	page 2-81	
PRINT	Print menu	page 2-93	page 3-46
STATUS	Audio/Video session menu Alarm Status menu Event Logging menu	page 2-93	page 3-47
SWEEP	Sweep menu	page 2-99	page 3-63
VECTOR	Vector menu	page 2-101	page 3-65
WFM	Waveform menu	page 2-105	page 3-73

1 **This menu appears in the WFM700M only.**

Using the Menu Diagrams

The menu diagrams contain the following components (see Figure 2-3):

1. A partial illustration of the instrument front panel, highlighting the front-panel button you select to enter the displayed menu.
2. Menu names, shown in bold text.
3. Unique submenus, connected with a dashed line. These soft keys appear only when a certain mode, such as Arrowhead, is selected.
4. A list of menu soft keys that are displayed on the touch screen. Touching one of these soft keys either activates a feature or enters a submenu.
5. Submenu names, shown in bold text.
6. Submenu soft keys.
7. A vertical line (|) separates two options on a toggle soft key. A slash (/) may also be used to separate multiple options from which you can select.
8. Variables, usually controlled by the general purpose knob, are shown as ellipses or generic names inside angle brackets <...> .

Making Menu Selections

The menu system uses several different methods for entering measurement and monitoring parameters. The following paragraphs describe how to make menu selections using various methods.

Mutually Exclusive Buttons

Some configuration parameters use a set of boxes containing all of the possible values or states (settings).

- The currently selected setting is highlighted.
- To change to another setting, touch the box containing that setting or press the SELECT button to cycle through all of the settings to the desired one.
- The readout updates when you change a setting.
- The submenu buttons remain displayed until you select another parameter name or exit the menu.

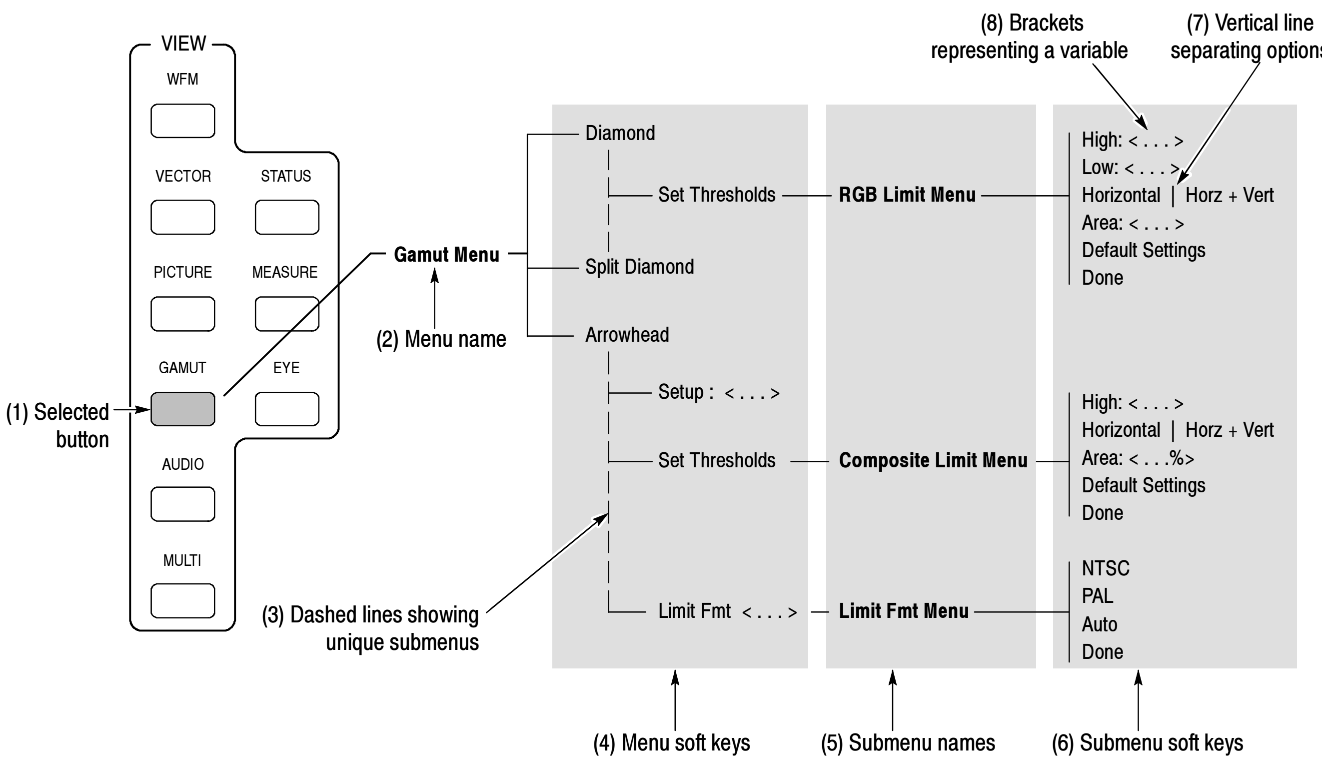


Figure 2-3: Example menu diagram showing components of the diagram

Numeric Value Menus

Some configuration parameters use a numeric value box.

- When you select such a parameter, the knob icon appears in the value box and the current parameter value is outlined.
- The part of the menu controlled by the general purpose knob and the knob icon are shown in bright blue.
- Use the general purpose knob to change the numeric value.

Checkbox Tables

In the Configure menu, the General, Serial, and Audio Alarms configuration parameters use check box tables.

- You can select any available alarm condition for monitoring.
- You can select one or more methods for reporting alarm conditions.
- To select or deselect a preference, touch the box on the screen or press the SELECT button.

List Box

Some configuration parameters show a list of items that you can scroll through using the general purpose knob, and select using the SELECT button. Depending on the length of the list, you may also be able to touch the desired item on the screen.

Command Buttons

If the configuration parameter that you select is a command button, it will open a command menu with instructions for you to follow. For example, System Upgrade displays a new screen with instructions on how to upgrade your firmware.

Configuration Menu Navigation

The top level Configure menu contains a list of submenus on the left, with the selections within the selected submenu shown on the right. To adjust a desired parameter, use one of the following methods:

1. In the top level Configure menu, highlight a submenu soft key by scrolling to the soft key with the general purpose knob or touching the soft key on the screen. The list of submenu selections on the right of the display will update when a new submenu soft key is highlighted.
2. Enter the selected submenu by touching the Next Menu soft key or pressing the SELECT button.
3. In the submenu, modify the desired parameter setting. You can use mutually exclusive soft keys, numeric value menus, checkbox tables, or a command button, depending on which parameter you are modifying. Descriptions of these methods begin on page 2–16.

Exiting a Menu

To exit all menus except the Configure menu, press the CLR MENU button or press any major mode button. To exit the Configuration menu, press the CONFIG button (once if you are at the top level or twice if you are in a submenu) or press any major mode button.

Audio Menu (Option DG Only)

***NOTE**. The Audio mode display depends on whether your instrument has the optional audio module installed. If your instrument has only video modules installed, the instrument displays the Embedded Audio Status screen and has no menu.*

Refer to Audio Mode *on page 3-6 for information about using Audio mode with only video modules installed. Refer to* Audio Reference *on page 3-79 for information about using the audio module.*

If your instrument has the optional audio module installed (Option DG), when you press the AUDIO button to enter the Audio mode, the Audio menu shown in Figure 2-4 is displayed.

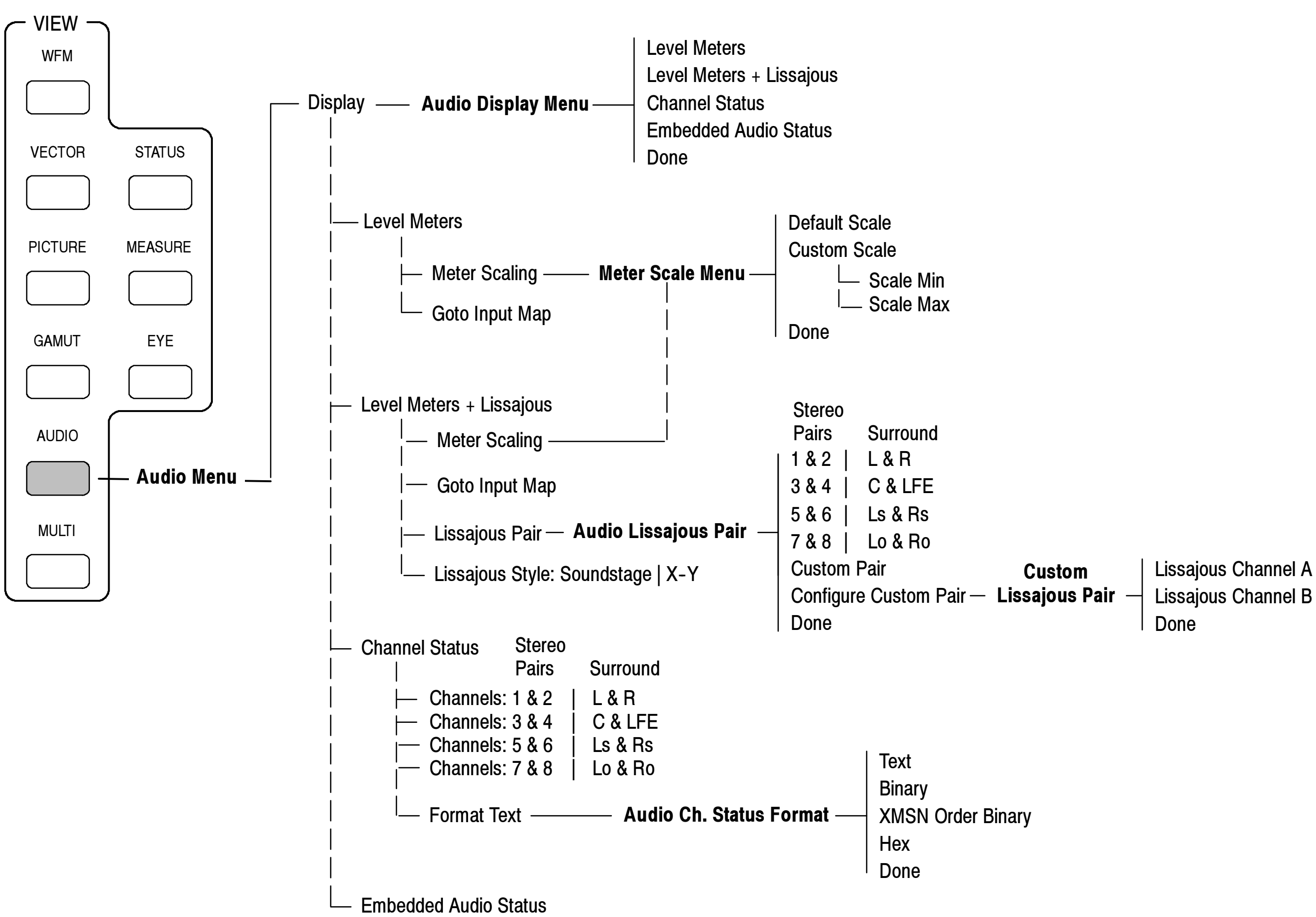


Figure 2-4: Audio menu diagram (Option DG only)

Display Mode Selection

The Display: soft key lists the selected Audio display mode: Level Meters, Level Meters + Lissajous, Channel Status, or Embedded Audio Status. The soft key selections that appear with the Display: soft key change depending on which of the audio display modes is selected. Press the Display: soft key to select the desired display mode.

Choices: Level Meters, Level Meters + Lissajous, Channel Status, Embedded Audio Status
Default: Level Meters

Level Meters Display

When you select the Level Meters display mode, the audio level of each audio channel is displayed (see Figure 2-5).

The appearance of the Level Meters display is specified by settings in the submenus of the Configure menu, including which audio channel is assigned to which level meter. Refer to *Audio Inputs/Outputs* on page 2-39, *Audio Displays* on page 2-43, and *Audio Thresholds* on page 2-45 for more information.

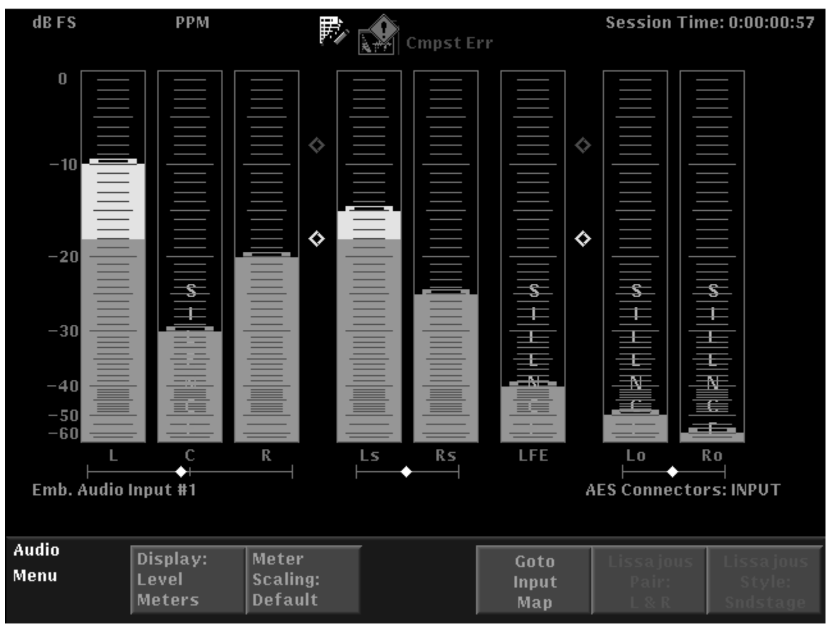


Figure 2-5: Audio Level Meters display (Option DG only)

Meter Scaling. Specifies the meter scale to use for the level meters. You can select between using the default scale and using a custom scale you define. When you select Custom Scale, you can use the Scale Min and Scale Max soft keys to adjust the minimum and maximum scale values, allowing you to attain 0.05 dB measurement precision. The meter scaling setting affects both the Level Meters display mode and the Level Meters + Lissajous display mode.

Choices: Default Scale, Custom Scale
Default: Default Scale

Goto Input Map. Opens the audio input-map where you can assign audio channels to specific level-meter bars. The Audio In setting in the Input menu specifies which audio input-map opens when you touch this soft key (embedded or AES inputs). After making changes to the input map, press the Audio button to return to the Audio menu.

Level Meters + Lissajous Display

When you select the Level Meters + Lissajous display mode, the audio level of each audio channel is displayed on the left half of the screen and the audio Lissajous display appears on the right half of the screen (see Figure 2-6).

***NOTE**. When the Level Meters + Lissajous display mode is enabled and you set the instrument to Multi display mode, the Lissajous display will appear when you select Audio as one of the display modes. You must select the Level Meters display mode to view the audio level meters in Multi mode.*

Meter Scaling. Specifies the meter scale to use for the level meters. You can select between using the default scale and using a custom scale you define. When you select Custom Scale, you can use the Scale Min and Scale Max soft keys to adjust the minimum and maximum scale values, allowing you to attain 0.05 dB measurement precision. The meter scaling setting affects both the Level Meters display mode and the Level Meters + Lissajous display mode.

Choices: Default Scale, Custom Scale
Default: Default Scale

Goto Input Map. Opens the audio input-map where you can assign audio channels to specific level-meter bars. The Audio In setting in the Input menu specifies which audio input-map opens when you touch this soft key (embedded or AES inputs). After making changes to the input map, press the Audio button to return to the Audio menu.

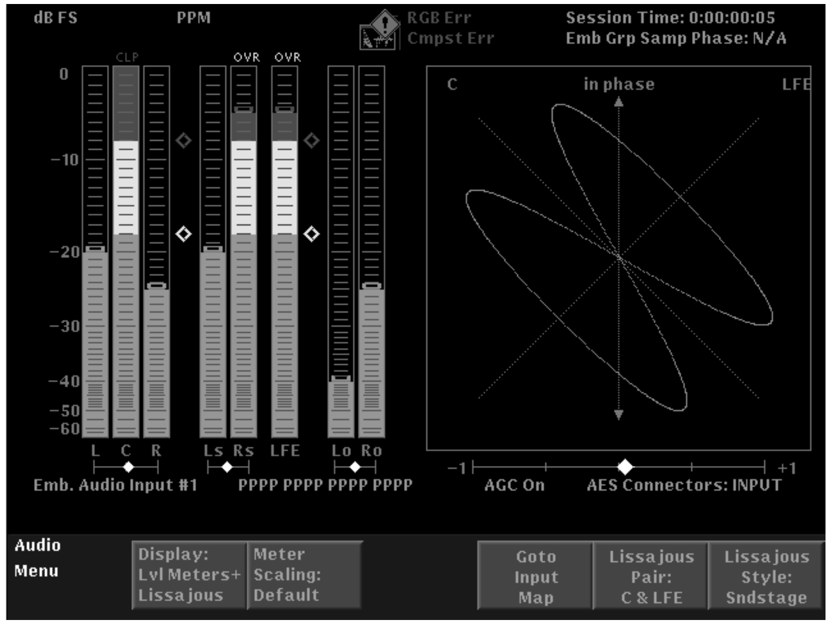


Figure 2-6: Audio Level Meters + Lissajous display with SD signal (Option DG only)

Lissajous Pair. Use this soft key to select which audio channel-pair will be displayed. The channel-pair labels depend on the Audio Program Type setting (Surround or Stereo Pairs) in the Configure menu.

***NOTE**. For embedded audio signals, which audio channels can be selected in the Lissajous display depend on the Embedded Input Map settings in the Configure menu.*

You can display one of four standard channel-pairs or you can use the Custom Pair: soft key to display the custom channel pair you selected using the Configure Channel Pair soft key.

Choices: L&R, C&LFE, Ls&Rs, Lo&Ro (Surround), Custom Pair,
Configure Custom Pair
or
1&2, 3&4, 5&6, 7&8 (Stereo Pairs), Custom Pair,
Configure Custom Pair
Default: L&R

***NOTE**. For SD embedded audio only:*
Preservation of audio-sample phase between different AES channel pairs or across embedded audio groups is not supported by SMPTE 272M alone. The Lissajous Custom Pair display may not correctly represent audio phase unless the following extensions to SMPTE 272M are observed:

1. *The selected audio channels must be embedded with exactly the same audio sample frequency.*
2. *The intended sample alignment must be represented by the average embedded sample position.*
3. *Most lines should carry phase-aligned samples and should have an equal number of samples from each group. This minimizes the number of attempts needed to reestablish correct alignment.*

These are not requirements of SMPTE 272M and some embedders do not meet these criteria. Furthermore, some de-embedding equipment may not make use of these characteristics, even if present. In these cases, there may be variation in the displayed audio phase between different AES channels. The variation is typically ± 1 audio sample, but may be greater depending on random startup conditions and the design of the embedder/de-embedder.

Lissajous Style. Use this soft key to toggle the style of the Lissajous display between Sndstage (soundstage) and X–Y. The soundstage display is rotated 45 degrees counterclockwise from the X–Y display. Both displays use L and R as the axes.

Choices: Sndstage, X–Y
Default: Sndstage

AES Channel Status Display

When you select the Channel Status display mode, the channel status for the selected AES audio channel-pair is displayed (see Figure 2–7).

Channels. Use the four Channels soft keys to select which AES audio channel-pair is displayed. The channel-pair labels depend on the Audio Program Type setting (Surround or Stereo Pairs) in the Configure menu.

Choices: L&R, C&LFE, Ls&Rs, Lo&Ro (Surround) or
1&2, 3&4, 5&6, 7&8 (Stereo Pairs)
Default: L&R

Format. Use the Format soft key to select which format is used to display audio-channel status information.

Choices: Text, Binary, XMSN Order Binary, Hex
Default: Text

Figure 2-7: AES Audio Channel Status display (Option DG only)

Figure 2-8: Embedded Audio Status display with HD signal

Embedded Audio Status Display

When you select the Embedded Audio Status display mode, the channel status for each embedded audio channel-pair is displayed as shown in Figure 2-8. Also shown is the source of the video input, the standard used by the embedded audio signal, the selected audio groups, and for HD signals only, the misalignment between the audio samples of the two selected embedded audio groups, quantified in microseconds and samples. Refer to *Elements of the Embedded Audio Status Display* on page 3-91 for more information.

***NOTE**. To enable the Audio Presence readout at the bottom of the Waveform, Vector, and Gamut displays, use the Audio Displays submenu of the Configure menu (refer to Audio Displays on page 2-43).*

Clear Menu

The CLR MENU button (clear menu) does not have its own menu display. Pressing this button removes the menu from the screen, without affecting the signal display and knob assignment. Readouts and Thumbnail picture, if enabled, move down into the space that was vacated by the menu.

Configure Menu

Press the CONFIG button to open the Configure menu, shown in Figure 2-9 through Figure 2-11. In this menu, you can adjust most instrument parameters. (To adjust display parameters, see the *Display Menu* on page 2-56.)

The configuration parameters are grouped into functional areas (submenus). The current value is shown in yellow next to the parameter name.

While the Configure menu is open, the on-screen alarm notifier option is disabled so you will not be interrupted while you are changing a setting.

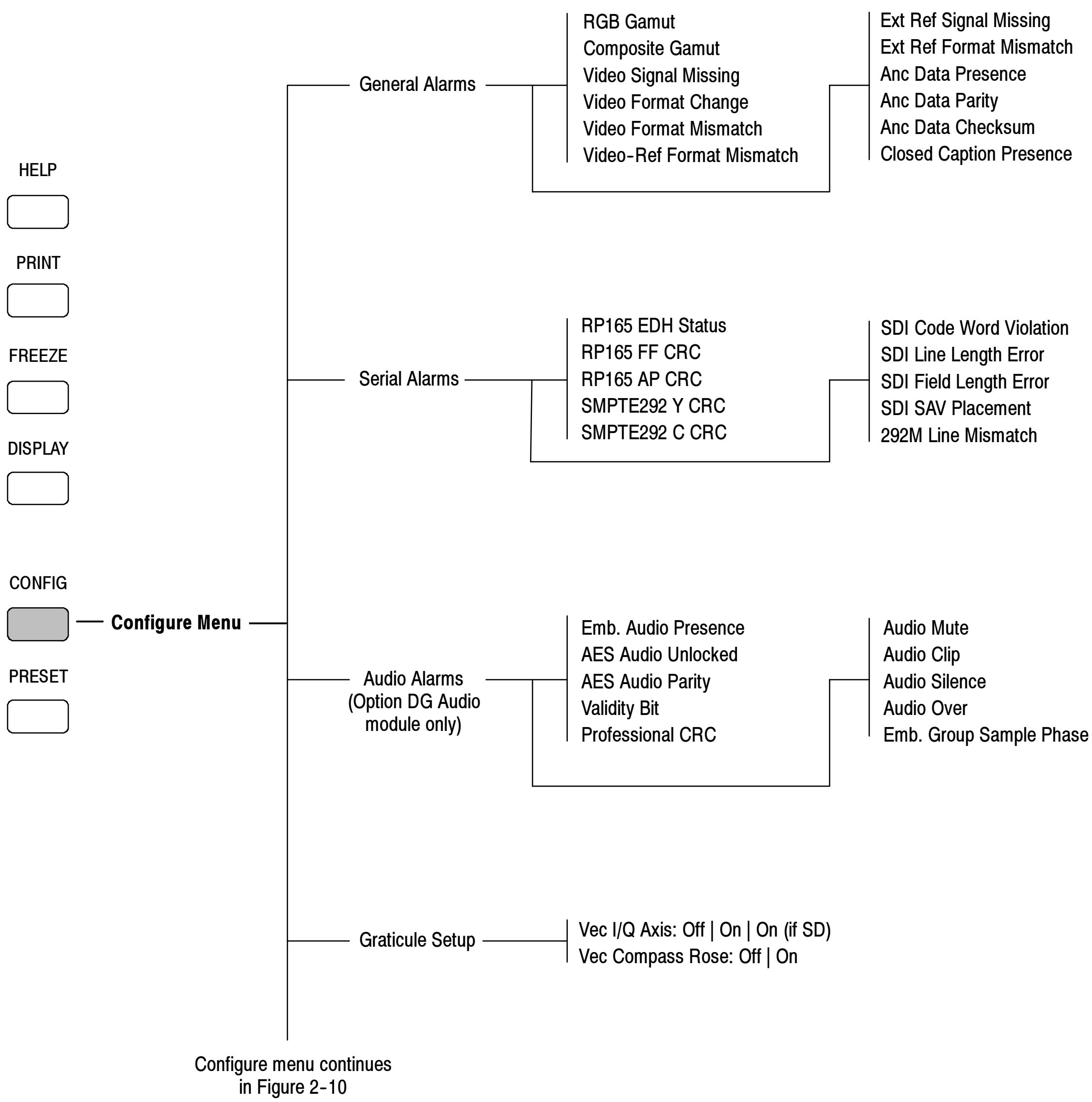


Figure 2-9: Configuration menu diagram - part 1

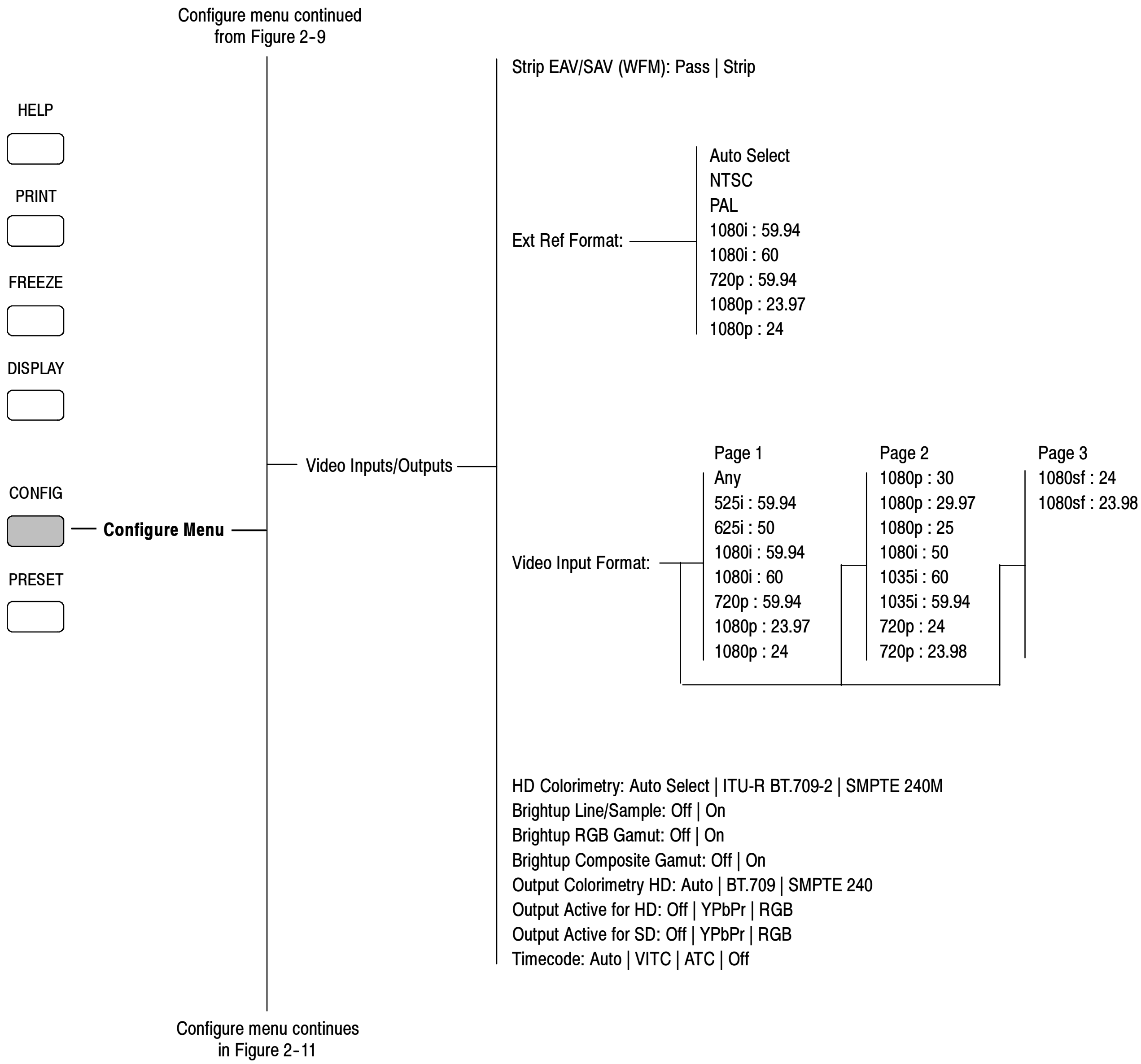


Figure 2-10: Configuration menu diagram - part 2

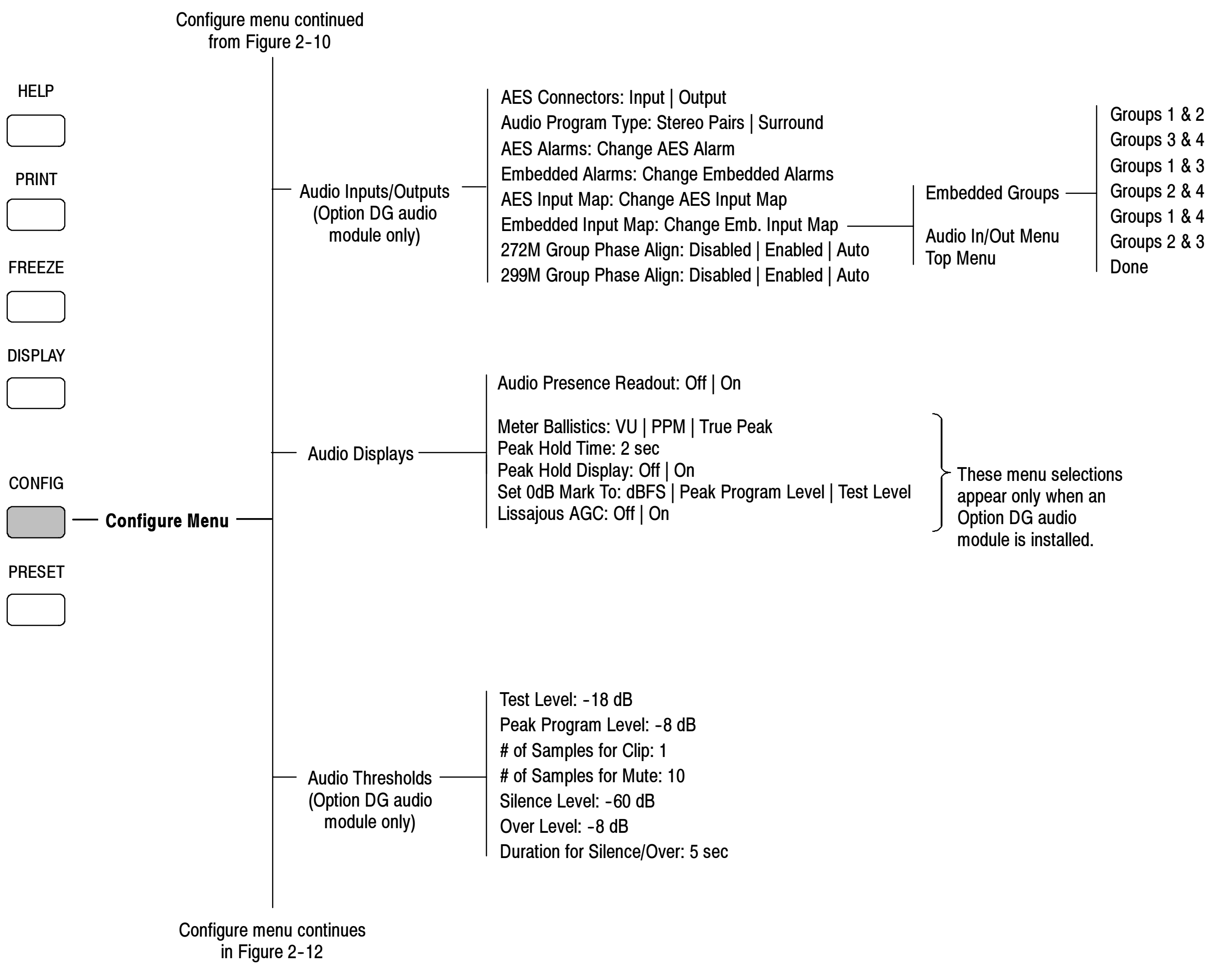


Figure 2-11: Configuration menu diagram - part 3

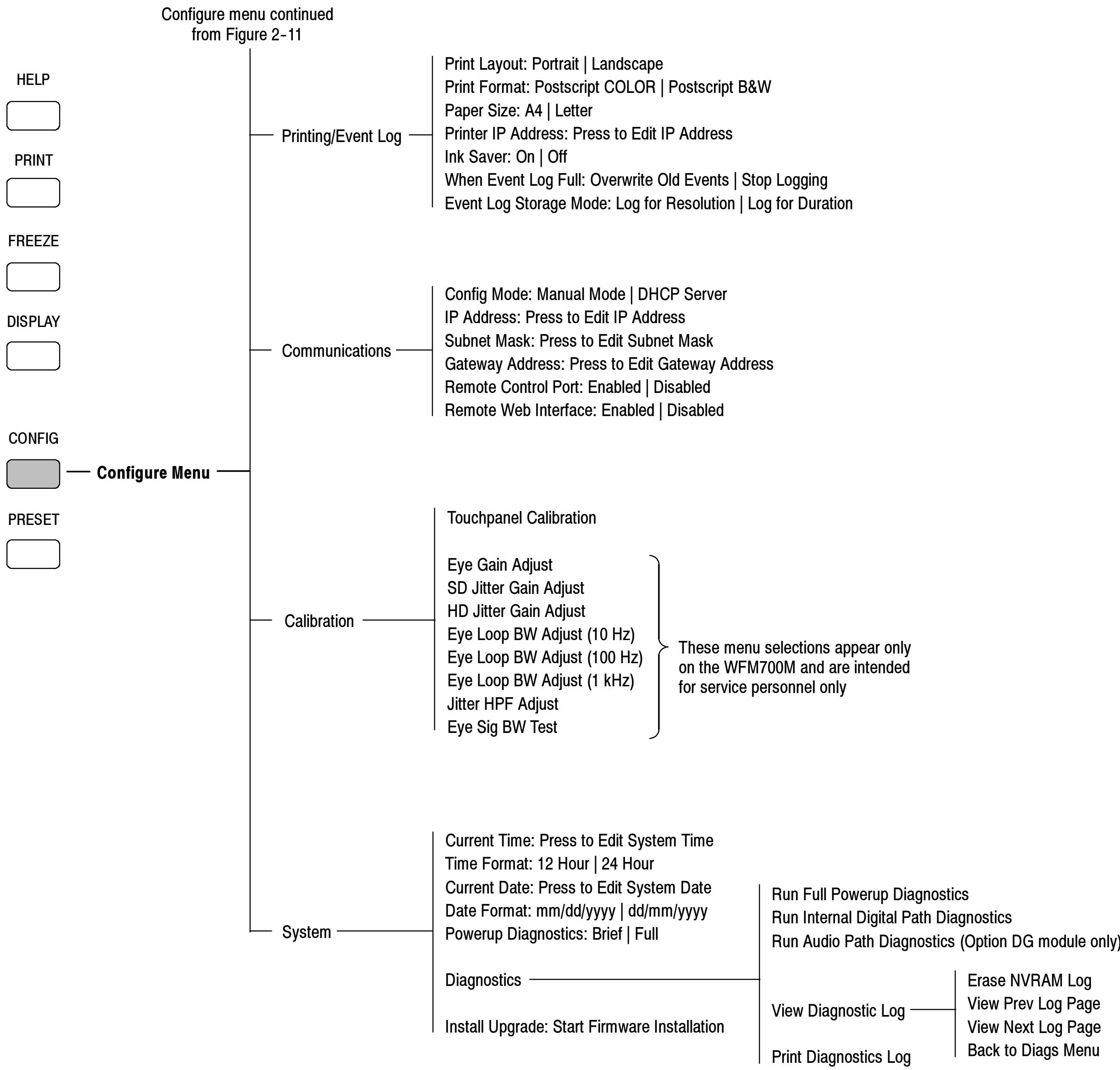


Figure 2-12: Configuration menu diagram - part 4

The following pages describe the various instrument settings you can change using the Configure menu.

General Alarms

In the General Alarms submenu of the Configure menu, you can select which general error conditions you will monitor and how you will be notified in the event of an error. The top level of the menu (see Figure 2–13) displays the current settings for each general alarm.

The four columns labeled OnSc (on-screen), Beep, Log (logging), and Gnd (ground closure) indicate the current settings for alarm notification. An “X” indicates that a condition is selected while an “O” indicates that the condition is not selected. Touch the list of general alarms or the Next Menu soft key to change the settings of the alarms indicators.

Table 2–3 describes the available general alarms.

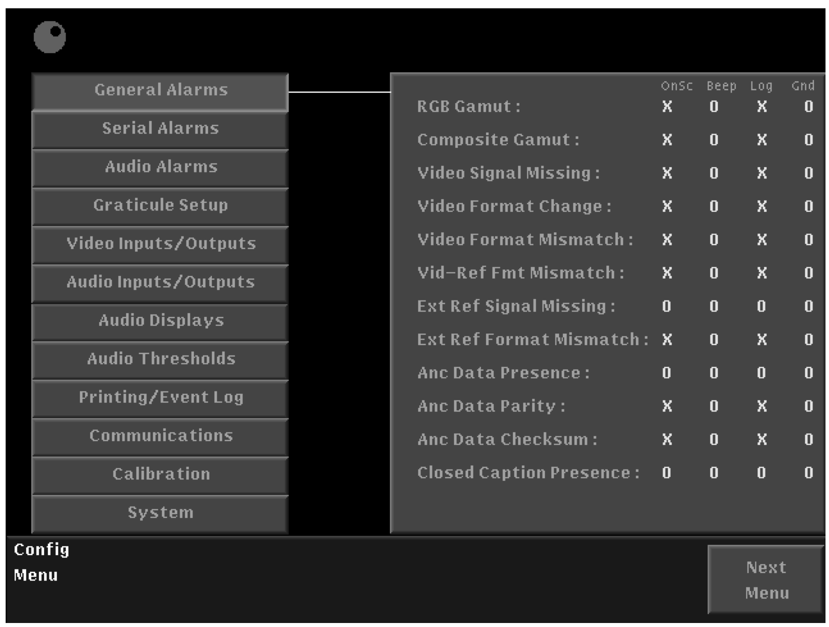


Figure 2-13: General Alarms menu display

Table 2-3: General alarm descriptions

Alarm	Description	Default alarm action settings
RGB gamut	The alarm condition indicates that the input signal contains colors that violate the currently set limits for RGB gamut. Refer to *Gamut Menu* on page 2-65 for information about setting RGB gamut threshold limits.	On-Screen and Logging: On Beep and Ground Closure: Off
Composite gamut	The alarm condition indicates that the input signal contains colors that violate the currently set limit for composite gamut. Refer to *Gamut Menu* on page 2-65 for information about setting the Composite gamut threshold limit.	On-Screen and Logging: On Beep and Ground Closure: Off
Video signal missing	The alarm condition indicates that the video signal is missing.	On-Screen and Logging: On Beep and Ground Closure: Off
Video format change	The alarm condition indicates that a change in the format of the video signal has occurred.	On-Screen and Logging: On Beep and Ground Closure: Off
Video format mismatch	The alarm condition indicates that the format of the video-input signal does not match the Video Input Format setting in the Video Inputs/Outputs submenu of the Configure menu. Refer to *Video Inputs/Outputs* on page 2-36.	On-Screen and Logging: On Beep and Ground Closure: Off
Video-reference format mismatch	The alarm condition indicates that there is a format mismatch between the video-input signal and the external-reference signal. Refer to Table B-2 on page B-2 for a listing of the allowed references for the various video-input formats.	On-Screen and Logging: On Beep and Ground Closure: Off
External reference signal missing	The alarm condition indicates that the external reference signal is missing.	On-Screen and Logging: Off Beep and Ground Closure: Off
External reference format mismatch	The alarm condition indicates that the format of the external reference signal does not match the Ext Ref Format setting in the Video Inputs/Outputs submenu of the Configure menu. Refer to *Video Inputs/Outputs* on page 2-36. *NOTE: Ensure that the video signal source and the WFM700 waveform monitor are locked to the same external reference signal.*	On-Screen and Logging: On Beep and Ground Closure: Off
Anc data presence	The alarm condition indicates that ancillary data is missing.	On-Screen and Logging: Off Beep and Ground Closure: Off
Anc data parity	The alarm condition indicates that the incoming video subframe does not have even parity as specified by the applicable standards. The data sample is unreliable and is ignored.	On-Screen and Logging: On Beep and Ground Closure: Off
Anc data checksum	The alarm condition indicates that the ancillary data checksum calculated by the instrument does not match the checksum embedded in the data.	On-Screen and Logging: On Beep and Ground Closure: Off
Closed caption presence	The alarm condition indicates that closed caption is missing. Default alarm action settings: On-Screen and Logging on, Beep and Ground Closure off.	On-Screen and Logging: Off Beep and Ground Closure: Off

Possible Alarm Actions. For each monitored General Alarm, Serial Alarm, and Audio Alarm (Option DG only) condition, you can select one or more notification methods:

- On-screen. An icon appears at the top of the current display. This alarm preference is disabled when the Configuration menu is active.
- Beep. The instrument makes an audible alarm.
- Logging. The instrument makes an entry in the Event Log. Refer to *Logging* on page 3-40 for information about using the Event Log.
- Ground Closure. The instrument sends a signal out the Remote port for a remote notification that an alarm condition occurred. Refer to *Appendix C: Remote Control* for more information.

***NOTE**. If you do not select a notification method for an error, you will not be notified if that error occurs. However, you can view any current error conditions using the Alarm Status display. Refer to* Alarm Status Displays *on page 3-60.*

Serial Alarms

In the Serial Alarms submenu of the Configure menu, you can select which error conditions in SDI format you will monitor and how you will be notified in the event of an error (refer to *Possible Alarm Actions* above for more information).

The four columns labeled OnSc (on-screen), Beep, Log (logging), and Gnd (ground closure) indicate the current settings for alarm notification. An “X” indicates that a condition is selected and an “O” indicates that the condition is not selected. Touch the list of general alarms or the Next Menu soft key to change the settings of the alarms indicators.

Table 2-4 describes the available serial alarms.

Table 2-4: Serial alarm descriptions

Alarm	Description	Default alarm action settings
RP165 EDH status	The alarm condition indicates that there is an error in the EDH packet (checksum or parity) of the SD signal. *NOTE: CRC is always present in HD video signals, so this alarm is not active for HD signals.*	On-Screen and Logging: On Beep and Ground Closure: Off
RP165 FF CRC	The alarm condition indicates that the RP165 FF CRC computed by the instrument is different from the CRC embedded in the data stream, or that it has been marked as invalid in the EDH packet.	On-Screen and Logging: On Beep and Ground Closure: Off
RP165 AP CRC	The alarm condition indicates that the RP165 AP CRC computed by the instrument is different from the CRC embedded in the data stream, or that it has been marked as invalid in the EDH packet.	On-Screen and Logging: On Beep and Ground Closure: Off
SMPTE292 Y CRC	The alarm condition indicates that the Y CRC computed by the instrument, for any line in the video frame, is different from the CRC embedded in the data stream. (There is no validity bit for SMPTE292 as there is for SMPTE RP165.)	On-Screen and Logging: On Beep and Ground Closure: Off
SMPTE292 C CRC	The alarm condition indicates that the C CRC computed by the instrument, for any line in the video frame, is different from the CRC embedded in the data stream. (There is no validity bit for SMPTE292 as there is for SMPTE RP165.)	On-Screen and Logging: On Beep and Ground Closure: Off
SDI code word violation	The alarm condition indicates that an SDI code word violation has occurred.	On-Screen and Logging: On Beep and Ground Closure: Off
SDI line length error	The alarm condition indicates that an SDI line length error has occurred.	On-Screen and Logging: On Beep and Ground Closure: Off
SDI field length error	The alarm condition indicates that an SDI field length error has occurred.	On-Screen and Logging: On Beep and Ground Closure: Off
SDI SAV placement	The alarm condition indicates that an SDI SAV placement error has occurred.	On-Screen and Logging: On Beep and Ground Closure: Off
292M line mismatch	The alarm condition indicates that the TRS count by the instrument does not agree with the line number embedded in the 292M line.	On-Screen and Logging: On Beep and Ground Closure: Off

Audio Alarms (Option DG Only)

The Audio Alarms submenu of the Configure menu appears only when there is an Option DG audio module installed in the instrument. In the Audio Alarms menu, you can select which audio error conditions you will monitor and how you will be notified in the event of an error (refer to *Possible Alarm Actions* on page 2–32 for more information).

The four columns labeled OnSc (on-screen), Beep, Log (logging), and Gnd (ground closure) indicate the current settings for alarm notification. An “X” indicates that a condition is selected and an “O” indicates that the condition is not selected. Touch the list of general alarms or the Next Menu soft key to change the settings of the alarms indicators.

Table 2–5 describes the available audio alarms.

Table 2-5: Audio alarm descriptions (Option DG only)

Alarm	Description	Default alarm action settings
Emb. audio presence	The alarm condition indicates that embedded audio is missing.	On-Screen and Logging: Off Beep and Ground Closure: Off
AES audio unlocked	The alarm condition indicates that AES audio is unlocked.	On-Screen and Logging: Off Beep and Ground Closure: Off
AES audio parity	The alarm condition indicates that the incoming AES audio subframe does not have even parity as specified by the applicable standards. The data sample is unreliable and is ignored.	On-Screen and Logging: On Beep and Ground Closure: Off
Validity bit	The alarm condition indicates that the Validity bit is set high for one or more data samples. In the AES/EBU standard, a set validity bit indicates that the sample is not suitable for conversion to audio.	On-Screen and Logging: On Beep and Ground Closure: Off
Professional CRC	The alarm condition indicates that the AES channel status CRC as calculated by the instrument does not agree with the CRC embedded in the channel status bytes. The channel status CRC only applies to audio encoding using the Professional audio interface.	On-Screen and Logging: On Beep and Ground Closure: Off
Audio mute	The alarm condition indicates that an audio mute error has occurred. Refer to *Audio Thresholds* on page 2-45 for information about setting the Audio Mute alarm threshold.	On-Screen and Logging: On Beep and Ground Closure: Off
Audio clip	The alarm condition indicates that an audio clip error has occurred. Refer to *Audio Thresholds* on page 2-45 for information about setting the Audio Clip alarm threshold.	On-Screen and Logging: On Beep and Ground Closure: Off
Audio silence	The alarm condition indicates that the audio level has dropped below the allowed silence level for longer than the allowed time. Refer to *Audio Thresholds* on page 2-45 for information about setting the silent level and the duration of the silent period before the alarm is triggered.	On-Screen and Logging: On Beep and Ground Closure: Off

Table 2-5: Audio alarm descriptions (Option DG only) (Cont.)

Alarm	Description	Default alarm action settings
Audio over	The alarm condition indicates that the audio level has exceeded the allowed over level for longer than the allowed time. Refer to *Audio Thresholds* on page 2-45 for information about setting the level for the audio over alarm.	On-Screen and Logging: On Beep and Ground Closure: Off
Emb. Group Sample Phase	The alarm condition indicates that the initially determined sample alignment between the two selected audio groups is no longer valid, or that sample alignment cannot be determined. *NOTE: For HD signals, the instrument uses the embedded clock word for each audio group to establish sample alignment. For SD signals, the instrument detects the average difference in embedded audio sample timing. In either case, the alarm occurs if sample misalignment exceeds about 0.625 audio samples.* *The alarm will also occur if there are too many audio sample errors, which may be caused by an unsupported audio sample rate, different audio sample rates between selected groups, or poor signal quality.* *Refer to* 272M Group Phase Align (SD Signals Only) *and* 299M Group Phase Align (HD Signals Only) *on page 2-42 for information about setting the instrument response to any detected sample misalignment.*	On-Screen and Logging: On Beep and Ground Closure: Off

Graticule Setup

In the Graticule Setup submenu of the Configure menu, you can define the following parameters:

Vec I/Q Axis. Adds graticule lines in Vector mode for the I axis and the Q axis.

Choices: Off, On, On (if SD)
Default: Off

Vec Compass Rose. Adds the compass rose graticule for component signals in the Vector mode display. (The compass rose graticule is always displayed for composite signals.)

Choices: Off, On
Default: Off

NOTE. *The component vector graticule is provided to allow comparison with other equipment that have similar displays. For a more accurate representation of hue shift, use the composite vector representation.*

Video Inputs / Outputs

In the Video Inputs/Outputs submenu of the Configure menu, you can set the following video input and output characteristics:

Strip EAV / SAV (WFM). This determines whether the EAV, SAV, and ancillary data, such as audio, are visible in the YPbPr Waveform display. Since these data values are not bandlimited, they usually ring when displayed through the video waveform filters. The EAV, SAV, and Anc portions of the signal are always stripped in other waveform color spaces, vector, and gamut modes. The EAV, SAV, and Anc portions of the signal are always displayed in the data modes.

Choices: Pass, Strip
Default: Strip

External Reference Format. Specifies the expected format of the video signal on the EXT REF IN connector. Set the external reference signal format to Auto Select to have the instrument automatically select the external reference signal format based on the video input signal. When you select a specific signal format from the choices listed below, the instrument reports an error if the format of the external reference signal does not match your selection, and if the Ext Ref Format Mismatch alarm is enabled. Refer to *General Alarms* on page 2-30.

Choices: Auto Select, NTSC, PAL, 1080i : 59.94, 1080i : 60, 720p : 59.94, 1080p : 23.97, 1080p : 24
Default: Auto Select

Video Input Format. Specifies the expected format of the video signal on the INPUT A or INPUT B connector. If you set the input signal format to Any Supported, the instrument will automatically select the input signal format based on the video input signal. When you select a specific signal format from the choices listed below, the instrument will report an error if the format of the input signal does not match your selection (provided you have enabled the Video Signal Format Mismatch alarm). Refer to *General Alarms* on page 2-30. Touch the Page 1, Page 2, and Page 3 soft keys to select from the available formats.

Choices: Any Supported, 525i : 59.94, 625i : 50, 1080i : 59.94, 1080i : 60, 720p : 59.94, 1080p : 23.97, 1080p : 24, 1080p : 30, 1080p : 29.97, 1080p : 25, 1080i : 50, 1035i : 60, 1035i : 59.94, 720p : 24, 720p : 23.98, 1080sf : 24, 1080sf : 23.98
Default: Any Supported

HD Colorimetry. Sets the matrix used to convert from YPbPr to RGB on the input signal while in HD mode. The Auto Select setting allows the instrument to automatically set the colorimetry of the input signal based on the input format.

Choices: Auto Select, ITU-R BT.709-2, SMPTE240M
Default: Auto Select

Brightup Line / Sample. Enables or disables the bright-up, or contrast pattern, on the pix monitor outputs at the selected line and sample. These bright-ups are always enabled on the thumbnail display and in Picture mode.

Choices: On, Off
Default: On

Brightup RGB Gamut. Enables or disables a bright-up, or contrast pattern, on the thumbnail display, in Picture mode, and on the pix monitor outputs in areas that are out of gamut as defined by the RGB thresholds. To set these thresholds, press the GAMUT button and touch the Diamond soft key.

Choices: On, Off
Default: Off

Brightup Composite Gamut. Enables or disables a bright-up or contrast pattern on areas that are out of gamut as defined by the composite thresholds. The bright-up appears in the thumbnail display, in Picture mode, and on the pix monitor outputs. To set these thresholds, press the GAMUT button and touch the Arrowhead soft key.

Choices: On, Off
Default: Off

Output Colorimetry HD. Sets the matrix used to convert from YPbPr to RGB on the Pix monitor outputs while in HD mode.

Choices: Auto, BT.709, SMPTE240
Default: Auto (automatically selects the colorimetry of the output signal based on the input format)

Output Active for HD. Sets the mode for the analog pix monitor outputs while in HD mode.

Choices: Off, YPbPr, RGB
Default: YPbPr

Output Active for SD. Sets the mode for the analog pix monitor outputs while in SD mode.

Choices: Off, YPbPr, RGB
Default: YPbPr

Timecode. Enables and specifies the type of timecode signal (VITC or ATC) the instrument will expect to find in the video signal. When enabled, the detected timecode signal is used to mark the time of Event Log entries.

VITC is a digitized analog timecode signal embedded in the vertical blanking interval of the video signal and complies with SMPTE12M. ATC is a digital ancillary timecode signal contained in ancillary data packets in the serial digital video signal and complies with SMPTE RP188-1999. Select the Auto setting if you want the instrument to automatically use the type of timecode signal contained in the video signal (VITC or ATC).

Choices: Auto, VITC, ATC, Off
Default: Off

***NOTE**. When the Timecode type is set to Auto, and both ATC and VITC timecodes are present in the video signal, the ATC timecode will be used and the VITC timecode will be ignored.*

When the Eye / Jitter operating mode is selected, the instrument cannot decode the timecode from the video signal if VITC timecode was used.

Audio Inputs / Outputs (Option DG Only)

In the Audio Inputs/Outputs submenu of the Configure menu, you can set the following audio input and output characteristics:

AES Connectors. Specifies the input/output function of the AES connectors.

***NOTE**. When you set the function of the AES connectors to output, the Audio In soft key in the Input menu is unavailable. In this situation, embedded audio is automatically selected as the audio input. You cannot monitor audio signals on the AES connectors until this menu selection is set to Input.*

Choices: Input, Output
Default: Input

Audio Program Type. Specifies the expected type of audio program to be monitored.

Choices: Stereo Pairs, Surround
Default: Surround

AES Alarms. Specifies which of the audio bars have AES alarms enabled.

Touch the Audio In/Out Menu soft key to return to the Audio Inputs/Outputs submenu. Touch the Top Menu soft key to return to the Configure menu. The channel-pair labels depend on the Audio Program Type setting.

Choices: L&R, C&LFE, Ls&Rs, Lo&Ro (Surround) or
1&2, 3&4, 5&6, 7&8 (Stereo Pairs)
Default: L&R, C&LFE, Ls&Rs, Lo&Ro

Embedded Alarms. Specifies which of the audio bars have embedded audio alarms enabled.

Touch the Audio In/Out Menu soft key to return to the Audio Inputs/Outputs submenu. Touch the Top Menu soft key to return to the Configure menu. The channel-pair labels depend on the Audio Program Type setting.

Choices: L&R, C&LFE, Ls&Rs, Lo&Ro (Surround) or
1&2, 3&4, 5&6, 7&8 (Stereo Pairs)
Default: L&R, C&LFE, Ls&Rs, Lo&Ro

AES Input Map. Specifies which AES audio input pair is displayed with which bar meter in the Level Meters display. Touch the Change AES Input Map soft key to open the display shown in Figure 2–14. An X in a checkbox indicates a selected mapping. The labels for the bars change depending on the Audio Program Type setting.

To make changes, use the general purpose knob and select button or touch the desired checkbox on the touchscreen to specify which audio input source is displayed in which bar in the Level Meters display.

Touch the Audio In/Out Menu soft key to return to the Audio Inputs/Outputs submenu. Touch the Top Menu soft key to return to the Configure menu.

Choices: Assign AES input pairs 1&2, 3&4, 5&6, and 7&8 to bar meters L&R, C&Lfe, Ls&Rs, and Lo&Ro (Surround) or to bar meters 1&2, 3&4, 5&6, and 7&8 (Stereo Pairs).
Default: 1&2 – L R
3&4 – C Lfe
5&6 – Ls Rs
7&8 – Lo Ro

Embedded Input Map. Specifies which embedded audio input is displayed in which bar meter in the Level Meters display for the two selected audio groups. Touch the Change Emb. Input Map soft key to open the display shown in Figure 2–15. An X in a checkbox indicates a selected mapping. The labels for the bars change depending on the Audio Program Type setting.

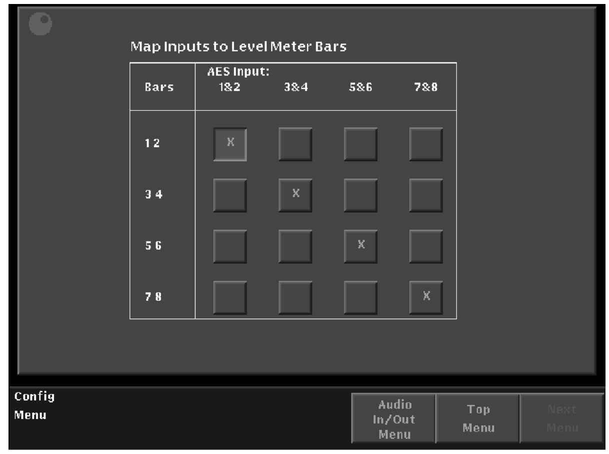
To make changes, use the general purpose knob and select button, or touch the desired checkbox on the touchscreen to specify which audio input source is displayed in which bar in the Level Meters display.

Touch the Embedded Groups soft key to select between audio group pairs.

***NOTE**. For embedded audio, use the Embedded Groups soft key to select which audio channels you can view in the Lissajous display.*

Choices: Assign input pairs for audio group 1 (1&2, 3&4), group 2 (5&6, 7&8), group 3 (9&10, 11&12), and group 4 (13&14, 15&16) to bar meters L R, C Lfe, Ls Rs, or Lo Ro
Default: Embedded Groups: 1&2
Mapping: 1&2 – L R
3&4 – C Lfe
5&6 – Ls Rs
7&8 – Lo Ro

Bar labels when Audio Program Type is set to Surround



Bar labels when Audio Program Type is set to Stereo Pairs

Figure 2-14: Mapping AES inputs to Level Meter bars

Bar labels when Audio Program Type is set to Surround

Bar labels when Audio Program Type is set to Stereo Pairs

Figure 2-15: Mapping embedded audio inputs to Level Meter bars

272M Group Phase Align (SD Signals Only). Specifies how the instrument handles any detected misalignment of the audio samples between the two selected SD embedded audio groups. Refer to the Note below for more information.

Choices: Disabled, Enabled, Auto
Default: Auto

299M Group Phase Align (HD Signals Only). Specifies how the instrument handles any detected misalignment of the audio samples between the two selected HD embedded audio groups. Refer to the Note below for more information.

Choices: Disabled, Enabled, Auto
Default: Auto

NOTE*. The Group Phase Align settings determine how the instrument responds to any misalignment of the audio samples between the two selected embedded audio groups. Select Enabled to have the instrument always attempt to realign the audio samples. Select Auto to have the instrument attempt to realign the audio samples only when the selected Lissajous Pair channels are from different embedded audio groups.*

When you select Disabled, or when you select Auto and the selected Lissajous Pair channels are from the same embedded audio group, the instrument does not attempt to realign the audio samples. This may be useful in the following situations:

- *When an older HD embedder has incorrectly encoded the SMPTE299M CLK word, which is used by the instrument to determine sample alignment*
- *When an embedded audio source was not intended to maintain phase integrity between audio groups, causing the audio groups to not be embedded at exactly the same audio sample frequency*
- *When two SD embedders used different algorithms to pack the audio samples in the ancillary data space (resulting in uneven sample distribution), which can cause the realignment algorithm to not work properly*

In any of the above situations, setting the Group Phase Align setting to Disabled will prevent added interruption to the displayed and output audio that would otherwise be caused by the instrument attempting to realign the audio samples. However, be aware of the following issues if you select Disabled:

- *The audio phase indicated on the Lissajous display may not be correct if the selected Lissajous channels are from different audio groups.*
- *You may encounter arbitrary phase relationships between embedded groups and/or phase relationships that change if errors are introduced in the signal.*

Audio Displays

The first menu selection, Audio Presence Readout, appears in all instruments. The remainder of the menu selections appear only if an Option DG audio module is installed in the instrument. Use this menu to set the following audio display characteristics:

Audio Presence Readout. Turns on or off the audio readout at the bottom of the screen.

Choices: Off, On
Default: Off

Meter Ballistics (Option DG Only). Specifies the response characteristics of the level meters. These settings only affect meter performance when the input is "live," or changing audio. A constant 1000 Hz, –10 dBFS tone, for example, will drive the meters to a constant –10 dBFS reading regardless of which ballistics setting is selected.

Choices: VU, PPM, True Peak
Default: VU

The VU display is a VU meter as defined by IEEE Std. 152-1991, but with an extended dB-linear scale (with the top portion of the dB scale using uniform graticule-tic spacing). When VU ballistics is selected, the meter bars will also contain true peak indicators, and the display designation of this setting is **VU + Peak**.

The PPM (Peak Program Meter) display shows "quasi-peak" levels as defined in IEEE Std. 152-1991 and IEC 268-10a. When PPM ballistics is selected, the meters also contain true peak indicators, and the display designation is **PPM + Peak**.

The True Peak display shows actual signal peaks regardless of their duration. Rise and Fall times are essentially instantaneous, although the in-bar peak indicator will persist at peak levels for the duration of the Peak Hold Time setting.

Peak Hold Time (Option DG Only). Specifies the number of seconds that the True Peak Indicator remains at the most recent peak level. Setting the hold time to 0 seconds turns off the peak indicator. Touch the soft key listing the current value and then use the General Purpose knob to set the desired number.

Range: 0 sec to 30 sec
Default: 2 sec

Peak Hold Display (Option DG Only). Switches the Peak Hold Indicator on or off.

Choices: Off, On
Default: Off

Set 0dB Mark To (Option DG Only). Specifies the numbers on the meter scale relative to Digital Full Scale or to one of the two user-adjustable levels. When the 0 dB mark is set to either Peak Program Level or Test level, the scale units are dBr, relative to the 0 dB level; units above the selected 0 dB mark are positive, and units below it are negative.

Peak Program Level is the level, relative to digital full scale, that you set as the maximum desired level for monitored programs. The meter bars change to red above the Peak Program level.

Test Level is the level, relative to digital full scale, that you set as the test or "line up" level for your system. The meter bars change to yellow between the Test and Peak Program levels.

Refer to *Audio Thresholds* on page 2–45 for information about setting the peak program and test levels for your system.

Choices: dBFS, Peak Program Level, Test Level
Default: dBFS

Lissajous AGC (Option DG Only). Switches the Lissajous auto-gain control (AGC) on and off. When AGC is enabled, the gain of the audio Lissajous display is adjusted by the instrument to maintain consistent signal amplitude.

Choices: Off, On
Default: On

Audio Thresholds (Option DG Only)

Use the Audio Thresholds submenu of the Configure menu to specify the following audio thresholds:

Test Level. Specifies the Test level, which is the level, relative to digital full scale, that you set as the test or "line up" level for your system. The meter bars change to yellow between the Test and Peak Program Levels.

Range: 0 dB FS to –60 dB FS
Default: –18 dB FS

Peak Program Level. Specifies the Peak Program level, which is the level, relative to digital full scale, that you set as the maximum desired level for monitored programs. The meter bars change to red above the Peak Program Level.

***NOTE**. The Peak Program Level cannot be set greater than the Test Level.*

Range: 0 dB FS to –30 dB FS
Default: –8 dB FS

# of Samples for Clip. Specifies the number of consecutive Full Scale samples that must occur for a clip alarm to be triggered. Touch the soft key listing the current value and then use the General Purpose knob to set the desired number. Refer to *Audio Alarms (Option DG Only)* on page 2–34 for more information.

Range: 1 to 100 samples
Default: 1 sample

# of Samples for Mute. Specifies the number of consecutive "0" samples that must occur for a mute alarm to be triggered. Touch the soft key listing the current value and then use the General Purpose knob to set the desired number. Refer to *Audio Alarms (Option DG Only)* on page 2–34 for more information.

Range: 1 to 100 samples
Default: 10 samples

Silence Level. Specifies the audio level below which the signal is considered silent and will trigger the Audio Silence alarm. Refer to *Audio Alarms (Option DG Only)* on page 2–34 for more information.

Range: 0 dB FS to –90 dB FS
Default: –60 dB FS

Over Level. Specifies the audio level above which the signal is considered over level and will trigger the Audio Over alarm. Refer to *Audio Alarms (Option DG Only)* on page 2–34 for more information.

Range: 0 dB FS to –30 dB FS
Default: –8 dB FS

Duration for Silence/Over. Specifies how long the audio level must exceed the Silence Level or Over Level settings before an alarm will be triggered.

Range: 1 to 100 sec
Default: 5 sec

Printing / Event Log

Select Printing to enter the Printing/Event Log Setup submenu of the Configure menu. You can use the printing settings to configure the instrument to print the Diagnostic Log or the instrument display to a printer on your local network.

You can use the Printing/Event Log submenu to set the following printing parameters:

Print Layout. Specifies the page orientation used for printing.

Choices: Portrait, Landscape
Default: Portrait

Print Format. Specifies the format used for printing.

Choices: Postscript Color, Postscript B&W
Default: Postscript Color

***NOTE**. The instrument can only print to postscript printers in color or black and white. The instrument cannot print using a print server.*

Paper Size. Specifies the paper size to be used by the printer.

Choices: A4, Letter
Default: Letter

Printer IP Address. To set the IP address of the printer, touch the Press to Edit IP Address soft key. This displays a screen where you can set the IP address using the following steps:

1. Touch the soft key that displays the IP address and reads: Select+Knob or Softkeys. The first digit of the IP address is selected (highlighted).
   - To select a different digit, press the SELECT button, touch the Move Right soft key, or touch the Move Left soft key.
   - To change the value of the selected digit, turn the general purpose knob, touch the Increase Value soft key, or touch the Decrease Value soft key.
2. To save your changes, touch the Save IP Address soft key. The changes you made will not be saved unless you touch this key.

Ink Saver. Enables or disables the Ink Saver mode. When this mode is enabled, the printer will use less ink by lightening the background of images that have dark backgrounds.

Choices: On, Off
Default: On

When Event Log Full. Specifies how the Logging function works when the Event Log becomes full. Refer to *Logging* on page 3-40 for more information about using the Event Log.

Choices: Overwrite Old Events, Stop Logging
Default: Stop Logging

Event Log Storage Mode. Specifies the storage method used by the Event Log. Select Log for Duration to increase the time span of the Event Log before it becomes full. Logging of duration will cause the instrument to reduce the number of log entries by combining repeated intermittent events into one log entry. For example, if the same error condition appears and goes away several times within a brief period (a second or so), the error will be logged as a single event. Refer to *Logging* on page 3-40 for more information about the Event Log.

Choices: Log for Resolution, Log for Duration
Default: Log for Duration

Communications

Select Communications to enter the Network Setup submenu of the Configure menu. The network settings determine how the waveform monitor interacts with your network through the Ethernet interface. The values you enter will be specific to your network. If you have any questions, contact your Network Administrator for assistance.

Use the Communications submenu to set the following network parameters:

Config Mode. Set the Config Mode to Manual if you want to manually assign an IP address to the waveform monitor. Select DHCP Server if your network uses DHCP service to assign IP addresses to connected equipment.

Choices: Manual Mode, DHCP Server
Default: Manual Mode

IP Address. You must set the Config. Mode setting to Manual Mode before you can set the IP address. You cannot set the IP address if the Config. Mode is set to DHCP Server.

To set the IP address of the waveform monitor, touch the Press to Edit IP Address soft key. This displays a screen where you can set the IP address using the following steps:

1. Touch the soft key that displays the IP address and reads: Select+Knob or Softkeys. The first digit of the IP address is selected (highlighted).

   - To select a different digit, press the SELECT button, touch the Move Right soft key, or touch the Move Left soft key.

   - To change the value of the selected digit, turn the general purpose knob, touch the Increase Value soft key, or touch the Decrease Value soft key.

2. To save your changes, touch the Save IP Address soft key. The changes you made will not be saved unless you touch this key.

Subnet Mask. You must set the Config. Mode setting to Manual Mode before you can set the subnet mask. You cannot set the subnet mask if the Config. Mode is set to DHCP Server.

To set the subnet mask of the waveform monitor, touch the Press to Edit Subnet Mask soft key. This displays a screen where you can set the subnet mask using the following steps:

1. Touch the soft key that displays the subnet mask and reads: Select+Knob or Softkeys.
2. To change the subnet mask, press the SELECT button, turn the general purpose knob, touch the Increase Mask soft key, or touch the Decrease Mask soft key.
3. To save your changes, touch the Save Subnet Mask soft key. The changes you made will not be saved unless you touch this key.

Gateway Address. To change the gateway address, touch the Press to Edit Gateway Address soft key. This displays a screen where you can set the IP address using the following steps:

1. Touch the soft key that displays the gateway address and reads: Select+Knob or Softkeys. The first digit of the gateway address is selected (highlighted).
   - To select a different digit, press the SELECT button, touch the Move Right soft key, or touch the Move Left soft key.
   - To change the value of the selected digit, turn the general purpose knob, touch the Increase Value soft key, or touch the Decrease Value soft key.
2. To save your changes, touch the Save Gateway Address soft key. The changes you made will not be saved unless you touch this key.

Remote Control Port. When you enable the remote control port, you can use the Ground Closure remote interface to recall instrument presets stored in presets 36 to 42.

Refer to *Preset Menu* on page 2–81 for information about using the Preset menu. Refer to *Appendix C: Remote Control* for information about using the Ground Closure remote interface.

Choices: Disabled, Enabled
Default: Disabled

Remote Web Interface. When you enable the remote Web interface, you can control the instrument from a remote PC. Refer to *Appendix C: Remote Control* for information about operating the Web interface.

Choices: Disabled, Enabled
Default: Disabled

Calibration

Use the Calibration submenu of the Configure menu to adjust the following hardware settings:

Touchpanel Calibration. Select the Touchpanel Calibration submenu, and then touch Start Touchpanel Calibration. Follow the on-screen instructions to adjust the alignment between the place that a touch occurs and the place that the waveform monitor registers that touch.

Adjustments and Test (WFM700M Only). There are seven hardware adjustments and one performance test that can be enabled using this menu. These menu selections enable special instrument setups, which allow service personnel using specific test equipment to adjust internally stored calibration constants affecting WFM700M measurement accuracy. See Figure 2–11 on page 2–28.

CAUTION. *To prevent a misadjustment of the instrument, do not use the adjustment menu selections in the Hardware Settings submenu without referring to the* WFM700HD, WFM700A, & WFM700M Waveform Monitors Service Manual *(Tektronix, Inc. part number 071-0915-XX).*

System

In the System submenu of the Configure menu, you can set the instrument time and display format, run instrument diagnostics, and configure the instrument for the installation of a firmware upgrade.

Current Time. Use this menu selection to set the system time of the instrument. The current time will be shown in the top right corner of many display modes and will appear for each Event Log entry.

To set the system time of the waveform monitor, touch the Press to Edit System Time soft key. This displays a screen where you can set the current time using the following steps:

1. Touch the soft key that displays the time and reads: Select+Knob or Softkeys. The digits for the hours setting is selected (highlighted).
   - To select a different digit, press the SELECT button, touch the Move Right soft key, or touch the Move Left soft key.
   - To change the value of the selected digit, turn the general purpose knob, touch the Increase Value soft key, or touch the Decrease Value soft key.
2. To save your changes, touch the Save System Time soft key. The changes you made will not be saved unless you touch this key.

Time Format. Use this menu selection to set the format of the time display to either 12 hour or 24 hour.

Default: The time format is not reset by the Restore Factory function in the Preset menu.

Current Date. Use this menu selection to set the system date of the instrument. The current date will be shown in the top right corner of many display modes and will appear for each Event Log entry.

To set the system date of the waveform monitor, touch the Press to Edit System Date soft key. This displays a screen where you can set the current date using the following steps:

1. Touch the soft key that displays the time and reads: Select+Knob or Softkeys. The digits for the year setting is selected (highlighted).
   - To select a different digit, press the SELECT button, touch the Move Right soft key, or touch the Move Left soft key.
   - To change the value of the selected digit, turn the general purpose knob, touch the Increase Value soft key, or touch the Decrease Value soft key.
2. To save your changes, touch the Save System Date soft key. The changes you made will not be saved unless you touch this key.

Date Format. Use this menu selection to set the format of the time display to either mm/dd/yyyy or dd/mm/yyyy.

Default: The date format is not reset by the Restore Factory function in the Preset menu.

Powerup Diagnostics. In this menu, you can designate which diagnostics run when the instrument is powered on or rebooted.

Choices: Full, Brief
Default: The type of power-up diagnostics is not reset by the Restore Factory function in the Preset menu.

Diagnostics. In this menu, you can run the available diagnostic tests and display or print a log of the last diagnostic test that was run. For more details, refer to *Diagnostics* on page 3-12 and *Logging* on page 3-40.

Choices: Run Full Powerup Diagnostics, Run Internal Digital Path Diagnostics, Run Audio Path Diagnostics (Option DG module only), View Diagnostic Log, Print Diagnostics Log

***NOTE**. Running the Internal Digital Path Diagnostics sets the instrument to a special diagnostics configuration mode. After running this diagnostic, you must reboot the instrument to return to normal operation.*

Install Upgrade. Use this menu selection to configure the instrument for the installation of a firmware upgrade.

To perform a firmware upgrade, follow the instructions located in *Appendix E: Firmware Upgrade*. New software options and updated firmware will be released periodically. These may be found at the Tektronix, Inc. Web site: www.tektronix.com.

Cursor Menu

Pressing the CURSOR button enables the cursors (if the instrument is in a mode that supports cursors) and displays the Cursor menu, shown in Figure 2-16.

For Waveform, Eye, or Jitter, you can use voltage cursors, time cursors, or both voltage and time cursors. The cursor 1 and 2 settings, and the difference between the two, are shown in the readout in the upper right part of the screen. Time cursor settings are displayed below the voltage cursor settings. The absolute measurement of each cursor is shown on the soft key.

***NOTE**. The V+T Control soft key toggles the general purpose knob between controlling the voltage cursors and the time cursors when both cursor types are enabled.*

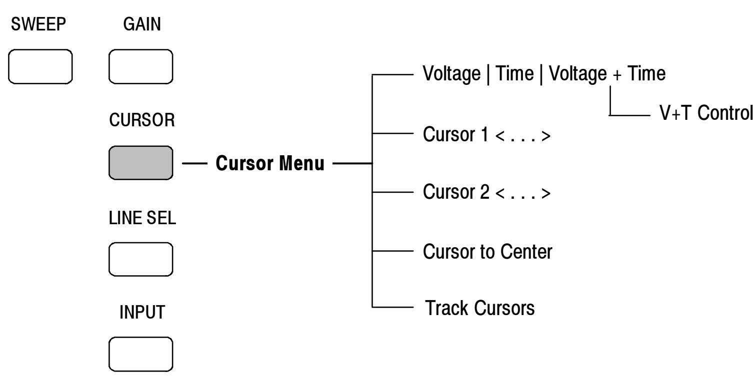


Figure 2-16: Cursor menu diagram

Waveform Cursors

The cursors appear as dashed lines, oriented vertically for time measurements and horizontally for amplitude measurements (see Figure 2-17). Cursor 1 has big line segments and cursor 2 has smaller line segments.

***NOTE**. When switching between normal sweep and MAG mode, the time cursors may change their horizontal position slightly. This is due to the increased horizontal resolution provided in MAG mode.*

Do not use the time cursors to measure time between components in a paraded waveform display. Parade mode is a special display format that represents all displayed components in a single screen, irrespective of the time relationship between components.

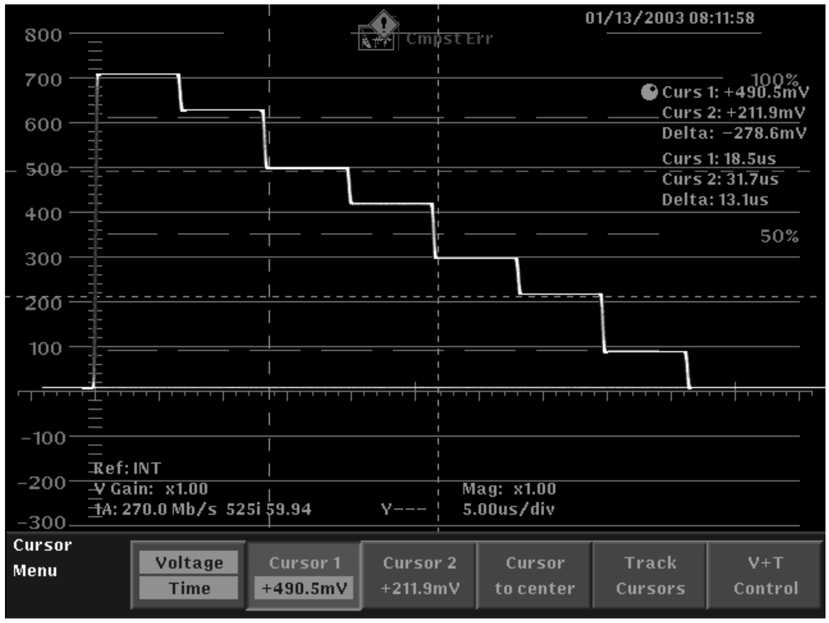


Figure 2-17: Waveform measurement cursors

Moving the Cursors

Selected (active) cursors are red and inactive cursors are blue.

To move the active cursor:

1. Touch the Voltage/Time soft key to select the cursor type: voltage, time, or both voltage and time. If you select both, use the V+T Control soft key to toggle between adjusting voltage cursors and adjusting time cursors.
2. Touch the corresponding soft key to select the active cursor: Cursor 1, Cursor 2, or Track Cursors. (Use Track Cursors if you want to adjust the position of either the voltage or the time cursors as a pair.) If Track Cursors is not selected, you can use the SELECT button to toggle between Cursor 1 and Cursor 2 as the active cursor.
3. Turn the general purpose knob to move the active cursor(s). The corresponding readouts and soft key displays update as you move the cursors.
4. You can touch the Cursor to Center soft key to move the selected cursor to the center of the display.

NOTE. *Mag or Gain settings other than X1 may cause the cursors to be off screen.*

Readouts

The cursor readouts appear on the right side of the screen. Two sets of readouts show the cursor 1 value, the cursor 2 value, and the difference between the two, for both voltage cursors (in mV or IRE) and time cursors (in μs). Voltage cursor readouts appear in IRE only in composite mode.

Cursor readouts are updated as you move the cursors.

Gain and Sweep with Cursors

At times the cursors may be off the screen when you select Mag or Gain settings other than X1. The readout of delta between the cursors is accurate even though one or both are off screen. You can make much more accurate measurements by using cursors in high gain or magnification modes. The all-digital design of the waveform monitor enables this accuracy because the value step between each pixel on the screen is smaller in higher Gain and Mag settings.

Cursor Menu Selections

You can select the following parameters:

Cursor Type. Selects the desired cursor function. When the cursor type is set to Voltage + Time, the V+T Control soft key appears. Touch the V+T Control soft key to select which cursor, Voltage or Time, is controlled by the general purpose knob. The selected cursor is highlighted.

Choices: Voltage, Time, Voltage + Time

Cursor 1 or Cursor 2. Assigns the general purpose knob to move Cursor 1 or Cursor 2.

Cursor to Center. Moves the selected cursor to the center of the screen.

Track Cursors. Assigns the general purpose knob to move both cursors as a unit.

V + T Control. When the cursor type is set to Voltage + Time, the V+T Control soft key appears. Touch the V+T Control soft key to select which cursor, Voltage or Time, is controlled by the general purpose knob. The selected cursor is highlighted.

Exit

To remove the Cursor menu but leave the cursors enabled, press the CLR MENU button or another major mode button.

To turn off the cursors, press the CURSOR button once when the Cursor menu is displayed or twice when the Cursor menu is not displayed.

Display Menu

Pressing the DISPLAY button opens the Display menu, shown in Figure 2-18. In the Display menu, you can adjust display parameters through the Trace, Graticule, and Readout & Backlight submenus. You can enable the thumbnail picture or Sleep mode. Touch the soft key (menu item) corresponding to the parameter that you want to adjust.

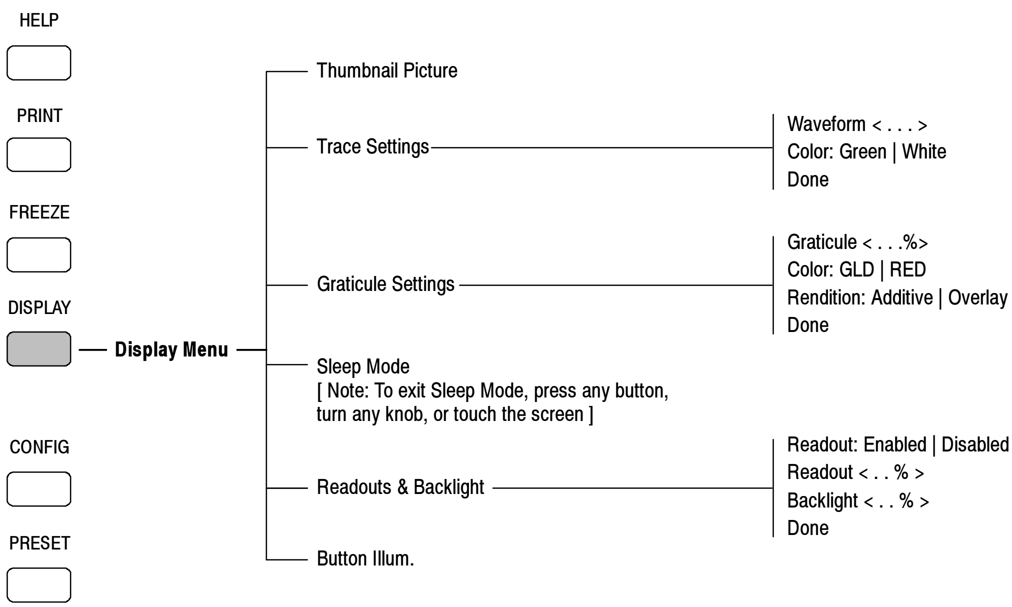


Figure 2-18: Display menu diagram

Thumbnail Picture

Enables a small video display in the lower right corner of the screen. The thumbnail picture is available in Waveform, Vector, Data, and Gamut display modes. The thumbnail picture will appear in the Multi mode display when the right window is set to one of these display modes.

If Line Select is enabled and the selected line is in an active picture region, that line appears as a yellow horizontal line in the thumbnail picture. If Sample Select is also enabled, the position of the selected sample will be shown by the intersection of horizontal and vertical yellow lines.

***NOTE**. Due to the number of pixels used to represent the thumbnail picture, not all of the video content can be accurately reproduced by this display. The thumbnail picture offers a means of visually identifying the content present at the active input and is not designed to replace the rear-panel PIX MON outputs, which contain all of the video content.*

Trace Settings

You can make the following trace settings:

Waveform. Assigns the general purpose knob to adjust waveform intensity.

Range: –99 to +40
Default: nominal (0)

Color. Toggles the waveform color. White is preferred in some applications. However, green has greater dynamic range because the trace goes to white for the highest intensity signals.

Choices: Green, White
Default: White

Done. Returns to the Display menu.

Graticule Settings

You can make the following graticule settings:

Graticule. Assigns the general purpose knob to adjust graticule intensity.

Range: 0% to 100%
Default: 50%

Graticule Color. Toggles the graticule color.

Choices: GLD (gold), RED
Default: GLD

Rendition. Toggles the graticule rendition. Additive adds the waveform and graticule points together, causing the points of intersection to appear brighter (unless the intensity is already at maximum). Overlay causes the graticule to be drawn on top of the waveform.

Choices: Additive, Overlay
Default: Additive

Done. Returns to the Display menu.

Sleep Mode

Turns the LCD backlight off or nearly off. The Display button LED blinks while Sleep mode is active, so you know that the instrument is still functional. To return the backlight to the previous state, press any front-panel button, turn any front-panel knob, or touch the touch screen.

Readouts & Backlight

You can make the following readout settings:

Readout Enabled. Enables or disables the readout.

Default: Enabled

Readout. Assigns the general purpose knob to adjust readout intensity.

Range: 0% to 100%
Default: 50%

Backlight. Assigns the general purpose knob to adjust LCD backlight intensity.

Range: 5% to 100%
Default: 100%

Done. Returns to the Display menu.

Button Illumination

Enables or disables a constant 10% illumination of the front-panel button LEDs. This selection is useful when the instrument is being used in a darkened room.

Under normal operation, front-panel LEDs are fully illuminated only when the associated button is selected. Use this menu selection to illuminate all of the LEDs at a 10% level. The LEDs will still illuminate fully when the associated button is selected.

Default: Disabled

Eye Menu (WFM700M Only)

To access the Eye menu and measurements, you must have a WFM700M or a unit with a WFM7M installed.

Pressing the EYE button enters the Eye mode and displays the Eye menu as shown in Figure 2-19. You can select Eye or Jitter display. When returning to Eye mode, the last selected display (Eye or Jitter) is active. For more information about the Eye mode, refer to *Eye Mode (WFM700M Only)* on page 3-14.

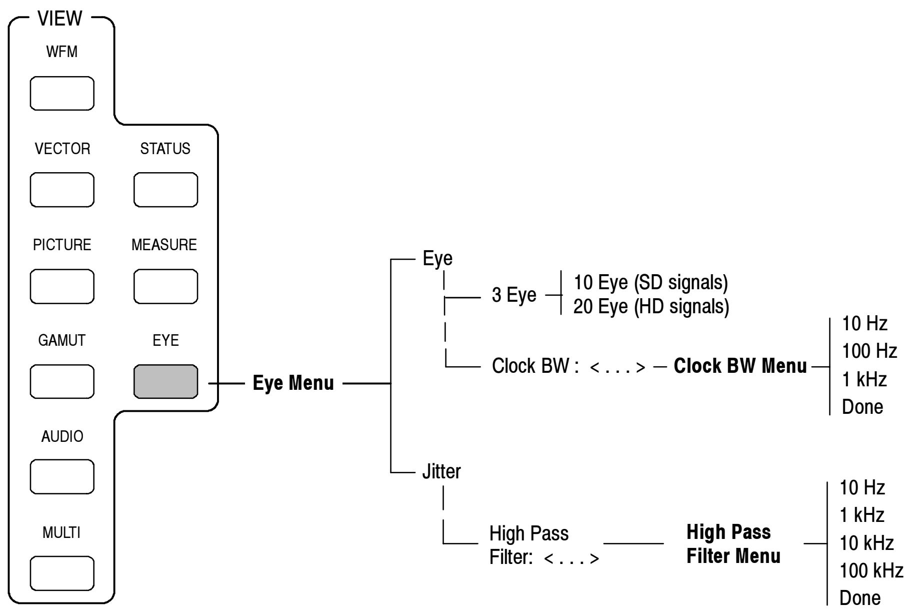


Figure 2-19: Eye menu diagram

Alarm Icon and Gamut Error Indicator Availability in Eye / Jitter Mode

When the instrument is in the Eye / Jitter operating mode, all of the General, Serial, and Audio Alarms are detected and reported except for the following three General Alarms:

- RGB gamut
- Composite gamut
- Closed caption presence

Eye Measurements

For HD signals, you can set the Eye display mode, shown in Figure 2-20, to 3 Eye or 20 Eye. For SD signals, you can set it to 3 Eye or 10 Eye.

Default: 3 Eye

You can set the clock recovery bandwidth to 10 Hz, 100 Hz, or 1 kHz. When returning to Eye mode, the last selected value is restored.

Default: 10 Hz

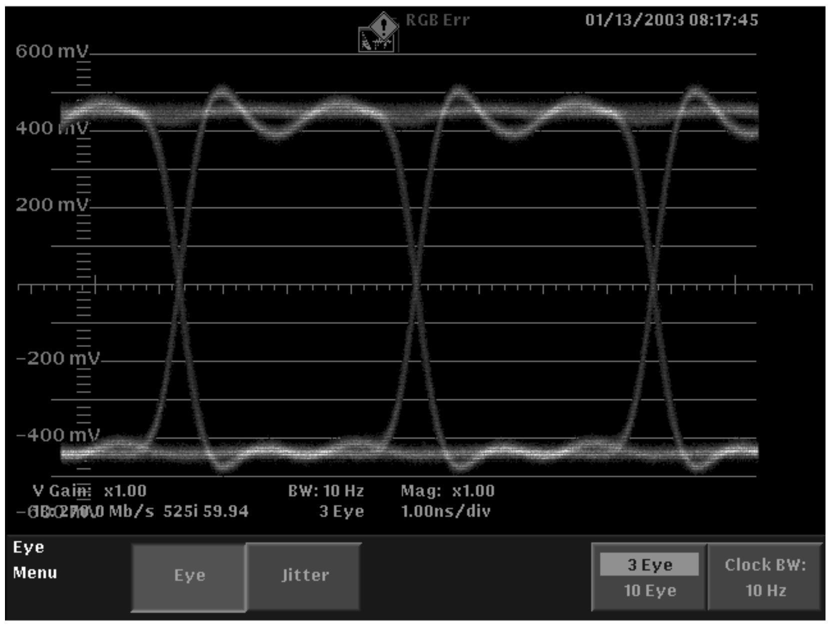


Figure 2-20: 3 Eye measurement display with SD signal

Jitter Measurements

In the Jitter display mode, shown in Figure 2-21, you can set the high-pass filter bandwidth to 10 Hz, 1 kHz, 10 kHz, or 100 kHz. When returning to Jitter mode, the last selected value is restored.

Default: 10 Hz

Refer to *Jitter Measurement Display* on page 3-22 for information about making jitter measurements.

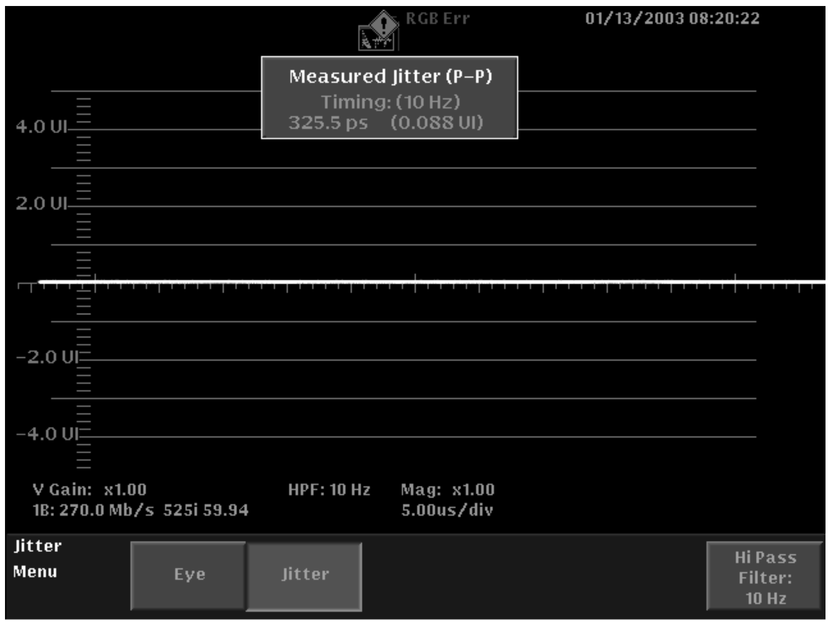


Figure 2-21: Jitter measurement display

Freeze Menu

Pressing the FREEZE button opens the Freeze menu, shown in Figure 2-22. Freeze mode lets you capture a signal.

***NOTE**. The Freeze function for the Data display in Measure mode freezes only the data waveform (left side of screen). The data list (right side of screen) continues to update in response to the incoming serial stream.*

The Freeze function does not operate for the Audio display because Audio display elements cannot be frozen. If a waveform is frozen, it will not be overlaid with audio when the Display Both function is selected.

If you have frozen a waveform (even if it is not displayed), the pixel density of the live waveform will be reduced. This is because the frozen waveform is using a portion of the display memory. Delete the captured waveform to regain full waveform density.

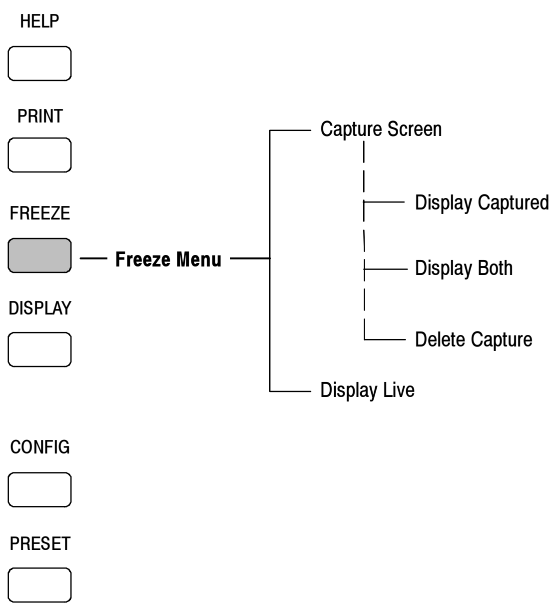


Figure 2-22: Freeze menu diagram

Capture Screen

Captures the active waveform as a “frozen” signal. When a capture is in the buffer, a freeze icon appears on the display and additional menu soft keys appear. The signal is held in the capture buffer until you delete it or touch the Capture Screen soft key to replace it with a new waveform.

Display Captured, Display Live, and Display Both

These three soft keys can be selected only one at a time. If the capture buffer is empty, Display Live is automatically selected. The other two soft keys are displayed only if there is a capture in the buffer.

Display Captured. This soft key displays the contents of the capture buffer instead of the active signal. The contents cannot be rescaled or repositioned.

Display Live. This soft key displays the active waveform. You can reposition the live signal using the horizontal and vertical position controls or apply various Gain or Sweep settings.

Display Both. This soft key displays both the contents of the capture buffer and the live waveform. The captured waveform appears in a contrasting color for ease of comparison with the live waveform. You can reposition the live signal using the horizontal and vertical position controls or apply various Gain or Sweep settings.

Delete Capture

When you touch this soft key, the contents of the capture buffer are deleted. The Freeze icon no longer appears on the display.

Exit

To exit the Freeze mode, press any major mode button or press the CLR MENU button. If the selection is Display Captured, the instrument will automatically change to Display Both mode upon exiting Freeze mode.

Gain Menu

Pressing the GAIN button displays the Gain menu, shown in Figure 2-23.

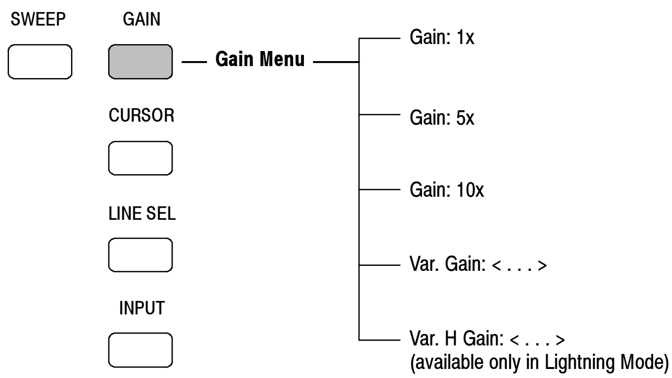


Figure 2-23: Gain menu diagram

To change the vertical gain, touch one of the soft keys (1x, 5x, or 10x). You can also select Variable Gain (labeled Variable Horizontal Gain in Lightning mode only). In variable gain modes, you can use the general purpose knob to set the gain. Turn left to decrease and right to increase the gain. The current gain setting is displayed on the soft key and in the readout.

The variable gain modes work together with the fixed settings. In this sense, the variable gain is a factor that applies to the fixed gain setting. For example, touch the 1x soft key, touch the Variable Gain soft key, and then turn the general purpose knob to select a setting of 1.50x. The vertical gain is 1.5. Now touch the 5x soft key. The gain is 7.50x (the product of 1.50 and 5).

***NOTE**. The variable gain range is from 0.25x to 14x. You cannot select values outside this range.*

Gain is only active in Waveform, Vector, Lightning, Eye, and Jitter modes.

In fixed gain settings, the vertical graticule appears with a calibrated scale. In Waveform mode, Jitter mode, and Eye mode variable gain, the graticule appears without a scale. In Vector and Lightning modes, the targets move when fixed gain settings are changed, but do not move as variable gain is adjusted.

The current gain setting is displayed in the lower left corner of the screen. The gain setting is displayed in yellow if variable gain is active.

Gamut Menu

Press the GAMUT button to enter the Gamut mode and display the Gamut menu shown in Figure 2–24.

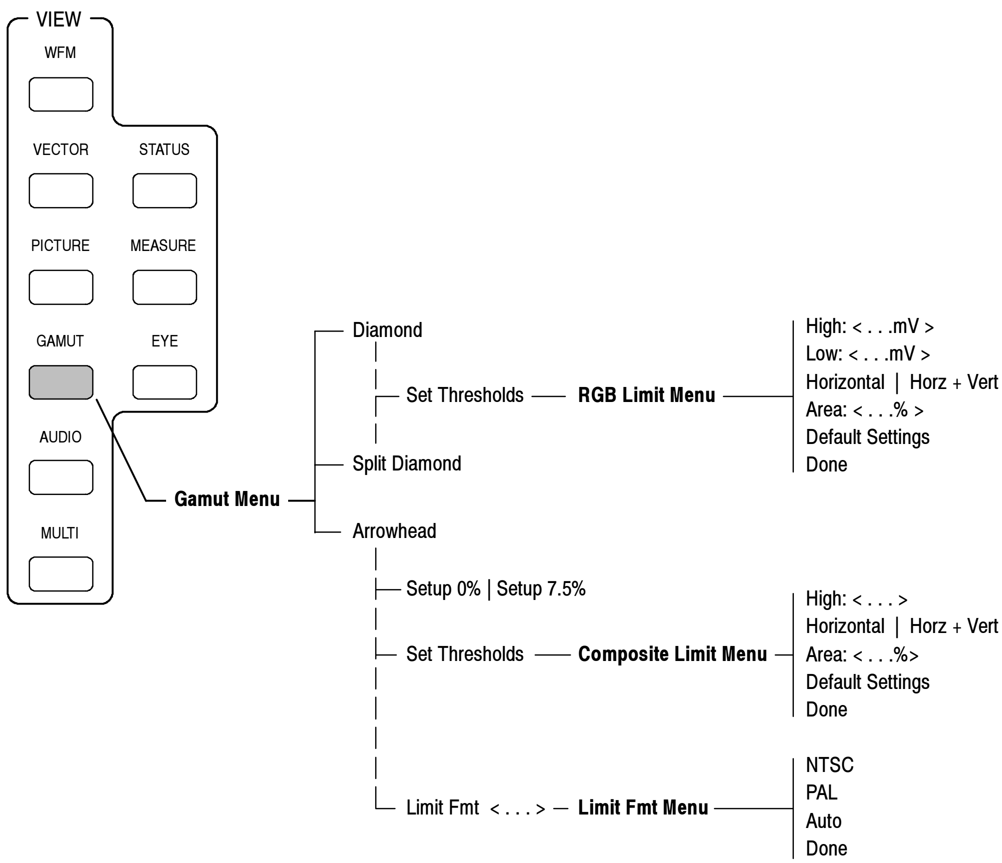


Figure 2-24: Gamut menu diagram

Displays

In the Gamut menu, you can select either the Diamond, Split Diamond, or Arrowhead displays, which are shown in Figure 2–25. For information about using these displays, refer to *Gamut Measurements* on page 3–28.

Diamond display

Split Diamond display

Arrowhead display

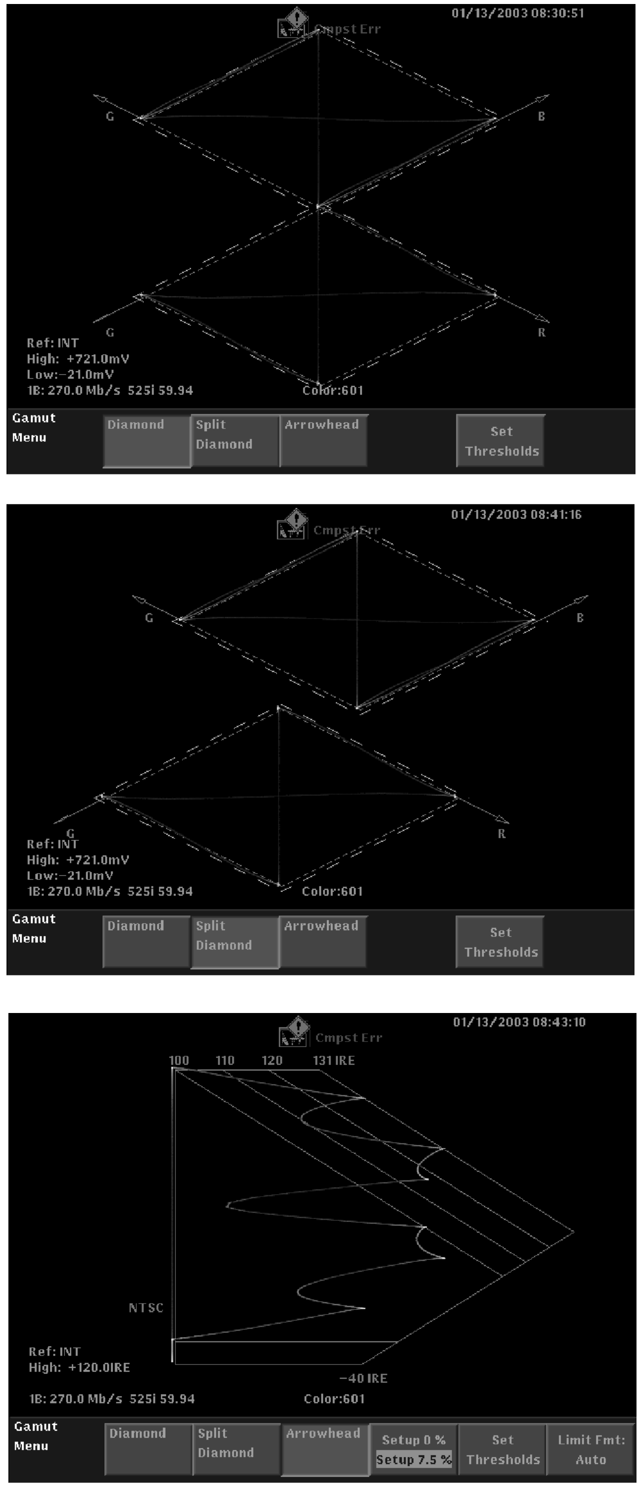


Figure 2-25: Diamond, Split Diamond, and Arrowhead measurement displays

Set Thresholds

Touch the Set Thresholds soft key, and then touch a soft key to choose the parameter you want to set. Touching the High, Low (if available), and Area soft keys assigns the general purpose knob to control the variable value. Variable ranges are shown in Table 2-6.

***NOTE**. When the Arrowhead display is selected, changing the thresholds in the NTSC limit format also changes the thresholds in the PAL limit format.*

High. Defines the threshold above which signals will be considered gamut errors.

Low. Defines the threshold below which signals will be considered gamut errors.

Horizontal | Horizontal + Vert. Touching the Horizontal | Horizontal + Vert soft key toggles between filtering in the horizontal dimension and filtering in both the horizontal and the vertical dimensions. This filtering reduces the overshoot from the conversion between color spaces before comparison with the selected gamut thresholds.

Area. Defines the percentage of total pixels in the image that you will allow to be out of gamut without reporting that the signal has a gamut error. The Area settings do not affect bright-up in the picture display.

Table 2-6: Variable ranges for High, Low, and Area thresholds

Mode	Minimum	Maximum	Default
NTSC	90 IRE	135 IRE	120 IRE
PAL	630 mV	930 mV	917 mV
Area	0%	10%	0%
High	+630 mV	+756 mV	+721 mV
Low	-50 mV	+35 mV	-21 mV

Default Settings. Touching the Default Settings soft key restores the default gamut limits for the current monitoring mode.

Setup (Arrowhead Only)

When you select Arrowhead, the Setup soft key is displayed. Touch this soft key to toggle between setup levels of 0% or 7.5%. When set to 7.5%, the composite waveform representation has 7.5 IRE of setup. When you change the setup setting between 0% and 7.5% in any menu, the setup setting in all other display-mode menus changes to match the current setting.

Default: 7.5%.

Limit Format (Arrowhead Only)

When you select Arrowhead, the Limit Format soft key is displayed. Touch this soft key to enter the submenu and select which format (NTSC, PAL, or Auto) you want to use as the limiting format for gamut errors. For example, you may be working with an HD video signal, but if one of the target viewing formats is NTSC, select NTSC to limit the color space to the NTSC format.

If you select Auto, the instrument assigns gamut limits that are appropriate for the current input video format.

Help Menu

Press the HELP button to enter the Help menu shown in Figure 2-26.

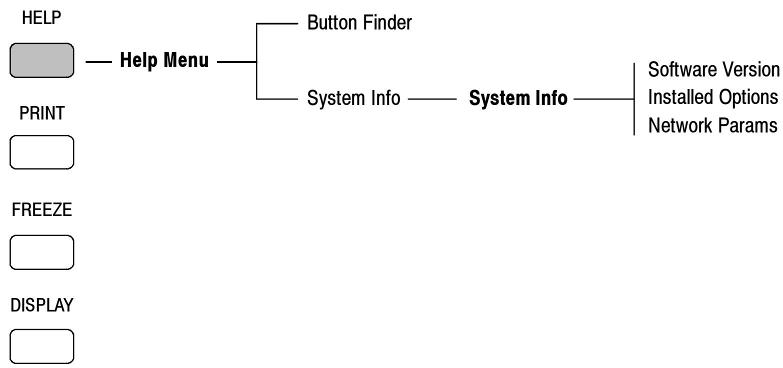


Figure 2-26: Help menu diagram

The Help menu provides access to the following:

Context-Sensitive Help

When the instrument is in a major mode, such as Waveform or Vector, pressing the HELP button displays help about that mode.

Button Finder

Touch the Button Finder soft key to illuminate all of the front-panel buttons for viewing in low-light conditions. To turn the button finder off, touch the Button Finder soft key again or press any button.

System Information

Touch the System Info soft key, and then touch one of the following soft keys to view the desired system information:

Software Version. Displays the instrument software version, which is automatically updated if you upgrade the instrument software.

Installed Options. Displays the modules you have installed in the waveform monitor. This information updates automatically when you install a new module.

Network Parameters. Displays the network parameters such as the Ethernet and IP addresses. To change these settings, use the Configure menu (shown starting on page 2-26).

Input Menu

Press the INPUT button to enter the Input mode, which displays the Input menu shown in Figure 2-27. For a list of supported input and reference signal formats, refer to *Appendix B: Supported Video Standards*.

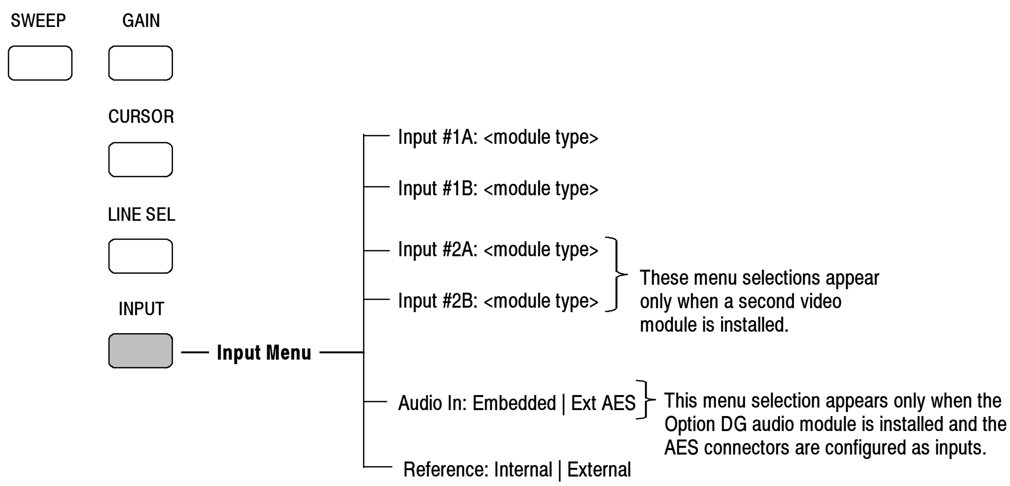


Figure 2-27: Input menu diagram

Selecting the Active Video Input

You can select the active video input from four possible inputs: input A and B for each installed video module, with up to two video modules installed. Soft keys appear only for the video modules that are installed.

The video inputs are labeled #1A, #1B, #2A, and #2B on the soft keys. The soft key labels for each video module also identify the type of video module installed in that slot (WFM7A, WFM7HD, or WFM7M).

Default: Input #1A

Selecting the Active Audio Input (Option DG Only)

You can select the active audio input from either the selected video input (embedded audio) or from the AES inputs.

***NOTE**. This menu selection appears only when the Option DG audio module is installed and the AES connectors are configured as inputs.*

Choices: Embedded, External AES
Default: Embedded

Selecting the Reference Mode

You can select which reference the instrument will use: Internal or External.

Internal. Selects the active signal as the reference. This is the default setting.

External. Selects the signal on the external reference input as the reference.

***NOTE**. The waveform monitor does not utilize the SMPTE 318M 10 Field Sequence flag. This causes inconsistent operation for combinations of input and reference format whose frame rates are not related by an integer multiplier. The inconsistent operation causes multiple possible timing orientations to be shown on the Waveform. The display is similar to that shown when a timing offset is present. The number of possible waveform orientations is related to the ratio of the input and reference frame rates.*

Line Select Menu

Pressing the LINE SEL button enables line select (if the instrument is in an operating mode that supports line select) and sample select (useful in Data mode only). Operating modes that support line select are: Waveform, Vector, Gamut, Jitter, Eye, and Data. The Line Select menu is shown in Figure 2-28.

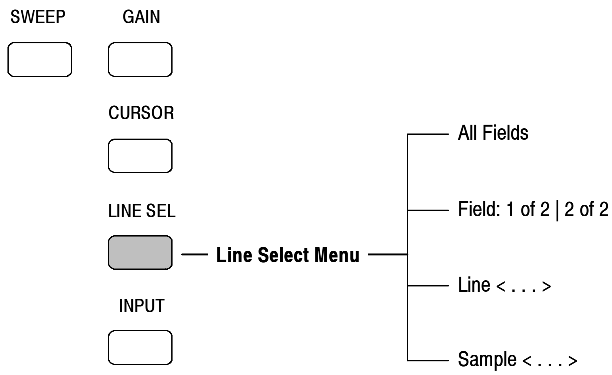


Figure 2-28: Line Select menu diagram

You can also enable line select by pressing the MEASURE button and entering the Data Display (WFM700M only). The selected line is highlighted in Picture mode and in the thumbnail picture. The external picture monitor signals also contain a bright-up, which is enabled in the Configure menu.

Selecting the Line or Sample

Touch either the Line or the Sample soft key to select which item you can change with the general purpose knob.

All Fields. Toggles the display between All Fields and Field: 1 of 2 / 2 of 2.

Field. Toggles the Field display between the first and second video fields. This selection is not available for progressive input formats or when All Fields is selected.

Choices: 1 of 2, or 2 of 2
Default: 1 of 2

Line. Assigns the general purpose knob to select the line. Press the SELECT button to toggle the general purpose knob assignment between Line and Sample.

Range: From line 1 to the maximum line number for the selected format.
Default: Line 1

Sample. (The sample select function is useful in Data mode only.) Assigns the general purpose knob to select the sample. Press the SELECT button to toggle the general purpose knob assignment between Sample and Line.

Range: From sample 1 to the maximum sample number for the selected format.

Exiting Line Select

To exit the Line Select menu and leave Line Select mode enabled, press the CLR MENU button or any major mode button. The line select indicator remains in the upper right corner of the screen, showing you which line or sample is selected. If you use the CLR MENU button, readouts, if present, will move down to the bottom of the screen.

To disable and exit the Line Select mode, press the LINE SELECT button again.

Measure Mode Menu (WFM700A and WFM700HD Only)

For instruments with only WFM7A and/or WFM7HD video modules installed, when you press the Measure button, you access the Bowtie mode. The Bowtie mode allows you to determine relative timing and gain differences between the three component signals, Y, P_b, and P_r, when you send a Bowtie signal through your system. Refer to *Bowtie Mode* on page 3-7 for more information.

Measure Mode Menus (WFM700M Only)

To access the Measure menu and Data Display mode, you must have a WFM700M or an instrument with a WFM7M module installed.

Press the MEASURE button to open the Data menu, shown in Figure 2-29. Use the Data Display mode to view the actual data used for measurements by the instrument. For more information about using the Data Display mode, refer to *Data Display (WFM700M Only)* on page 3-9.

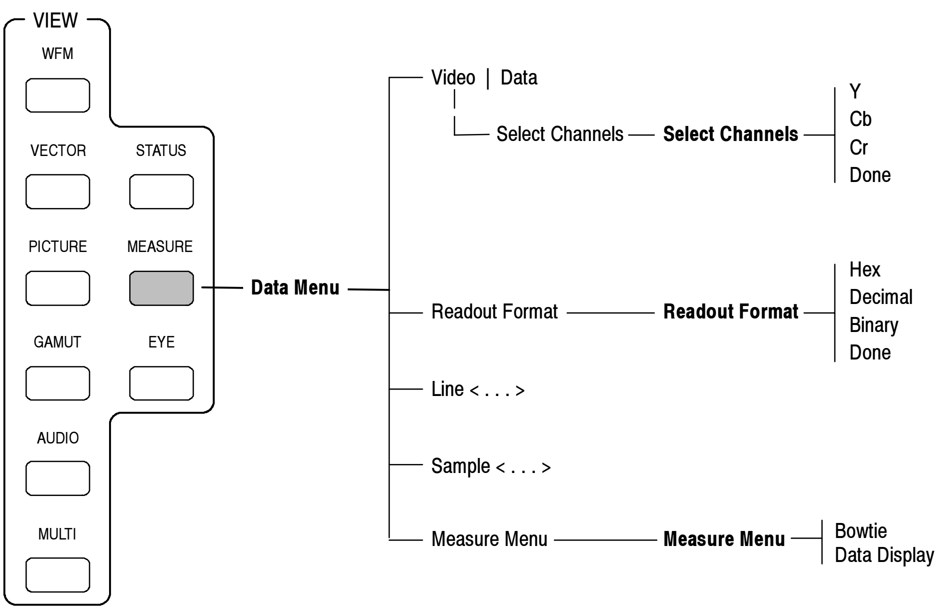


Figure 2-29: Data menu diagram

Data Display

You can select the following parameters in the Data menu:

Video / Data. Touch the Video / Data soft key to toggle between video display and a data display.

Default: Video

- Video mode shows the data like the video YPbPr display in waveform mode, but without interpolation (see Figure 2-30). The Y, Cb, and Cr traces are offset vertically to separate them, but are aligned temporally.
- Data mode for SD shows the data in the same sequence as it occurs in the serial domain (see Figure 2-31). You see a sample of Y, then of Cb, then of Y' (Y prime), and then of Cr. Then the sequence repeats. The Y sample is the co-sited sample, and the Y' sample is the isolated luma sample.
- Data mode for HD splits the serial input into a Y channel and a multiplexed Cb/Cr channel. The intent is to show the data in the same block structure as it occurs in the serial domain, even though it is displayed as 8 or 10-bit values.

***NOTE**. Selecting Freeze in Data Display mode freezes only the waveform portion (left side of screen) of the data display. The data list continues to update in response to input signal changes, if any.*

Select Channels (Video Only). This soft key appears only when Video is selected (highlighted in the Video / Data soft key). Pressing this key displays a set of soft keys that lets you turn off individual components of the display. At least one component must be displayed at all times.

Readout Format. Opens the Readout Format menu; touch a soft key to choose the base in which to view the data display.

Choices: Hex, Decimal, Binary
Default: Hex

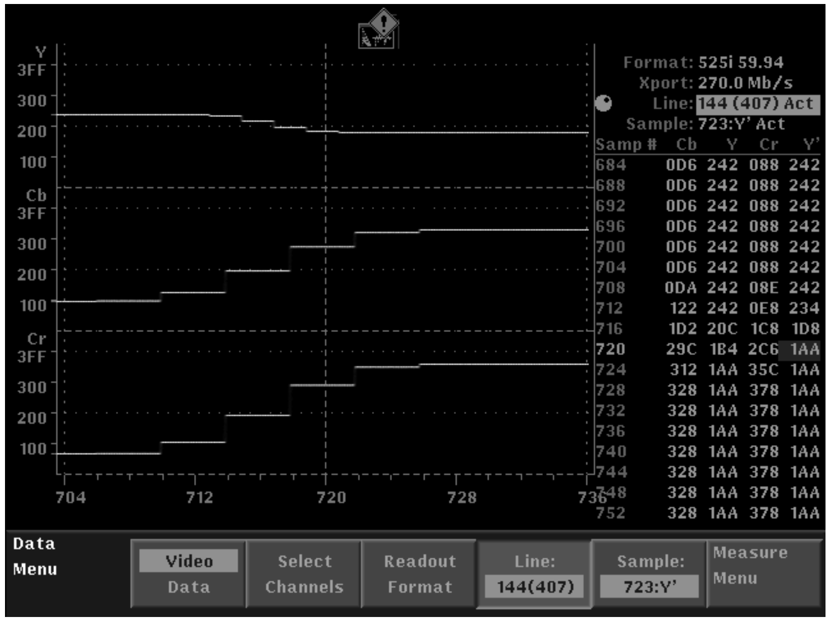


Figure 2-30: Data display in Video mode

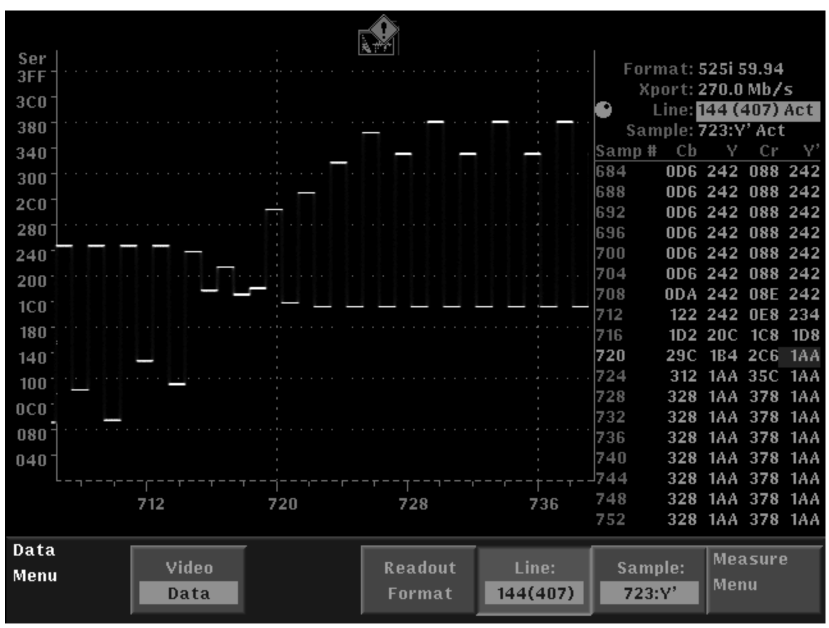


Figure 2-31: Data display in Data mode

Line. Assigns the general purpose knob to control the line and field number.

Range: From field 1, line 1 to the maximum field and line in the current input signal format.
Default: 1

Sample. Assigns the general purpose knob to control the sample number.

Range: As appropriate for the selected input signal format.
Default: 0:CbY

Measure Menu. Exits the Data Display mode and opens the Measure menu display, where you can access the Bowtie mode.

Bowtie Display

When you touch the Measure Menu soft key from the Data display mode, you can access the Bowtie mode. The Bowtie mode allows you to determine relative timing and gain differences between the three component signals, Y, P_b, and P_r, when you send a Bowtie signal through your system. Refer to *Bowtie Mode* on page 3–7 for more information.

Press the Data Display soft key to return to the Data Display mode.

Multi Menu

Press the MULTI button to enter Multi mode, which displays the Multi menu shown in Figure 2–32. Using Multi mode, you can show two different views of the same input signal side-by-side (see Figure 2–33). You can view the current Waveform, Vector/Lightning, Gamut, Audio, Status, or Data Display in either of the two windows.

***NOTE**. Multi mode shows two different views of the same input signal. You must use the Input menu to select a different input signal to display.*

The front-panel controls affect only the display mode in the currently selected Multi-mode window. The currently selected window is highlighted, as shown by a box around that window. You can use any of the following methods to switch front-panel control to the other window:

- Press the SELECT button
- Touch the Selected Window softkey
- Touch the desired window on the touchscreen display

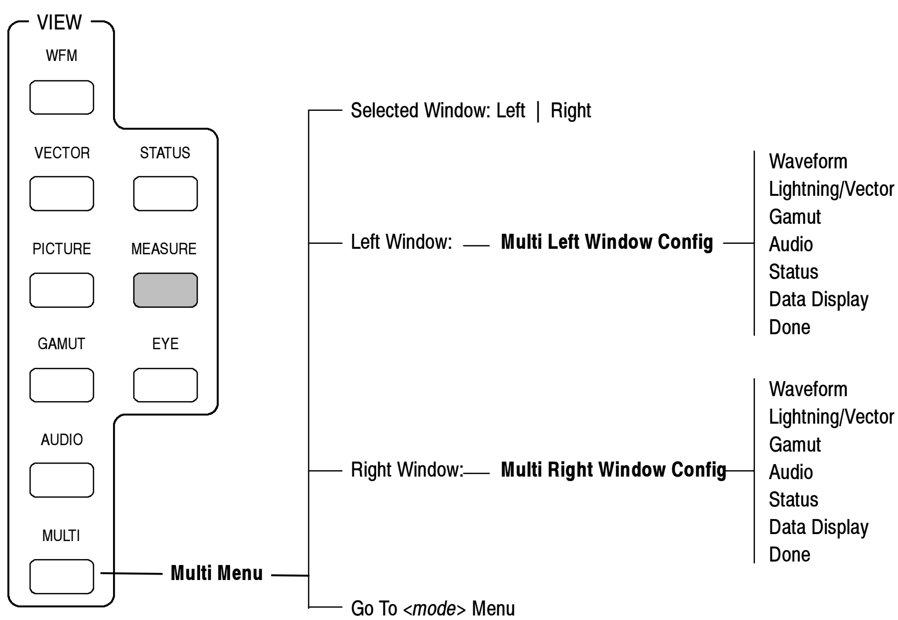


Figure 2-32: Multi menu diagram

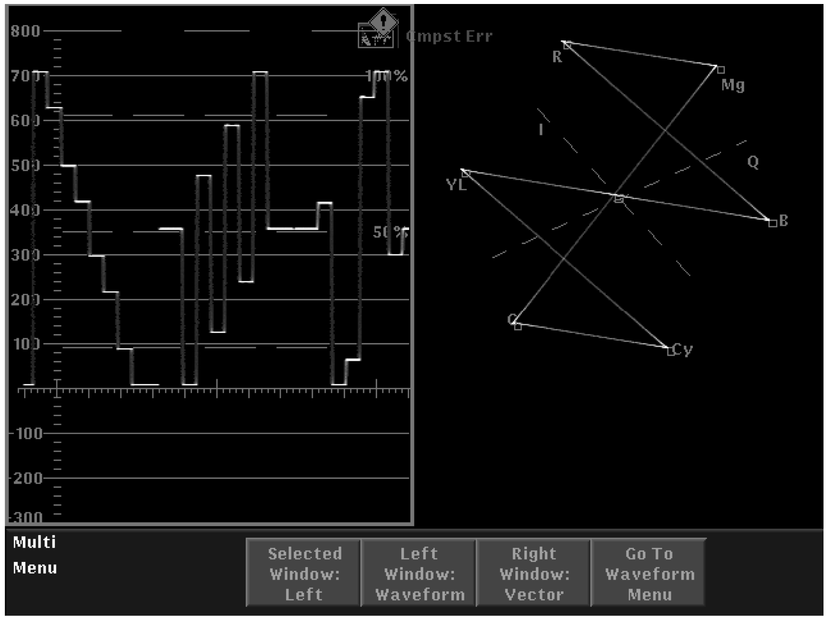


Figure 2-33: Multi mode showing the Waveform and Vector displays

The Multi-mode menu provides the following menu selections:

Selected Window

Touch this soft key to toggle front-panel control between the display modes shown in the two windows. The front-panel controls affect only the display mode in the currently selected Multi-mode window. The currently selected window is highlighted, as shown by a box around that window.

Left Window: <*Mode*>

Touch the Left Window soft key to select which display mode will be shown in the left window of the Multi-mode display. The currently selected display mode is listed on the soft key. For example, if Waveform is the currently selected display mode, the soft key displays Left Window: Waveform.

Touching the Left Window soft key opens the Multi Left Window Config submenu. Touch the associated soft key to select a display mode, and then touch the Done soft key to enable that display mode and return to the Multi menu.

The display mode shown in the left window must be a different mode than the display mode shown in the right window.

Choices: Waveform, Lightning/Vector, Gamut, Audio, Status, Data Display, Done
Default: Waveform

Right Window: <*Mode*>

Touch the Right Window soft key to select which display mode will be shown in the right window of the Multi-mode display. The currently selected display mode is listed on the soft key. For example, if Waveform is the currently selected display mode, the soft key displays Right Window: Waveform.

Touching the Right Window soft key opens the Multi Right Window Config submenu. Touch the associated soft key to select a display mode, and then touch the Done soft key to enable that display mode and return to the Multi menu.

The display mode shown in the right window must be a different mode than the display mode shown in the left window.

Choices: Waveform, Lightning/Vector, Gamut, Audio, Status, Data Display, Done
Default: Lightning/Vector

Go To <*Display Mode*> Menu

Press the Go To soft key to open the menu for the operating mode in the currently selected Multi-mode display. The name of the selected display is listed on the soft key. For example, if Waveform is the display mode in the currently selected Multi-mode window, this soft key displays Go To Waveform Menu.

***NOTE**. Changes you make in the menu of an operating mode while the instrument is in Multi mode affect that operating mode when you exit Multi mode.*

Picture Mode

Press the PICTURE button to display a full screen representation of the video signal present at the selected input. The Picture mode has no menu. To enable a thumbnail picture that appears in other modes, go to the Display menu (see page 2–56).

***NOTE**. Due to the number of pixels in the LCD display of the waveform monitor, not all of the video content (particularly in HD formats) can be reproduced with 100% accuracy by this display module. The picture display offers a means of visually identifying the content present at the active input and is not designed to replace the rear-panel PIX MON outputs, which contain all of the video content.*

Preset Menu

The Preset menu (see Figure 2-34) allows you to store and recall instrument configuration settings. There are 42 user-programmable presets available in addition to the Factory preset. You can designate up to four presets as shortcuts. To help you remember the functionality of the the presets you have created, you can assign names to the presets using up to eight characters.

Presets 36 to 42 are labeled “Remote” to signify that these presets can be recalled by the remote control port. Refer to *Remote Control Port* on page 2-50 for information about enabling or disabling this function. Refer to *Appendix C: Remote Control* for information about using the remote control port.

Pressing the PRESET button displays page 1 of the Preset menu. Page 1 of the Preset menu allows you to load one of four presets you have previously set up as shortcuts. You can also restore the instrument to its configuration state before you loaded a preset.

Use page 2 of the Preset menu (see Figure 2-35) to save, remove, and rename presets and to restore the instrument to the factory-default configuration. To display page 2 of the Preset menu, touch the More soft key.

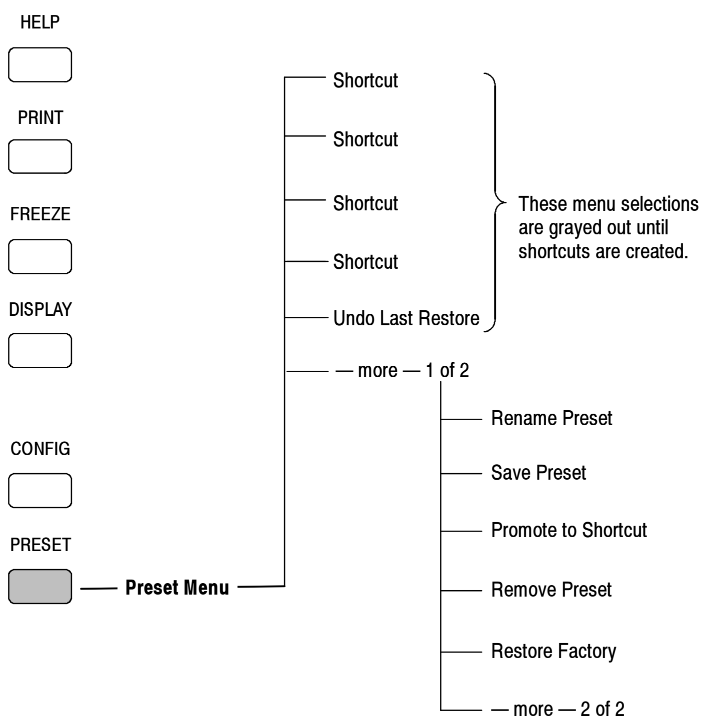


Figure 2-34: Preset menu diagram

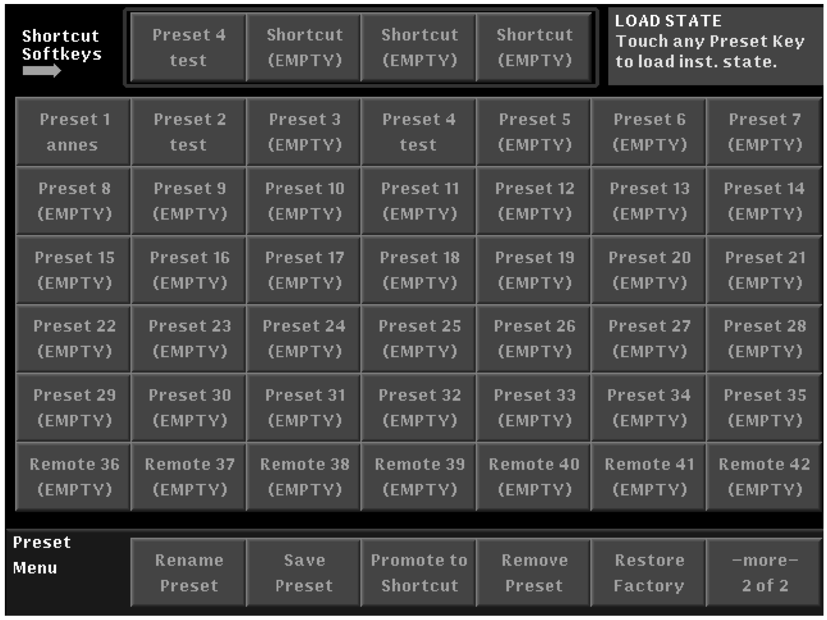


Figure 2-35: Page 2 of the Preset menu

Shortcut

Touch one of the Shortcut soft keys on page 1 of the Preset menu to load one of the four presets that you have previously setup as a shortcut. If the shortcut is empty, the instrument displays a message and will not load the shortcut. To store a preset as a shortcut, use the Promote to Shortcut soft key on page 2 of the Preset menu.

Undo Last Preset

After you load a preset, the Undo Last Preset soft key appears on page 1 of the Preset menu. Touch this soft key to return the instrument configuration to the state it was in prior to loading the last preset.

More <x> of 2

This soft key appears on both pages of the Preset menu. Touch this soft key to toggle between the two menu pages. 1 of 2 or 2 of 2 appears on the soft key to indicate which menu page you are viewing.

Load State

The Load State prompt appears in a box in the upper right corner of the screen when you first open page 2 of the Preset menu. When this prompt is displayed, you can touch any preset to load the instrument settings stored in that preset.

The user-prompts displayed in the box change depending on the menu command you select on page 2 of the Preset menu. These prompts are displayed to help you use the Preset menu commands.

Rename Preset

To rename a preset, first touch the Rename Preset soft key on page 2 of the Preset menu. Next, touch a preset to rename, as prompted by yellow text in the upper right corner of the screen. An alphanumeric entry screen is provided to rename the selected preset. Enter the name (up to eight characters), and then touch the Done soft key to accept or the Cancel soft key to cancel the rename operation.

***NOTE**. You cannot rename an empty preset. You must first save the preset.*

Save Preset

To save the current instrument configuration in a preset, first set up the instrument configuration as you want it saved. Next, touch the Save Preset soft key on page 2 of the Preset menu. Touch the desired preset on the screen, as prompted by yellow text in the upper right corner of the screen. The instrument settings are then stored in the preset you selected.

After you have saved a preset, you can then use the Rename Preset soft key to attach a name to the preset to help you remember the instrument configuration saved in that preset.

Promote to Shortcut

You can save up to four presets as shortcuts. The presets you save as shortcuts appear on the first page of the preset menu, providing you a quicker method of recalling commonly used presets.

To store an instrument setup in a shortcut key, first save the setup as a preset. Then touch the Promote to Shortcut soft key on page 2 of the Preset menu. Touch the desired preset on the screen, as prompted by yellow text in the upper right corner of the screen, and then touch the shortcut number to which the preset will be assigned.

After you have promoted a preset to a shortcut, the associated shortcut soft key on page 1 of the Preset menu will display the preset number (1 to 42) assigned to that shortcut and will display the custom name of the preset if you had assigned one to the preset.

Remove Preset

To delete the contents of a preset, first touch the Remove Preset soft key on page 2 of the Preset menu. Then touch the preset that you want to empty, as prompted by yellow text in the upper right corner of the screen. The contents of the preset are deleted. If the preset had been given a custom name, it will revert to (EMPTY).

Restore Factory

To restore all instrument settings to the factory presets, touch the Restore Factory soft key on page 2 of the Preset menu. Table 2-7 lists the factory default instrument settings restored by this soft key.

Table 2-7: Factory default instrument settings

Parameter	Setting	Comments
Display mode (VIEW)	Waveform	
Input menu		
Selected Input	Input #1A	
Audio In	Embedded	
Reference	Internal	
Sweep menu		
Parade/Overlay mode	Parade	
Sweep	Line	
Mag	Off	
Gain menu		All display modes
Gain	1x	
Variable Gain	Off (1.00x)	

Table 2-7: Factory default instrument settings (Cont.)

Parameter	Setting	Comments
Display menu		
Thumbnail Display	Enabled	
Display Intensity (Waveform)	0	
Trace Color	White	
Graticule Intensity	50%	
Graticule Color	Gold	
Graticule Rendition	Additive	
Readouts	Enabled	
Readout Intensity	50%	
Backlight Intensity	100%	
Button Illumination	Disabled	10% constant intensity when enabled
Line Select menu		Line Select mode is off by default.
Fields	1 of 2	
Line	1	
Sample	0:CbY	
Cursor menu		Cursors are turned off by default.
Cursor Type	Time	
Cursor 1	0.00 μs	
Cursor 2	180.0 μs	
Sample	0:CbY	
Waveform menu		
Parade/Overlay mode	Parade	
Color Space	YPbPr	
Filter	Flat	
Vector menu		
Vector Display	Vector	
Vector Graticule	Component	
Color Bar Targets	75%	
Vector Composite Graticule Format	Auto	
Composite Setup	7.5% (IRE)	All modes

Table 2-7: Factory default instrument settings (Cont.)

Parameter	Setting	Comments
Eye Menu		
Eye Display	Eye	
Eye Pattern Mode	3 Eye	
Eye Clock Bandwidth	10 Hz	
Jitter High-Pass Filter	10 Hz	
Gamut Menu		
Display	Diamond	
SD Diamond Thresholds		
High	721 mV (3%)	
Low	-21 mV	
Area	Horizontal only; 0%	
HD Diamond Thresholds		
High	721 mV (3%)	
Low	-21 mV	
Filtering	Horizontal	
Area	0%	
SD Arrowhead Thresholds		PAL and NTSC limits are not stored separately. Factory default will use 840 mV (NTSC) value.
PAL	930 mV	
NTSC	120 IRE (840 mV)	
Filtering	Horizontal	
Area	0%	
HD Arrowhead Thresholds		PAL and NTSC limits are not stored separately. Factory default will use 840 mV (NTSC) value.
PAL	930 mV	
NTSC	120 IRE (840 mV)	
Filtering	Horizontal	
Area	0%	
Arrowhead Limit Format	Auto	

Table 2-7: Factory default instrument settings (Cont.)

Parameter	Setting	Comments
Data Menu (Measure mode)		
Display	Video	
Readout Format	Hexadecimal	
Audio menu (Option DG Only)		
Display	Level Meters	
Meter Scaling	Default	0 dBFS to -70 dBFS
Lissajous Pair	L & R	
Custom Lissajous Pair	L & R	
Lissajous Style	Soundstage	
Channel Status	L & R	
Channel Status Format	Text	
Multi Menu		
Left Window	Waveform	
Right Window	Vector	
Selected Window	Left	
Status menu		
Session Type	Video	
Session State	Stopped	Audio and video
Alarm Status Display	General Alarms	
Event Logging State	Stopped	
Log Filter Menu		
Events	Show All Events	
Alarms	Show All Alarms	

Table 2-7: Factory default instrument settings (Cont.)

Parameter	Setting	Comments
Configure menu		
General Alarms submenu		
RGB Gamut	On-screen and Logging: On; Beep and Ground Closure: Off	
Composite Gamut	On-screen and Logging: On; Beep and Ground Closure: Off	
Video Signal Missing	On-screen and Logging: On; Beep and Ground Closure: Off	
Video Format Change	On-screen and Logging: On; Beep and Ground Closure: Off	
Video Format Mismatch	On-screen and Logging: On; Beep and Ground Closure: Off	
Video-Ref Fmt Mismatch	On-screen and Logging: On; Beep and Ground Closure: Off	
Ext Ref Signal Missing	On-screen, Beep, Logging, and Ground Closure: Off	
Ext Ref Format Mismatch	On-screen and Logging: On; Beep and Ground Closure: Off	
Anc Data Presence	On-screen, Beep, Logging, and Ground Closure: Off	
Anc Data Parity	On-screen and Logging: On; Beep and Ground Closure: Off	
Anc Data Checksum	On-screen and Logging: On; Beep and Ground Closure: Off	
Closed Caption Presence	On-screen, Beep, Logging, and Ground Closure: Off	

Table 2-7: Factory default instrument settings (Cont.)

Parameter	Setting	Comments
Configure menu (continued)		
Serial Alarms submenu		
RP165 EDH Status (SD-only)	On-screen and Logging: On; Beep and Ground Closure: Off	
RP165 FF CRC	On-screen and Logging: On; Beep and Ground Closure: Off	
RP165 AP CRC	On-screen and Logging: On; Beep and Ground Closure: Off	
SMPTE292 Y CRC	On-screen and Logging: On; Beep and Ground Closure: Off	
SMPTE292 C CRC	On-screen and Logging: On; Beep and Ground Closure: Off	
SDI Code Word Violation	On-screen and Logging: On; Beep and Ground Closure: Off	
SDI Line Length Error	On-screen and Logging: On; Beep and Ground Closure: Off	
SDI Field Length Error	On-screen and Logging: On; Beep and Ground Closure: Off	
SDI SAV Placement	On-screen and Logging: On; Beep and Ground Closure: Off	
292M Line Mismatch	On-screen and Logging: On; Beep and Ground Closure: Off	

Table 2-7: Factory default instrument settings (Cont.)

Parameter	Setting	Comments
Configure menu (continued)		
Audio Alarms submenu (Option DG audio module only)		
Emb. Audio Presence	On-screen, Beep, Logging, and Ground Closure: Off	
AES Audio Unlocked (Option DG audio module only)	On-screen, Beep, Logging, and Ground Closure: Off	
AES Audio Parity (Option DG audio module only)	On-screen and Logging: On; Beep and Ground Closure: Off	
Validity Bit (Option DG audio module only)	On-screen and Logging: On; Beep and Ground Closure: Off	
Professional CRC (Option DG audio module only)	On-screen and Logging: On; Beep and Ground Closure: Off	
Audio Mute (Option DG audio module only)	On-screen and Logging: On; Beep and Ground Closure: Off	
Audio Clip (Option DG audio module only)	On-screen and Logging: On; Beep and Ground Closure: Off	
Audio Silence (Option DG audio module only)	On-screen and Logging: On; Beep and Ground Closure: Off	
Audio Over (Option DG audio module only)	On-screen and Logging: On; Beep and Ground Closure: Off	
Emb. Group Sample Phase (Option DG audio module only)	On-screen and Logging: On; Beep and Ground Closure: Off	

Table 2-7: Factory default instrument settings (Cont.)

Parameter	Setting	Comments
Configure menu (continued)		
Graticule Setup submenu		
Vec I/Q Axis Graticule (Component)	On	Both HD and SD
Compass Rose Graticule (Component)	Off	
Video Inputs / Outputs submenu		
Strip EAV/SAV (WFM)	Strip	
Ext Ref Format	Auto Select	
Video Input Format	Any Supported	
HD Colorimetry	Auto Select	
Output Brightup Line/Sample	On	Affects only external picture outputs
Output Brightup RGB Gamut	Off	Setting affects Int, Ext, Thumbnail, and Picture
Output Brightup Composite Gamut	Off	Setting affects Int, Ext, Thumbnail, and Picture
Output Colorimetry HD	Auto	
Output Active for HD	YPbPr	
Output Active for SD	YPbPr	
Timecode	Off	
Audio Inputs / Outputs submenu (Option DG audio module only)		
AES Connector	Input	
Audio Program Type	Surround	
AES Alarms	L&R, C&LFE, Ls&Rs, Lo&Ro = On	
Embedded Alarms	L&R, C&LFE, Ls&Rs, Lo&Ro = On	
AES Input Map	1&2: L R 3&4: C Lfe 5&6: Ls RS 7&8: Lo Ro	
Embedded Input Map	1&2: L R 3&4: C Lfe 5&6: Ls RS 7&8: Lo Ro	Groups 1 & 2 selected
272M Group Phase Align	Auto	
299M Group Phase Align	Auto	

Table 2-7: Factory default instrument settings (Cont.)

Parameter	Setting	Comments
Configure menu (continued)		
Audio Displays submenu		
Audio Presence Readout	Off	
Meter Ballistics	PPM	Option DG audio module only
Peak Hold Time	2 sec	Option DG audio module only
Peak Hold Display	On	Option DG audio module only
Set 0dB Mark to	dBFS	Option DG audio module only
Lissajous AGC	On	Option DG audio module only
Audio Thresholds submenu (Option DG audio module only)		
Test Level	-18 dB FS	
Peak Program Level	-8 dB FS	
# of Samples for Clip	1	
# of Samples for Mute	10	
Silence Level	-60 dB	
Over Level	-8 dB	
Duration for Silence/Over	5 sec	
Printing / Event Log submenu		
Print Layout	Portrait	
Print Format	Postscript Color	
Paper Size	Letter	
Ink Saver	On	
When Event Log Full	Stop logging	
Event Log Storage Mode	Log for Duration	
Communications submenu		
Config Mode	Manual	
Remote Control Port	Disabled	
Remote Web Interface	Disabled	
System submenu		None of the System submenu selections are set by the Restore Factory function in the Preset menu.

Print Menu

When you press the Print button, the Abort Printing soft key appears. Press this soft key to abort the print request.

Status Menu

Press the STATUS button to enter the Status display mode, which displays the Status menu shown in Figure 2–36. Use the Status display mode to perform the following tasks:

- View the status of the selected video signal
- View the status of the selected audio signal
- View the status of the monitored alarms
- Enable, disable, configure, and view the event log

For more information about using the Status mode displays, refer to *Status Displays* on page 3–47.

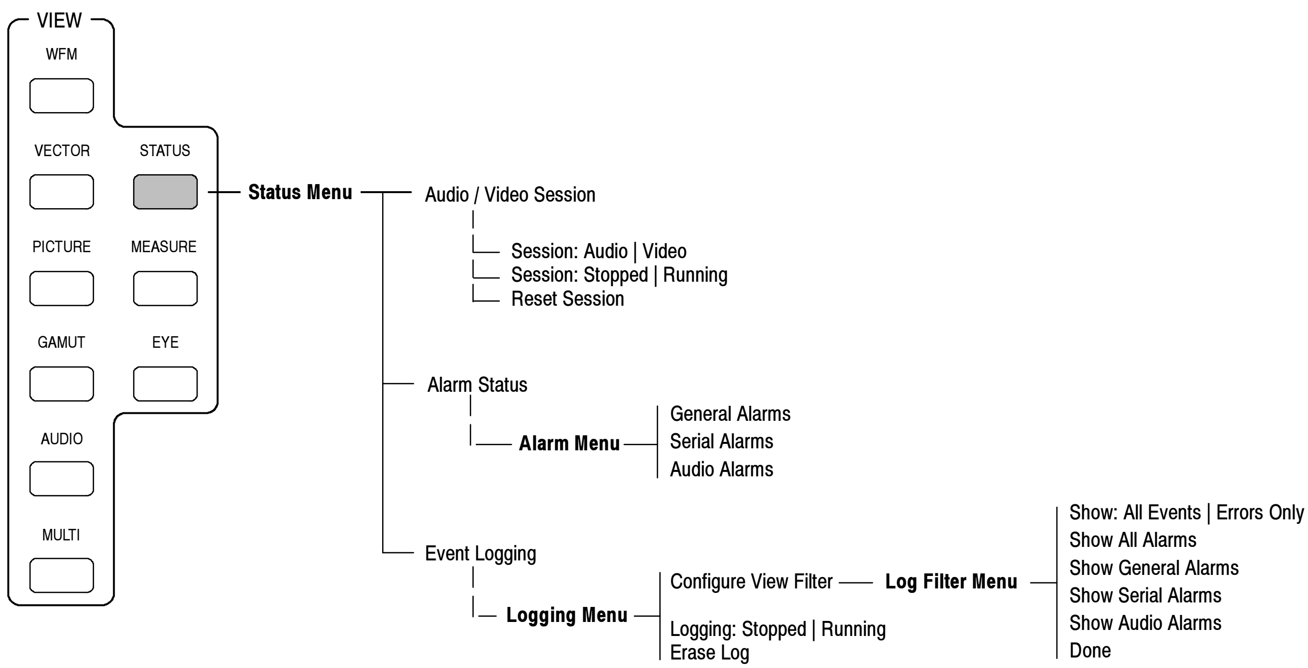


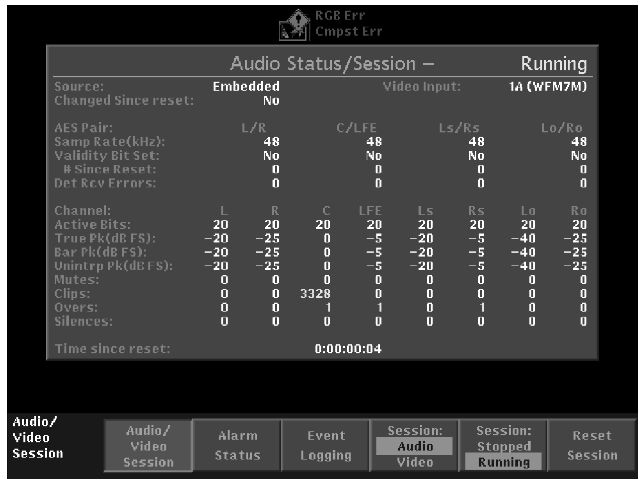
Figure 2-36: Status menu diagram

Audio / Video Session

Displays the audio or video status display. When this soft key is selected, the following soft keys are available:

Session: Audio / Video. Toggles the status display between Audio Status and Video Status (see Figure 2-37). Refer to *Status Displays* on page 3-47 for a description of the information shown in the audio and video status displays.

Audio Status display



Video Status display (SD signal)

Figure 2-37: Audio and Video status displays

Session: Stopped / Running. Toggles the state of both the audio and video session displays between stopped and running. The soft ley displays the current state (stopped or running) of the status sessions.

Reset Session. Resets the display of both the audio and video status sessions. All monitored aspects of the signal are rechecked and the various parameter counts are cleared.

NOTE*. The Session: Stopped/Running and the Reset Session soft keys affect both the audio and video session displays. For example, if you stop/start or reset the session when the currently displayed session is audio, the video session is also stopped/started or reset.*

The contents of the audio or video sessions cannot be recovered after the session has been reset.

Alarm Status

Displays the current status of the selected alarm group (see Figure 2-38). Refer to *Status Displays* on page 3-47 for a description of the information shown in the alarm status displays. When this soft key is selected, the following soft keys are available:

General Alarms. Displays the status of the alarms in the General Alarms group. Refer to *General Alarms* on page 2-30 for a description of these alarms.

Serial Alarms. Displays the status of the alarms in the Serial Alarms group. Refer to *Serial Alarms* on page 2-32 for a description of these alarms.

Audio Alarms. Displays the status of the alarms in the Audio Alarms group. Refer to *Audio Alarms (Option DG Only)* on page 2-34 for a description of these alarms.

General Alarms
status display

Serial Alarms
status display

Audio Alarms
status display

Figure 2-38: General Alarms, Serial Alarms, and Audio Alarms status displays

Event Logging

Displays the current contents of the Event Log. The Event Log lists the monitored events that were enabled for logging and occurred after the state of the Event Log was set to running (see Figure 2-39). The contents of the Event Log remain available until the log is erased. Refer to *Logging* on page 3-40 for more information about using the Event Log.

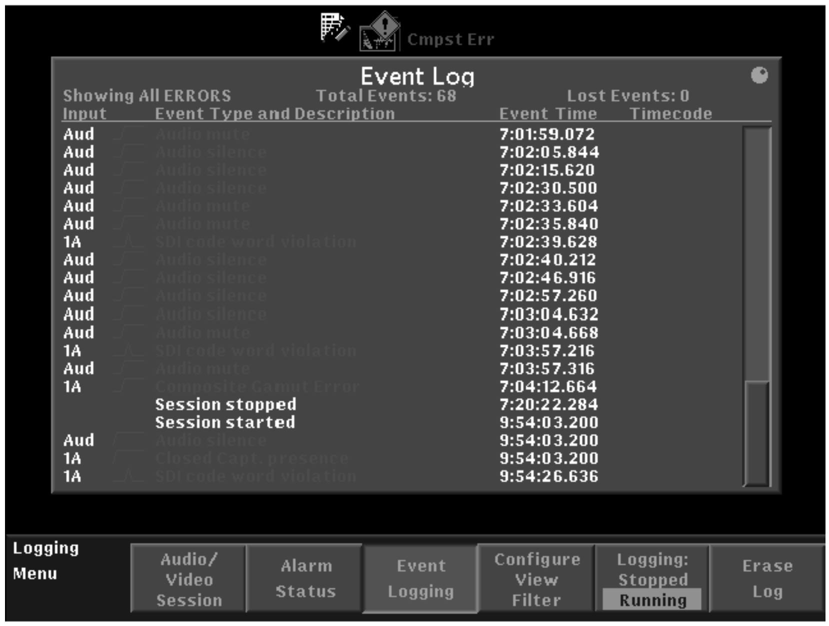


Figure 2-39: Event log display

When the Event Logging soft key is selected, the following soft keys are available:

Configure View Filter. Opens the Log Filter menu, which provides the following soft keys to configure which monitored events will be reported to the Event Log:

- Show. Use this soft key to select whether all events will be reported to the Event Log or only error events. The event log can contain up to 10,000 entries. Use the Errors Only setting to extend the timespan of the Event Log.

  Choices: All Events, Errors Only
  Default: All Events

- Show All Alarms. Use this soft key to show events related to all three alarm groups (General, Serial, and Audio).
- Show General Alarms. Use this soft key to show only events corresponding to the alarms in the General Alarm group. Refer to *General Alarms* on page 2-30 for a description of these alarms.
- Show Serial Alarms. Use this soft key to show only events corresponding to the alarms in the Serial Alarm group. Refer to *Serial Alarms* on page 2-32 for a description of these alarms.
- Show Audio Alarms. Use this soft key to show only events corresponding to the alarms in the Audio Alarm group. Refer to *Audio Alarms* on page 2-34 for a description of these alarms.

Logging: Stopped / Running. Sets the state of the Event Log to Stopped or Running.

Erase Log. Erases the current contents of the Event Log.

***NOTE**. The contents of the Event Log cannot be recovered after the log has been erased.*

Sweep Menu

Pressing the SWEEP button while in Waveform mode displays the Sweep menu, as shown in Figure 2–40. You can choose the horizontal display mode by touching the desired soft key. The Sweep menu is also functional in Vector and Eye Modes, although not all selections are available.

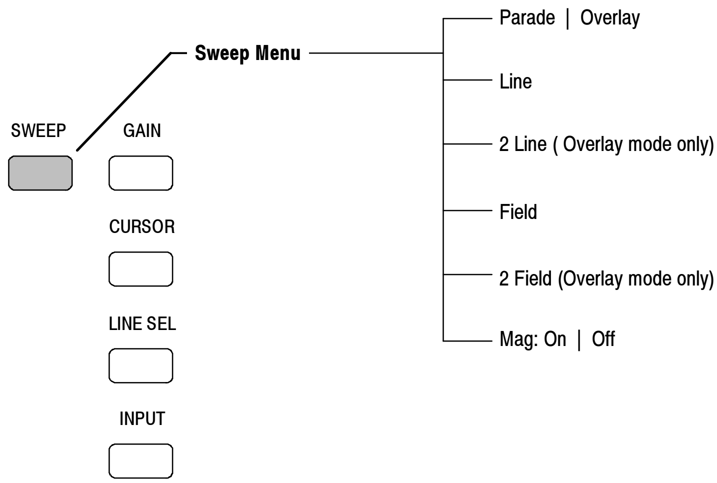


Figure 2-40: Sweep menu diagram

Parade / Overlay

This soft key toggles between the Parade and Overlay modes. The default mode is Parade.

Line / Field Sweeps

Touch a soft key to select from the following line or field sweeps:

NOTE. *In waveform mode, the instrument does not maintain separate sweep settings for the different color space selections. Changing the sweep selection in one color space setting changes the sweep mode in all color space settings.*

The composite color space does not support 2 Line and 2 Field sweeps.

Time/div varies with format and sweep type to keep the displayed waveform a reasonable size.

You must press either the Line or Field soft key to make the Parade / Overlay soft key appear once you have selected 2 Line or 2 Field displays.

Line Select mode is automatically disabled when Field sweep is selected.

- Line. One line sweep
- 2 Line. Two line sweep (available in Overlay mode only)
- Field. One field sweep
- 2 Field. Two field sweep (available in Overlay mode only)

Mag

Touch the Mag soft key to turn the horizontal magnification on or off. You can also use the Mag to expand the horizontal scale in Lightning mode.

When operating in 2 Line sweep mode, MAG factors are chosen that optimize the evaluation of the horizontal blanking interval. To use this feature, perform the following steps:

1. Ensure that the waveform display is in OVERLAY mode.
2. Select 2LINE sweep.
3. Use the horizontal position control to adjust the waveform so that the blanking interval is aligned with the horizontal graticule indicating the center of the screen.
4. Select MAG sweep.

Vector Menu

Press the VECTOR button to enter the Vector mode and display the Vector menu shown in Figure 2-41. In this menu you can select the display type (Lightning or Vector) and the graticule target positions.

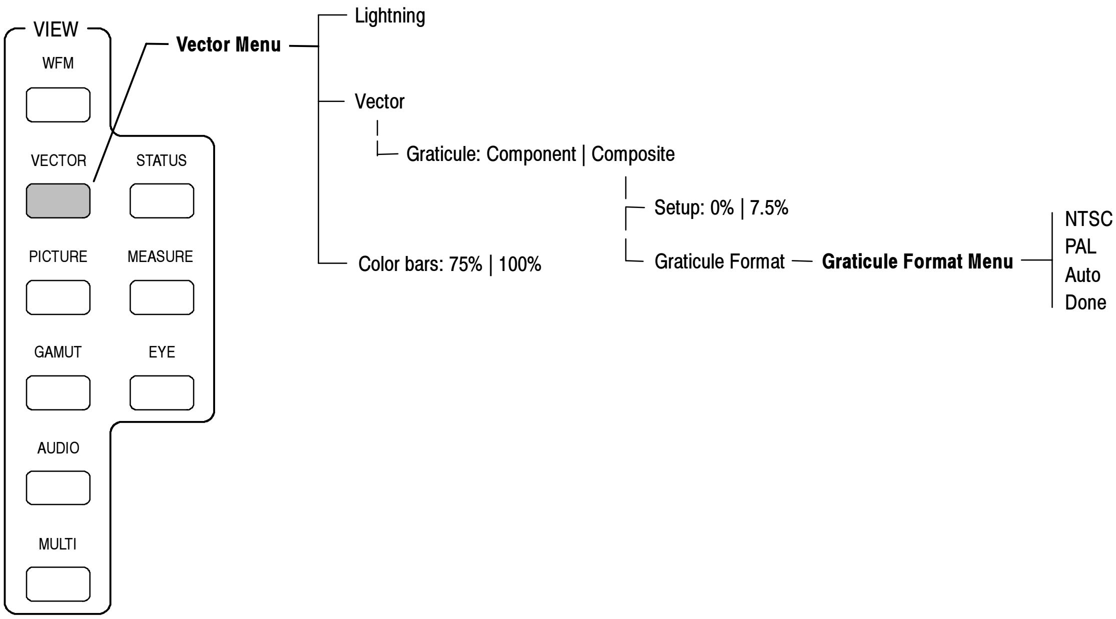


Figure 2-41: Vector menu diagram

Vector and Lightning Displays

Touch either soft key to select the desired display type.
Default: Vector

Lightning. This Tektronix-patented display (see Figure 2-42) combines the chrominance and luminance signal information in a manner that allows you to detect timing errors. Bowing of traces in the upper half of the display represents a timing problem between Y and Pb, while bowing of the traces in the lower half of the display represents timing errors between Y and Pr. Calibrated graticule marks at each Green-Magenta transition allow you to quantify interchannel timing errors without using a specialized test signal.

Vector. This display allows you to visualize the signal as a complex vector of color components, with no luminance information included (see Figure 2-43 and Figure 2-44). The radial magnitude represents saturation and the phase angle represents hue.

For more information about the Lightning and Vector displays, refer to *Vector Mode* on page 3-65.

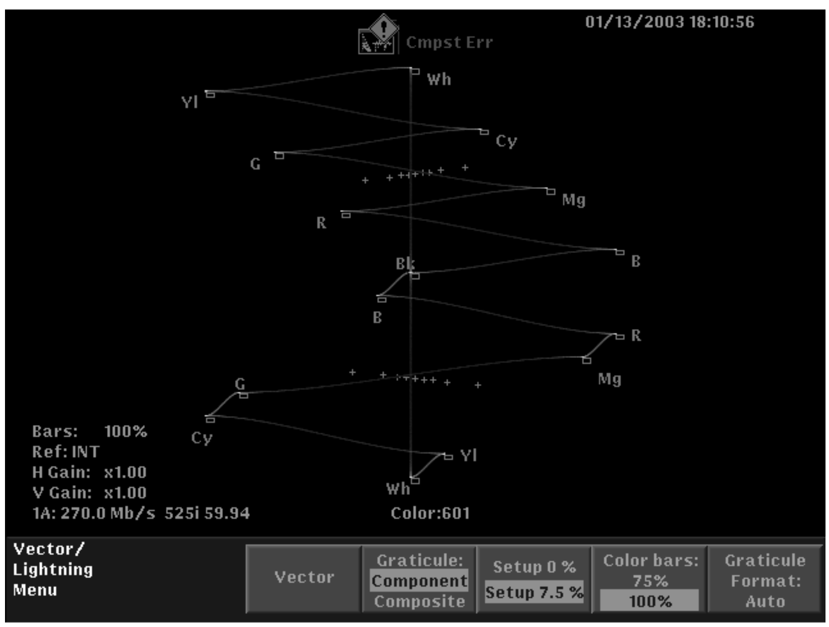


Figure 2-42: Lightning display

75% / 100% Color Bars

This soft key toggles the vector target position to correspond to 75% and 100% Color Bar signals. Select the setting that corresponds to the type of signal you are monitoring.

Default: 75%

Component / Composite Graticules

This soft key toggles the compass rose display (available in Vector mode only) between the component and composite graticules and signal representations (see Figure 2-43 and Figure 2-44). Select the display type that corresponds to the vector representation you wish to view. The composite representation is independent from the Colorimetry in the signal source, and provides a uniform representation of the hue shift.

Use the Graticule Setup submenu of the Configure menu to turn the vector I/Q axis on and off and to turn on the compass rose for the component vector graticule.

Choices: Component, Composite
Default: Component

To display the compass rose graticule when you select the component vector graticule, you must enable the compass rose display in the Graticule Setup section of the CONFIG menu. The compass rose graticule is always displayed when you select the composite vector graticule.

Setup 0% / 7.5%

This soft key appears only when you select the Composite vector graticule. Touch this soft key to toggle between setup levels of 0% or 7.5%. When set to 7.5%, the composite waveform representation has 7.5 IRE of setup. When you change the setup setting between 0% and 7.5% in any menu, the setup setting in all other display-mode menus changes to match the current setting.

Default: 7.5%

Graticule Format

This soft key appears only when you select the composite vector graticule. Touch this soft key to enter the Graticule Format menu where you can select the graticule format that matches the signal you are monitoring. The Auto setting allows the instrument to select the graticule based on the type of signal you are monitoring.

Choices: NTSC, PAL, or Auto
Default: Auto

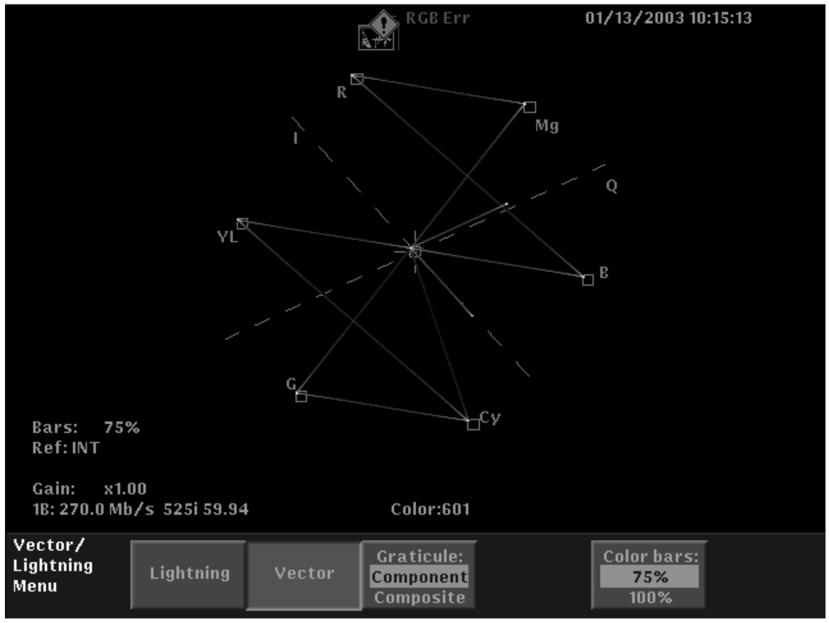


Figure 2-43: Vector display with component graticule selected and with compass rose turned off

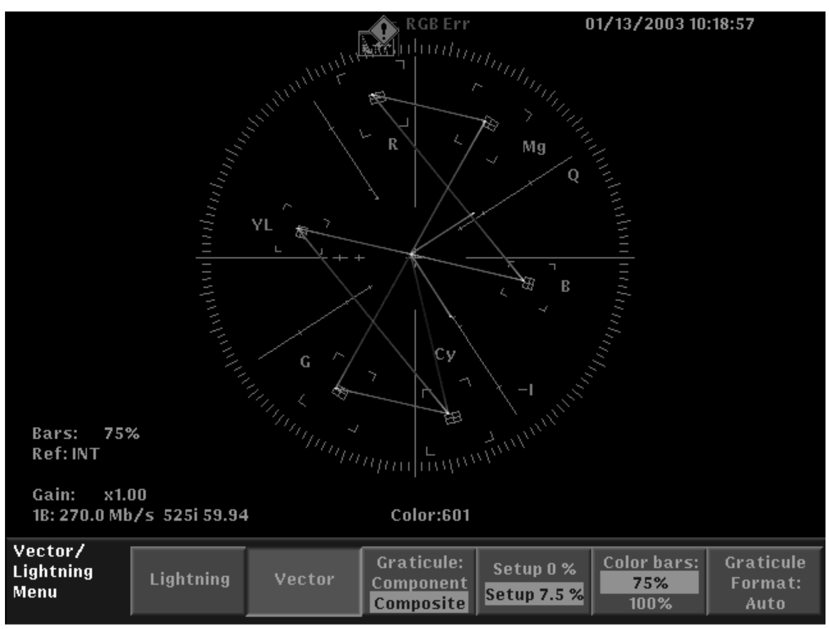


Figure 2-44: Vector display with composite graticule selected

Waveform Menu

Pressing the WAVEFORM button brings up a waveform display of the selected signal input and displays the Waveform menu, shown in Figure 2-45 and described in the following text. For more information about Waveform mode, refer to page 3-73.

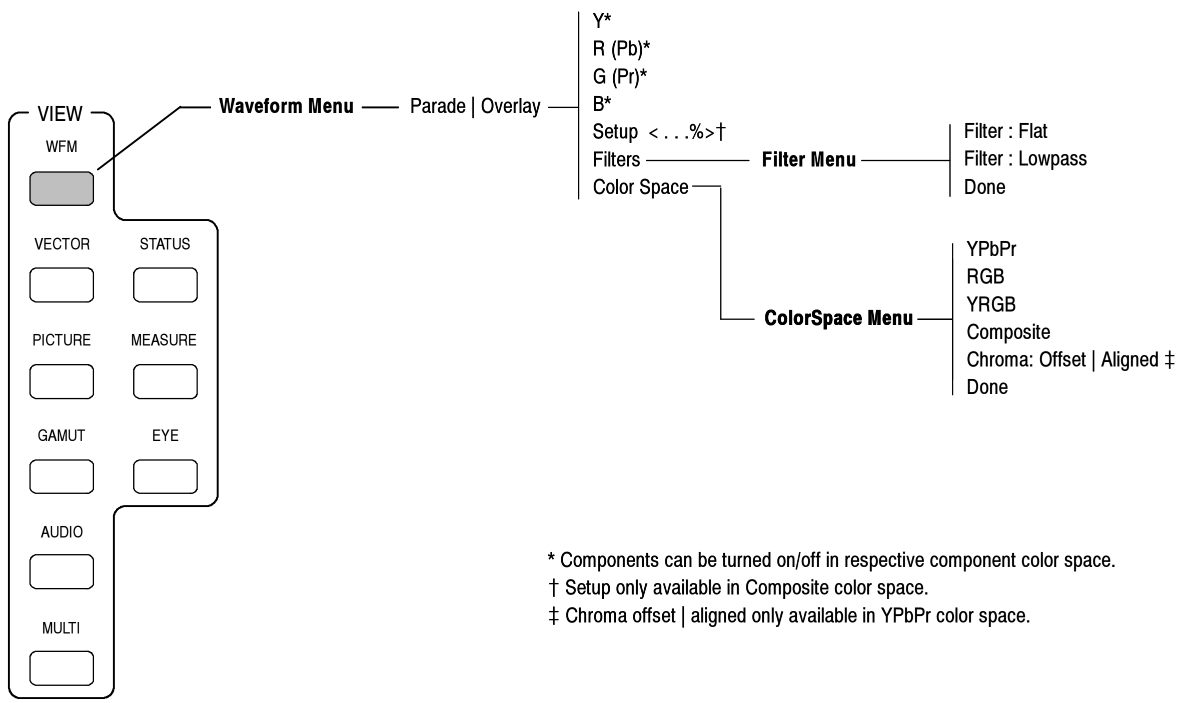


Figure 2-45: Waveform menu diagram

In the Waveform menu, you can make the following selections:

Parade / Overlay

Choices: Parade, Overlay
Default: Parade

Parade. In this mode, each selected component is displayed in a portion of the screen. For example, if Y, R, G, and B are selected, each will be displayed from left to right across the screen (see Figure 2–46). If any component(s) is/are not selected, the remaining component(s) will expand to take up the screen width.

***NOTE**. Do not use the time cursors to measure time between components in a paraded waveform display. Parade mode is a special display format that represents all displayed components in a single screen, irrespective of the time relationship between components.*

Overlay. In this mode, all selected components of the signal are simultaneously displayed in full screen width (see Figure 2–47).

Y

Enables or disables the display of the Y component when YPbPr or YRGB is selected using the Color Space soft key.

R (Pb)

Enables or disables the display of the R component when RGB or YRGB is selected using the Color Space soft key. Enables or disables the display of the Pb component when YPbPr is selected.

G (Pr)

Enables or disables the display of the G component when RGB or YRGB is selected using the Color Space soft key. Enables or disables the display of the Pr component when YPbPr is selected.

B

Enables or disables the display of the B component when RGB or YRGB is selected using the Color Space soft key.

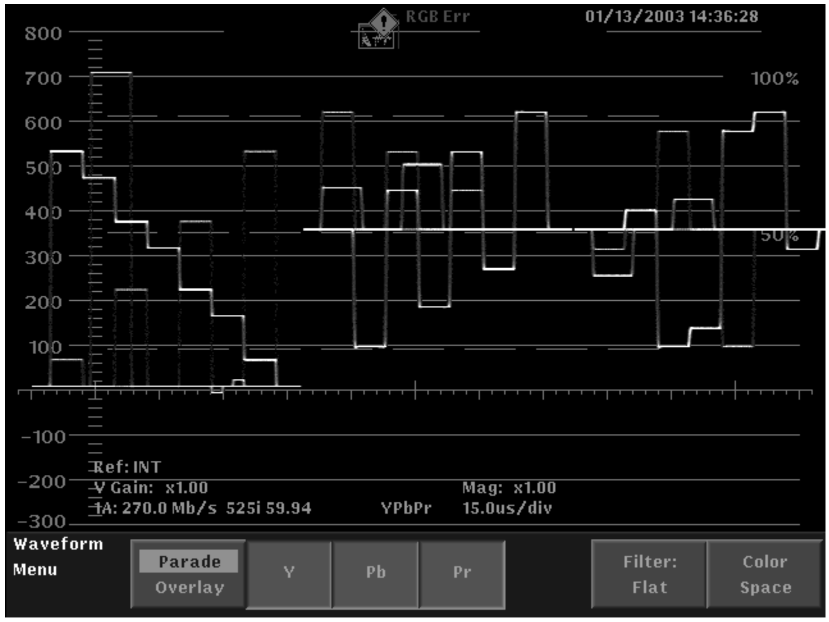


Figure 2-46: Waveform mode showing a YPbPr Parade display

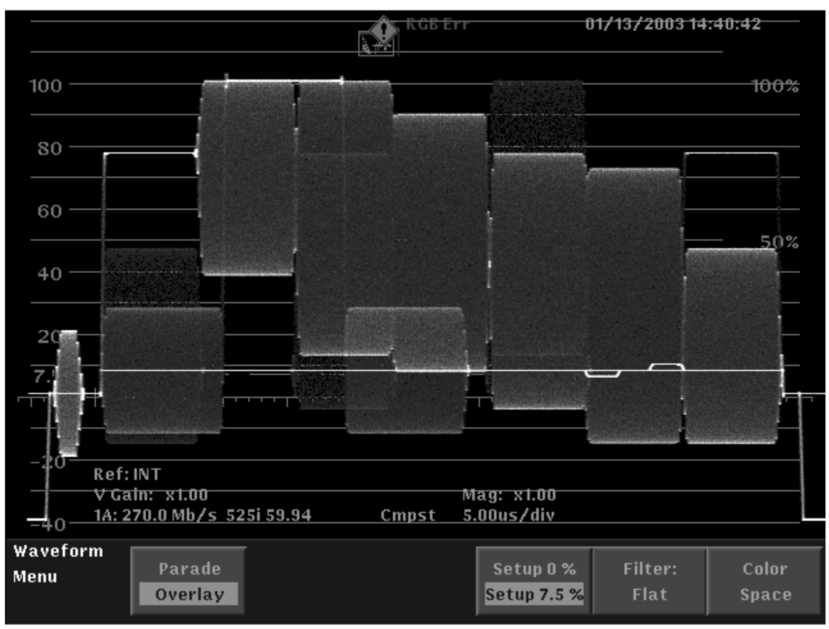


Figure 2-47: Waveform mode Overlay display showing the Composite graticule with 7.5% setup selected

Setup (Composite Only)

When you set the Color Space setting to Composite, the Setup soft key is displayed. Touch this soft key to toggle between setup levels of 0% or 7.5%. When set to 7.5%, the composite waveform representation has 7.5 IRE of setup (see Figure 2–47). When you change the setup setting between 0% and 7.5% in any menu, the setup setting in all other display-mode menus changes to match the current setting.

Default: 7.5%

Filter

Choices: Flat, Low Pass
Default: Flat

Flat. This setting displays all frequency components of the waveform in creation of the image.

Low Pass. This setting activates a filter that removes high frequency components.

Color Space

Choices: YPbPr, RGB, YRGB, Composite, Chroma Offset | Aligned
Default: YPbPr

Selects the representation of the video that will be used to create the waveform display.

Composite. The WFM700 provides a composite representation of both SD and HD component signals. For more information about composite mode, refer to page 3–9.

Chroma Offset | Aligned. (YPbPr color space only) Determines the vertical position of the color difference signals.

- When you select Offset, the chroma is offset by 350 mV from the luminance zero level. The color difference signals will occupy the same vertical range as the luma.
- When you select Aligned, the chroma zero levels are aligned with the luminance zero level. The color difference signals will extend below luma, but Gain will expand around the zero levels.

Reference

Video Reference

The *Reference* section is divided into the following two subsections:

- *Video Reference* describes modes and features available for instruments with video modules installed. Included in this section are descriptions of modes and features that are common to all WFM700 waveform monitors.
- *Audio Reference (WFM7DG Only)* describes only modes and features that are added to the instrument when the optional WFM7DG audio module is installed.

***NOTE**. Refer to* Related Reference Documents *on page xvi for a list of reference documents that are available at the Tektronix, Inc. Web site: www.tektronix.com.*

The topics in *Video Reference* listed below are organized alphabetically:

- Alarms
- Audio mode
- Bowtie mode
- Composite display
- Data display
- Diagnostics
- Eye mode
- Freeze mode
- Gamut measurements
- Line Select mode
- Logging
- Measure mode
- Multi mode
- Printing
- Readouts
- Status displays
- Sweep mode
- Vector mode
- Waveform mode

Alarms

The waveform monitor can be configured to report alarms on a variety of conditions. Users with different situations will find different alarms and reporting conditions useful.

Types of Alarms

The instrument divides alarms into the following categories:

General Alarms. General alarms report general video-signal errors including Composite and RGB gamut errors, input and reference signal format errors, and ancilliary data errors. Refer to *General Alarms* on page 2–30 for a description of each general alarm.

Serial Alarms. Serial alarms report errors with the serial data stream including RP165 and SMPTE292M CRC errors, and SDI line and field length errors. Refer to *Serial Alarms* on page 2–32 for a description of each serial alarm.

Audio Alarms (Option DG Only). Audio alarms report errors with the embedded audio in the video signal or with the AES audio signal including mute and clip errors, AES parity and CRC errors, and audio silence and over-level errors. Refer to *Audio Alarms (Option DG Only)* on page 2–34 for a description of each audio alarm.

Possible Alarm Actions

For each monitored General Alarm, Serial Alarm, and Audio Alarm (Option DG only) condition, you can select one or more notification methods:

- On-screen. An icon appears at the top of the current display. This alarm preference is disabled when the Configuration menu is active.
- Beep. The instrument makes an audible alarm.
- Logging. The instrument makes an entry in the Event Log. Refer to *Logging* on page 3–40 for information about using the Event Log.
- Ground Closure. The instrument sends a signal out the Remote port for a remote notification that an alarm condition occurred. Refer to *Appendix C: Remote Control* for more information.

***NOTE**. If you do not select a notification method for an error, you will not be notified if that error occurs. However, you can view current error conditions using the Alarm Status display. Refer to* Alarm Status Displays *on page 3-60.*

Most, if not all, error detection and alarm reporting is disabled in Eye and Jitter display modes.

Configuring Alarms

Use the Configure menu to select from none to one or more notification methods for each available alarm: audible beep, on-screen icon or message, logging, and ground closure through the remote control port. Refer to *Configure Menu* on page 2–25 for more information.

NOTE. *If you do not select a notification method for an error or signal condition change, you will not be notified if that error occurs.*

Viewing Alarms

Current alarm-status conditions can be observed using the Status Display mode. To view past alarms from your monitoring session, use the Event Log. Refer to *Status Display* on page 3–47 and *Logging* on page 3–40 for more information.

Alarm Icon and Gamut Error Indicator Availability in Major Operating Modes

Table 3-1 lists each major operating mode and notes whether the alarm icon and gamut error indicators are available in a particular operating mode.

***NOTE**. Alarm conditions you have enabled are detected by the instrument even if in certain operating modes the error icon is not displayed. For alarm conditions where you have enabled the logging notification method, you can use the Event Log to view all detected alarm conditions.*

Table 3-1: Alarm icon and gamut error indicator availability in major operating modes

Operating mode	Alarm icon	Gamut error indicators
Waveform	Yes	Yes
Vector / Composite Vector	Yes	Yes
Lightning	Yes	Yes
Picture	Yes	Yes
Diamond / Split Diamond	Yes	Yes
Arrowhead	Yes	Yes
Audio	Yes	No
Multi	Yes	Yes for modes that support gamut error indicators
Video Status	Yes	Yes
Audio Status	Yes	Yes
Alarm Status	Yes	Yes
Event Logging	Yes	Yes
Data List	Yes	No
Eye / Jitter	Yes[1]	No[2]
Configuration	No	No
Help	No	No
Preset (page 2)	No	No

1 The alarm icon appears but has limited functionality in the Eye / Jitter modes. Refer to *Alarm Icon and Gamut Error Indicator Availability in Eye / Jitter Modes* on the next page for more information.

2 Gamut measurements are not possible in Eye / Jitter modes. In other modes where gamut error indicators are not displayed, current error information is available in the Alarm Status display.

Alarm Icon and Gamut Error Indicator Availability in Eye / Jitter Mode

When the instrument is in the Eye / Jitter operating mode, all of the General, Serial, and Audio Alarms are detected and reported except for the following three General Alarms:

- RGB gamut
- Composite gamut
- Closed caption presence

NOTE. *Detection of analog (line 21) closed caption also does not operate if the instrument is in Data mode or in Multi mode when the Data display is selected as one of the displays.*

Audio Mode

***NOTE**. The information below describes the Audio mode display for instruments with only video modules installed. Refer to* Audio Reference *on page 3-79 for information about using Audio mode for instruments with the Option DG audio module installed.*

Audio mode provides a protocol-level check for the AES stream. The Embedded Audio Status screen reports the following information:

- Which video input is the source of the embedded audio
- The standard used by the audio signal
- Whether the header indicates that audio is present on each pair of channels (Status = Present or Not Present)

The Embedded Audio Status readout groups the 16 audio channels into eight pairs of two channels. If audio is present on a channel pair, the readout displays "Present" for that channel pair (see Figure 3-1). If no audio is present, the readout displays "Not Present" for that channel pair.

An audio presence readout also appears near the bottom center of the Waveform, Vector, and Gamut displays if enabled in the Configure menu (refer to *Audio Displays* on page 2-43).

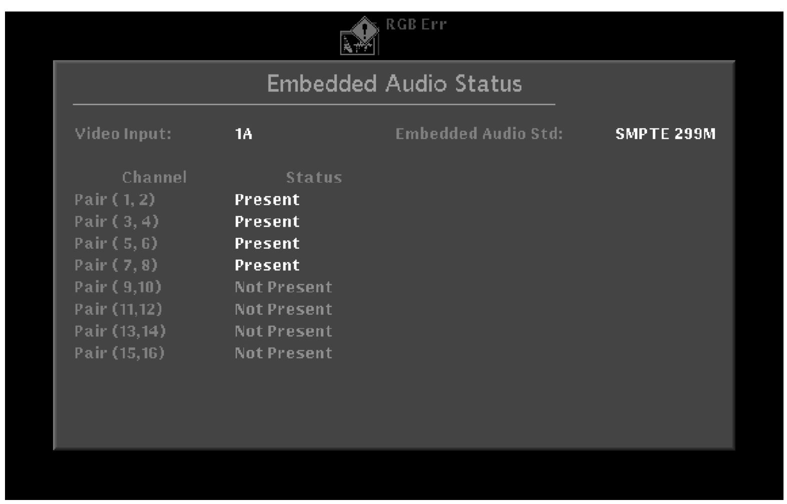


Figure 3-1: Embedded Audio Status display with HD signal

Bowtie Mode

The Bowtie display evaluates the relative amplitude and timing between the three video channels. This display requires a special test signal from the monitored source. The Tektronix TG2000 Signal Generation Platform can produce a Bowtie signal with 20 ns time marks, which aid in signal evaluation. The signal is a 500 kHz sinewave on CH 1 (luminance) and 502 kHz sine waves on CH 2 (Pb) and CH 3 (Pr).

The display is made up of two separate waveforms as shown in Figure 3-2. The left waveform always compares CH 1 to CH 2. The right waveform always compares CH 1 to CH 3.

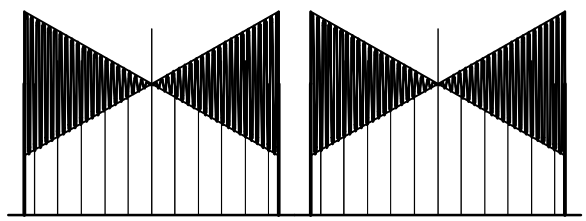


Figure 3-2: Typical Bowtie display

Timing Measurement

The timing measurement is based on alignment of the center marker and the null point at the center of the waveform. The generator provides a center marker, which is centered on the null point when interchannel timing is correct.

A shift of the null to the left or right indicates a difference in the relative timing. If the null shifts two full time markers, the relative timing error between channels will be 40 ns. If the null is to the left of the center marker, the color difference channel is advanced relative to the luminance channel. When either of the nulls is shifted to the right, that color difference signal is delayed relative to the luminance channel.

In Figure 3–3, the chrominance channel, CH 3 (Pr), is advanced relative to the luminance channel by 20 ns.

Although you can use Waveform or Lightning displays to determine channel timing, the Bowtie method provides better resolution of channel timing.

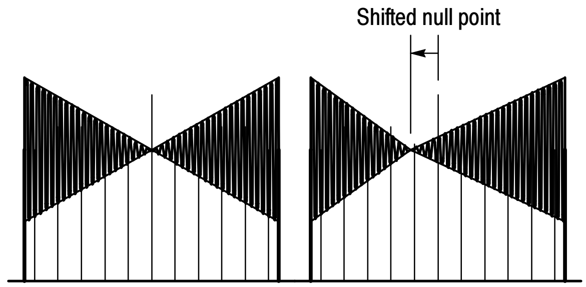


Figure 3-3: Bowtie waveform showing a timing error in CH 3

Relative Gain Check

The Bowtie measurement provides a method to determine whether the relative channel gain is correct. If the gains are not equal, the center null point will not be a complete null.

Figure 3–4 shows a Bowtie display with an incomplete null in the right waveform. If the gain error is in CH 1, neither waveform has a complete null. If CH 2 gain is off, the left waveform will not null completely, but the right one will. If the gain is off for CH 3, as in Figure 3–4, the left waveform will be normal and the right one will not reach a complete null.

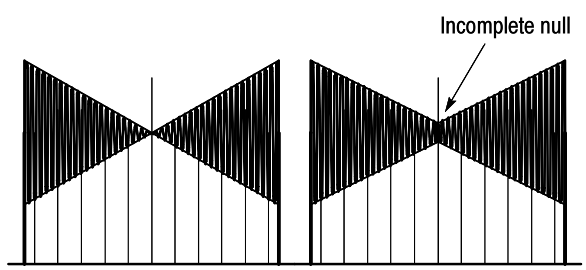


Figure 3-4: Bowtie waveform showing gain error in CH 3

Composite Display

The waveform monitor provides a composite representation of both SD and HD component signals. To access the composite display, set the color space to composite in Waveform mode or select Composite Graticule in Vector mode. Refer to *Vector Mode* on page 3-65 and *Waveform Mode* on page 3-73 for more information about setting the instrument to display composite graticules.

Data Display (WFM700M Only)

The Data Display mode (see Figure 3-5 and Figure 3-6) shows the actual SD or HD input data without any interpolation. It is useful for examining streams for protocol errors, or for looking at ancillary data.

From the Data Display mode menu, you can access the Measure menu where you can use the Bowtie mode to determine timing and gain differences between the three component signals, Y, P_b, and P_r.

For more information, refer to *Bowtie Mode* on page 3-7 and *Line Select Menu* on page 2-72.

Data Display Colors

The different fields of the data stream are shown in different colors, as shown in Table 3-2. You can choose to display data in Hex, Decimal, or Binary units.

Table 3-2: Data Display colors

Color	Use
Green	Active video data
Gray	Data in horizontal or vertical blanking intervals
White	EAV and SAV packets; other reserved values such as the XYZ word
Yellow	Data outside the nominal allowed values
Red	Data with illegal values

In Data Display mode, the general purpose knob is automatically assigned to control sample select. Touch the Line Select soft key or the SELECT button to assign the general purpose knob to control line select.

NOTE. *Use of Freeze in Data Display mode freezes only the waveform portion (left side of screen) of the data display. The data list continues to update in response to input signal changes, if any.*

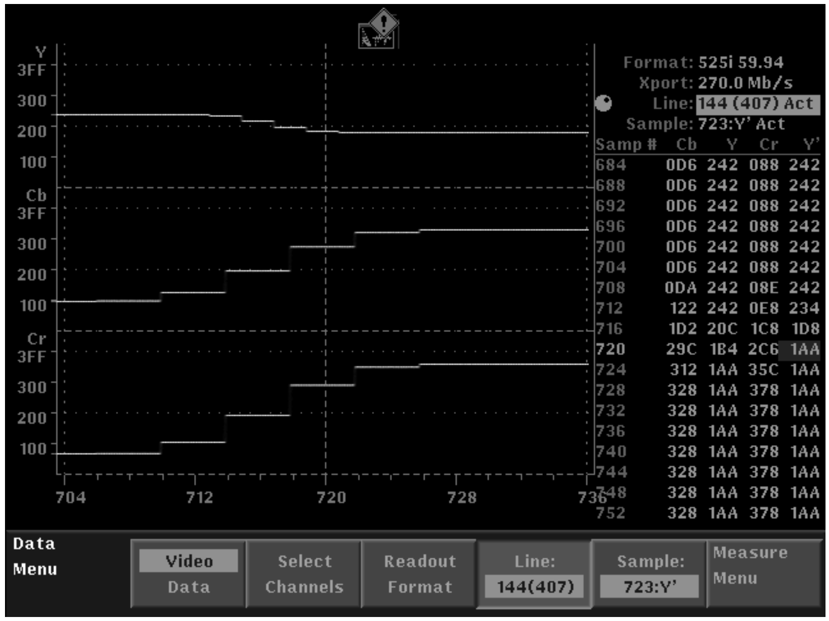


Figure 3-5: Data display in Video mode

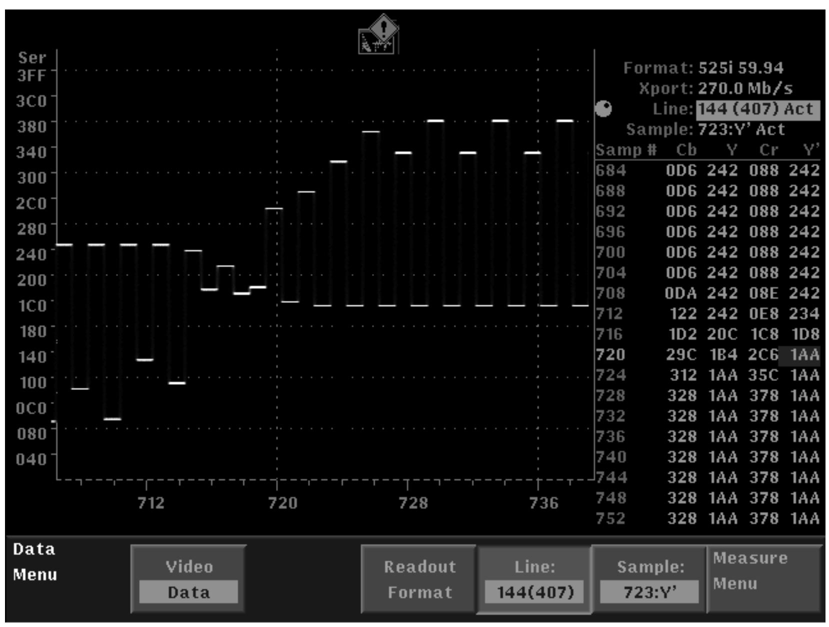


Figure 3-6: Data display in Data mode

Video / Data Selection

There are two ways of representing the data:

Video Mode. Shows the data like the video YPbPr display in waveform mode, but without interpolation (see Figure 3-5). The Y, Cb, and Cr traces are offset vertically to separate them, but are aligned temporally. Since Cb and Cr have half the data rate of Y, the samples appear twice as long. In Video mode, you can touch the Select Channels soft key to turn off individual components of the display.

Data Mode (SD). Shows the data in the same sequence as it occurs in the serial domain (see Figure 3-6). You see a sample of Y, then of Cb, then of Y’ (Y prime), and then of Cr. Then the sequence repeats. The Y sample is the co-sited sample, and the Y’ sample is the isolated luma sample.

Data Mode (HD). Splits the serial into a Y channel and a multiplexed Cb/Cr channel. The intent is to show the data in the same orientation as it occurs in the serial domain, even though it is displayed as 8 or 10 bit values.

Line Select / Sample Select

In the Data Display mode, Line Select is set to Sample by default. Use the general purpose knob to select samples within a line. The current line and sample number are displayed in the respective soft keys. The line number is also displayed in the upper right corner of the screen; the sample number is highlighted in the data list. Touch the Line Select soft key to select lines instead of samples. You can also toggle between line and sample by pressing the SELECT button.

Closed Caption Detection in Data Mode

Detection of analog (line 21) closed caption does not operate if the instrument is in Data mode or in Multi mode when the Data display is selected as one of the displays.

Diagnostics

The waveform monitor provides diagnostics capabilities, which are accessed through the System submenu of the Configure menu. You can view or print the Diagnostics Log, which contains the results of the last diagnostic test that the instrument performed.

Powerup Diagnostics Setting

The instrument runs either full or brief diagnostics at power up, depending on the Powerup Diagnostics setting in the System submenu of the Configure menu.

Running Diagnostics

You should run diagnostics after installing a new module, software upgrade or firmware upgrade, or when troubleshooting suspected instrument problems. You have the following diagnostic choices:

Run Full Powerup Diagnostics. The instrument goes through all of the diagnostics and displays the results for the various tests. Warning messages are displayed in yellow text; PASS and FAIL messages are labeled PASS (green text) or FAIL (red text).

Run Internal Digital Path Diagnostics. The instrument checks the main digital paths within the instrument and displays the results of the various tests. If there is only one video module installed, expect some yellow warnings. Refer to the *WFM700 Service Manual* for details.

***NOTE**. Running the Internal Digital Path Diagnostics sets the instrument to a special diagnostics configuration mode. After running this diagnostic, you must reboot the instrument to return to normal operation.*

Run Audio Path Diagnostics (WFM7DG Only). The instrument checks the audio paths within the instrument from the optional WFM7DG audio module and displays the results of the various tests.

***NOTE**. Running the Audio Path Diagnostics sets the instrument to a special diagnostics configuration mode. After running this diagnostic, you must reboot the instrument to return to normal operation.*

Viewing and Printing the Diagnostic Log

From the System submenu of the Configure menu, you can view or print the Diagnostic Log, which contains the results of the last diagnostic test that the instrument performed. Figure 3-7 shows an example diagnostic log.

When you are viewing the log, touch the View Next Log Page and View Previous Log Page soft keys to page through the log. You can also touch the **Erase** NVRAM Log soft key to clear the diagnostic messages.

To print the Diagnostic Log, you must have first configured the printing function for the instrument. Refer to *Printing / Event Log* on page 2-46 for information about configuring the instrument for printing.

You can also download the Diagnostic Log using the Remote Web Interface. Refer to *Appendix C: Remote Control* for more information.

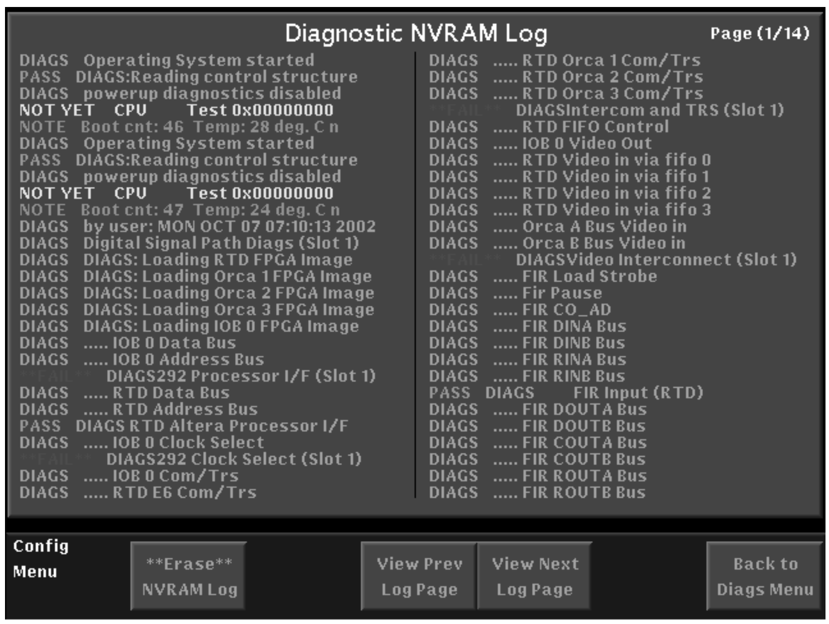


Figure 3-7: Viewing the diagnostic log

Eye / Jitter Mode (WFM700M Only)

To access the Eye / Jitter menu and measurements, you must have a WFM700M, a unit with option 2M, or a WFM7M module installed.

Eye Measurement Display

The Eye pattern display presents a voltage-versus-time waveform composed of multiple sweeps of the serial bit stream. You can view and measure the amplitude, rise time, aberrations, and jitter of the serial signal using the Eye pattern display.

The eye-pattern display can measure both standard definition (270 Mb/s) and high-definition (1.485 Gb/s) data streams.

You can set the sampled eye pattern to display either a full word of correlated data (10 Eye display in SD; 20 Eye display in HD) or a three-data-bit overlay showing jitter uncorrelated to the parallel word (3 Eye display). Figure 3-8 shows the 10 Eye display and Figure 3-9 shows the 3 Eye display. In the word-correlated mode, the sweep is also synchronized to the video, so that you can see any shift in the data stream timing correlated to horizontal or vertical video information. This mode is most useful for detecting jitter patterns or modulation related to parallel-to-serial conversions.

The scale at 1x vertical gain for the Eye mode is 100 mv/div. You can expand the vertical scale for better viewing by selecting X5, X10, or Variable gain from the Gain menu. You can also use the Mag setting in the Sweep menu to horizontally expand the signal for better viewing.

Jitter is seen in the eye diagram as a horizontal thickening of the trace. As jitter increases, the opening in the eye shrinks until the receiver can no longer reliably decode the serial stream.

The eye measurement is useful at short cable lengths. Even a short cable will slow the rise time and make evaluation of a source difficult. Slightly longer cables will make one eye run into the next. This is called intersymbol interference. It makes the eye appear to have multiple levels and closes the eye opening vertically long before the receiver fails to decode the signal. The only information the eye gives on longer cables is some idea of the cable length.

Different clock recovery bandwidths can be selected to help isolate the frequency of any jitter that is observed. When the 10 Hz setting is selected, all jitter above 10 Hz is displayed. When a higher setting is chosen, only frequencies above that cut-off are observed. Refer to *Jitter Measurement Display* on page 3-22.

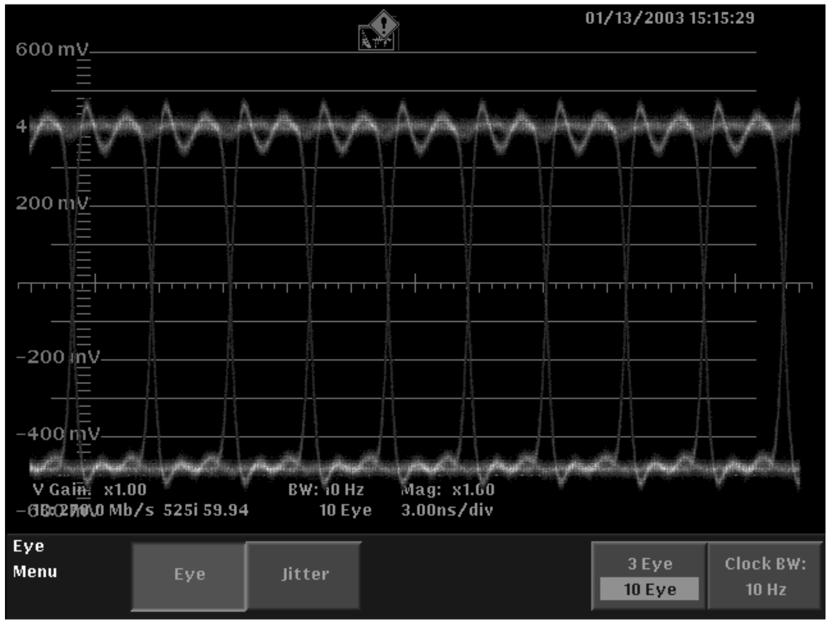


Figure 3-8: 10 Eye measurement display (SD signal)

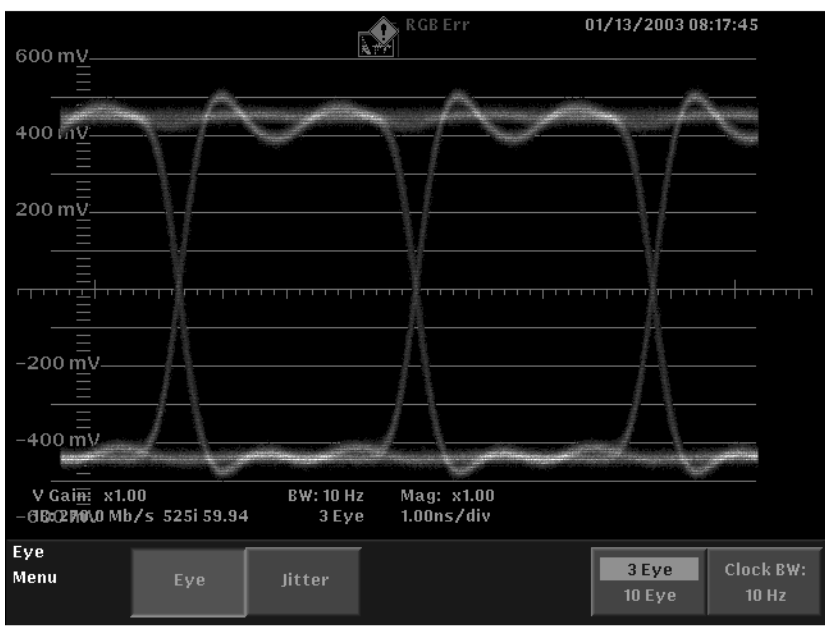


Figure 3-9: 3 Eye measurement display (SD signal)

Alarm Icon and Gamut Error Indicator Availability in Eye Mode. When the Eye operating mode is selected, the instrument detects and reports all of the General, Serial, and Audio Alarms except for the following three General Alarms:

- RGB gamut
- Composite gamut
- Closed caption presence

Timecode Detection in Eye Mode. When the Eye operating mode is selected, the instrument cannot decode the timecode from the signal if VITC timecode was used.

Making Eye Measurements

This section describes how to measure parameters of the Eye pattern to verify standard signal specifications for serial digital transmission. The measurements discussed here are amplitude, aberrations, rise time, and jitter.

Setup for Eye Measurements. Perform the following steps in preparation for the Eye pattern measurements:

1. Connect the serial video-signal source to the monitor with a 75 Ω cable two meters or less in length. Use high quality, low loss coaxial cable, such as Belden 8281.
2. Set the serial source to output a 100% Color Bar signal.
3. Press the WFM700 EYE button to select the Eye Pattern display.
4. Press the GAIN MENU button and select 1X vertical gain.
5. Adjust the vertical position so the bottom of the waveform rests on the –400 mV line.

Measuring Amplitude. Measuring the signal amplitude can help you determine if the signal amplitude is too low due to cable losses or other system problems. This procedure shows you how to measure the signal amplitude using both the graticule and the Voltage Cursors. To measure the signal amplitude, follow these steps:

1. Perform the initial settings for Eye measurements described in *Setup for Eye Measurements* above.
2. Select the desired input channel (input 1A or 1B).
3. Use either the 3 EYE or 10 EYE (20 EYE for HD signals) display mode.
   a. Press the EYE button.
   b. Touch the 3 EYE/10 EYE soft key to select the desired display.

***NOTE**. 10 EYE will appear on the soft key for SD video signals and 20 EYE will appear for HD video signals.*

---

4. Set the CLOCK BW to 1 kHz. This setting will reduce the effects of timing jitter, which can obscure the amplitude measurement.
   a. Touch the CLOCK BW soft key.
   b. Touch the 1 kHz soft key, and then touch the Done soft key.
5. For graticule measurement, select 1X vertical gain and make sure that variable gain is off. At 1X gain, the vertical scale is 100 mV/div.
   a. Press the GAIN button to open the Gain menu.
   b. Touch the Gain: 1x soft key.
   c. Verify that the VAR GAIN soft key is not highlighted.
6. Use the VERT POS knob to position the waveform bottom at the 0.4 V graticule line. Measure the amplitude at a horizontal part of the waveform top line.
7. Enable the Voltage Cursors.
   a. Press the CURSORS button.
   b. Touch the Voltage/Time soft key until Voltage is selected.

8. Position one cursor at the top horizontal part of the waveform; ignore any overshoot on the rising edge.

  a. In the CURSORS menu, touch the Cursor 1 soft key.

  b. Use the vertical position control to position the cursor at the top horizontal part of the waveform; ignore any overshoot on the rising edge.

9. Position the second cursor at the bottom of the waveform; ignore any undershoot.

  a. In the CURSORS menu, touch the Cursor 2 soft key.

  b. Use the vertical position control to position the cursor at the bottom horizontal part of the waveform.

10. The Voltage Cursor readout gives the signal amplitude.

***NOTE**. For Cursor measurements, you can use any gain setting, including variable gain, since the waveform and the cursors are equally affected by the gain setting. Use higher gain settings, such as 5X, to help match the cursor to the waveform.*

Signal sources should measure 800 $mV_{p\text{-}p}$ ±10%. Signal amplitudes outside of this range can degrade receiver performance.

Measuring Aberrations. Serial sources should produce good signal transitions with a minimum of overshoot and ringing. Automatic equalizer circuits in receivers may be sensitive to aberrations of greater than 10%.

To measure aberrations, perform the following steps:

1. Perform the steps in *Setup for Eye Measurements* on page 3–16.
2. Enable the Voltage Cursors.
   a. Press the CURSORS button.
   b. Touch the Voltage/Time soft key until Voltage is selected.
3. Position one cursor at the peak of the overshoot at the top horizontal part of the waveform.
   a. In the CURSORS menu, touch the Cursor 1 soft key.
   b. Use the vertical position control to position the cursor at the peak of the overshoot at the top horizontal part of the waveform.
4. Position the second cursor at the bottom of the top line of the waveform. Include any ringing (the oscillation following overshoot) in the measurement. Essentially, you are measuring the thickness of the top line of the waveform.
   a. In the CURSORS menu, touch the Cursor 2 soft key.
   b. Use the vertical position control to position the cursor at the bottom of the top line of the waveform.
5. The Voltage Cursor readout gives the signal amplitude.
6. Perform the same voltage-cursor measurement on the bottom line thickness, including any undershoot and ringing.

***NOTE**. Aberrations at the top or bottom line of the waveform should not exceed 10% of the signal amplitude.*

Measuring Rise Time. Rise time measurements provide a check on the performance of sources and signal degradation by cabling.

To measure rise time, perform the following steps:

1. Perform the steps in *Setup for Eye Measurements* on page 3–16.

2. Select Variable Gain and resize the waveform to 10 major divisions:

   a. Press the GAIN button to open the Gain menu.

   b. Touch the Var Gain soft key.

   c. Use the General Purpose knob to adjust the size of the waveform to 10 major divisions.

3. Use the VERT POS knob to position the bottom of the waveform at a graticule line. Verify that the top of the waveform is aligned with the graticule line 10 divisions above the bottom of the waveform.

4. Enable the Timing Cursors:

   a. Press the CURSORS button.

   b. Touch the Voltage/Time soft key until Time is selected.

5. Align the cursors as shown in Figure 3–10 to measure the 20 – 80% risetime of the waveform:

NOTE*. You can use the horizontal MAG control in the Sweep menu for greater accuracy when adjusting the time cursors.*

---

   a. Position the first time cursor at the crossing of the rising edge of the Eye waveform and the graticule line two divisions above the bottom of the waveform.

   b. Position the second time cursor at the crossing of the rising edge of the Eye waveform and the graticule line two divisions below the top of the waveform.

6. The indicated Delta time value readout is the standard 20 – 80% rise time measurement.

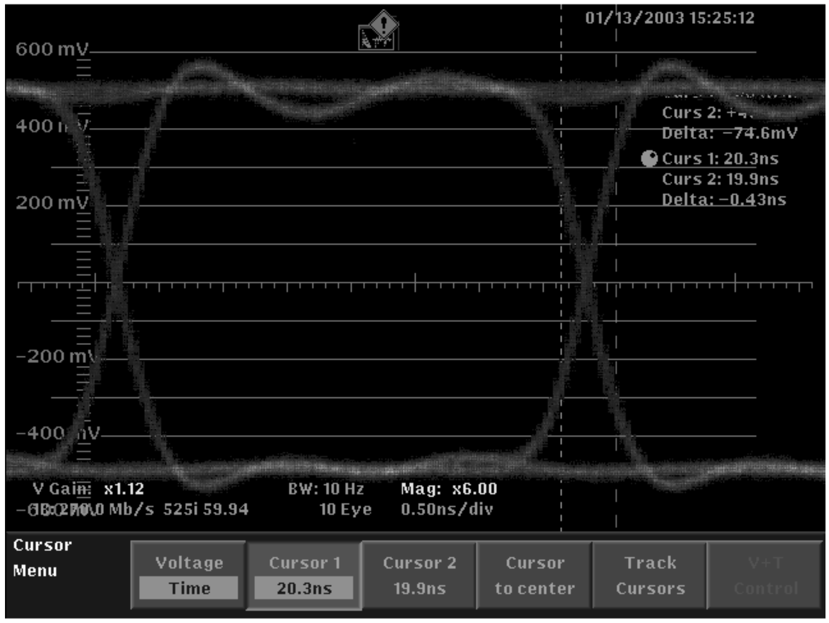


Figure 3-10: Timing Cursors alignment for measuring 20-80% rise time

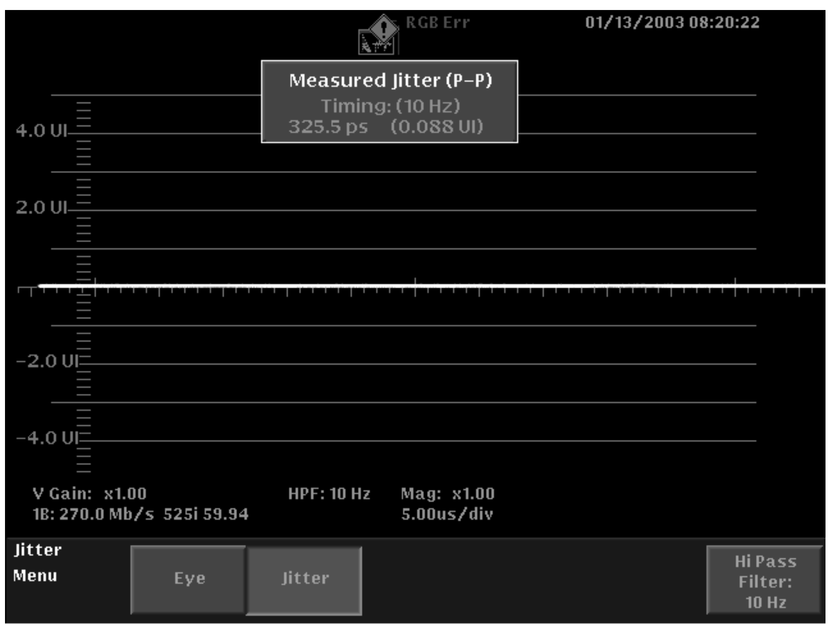


Figure 3-11: Jitter measurement display

Jitter Measurement Display

The Jitter display mode (see Figure 3-11) plots jitter versus time as a trace and measures peak-to-peak time jitter on the active input signal. The Jitter mode converts any phase modulation to amplitude and plots it against time.

You can select one of four high-pass filters to separate the medium and high frequency jitter from low frequency jitter. When you select a filter, depending on the active input signal, you select the jitter measurement type (Timing, Alignment, or neither, as defined by the SMPTE standard). Use the lowest settings to measure timing jitter and the higher settings to measure alignment jitter. The type of jitter measurement is displayed in the Measured Jitter box.

Only jitter above the filter cut-off frequency will be displayed. For this reason, the jitter should always be greatest on the lowest filter setting because it will pass the widest range of jitter frequencies. Higher filter settings will cut off lower frequency jitter components.

Additional functions you can use to help view the jitter measurement are:

- Sweep Mode, including horizontal MAG
- Line Select to view the jitter on an individual video line
- Vertical Gain
- Cursors

Digital jitter readouts appear in a box labeled “Measured jitter (p-p)”. The type of measurement and the filter setting are displayed below the label. The jitter readout is displayed in nanoseconds (nsecs) or picoseconds (psecs) and unit intervals (UI).

***NOTE**. The updates of the jitter measurement readout are disabled while the vertical position knob is being adjusted.*

Alarm Icon and Gamut Error Indicator Availability in Jitter Mode. When the Jitter operating mode is selected, the instrument detects and reports all of the General, Serial, and Audio Alarms except for the following three General Alarms:

- RGB gamut
- Composite gamut
- Closed caption presence

Timecode Detection in Jitter Mode. When the Jitter operating mode is selected, the instrument cannot decode the timecode from the signal if VITC timecode was used.

Making Jitter Measurements

The following paragraphs describe how to use the Jitter display mode to measure timing jitter. Timing jitter is the deviation of signal transitions compared to those of a reference clock. Ideally, all data bit transitions occur at equal intervals. In real systems, factors such as noise, pulse distortion, and variations in bit patterns cause timing jitter. Jitter results in Eye closure along the time axis, narrowing the window in which the data values can be accurately determined. Data errors result when the Eye becomes too narrow.

Jitter is characterized by both its magnitude and frequency. Signal transitions deviate from their ideal position by a peak amount and at one or more frequencies, depending on the sources. The frequency of the jitter is important in determining its effect on the system. Typically, only high frequency jitter affects data recovery. But low frequency jitter can affect time-critical operations such as signal multiplexing and D/A conversion.

Jitter Demodulation. The Jitter measurement uses a demodulator method to determine signal jitter. The serial clock is recovered from the input signal and demodulated against a very stable oscillator, which translates any phase modulation (jitter) into a DC value. This DC value represents the phase difference between the input signal and the reference oscillator.

The resulting DC values plotted against time are proportional to jitter in the serial signal. This jitter waveform is passed through a high-pass filter and applied to a peak detector. The peak detector measurement is presented in the jitter measurement box seen in Figure 3–11 on page 3–21. The demodulator can detect jitter up to 5 MHz.

Bandwidth Filters. The waveform monitor provides four bandwidth filters: 10 Hz, 1 kHz, 10 kHz, and 100 kHz. These filters only show jitter terms above the selected filter frequency. For example, with 1 kHz selected, 50 Hz jitter is heavily attenuated but 10 kHz jitter appears unattenuated.

To measure timing jitter, select the 10 Hz filter for both SD and HD video signals. To measure alignment jitter, select the 1 kHz filter for SD video signals and the 100 kHz filter for HD video signals.

***NOTE**. To date, many of the jitter problems in systems have been the result of genlocking clocks to other references such as the horizontal synchronization pulse. Reference jitter transferred by genlocks into a serial system is typically between 20 and several hundred Hertz. Also, the phase detection process used by the genlock can add noise, which results in jitter in the 10 Hz to 1 kHz range. By using the appropriate BW Limit filter, genlock jitter can be included or rejected from a jitter measurement.*

Using Line Select. When Line Select is off, the jitter measurement readout reflects the maximum amount of jitter in the full field. This is true for both Line and Field sweeps. When Line Select is on and Line sweep is selected, the jitter measurement readout displays “line *n* jitter,” with *n* being the selected line number. This readout indicates that the jitter measurement is for the selected line only. Line Select is automatically disabled for Field sweep.

***NOTE**. The jitter measured on an individual line will always be equal to or less than the full field jitter measurement.*

Measurement Accuracy Using the Measurement Cursors. The waveform monitor uses an internal peak detector to perform jitter measurements. The jitter measurement readout reflects the results determined by the peak detector.

If you use the measurement cursors to measure the jitter, you may measure a different result than that shown in the jitter measurement box. There are two reasons why the measurement results may differ:

- The peak detector does a better job of measuring jitter excursions than a human can when using their naked eye to position the cursors
- The noise floor is removed from the jitter measurement readout but not from the cursor delta readout

Observing Word Correlated Behavior. The Eye Pattern display allows you to analyze word correlated jitter in video signals. Use the 10-Eye mode to analyze SD format signals and use the 20-Eye mode to analyze HD format signals.

When video is serialized, a 270 MHz serial clock is derived from the 27 MHz rate parallel word clock. Often there is slight phase modulation of the serial clock between the transitions of the parallel clock producing jitter at data-bit transitions. This jitter is not random; it is correlated to the parallel word rate. Also, the video pattern applied to the serializer changes at a 27 MHz rate or at an integer fraction of this rate. Any video pattern related effects in the serial system typically appear at fixed data-bit locations with respect to the parallel word.

In the 10-Eye or 20-Eye display modes, the trigger is on the parallel word boundaries, with 10 or 20 Eyes shown per sweep. Parallel word and TV-line correlated behavior can be seen in these modes. If a serial system has a disturbance that appears related to video patterns, either word or TV-line, use the 10-Eye (SD) or 20-Eye (HD) display mode to analyze the problem. Use the Line Select function to place the area of interest in the Eye pattern display.

Measuring Timing Jitter. To measure timing jitter using the waveform monitor, perform the following steps:

1. Perform the steps in *Setup for Eye Measurements* on page 3-16.
2. Select the 3 EYE display mode:
   a. Press the EYE button.
   b. Touch the 3 EYE/10 EYE soft key until 3 EYE is selected.

NOTE. *In the 3 Eye mode, each of the ten bits of a scrambled serial word are overlaid in the same location, showing peak jitter at each eye crossing.*

3. Select the 10 Hz bandwidth filter to measure the total broadband jitter (use this bandwidth setting if composite D/A conversion is planned):
   a. Touch the CLOCK BW soft key.
   b. Touch the 10 Hz soft key, and then touch the Done soft key.
4. Enable the Timing Cursors:
   a. Press the CURSORS button.
   b. Touch the Voltage/Time soft key until Time is selected.
5. Position the timing cursors to measure the width of the Eye zero-crossing point (see Figure 3-12).
6. If necessary, set the Gain to 5x for better vertical resolution; use SWEEP MAG for better horizontal resolution:
   a. Press the GAIN button to open the Gain menu.
   b. Touch the Gain: 5x soft key.
   c. Verify that the VAR GAIN soft key is not highlighted.
7. If necessary, magnify the sweep for better horizontal resolution:
   a. Press the SWEEP button to open the Sweep menu.
   b. Touch the Mag soft key so that it displays Mag: On.
8. Check that delta between the two timing cursors is less than the following over one horizontal line:
   - SD signals: 740 ps (0.2 unit intervals per SMPTE259M)
   - HD signals: 673 ps (1.0 unit interval per SMPTE292M)

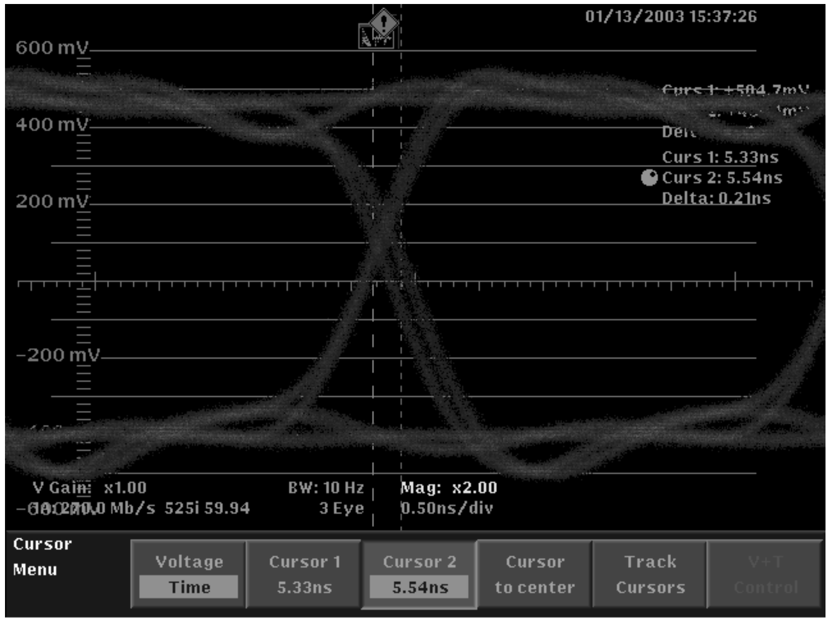


Figure 3-12: Timing Cursors alignment for measuring timing jitter

Freeze Mode

Freeze mode is useful for capturing a trace while an error is present. It is also useful for checking matching between sources.

Freeze Mode lets you:

- Capture (freeze) the active signal and hold it in the Capture buffer.
- Display the frozen signal or the live signal.
- Compare the frozen signal and the live signal by selecting Display Both.

If there is nothing in the Capture buffer, Display Live is automatically selected.

If there is a capture in the buffer, a Freeze icon appears on the left-middle portion of the display. For optimum display performance, delete the capture when you are finished viewing the waveform.

For ease of comparison, Freeze displays the live signal and the frozen signal in contrasting colors, regardless of the selected trace color.

Freeze is not available in all modes. Refer also to *Freeze Menu* on page 2–62.

***NOTE**. The Freeze function for the Data display in Measure mode freezes only the data waveform (left side of screen). The data list (right side of screen) continues to update in response to the incoming serial stream.*

The Freeze function does not operate for the Audio display because Audio display elements cannot be frozen. If a waveform is frozen, it will not be overlaid with audio when the Display Both function is selected.

If you have frozen a waveform (even if it is not displayed), the pixel density of the live waveform will be reduced. This is because the frozen waveform is using a portion of the display memory. Delete the captured waveform to regain full waveform density.

Gamut Measurements

The waveform monitor features three types of gamut displays (Diamond, Split Diamond, and Arrowhead) that are associated with two gamut measurements. Both gamut measurements can trigger an alarm when the input signal exceeds a gamut limit. Figure 3–13 shows the three displays.

Refer to *Defining Legal and Valid Gamut* on page 3–36 for information about gamut limits. Refer to *Setting Gamut Alarm Limits* on page 3–38 for information about setting alarm limits for the Diamond and Arrowhead displays.

***NOTE**. Gamut error detection is disabled in Eye and Jitter display modes.*

The Diamond and Split Diamond modes display the gamut space for component RGB signals, and are associated with the RGB gamut measurement. The Arrowhead mode displays the composite gamut space and is associated with the composite gamut measurement.

- The Diamond display checks that signals conform to legal RGB gamut space.
- The Split Diamond display separates the upper and lower diamonds to show excursions below black; otherwise it is identical to the Diamond display.
- The Arrowhead display checks that signals conform to legal composite gamut space.

Diamond display

Split Diamond display

Arrowhead display

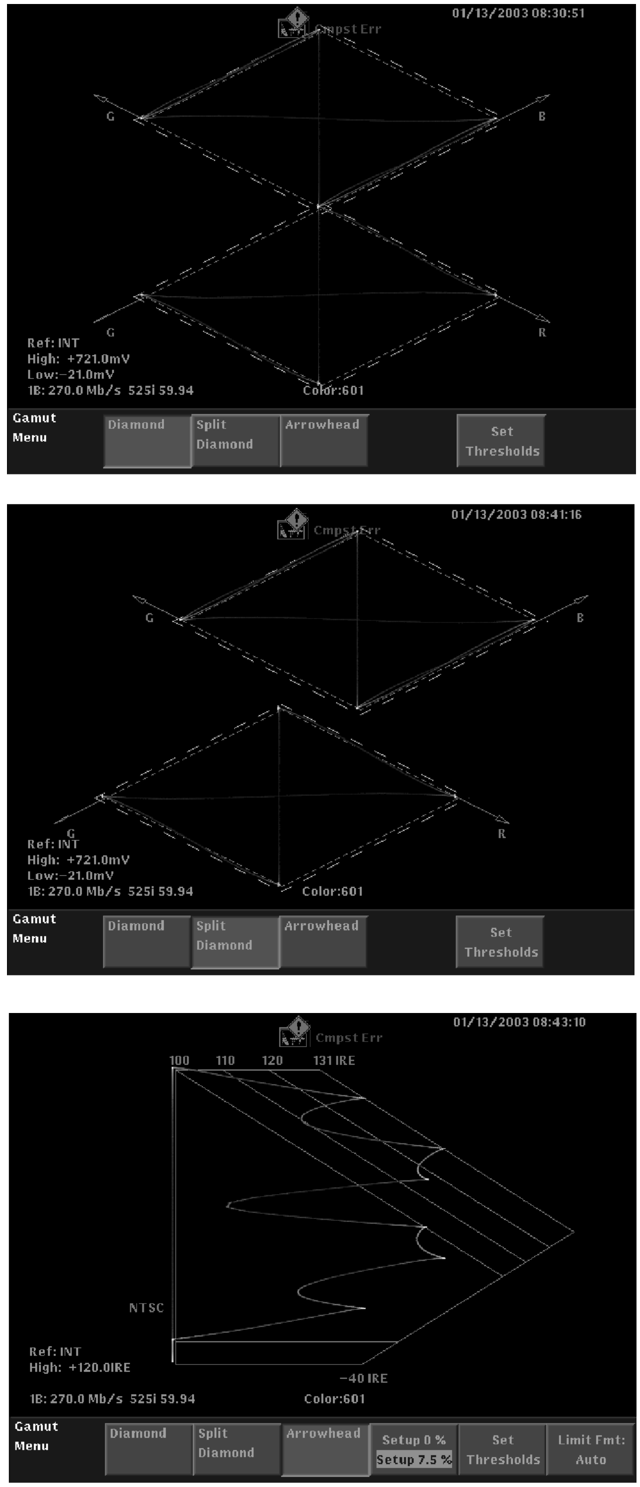


Figure 3-13: Diamond, Split Diamond, and Arrowhead measurement displays

Diamond Display

The Diamond display (see Figure 3–13) is designed to show the relationship between the R, G, and B signal video signals. The waveform monitor converts the Y, P_b, and P_r components recovered from the serial signal into R, G, and B to form the Diamond display. Figure 3–14 shows how the Diamond plot is developed.

Ultimately all color video signals are coded as RGB for display on a picture monitor. To predictably display all three components, they must lie between peak white, 700 mV, and black, 0 V. Picture monitors handle excursions outside the standard range (gamut) in different ways.

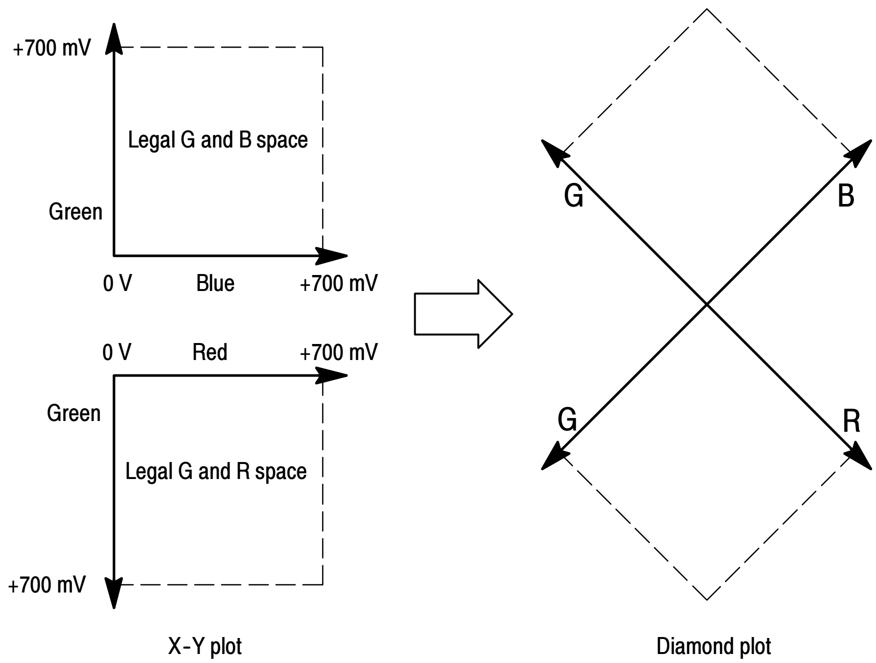


Figure 3-14: Construction of the Diamond display

Creating the Diamond Display. Looking at a diamond graticule with no waveform, you will notice that the green and blue components form the upper diamond in the display, and the green and red components comprise the lower diamond.

The equation used to combine the green and blue components to drive the vertical axis of the upper diamond is B′+G′, while B′–G′ drives the horizontal axis. Figure 3–15 illustrates what the B′+G′ and B′–G′ waveforms look like for a 100% color bars signal and how their combination creates the diamond shape. In Figure 3–15, the points on each waveform correspond to the numbers at each corner of the diamond. Using these numbers, you can follow the path taken by the trace made by a 100% color bars signal.

R′+G′ and –(R′+G′) form the lower diamond in a similar manner.

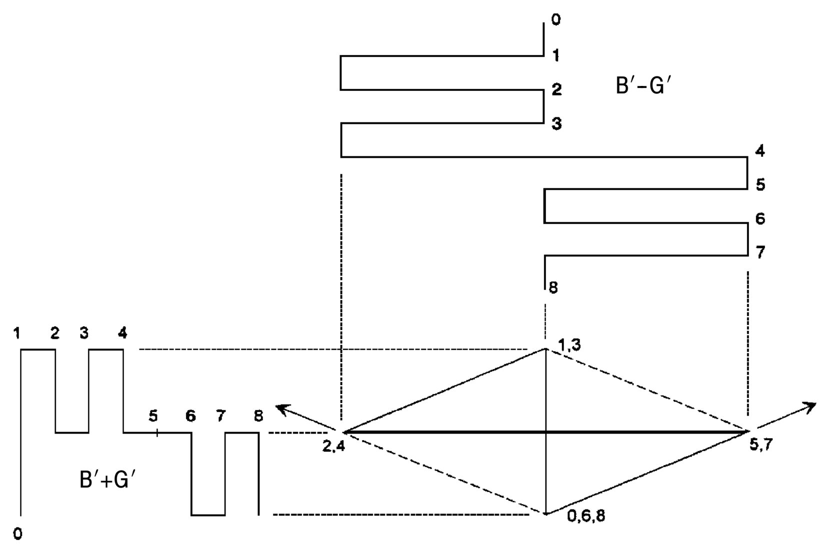


Figure 3-15: Formation of the upper diamond display with G′ and B′

Checking RGB Gamut. For a signal to be in gamut, all signal vectors must lie within the G-B and G-R diamonds. Conversely, if a vector extends outside the diamond, it is out of gamut. The direction of an excursion out of gamut indicates which signal is excessive. Errors in green amplitude affect both diamonds equally, while blue amplitude errors affect only the top diamond and red errors affect only the bottom diamond. You can set the threshold(s) that the instrument uses to define gamut limits. See *Gamut Menu* on page 2-65.

The intensity of a vector indicates its duration. A momentary out-of-gamut condition appears as a faint trace. Long duration violations show as a bright trace. Figure 3-16 gives some sample out-of-gamut signals on the Diamond display.

On the Diamond Display, monochrome signals appear as vertical lines. Nonlinear component processing, such as from a gamma corrector that alters white balance, can cause deviations along the vertical axis.

Bending of the transitions indicates timing delays. When a color bar signal is applied, the vertical axis becomes an indicator of delay errors.

***NOTE**. The Diamond and Split Diamond displays allow you to visualize interchannel timing errors; use the Lightning display to quantify the amount of timing error.*

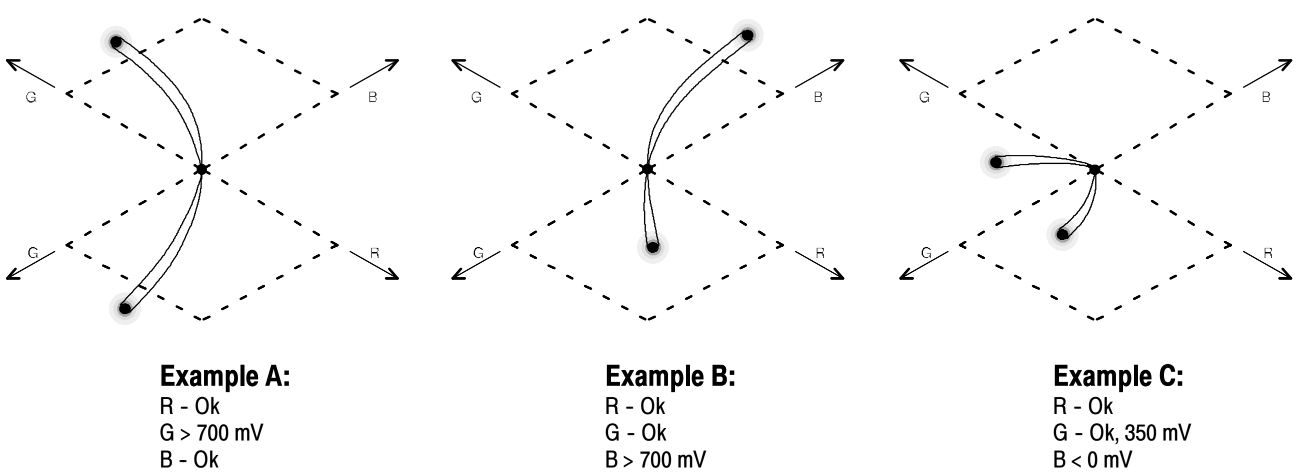


Figure 3-16: Out-of-gamut signals on a Diamond display

Split Diamond Display

Excursions below black can sometimes be masked by the opposite diamond in a traditional Diamond display. Therefore, it is useful to split the diamond into two parts to see excursions below black in either of the G–B or G–R spaces. The Split Diamond display (see Figure 3–13 on page 3–29) provides this capability.

Arrowhead Display

The Arrowhead display (see Figure 3–13 on page 3–29) shows out of gamut conditions in composite color-space, without requiring a composite decoder. The Arrowhead display plots luminance on the vertical axis, with blanking at the lower left corner of the arrow. The magnitude of the chroma subcarrier at every luminance level is plotted on the horizontal axis, with zero subcarrier at the left edge of the arrow. The upper sloping line forms a graticule indicating 100% color bar total luma + subcarrier amplitudes. The lower sloping graticule indicates a luma–subcarrier extending towards sync tip (maximum transmitter power).

Arrowhead Graticules. The electronic graticule provides a reliable reference to measure what luminance plus color subcarrier will be when the signal is later encoded into NTSC or PAL.

On the NTSC Arrowhead graticule (see Figure 3–17), the 120 IRE line represents the level at which a transmitter starts clipping the signal. The –40 IRE line represents the sync tip level, while the 7.5 IRE line represents the setup level.

On the PAL Arrowhead graticule (see Figure 3–18), the 950 mV line represents the level at which a transmitter starts clipping the signal. The 930 mV line represents the upper limit of chrominance excursion, and the –230 mV line is the lower limit of chrominance excursion. The –300 mV line represents the sync tip level.

Signals exceeding the luminance amplitude gamut extend above the top horizontal limit (top electronic graticule line). Signals exceeding the luminance plus or minus peak chrominance amplitude gamut extend beyond the upper and lower diagonal limits. The bottom horizontal line shows the minimum allowed luminance level.

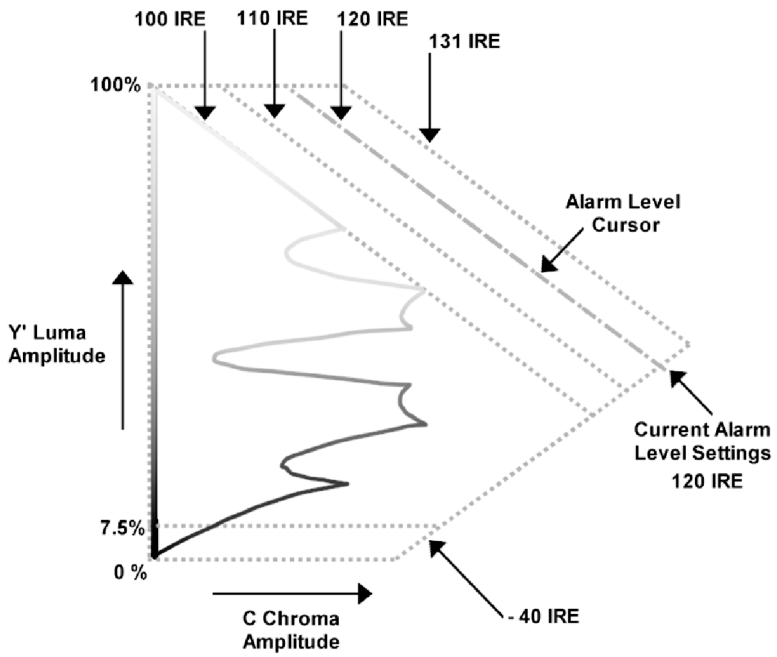


Figure 3-17: NTSC Arrowhead graticule

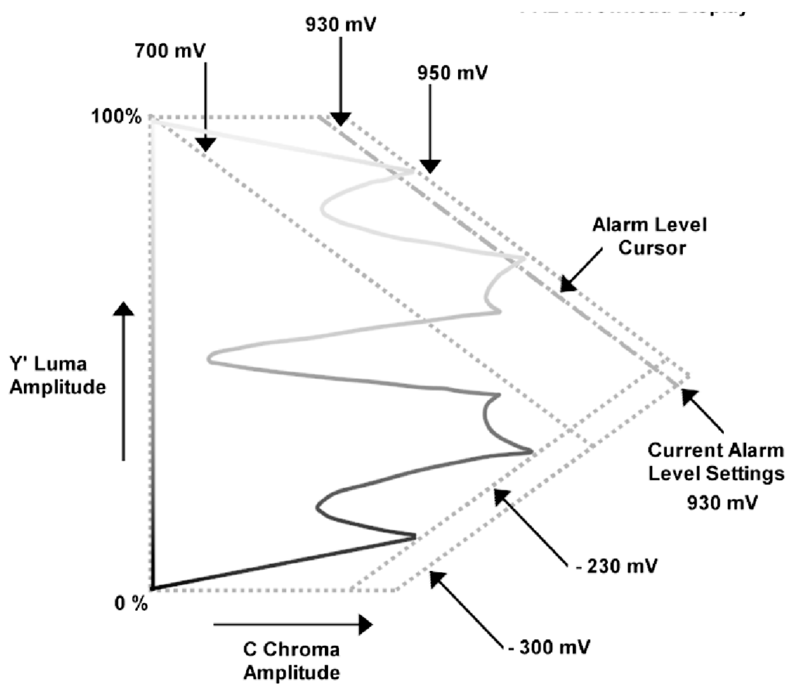


Figure 3-18: PAL Arrowhead graticule

Default Settings

Each of the Gamut modes offers the ability to set the high, and, in some cases, the low gamut thresholds. The waveform monitor also features a set of default thresholds that are based on the input video format. These are shown in Table 2-6 on page 2-67. Touch the Default Settings soft key to quickly restore gamut limits to the default values.

Area Masking

This feature lets you set the percentage of the total image pixels (up to 10%) that can be outside the current gamut limits, yet not be reported as a gamut error.

***NOTE**. The Area settings in the Gamut menu do not affect bright-up in the picture display.*

Filtering

Two filters in the WFM700 let you accept overshoot that would otherwise be reported as a gamut error. Overshoot occurs due to the unequal rise time of the chroma and luma inherent in the YPbPr signal. It is seen on many signals, including color bars. Most gamut detection systems filter in the horizontal dimension only (equivalent to the default Horizontal setting), allowing the instrument to accept a vertical line that is out of gamut. The addition of the Horz + Vert filter expands the filtering to accept horizontal artifacts, making the detection symmetrical in the picture domain.

Horizontal filtering looks for out-of-gamut errors within a single horizontal line using a low-pass filter (SD: < 1 MHz, HD: < 1.2 MHz).

Horizontal + vertical filtering looks for out-of-gamut errors on three consecutive horizontal lines with a weighting of 25% for the first and third lines and 50% for the second line.

Defining Legal and Valid Gamut

The term gamut has been used to refer to the range or gamut of colors reproducible by a television system when a scene is illuminated by a reference white (6500K illuminant D for NTSC/PAL and High Definition Systems). Gamut is defined by the chromaticity value or CIE chromaticity coordinates for a given system. This range of colors, of variable saturation, is reproduced in the picture monitor by the R'G'B' signal values. When R'=G'=B', the components are of equal value, and the image is colorless to the extent it represents the monochrome signal or reference white (shades of gray or gray-scale) on a properly adjusted picture monitor. Otherwise, a colored hue of nonzero saturation results. All colors within the gamut of reproducible colors are possible by independently adjusting the values of the R'G'B' signals.

Legal Gamut. Because the values of the R'G'B' signals directly represent these colors, the term gamut is often used to refer to the voltage range of R'G'B' signals. R'G'B' signals extending outside the specified voltage range, or gamut, may produce desirable color values (albeit outside the system color gamut) on a given picture monitor, but may be clipped or compressed in subsequent signal processing, distorting the color when displayed on another picture monitor.

For example, R'G'B' systems have an upper gamut limit of 700 mV and a lower gamut limit of 0 mV. If any channel of an R'G'B' signal exceeds either the upper or lower limit, a gamut violation exists. Violation of gamut limits makes the signal illegal. Legal signals are those signals that do not violate the signal voltage limits for the particular format in use. Legal signals, however, can be invalid in color-difference formats like Y'P'bP'r. In this format, the allowed range for the luma signal is 0 mV to 700 mV, and for the color difference signals P'b and P'r, the range is ±350 mV.

Valid Gamut. A valid signal is one that is within color gamut and remains legal when translated into any other format. A valid signal is always legal, but a legal signal is not necessarily valid. The latter case most often occurs with a color-difference format component signal, where the signal levels are not independent, as they are in R'G'B' systems. The following description explains how a simple gain distortion in a color difference component signal can make the signal invalid, though not illegal.

The left side of Figure 3-19 shows a legal and valid color difference signal (top) and the legal R'G'B' signal (bottom) into which it translates. The right side of Figure 3-19 however, shows that the luminance channel of the color difference signal (top) is distorted; it has a relative gain of only 90%. When the distorted signal is transcoded to the R'G'B' format (bottom), the result is an illegal signal; all three components extend below the minimum allowed signal level. Since the distorted color difference signal cannot be translated into a legal R'G'B' signal, it is said to be invalid. Additionally, other forms of distortion can create a variety of invalid signals.

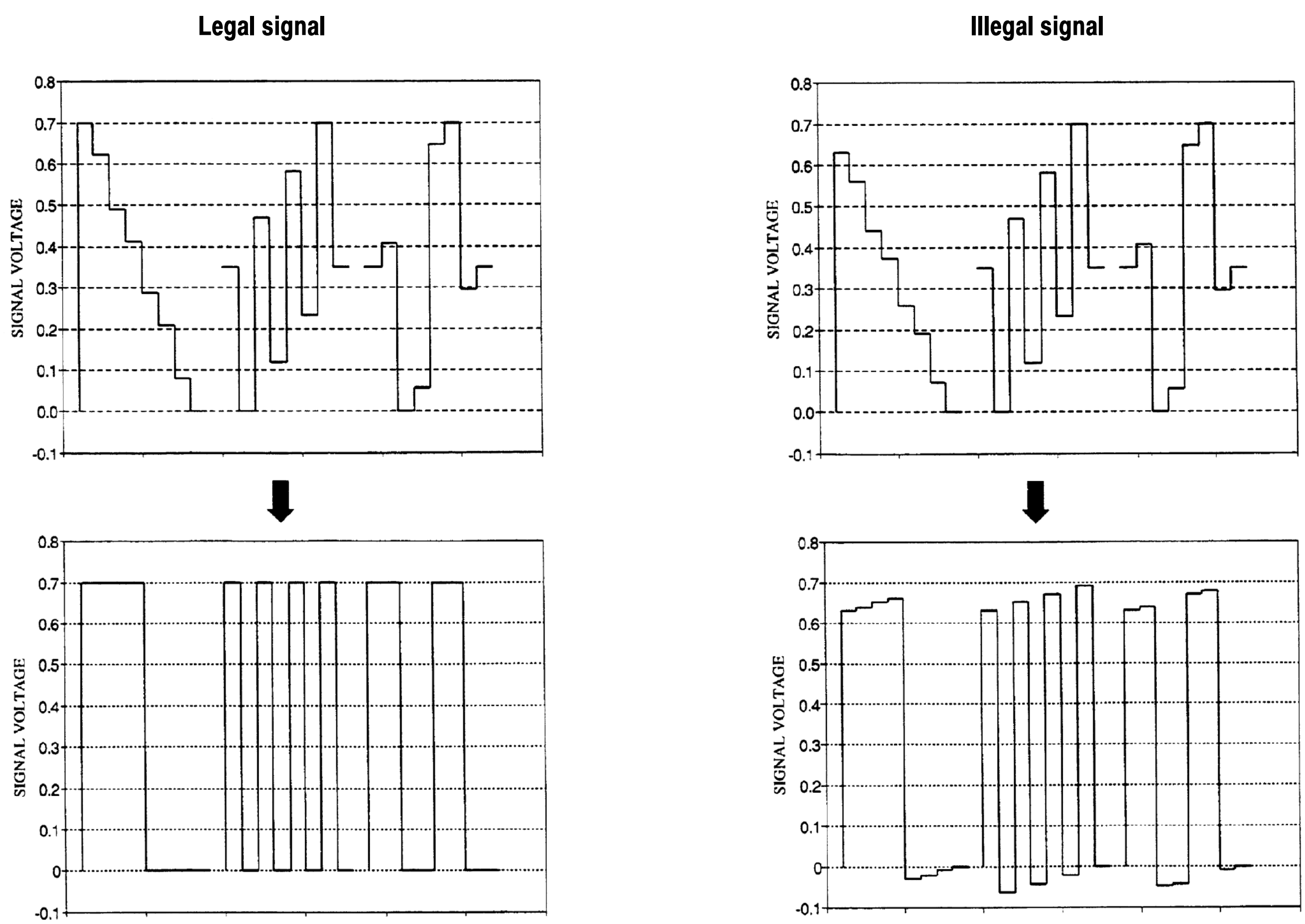


Figure 3-19: Example of legal and illegal color-difference signals

Signal Format and Colorimetry Concerns. Common television test signals are legal in some formats, but not in others. For example, SMPTE color bars, while within composite gamut space, are illegal in component (RGB) space; conversely 100% bars, legal in RGB gamut space, are illegal in composite space. 75% bars is an example of a legal and valid signal signal in both component and composite gamut spaces.

Colorimetry is the mathematical relationship that transforms native RBG into YPbPr. These equations differ depending on the colorimetry standard used. Also, the component color spaces themselves encompass different areas. The number of possible colors defined by YPbPr signals far exceeds the range of legal RBG colors.

Setting Gamut Alarm Limits

Listed below are general guidelines for setting gamut alarm limits for the Diamond and Arrowhead displays.

Diamond Display Gamut Limits. First, use the Gamut menu to set the upper and lower levels for a 5 mV tolerance (+705 mV and –5 mV). This will cover the tolerance of any signal generator that provides color bars. This tolerance is close enough to the nominal values of 700 mV and 0 mV to be undetectable by the human eye.

Next, set the Horizontal/Horiz+Vert soft key setting to Horiz+Vert. This setting will trigger on gamut errors that form a block covering several video lines, and thus are more visible to the human eye.

Arrowhead Display Gamut Limits. For North American applications of NTSC video signals, set the Setup control to 7.5%. In addition, set the upper threshold to 120 IRE because that is the level at which a TV transmitter starts to clip the signal.

For the majority of PAL video signal applications, set the Setup control to 0%. In addition, set the upper threshold to 935 mV because that is the limit of chrominance excursion. If you set the Limit Format setting for Arrowhead to Auto, Setup will always be 0% for PAL video signals.

Next, for both NTSC and PAL signals, set the Horizontal/Horiz+Vert soft key setting to Horiz+Vert. This setting will trigger on gamut errors that form a block covering several video lines, and thus are more visible to the human eye.

Line Select Mode

In Line Select mode, you can select one line of the video signal to display and measure. You can use Line Select to isolate the characteristics of one portion of the image: for example, you can look at the color of an actor's face.

The selected line is highlighted in Picture mode and in the thumbnail picture. The external picture monitor signals also contain a bright-up, which can be enabled in the Configure menu.

Line Select modifies many of the displays in the instrument. For example, in the Waveform display, instead of seeing a waveform that is representative of the entire video frame, the waveform displayed will be the video signal of a single line. The same is true of the Vector, Lightning, and Gamut displays.

Line Select stays active as you change between major modes. This enables you to select a line in Picture mode, and then go to Waveform, Vector, Diamond, or other modes and view the same line.

***NOTE**. Line Select mode is automatically disabled when Field sweep is selected. Line Select mode is always enabled in Data mode.*

Field Selection

The Field and Next Field soft keys select the field from which the selected line/sample is taken. Selecting All Fields displays the same line number from all fields in a frame. The 1 of 2 selection lets you choose a line from only one field in a frame. Touch the Next Field soft key repeatedly to cycle through the fields in a frame.

Sample Selection

Sample Select determines what portion of the line is viewed in Data Display mode (WFM700M only). The general purpose knob is automatically assigned to adjust the sample number. To adjust the line, touch the Line Select soft key or press the SELECT button. Sample Select is also active in Picture and thumbnail modes to allow correlation of events between modes.

Readout

The readout, in the upper right corner of the screen, shows both line select and sample select information, with the active selection highlighted.

- The readout for Line Select shows the selected field, the selected line, and the portion of the video signal in which the selected line occurs (such as active video or vertical blanking).
- The readout for Sample shows the selected sample number and the component of the video signal in which the sample occurs.

Logging

The instrument contains two different log files: diagnostics and events. You can use the Remote Web Server interface to download the contents of either log file. Refer to *Printing* on page 3–46 and to *Web Server Interface* on page C–4 for more information about printing the log files.

Diagnostics Log

This log contains the results of the last diagnostic test that the instrument performed. The contents of this log will be the results of the power-up diagnostic tests unless you ran one of the other diagnostic tests available in the System submenu of the Configure menu since you last powered on the instrument.

Refer to *Diagnostics* on page 3–12 for more information about viewing or printing the Diagnostics Log.

Event Log

The instrument maintains an event log in which every entry is time-stamped with the time-of-day when the instrument logged the event. When you enable Timecode in the Video Inputs/Outputs submenu of the Configure menu, the event log will time stamp events with the timecode embedded in the video signal you are monitoring.

Controlling the Size of the Event Log. The event log can contain up to 10,000 entries. Recording each individual event separately would fill the event log quickly. To handle this problem, the instrument classifies event log entries as one of the following:

- Single shot. One isolated occurrence is logged as one entry.
- Continuous. Uninterrupted sequence of occurrences is logged as two entries marking the beginning and end of the sequence.
- Intermittent. Interrupted sequence of closely spaced occurrences can be logged as separate entries or as one entry. Use the Printing/Event Log Setup submenu of the Configure menu to set the event log storage mode.

  Select Log for Duration to log intermittent events as one event, which saves space in the event log.

  Select Log for Resolution to log intermittent events separately, preserving time stamp information for each event, but filling up the event log quickly.

By default, most of the possible alarms conditions are enabled. If you leave all of these possible alarms enabled for logging, recording all of the events will fill the event log quickly. Use the General Alarms, Serial Alarms, and Audio Alarms submenus of the Configure menu to select which error conditions you will monitor and how you will be notified in the event of an error.

Figure 3-20 shows the General Alarms submenu of the Configure menu. The four columns labeled OnSc (on-screen), Beep, Log (logging), and Gnd (ground closure) indicate the current settings for alarm notification. An “X” indicates that a condition is selected and an “O” indicates that the condition is not selected. Touch the associated box to change the settings of the alarms indicators.

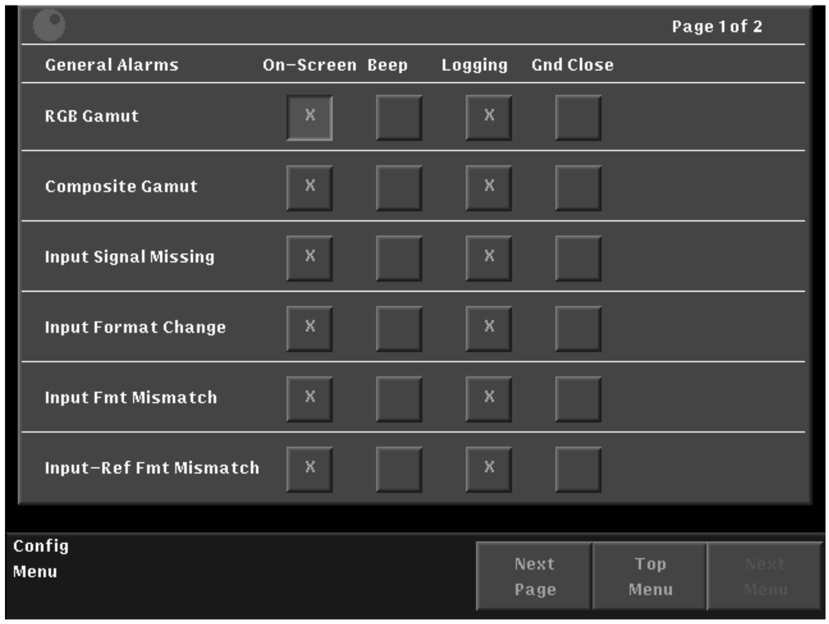


Figure 3-20: Configuring alarms for the Event Log

To reduce the size of the event log, you can use the Printing/Event Log submenu of the Configure menu to set the instrument to either logging for resolution or logging for duration. Logging of duration will cause the instrument to reduce the number of log entries by combining repeated intermittent events into one log entry. For example, if the same error condition appears and goes away several times within a brief period (a second or so), the error will be logged as a single event.

NOTE. *The Event Log always indicates whether it is logging for resolution or duration. If the logging method is changed in the middle of a logging session, the log indicates the logging-method change.*

Configuring the Event Log Full Condition. Use the Printing/Event Log Setup submenu of the Configure menu to configure the instrument to either stop logging events or to overwrite events when the event log has filled up to the 10,000 entry level. The default state is to stop logging when the event log is full.

Viewing and Printing the Event Log. You can view the Event Log using the Status menu or using the Remote Web Interface. Using the Status menu, you can configure the display to show only the signal events you want to view. Touch the Configure View Filter soft key to open the Log Filter menu where you can select to view all events, only errors, all alarms, or only general, serial, or audio alarms. The Event Log display indicates the current filter setting. In Figure 3-21, the display indicates that the log filter is set to Show All Errors.

When you press the Print button with the Event Log displayed, the complete Event Log file will be printed.

***NOTE**. The Log Filter menu settings only affect how you view the log entries using the Status display. These settings do not affect the actual contents of the Event Log, nor do they affect the Event Log display when you use the Remote Web Interface to view the Event Log.*

The contents of the Event Log cannot be recovered after the log has been erased.

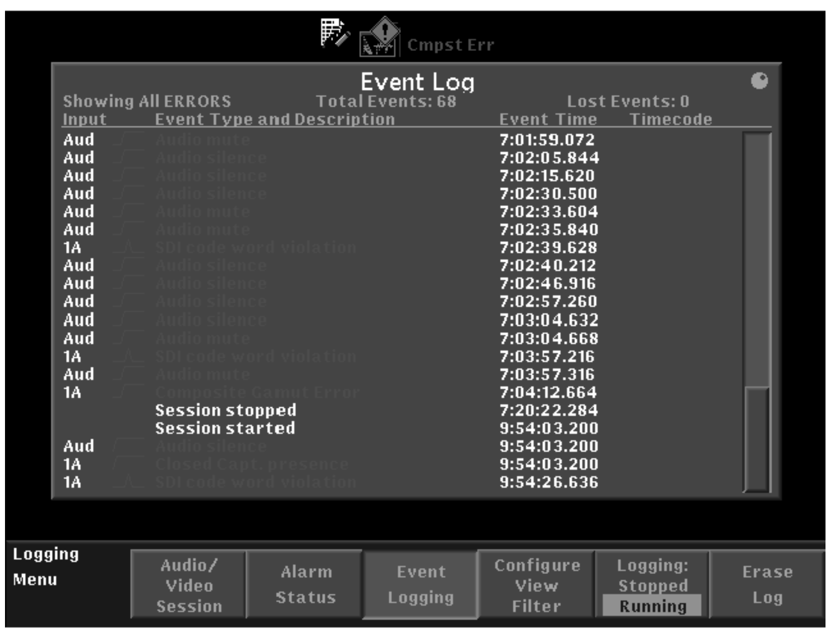


Figure 3-21: Event Log display

The Event Log uses icons to indicate the type and duration of detected signal conditions. Table 3–3 shows the Event Log icons you may encounter as they appear on-screen and in the Event Log file you can download using the Remote Web Interface.

Table 3-3: Event Log error status icons

On-screen icon	Remote Web Interface symbols	Description
	XXXX	Identifies a persistent (more than one video field) alarm condition that was present when logging started. The on-screen icon is red.
	_/XX	Identifies an alarm condition that persisted for more than one video field. The on-screen icon is red.
	_/_	Identifies a momentary (pulse) alarm condition that persisted for less than or equal to one video field. The on-screen icon is red.
	X__	Identifies an alarm condition that cleared for more than one video field. The on-screen icon is green.
	X\/X	Identifies an alarm condition that cleared for less than or equal to one video field. The on-screen icon is red.
	/\/\	Identifies an intermittent alarm condition (one field on, one field off). The on-screen icon is red.

Measure Mode (WFM700M Only)

Press the MEASURE button to access the Data Display. The Data Display mode shows the actual SD or HD input data without any interpolation. Refer to *Data Display (WFM700M Only)* on page 3–9 for more information about using the Data Display mode.

From the Measure submenu of the Data Display menu, you can set the instrument to Bowtie mode. When you send a Bowtie signal through your system, you can use the Bowtie mode to determine timing and gain differences between the three component signals, Y, P_b, and P_r. Refer to *Bowtie Mode* on page 3–7 for more information.

Multi Mode

Press the MULTI button to enable the Multi mode display. Using Multi mode, you can show two different views of the same input signal side-by-side (see Figure 3–22). You can view the current Waveform, Vector/Lightning, Gamut, Audio, Status, or Data Display in either of the two windows.

***NOTE**. Multi mode shows two different views of the same input signal. You must use the Input menu to select a different input signal for display.*

Multi mode horizontally compresses displays so that they will fit side-by-side. When the Status display is selected as one of the Multi mode displays, there may be some overwriting of the label text in the Status display. The measurement text is not affected by the display compression. In addition, the audio-presence indicators for groups 3&4 may not appear on the Status display in Multi mode.

Option DG Audio Module Only: When Level Meters + Lissajous is the selected Audio-mode display and you set the instrument into Multi mode, the Lissajous display will appear when you select Audio as one of the Multi mode displays. You must select the Level Meters as the Audio-mode display to view the audio level meters in Multi mode.

The front-panel controls affect only the display mode in the currently selected Multi-mode window. The currently selected window is highlighted, as shown by a box around that window. You can use any of the following methods to switch front-panel control to a desired window:

- Press the SELECT button
- Touch the Selected Window softkey
- Touch the desired window on the touchscreen display

Press the Go To softkey to open the menu for the operating mode in the currently selected Multi-mode display. The name of the selected display is listed on the soft key. For example, if Waveform is the display mode in the currently selected Multi-mode window, this soft key displays Go To Waveform Menu.

***NOTE**. Changes you make in the menu of an operating mode while the instrument is in Multi mode affect that operating mode when you exit Multi mode.*

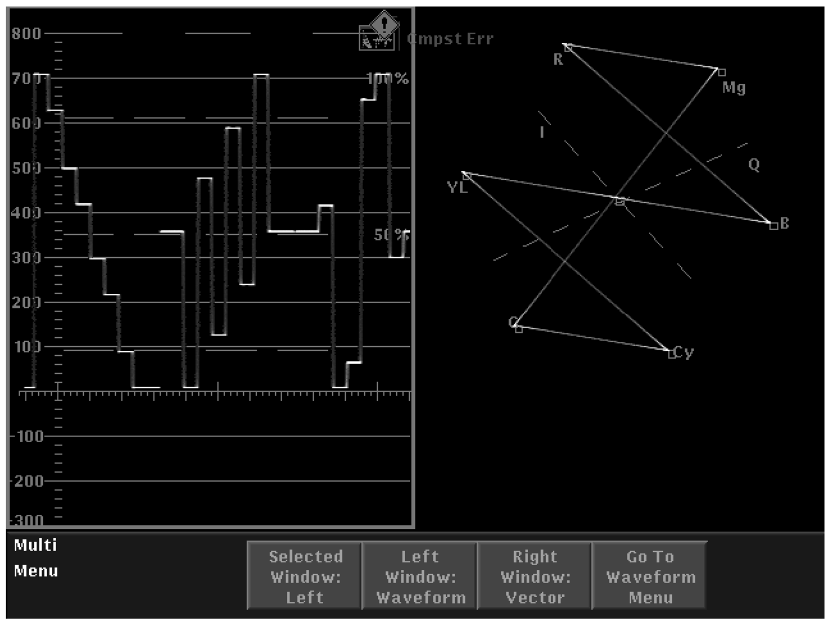


Figure 3-22: Multi mode showing the Waveform and Vector displays

Closed Caption Detection in Data Mode

Detection of analog (line 21) closed caption does not operate if the instrument is in Data mode or in Multi mode when the Data display is selected as one of the displays.

Printing

***NOTE**. The instrument formats print output in Postscript color, or Postscript black and white formats. The selected network printer must support LPD protocol.*

You can use the Printing/Event Log submenu of the Configure menu to configure the instrument to print the following items to a printer on your local network:

- **Instrument display.** To print the current instrument display (waveforms and text), press the Print button.

***NOTE**. When printing the Eye pattern display, set the trace intensity to a value greater than 20 for good contrast between the trace and the background.*

- **Event Log file.** To print the Event Log file, press the Print button when you are viewing the Event Log in the Status display. The complete Event Log file will be printed, not just the portion displayed on the instrument screen.
- **Diagnostics Log file.** To print the Diagnostic Log file, touch the Print Diagnostics Log soft key in the System submenu of the Configure menu.

Refer to *Printing / Event Log* on page 2–46 for information about configuring the instrument for printing.

Readouts

There are a number of readouts that may appear on the the screen, depending on the current state of the instrument. Refer to page 2–7 for information about specific readouts.

When a menu is displayed, the readouts on the lower part of the screen move up above the menu. When CLR MENU is pressed, these readouts move down.

Status Displays

The instrument provides several status displays, which allow you to observe various aspects of the monitored signal. Press the Status button to access the following status displays:

- Video status and session display
- Audio status and session display (Option DG only)
- General alarms status
- Serial alarms status
- Audio alarms status
- Event log

This subsection describes the contents of the various status displays. Refer to *Logging* on page 3–40 for information about using the Event Log.

Status Display Colors

Messages and values in the different status displays use the following colors to help indicate signal status:

White. This color identifies items that are informational. These items represent changes in the instrument state.

Green. This color indicates error conditions that have cleared.

Yellow. This color indicates a warning condition; a condition that might require attention but does not meet the requirements of an error condition.

Red. This color indicates signal information that has been found to be in an ongoing error state.

Video Status and Session Display

The Video Status display (see Figure 3–23 and Figure 3–24) shows the current status of the video signal being monitored. The Video Session display shows the cumulative results of the current video monitoring session. Use the Session Stopped/Running soft key to start or stop the monitoring session. Use the Reset Session soft key to clear the display.

***NOTE**. The Session: Stopped/Running and the Reset Session soft keys affect both the audio and video session displays. For example, if you stop/start or reset the session when the currently displayed session is audio, the video session is also stopped/started or reset.*

The Video Status and Video Session display contains the following information:

Video Session. Displays the current state of the video session: Running or Stopped. In Figure 3–23, the session state is running.

Input. Displays the selected input source and module type. The input source can be either 1A, 1B, 2A, or 2B. The module type can be either WFM7A, WFM7HD, or WFM7M. In Figure 3–23, the input source is input 1A and the module type is WFM7M.

Signal. Displays the rate of the input signal. In Figure 3–23, the signal rate is reported as 270.0 Mb/s. The following rates may appear:

- For SD signals (525 lines and 625 lines), 270 Mb/s is displayed.
- For HD signals with frame rates of 59.94 Hz, 24.98 Hz, and 23.97 Hz, 1.4835 Gb/s is displayed.
- For HD signals with frame rates of 60 Hz, 50 Hz, 30 Hz, 25 Hz, and 24 Hz, 1.4850 Gb/s is displayed.

Format Exp. Displays the expected format of the video signal as set in the Video Inputs/Outputs submenu of the Configure menu. In Figure 3–23, the expected signal format is reported Any Supported.

Format Det. Displays the determined format of the video signal. In Figure 3–23, the determined signal format is reported as 525i 59.94 (525-line interlaced signal at 59.94 Hz).

Figure 3-23: Video status and session display with SD signal input

Figure 3-24: Video status and session display with HD signal input

Colorimetry. Displays the current colorimetry setting, which determines the equations used by the waveform monitor to create the color difference signals. The following settings may appear:

***NOTE**. The colorimetry settings of 601 and 709 represent international digital-video standards, and 240 represents a SMPTE digital-video standard.*

- 601 is displayed for SD signals conforming to ITU-R BT.601
- BT.709 is displayed for 1080i, 720p HD signals conforming to ITU R BT.709
- 240 is displayed for 1035i HD signals conforming to SMPTE240M
- Auto is displayed when the instrument is set to determine the colorimetry from the input signal

Embedded Audio. Displays “P” when audio is present and displays “–” when audio is not present for each of the channels in the audio embedded in the video signal. In Figure 3–23, PPPP PPPP PPPP PPPP is displayed, indicating that embedded audio is present for all four channels in all four audio groups.

Ancillary Data. Indicates whether ancillary data exists in the video signal. In Figure 3–23, None is displayed, indicating there is no ancillary data present.

Active Video Width. Displays how many bits are used for video resolution. In Figure 3–23, 10 bits is the reported width of the active video.

Timecode. Indicates whether timecode data exists in the video signal. In Figure 3–23, None is displayed indicating there is no timecode data present.

Selected Ref. Displays the current reference setting from the Input menu: INT for internal or EXT for external. In Figure 3–23, INT is displayed, indicating that internal reference is selected.

Ref Format. Displays the format of the external reference signal. N/A is displayed when internal reference is selected. When external reference is selected, the display indicates the format of external reference signal and indicates whether the format of the signal matches the External Reference Format setting in the Video Inputs/Outputs submenu of the Configure menu. If the format of the reference signal does not match the expected format as set in the Configure menu, the expected format is displayed in red text along with the word “Forced.” In Figure 3–23, N/A is displayed, indicating that internal reference is selected.

Closed Caption. Indicates whether closed caption data exists in the video signal. In Figure 3-23 on page 3-49, Missing is displayed, indicating there is no closed caption data present.

Stuck Bits. For SD signals only, displays which of the video bits are stuck. In Figure 3-23 on page 3-49, ---- ---- -- is displayed, indicating that none of the 10 video bits are stuck.

Y Stuck Bits. For HD signals only, displays which of the luminance (Y) video bits are stuck. In Figure 3-24 on page 3-49, ---- ---- LL is displayed, indicating that none of the 8 video bits are stuck. LL is displayed for the two unused bits.

C Stuck Bits. For HD signals only, displays which of the chrominance (C) video bits are stuck. In Figure 3-24 on page 3-49, ---- ---- LL is displayed, indicating that none of the 8 video bits are stuck. LL is displayed for the two unused bits.

F1 AP CRC. For SD signals only, displays the calculated active picture CRC (Cyclical Redundancy Check) value for field one in hexadecimal. In Figure 3-23 on page 3-49, the calculated CRC is F3C3. The instrument uses the SMPTE RP165 standard for error checking. For HD signals, the CRCs change on every video line and are impossible to display in a meaningful way.

Changed Since Reset. For SD signals only, indicates whether the F1 AP CRC value has changed since the last video session reset. In Figure 3-23 on page 3-49, Yes is displayed, indicating that the F1 AP CRC has changed since the last session reset.

F2 AP CRC. For SD signals only, displays the calculated active picture CRC (Cyclical Redundancy Check) value for field two in hexadecimal. In Figure 3-23 on page 3-49, the calculated CRC is F3C3. The instrument uses the SMPTE RP165 standard for error checking. For HD signals, the CRCs change on every video line and are impossible to display in a meaningful way.

Changed Since Reset. For SD signals only, indicates whether the F2 AP CRC value has changed since the last video session reset. In Figure 3-23 on page 3-49, Yes is displayed, indicating that the F2 AP CRC has changed since the last session reset.

Y Errored Lines. For HD signals only, the number of video lines with luminance (Y) errors. In Figure 3-24 on page 3-49, six is displayed, indicating that six video lines have had luminance errors.

C Errored Lines. For HD signals only, the number of video lines with chrominance (C) errors. In Figure 3-24 on page 3-49, six is displayed, indicating that six video lines have had chrominance errors.

Time Since Reset. Displays the length of time since the last reset of the video session occurred. Time is displayed as “DD:HH:MM:SS”, where DD is the number of days, HH is the number of hours, MM is the number of minutes, and SS is the number of seconds. In Figure 3-23 on page 3-49, the time since reset is displayed as 2 hours, 24 minutes, and 57 seconds.

RP165 EDH. Indicates the status of the RP165 EDH in the video signal. In Figure 3-23 on page 3-49, the RP165 EDH is Present. The status values can be one of the following:

- **Present –** Indicates the EDH packet is present and has no errors.
- **Missing –** Indicates the EDH packet is missing, which probably means that the EDH packet was not inserted by the source.
- **Error –** Indicates that an EDH packet is present, but there is an error (checksum or parity) in the RP165 EDH packet.

FF Errored Seconds. For SD signals only, displays the number of seconds containing at least one error detected in either the active or blanking portion (Full Field) of the video signal. In Figure 3-23 on page 3-49, the number of full field errored seconds is one.

FF Errored Fields. For SD signals only, displays the number of fields that contained an error since the last reset. In Figure 3-23 on page 3-49, the number of errored fields is one.

FF % Errored Fields. For SD signals only, displays a calculated number listing the percentage of fields since the last reset that contained at least one error. In Figure 3-23 on page 3-49, the percentage of errored fields is >0.00%.

FF Status. For SD signals only, displays the current FF status of the video signal. In Figure 3–23 on page 3–49, the FF status is OK. The status values can be one of the following:

- **OK** – Indicates the computed CRC value matches the embedded CRC value.
- **Invalid** – Indicates the status bit was marked invalid in the EDH packet.
- **Error** – Indicates the embedded CRC value does not match the calculated CRC value, and thus a transmission error has occurred.
- **N/A** – Appears when RP165 EDH status is Missing or Error.

AP Errored Seconds. For SD signals only, displays the number of seconds containing at least one error detected in the active picture (AP) portion of the video signal. In Figure 3–23 on page 3–49, the number of errored seconds is one.

AP Errored Fields. For SD signals only, displays the number of fields that contained an active picture error since the last reset. In Figure 3–23 on page 3–49, the number of errored fields is one.

AP % Errored Fields. For SD signals only, displays a calculated number listing the percentage of fields since the last reset that contained at least one error. In Figure 3–23 on page 3–49, the percentage of errored fields is >0.00%.

AP Status. For SD signals only, displays the status of the Active Picture portion of the video signal. In Figure 3–23 on page 3–49, the AP status is OK. The status values can be one of the following:

- **OK** – Indicates the computed CRC value matches the embedded CRC value.
- **Invalid** – Indicates the status bit was marked invalid in the EDH packet.
- **Error** – Indicates the embedded CRC value does not match the calculated CRC value, and thus a transmission error has occurred.
- **N/A** – Appears when RP165 EDH status is Missing or Error.

Y Errored Seconds. For HD signals only, displays the number of seconds containing at least one error detected in the luminance (Y) portion of the video signal. In Figure 3–24 on page 3–49, the number of errored seconds is zero.

Y Errored Fields. For HD signals only, displays the number of fields that contained an error since the last reset. In Figure 3–24 on page 3–49, the number of errored fields is zero.

Y % Errored Fields. For HD signals only, displays a calculated number listing the percentage of fields since the last reset that contained at least one error. In Figure 3–24 on page 3–49, the percentage of errored fields is zero.

Y Status. For HD signals only, displays the current luminance (Y) status of the video signal. In Figure 3–24 on page 3–49, the Y status is OK. The status values can be one of the following:

- **OK** – Indicates the embedded CRC value matches the calculated CRC value.
- **Error** – Indicates the embedded CRC value does not match the calculated CRC value, and thus a transmission error has occurred.

C Errored Seconds. For HD signals only, displays the number of seconds containing at least one error detected in the color (C) portion of the video signal. In Figure 3–24 on page 3–49, the number of errored seconds is zero.

C Errored Fields. For HD signals only, displays the number of fields that contained a color picture error since the last reset. In Figure 3–24 on page 3–49, the number of errored fields is zero.

C % Errored Fields. For HD signals only, displays a calculated number listing the percentage of fields since the last reset that contained at least one error. In Figure 3–24 on page 3–49, the percentage of errored fields is zero.

C Status. For HD signals only, displays the status of the color portion of the video signal. In Figure 3–24 on page 3–49, the Y status is OK. The status values can be one of the following:

- **OK** – Indicates the embedded CRC value matches the calculated CRC value.
- **Error** – Indicates the embedded CRC value does not match the calculated CRC value, and thus a transmission error has occurred.

Gamut. Evaluates the input signal against the thresholds set for the Diamond and Arrowhead displays. If an error occurs, Error is displayed for about one-half second after an error condition goes away.

RGB Errored Seconds. Displays the number of seconds containing at least one detected RGB gamut error. In Figure 3–23 on page 3–49, the number of RGB gamut errored seconds is 834.

RGB Errored Fields. Displays the number of fields that contained an RGB gamut error since the last reset. In Figure 3–23 on page 3–49, the number of errored fields is three.

RGB % Errored Fields. Displays a calculated number listing the percentage of fields since the last reset that contained at least one RGB gamut error. In Figure 3–23 on page 3–49, the percentage of errored fields is >0.00%.

RGB Gamut Status. Displays the current RGB gamut status of the video signal. In Figure 3–23 on page 3–49, the RGB gamut status is OK. The status values can be one of the following:

- **OK** – Indicates that the RGB gamut values are within the thresholds set for the Diamond display.
- **Error** – Indicates that the RGB gamut values exceed the thresholds set for the Diamond display. The Error indicator is displayed for one second after an error occurs.

Cpst Errored Seconds. Displays the number of seconds containing at least one detected composite gamut error. In Figure 3–23 on page 3–49, the number of composite gamut errored seconds is 7860.

Cpst Errored Fields. Displays the number of fields that contained a composite gamut error since the last reset. In Figure 3–23 on page 3–49, the number of errored fields is 463651.

Cpst % Errored Fields. Displays a calculated number listing the percentage of fields since the last reset that contained at least one composite gamut error. In Figure 3–23 on page 3–49, the percentage of errored fields is 98.08%.

Cpst Gamut Status. Displays the current composite gamut status of the video signal. In Figure 3–23 on page 3–49, the composite gamut status is Error. The status values can be one of the following:

- **OK** – Indicates that the composite gamut values are within the thresholds set for the Arrowhead display.
- **Error** – Indicates that the composite gamut values exceed the thresholds set for the Arrowhead display. The Error indicator is displayed for one second after an error occurs.

Audio Status and Session Display (Option DG Only)

The Audio Status/Session display (see Figure 3-25) shows the current status of the audio signal being monitored. Use the Session Stopped/Running soft key to start or stop the monitoring session. Use the Reset Session soft key to clear the display.

Messages and values in the audio status and session display use colors to help indicate signal status. Refer to *Status Display Colors* on page 3-47.

***NOTE**. The Session: Stopped/Running and the Reset Session soft keys affect both the audio and video session displays. For example, if you stop/start or reset the session when the currently displayed session is audio, the video session is also stopped/started or reset.*

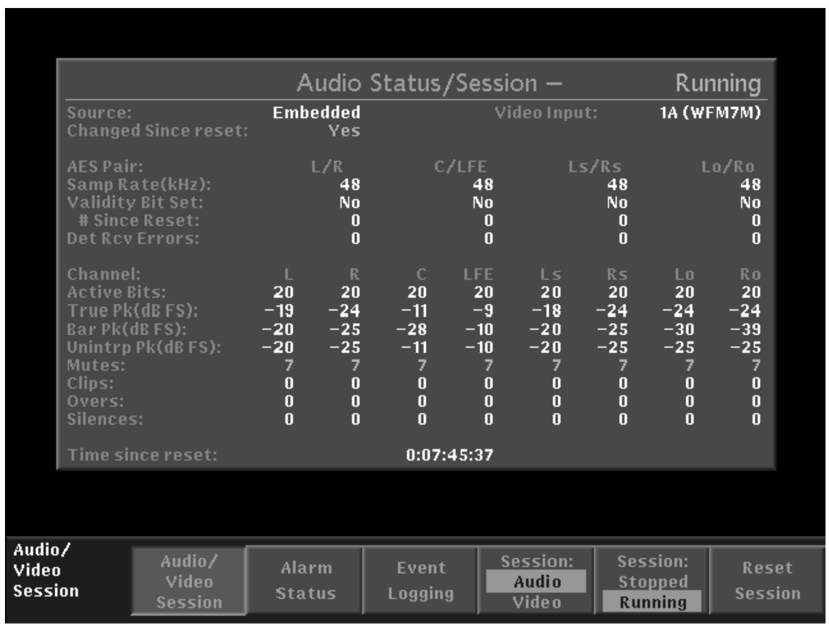


Figure 3-25: Audio status and session display

The Audio Status/Session display contains the following information:

Audio Session. Displays the current state of the audio session: Running or Stopped. In Figure 3-25, the session state is running.

Source Displays the source of the audio signal: Embedded or External AES. In Figure 3-25, the signal source is Embedded.

Video Input. Displays the selected video input source and module type when the audio source is embedded. The video input source can be either 1A, 1B, 2A, or 2B. The module type can be either WFM7A, WFM7HD, or WFM7M. In Figure 3-25, the input source is input 1A and the module type is WFM7M.

Changed Since Reset. Indicates whether the signal source has changed since the last audio session reset. In Figure 3-25, Yes is displayed, indicating that the signal source has changed since the last session reset.

AES Pair. Displays the labels for each audio channel pair. The labels depend on the Audio Program Type setting (surround or stereo pairs) in the Audio Inputs/ Outputs submenu of the Configure menu. The labels are L/R, C/LFE, Ls/Rs, and Lo/Ro when the Audio Program Type is set to surround, and the labels are 1/2, 3/4, 5/6, and 7/8 when the Audio Program Type is set to stereo pairs. In Figure 3-25, the channel labels are L/R, C/LFE, Ls/Rs, and Lo/Ro, indicating that the Audio Program Type is set to surround.

Samp Rate (kHz). Displays the sample rate for each channel pair. In Figure 3-25, the sample rate for each channel pair is 48 kHz.

Validity Bit Set. Displays Yes or No to indicate whether the validity bit has be set for each channel pair. In Figure 3-25, No is displayed for each channel pair, indicating that the validity bit has not been set.

 # Since Reset. Displays the number of samples for each channel pair that have had the validity bit set since the last audio session reset. In Figure 3-25, 0 is displayed for each channel pair, indicating that no validity bits have been set.

Det Rcv Errors. Displays the detected number of receive errors for each channel pair. In Figure 3-25, 0 is displayed for each channel pair, indicating that no receive errors have been detected.

***NOTE**. The detection process can fail to record very short duration errors, although the receiver can signal an alarm on these errors. In this case, the value in the Det Rcv Errors field will be slightly lower than the actual number of receive errors.*

Channel. Displays the labels for each audio channel. The labels depend on the Audio Program Type setting (surround or stereo pairs) in the Audio Inputs/Outputs submenu of the Configure menu. The labels are L, R, C, LFE, Ls, Rs, Lo, and Ro when the Audio Program Type is set to surround. The labels are 1, 2, 3, 4, 5, 6, 7, and 8 when the Audio Program Type is set to stereo pairs. In Figure 3-25, the channel labels are L, R, C, LFE, Ls, Rs, Lo, and Ro, indicating that the Audio Program Type is set to surround.

Active Bits. Displays the number of active bits for each audio channel. In Figure 3-25, 20 is displayed for each channel indicating that each channel has 20 active bits.

True Pk (dB FS). Displays the true peak of the signal for each audio channel in dB FS units. In Figure 3-25, the following true peaks are displayed: L (-19), R (-24), C (-11), LFE (-9), Ls (-18), Rs (-24), Lo (-24), Ro (-24).

Bar Pk (dB FS). Displays the bar peak in the level meters display for each audio channel in dB FS units. In Figure 3-25, the following bar peaks are displayed: L (-20), R (-25), C (-28), LFE (-10), Ls (-20), Rs (-25), Lo (-30), Ro (-39).

Unintrp Pk (dB FS). Displays the uninterpolated peak for each audio channel in dB FS units. In Figure 3-25, the following uninterpolated peaks are displayed: L (-20), R (-25), C (-11), LFE (-10), Ls (-20), Rs (-25), Lo (-25), Ro (-25).

Mutes. Displays the number of mutes detected for each audio channel. In Figure 3-25, the number of mutes detected for each audio channel is seven.

***NOTE**. The number of audio mutes reported in the Audio Status/Session display is directly affected by the # of Samples for Mute setting in the Audio Thresholds submenu of the Configure menu.*

Clips. Displays the number of clips detected for each audio channel. In Figure 3-25, the number of clips detected for each audio channel is zero.

***NOTE**. The number of audio clips reported in the Audio Status/Session display is directly affected by the # of Samples for Clip setting in the Audio Thresholds submenu of the Configure menu.*

Overs. Displays the number of over levels detected for each audio channel. In Figure 3-25, the number of overs detected for each audio channel is zero.

***NOTE**. The number of audio overs reported in the Audio Status/Session display is directly affected by the Over Level setting and the Duration for Silence/Over setting in the Audio Thresholds submenu of the Configure menu.*

Silences. Displays the number of silences detected for each audio channel. In Figure 3-25, the number of silences detected for each audio channel is zero.

***NOTE**. The number of audio silences reported in the Audio Status/Session display is directly affected by the Silence Level setting and the Duration for Silence/Over setting in the Audio Thresholds submenu of the Configure menu.*

Time Since Reset. Displays the length of time since the last reset of the audio session occurred. Time is displayed as “DD:HH:MM:SS”, where DD is the number of days, HH is the number of hours, MM is the number of minutes, and SS is the number of seconds. In Figure 3-25, the time since reset is displayed as 2 hours, 22 minutes, and 24 seconds.

Alarm Status Displays

The instrument provides three alarm status displays which correspond to the three categories of alarms provided in the Configure menu: general, serial, and audio. Each alarm display (see Figure 3-26) indicates the status of all the available alarms in that alarm category.

Alarm Status Indicators. An "X" appears in the Enabled column of the display for all of the alarms you enabled in the Configure menu. The Status column indicates the status of each alarm, whether or not that alarm condition has been enabled. Table 3-4 lists the status indicators that may appear in the alarm status displays.

***NOTE**. Refer to* General Alarms *on page 2-30,* Serial Alarms *on page 2-32, and* Audio Alarms *on page 2-34 for a description of the various alarms you can set.*

Status indicators and values in the alarm status displays use colors to help indicate alarm status. Refer to *Status Display Colors* on page 3-47.

Table 3-4: Alarm status indicators

Indicator	Description
OK	No alarm condition is detected.
Yes / No	Indicates whether or not a condition was detected.
Error	An alarm is detected and information about the error is displayed.
N/A	The alarm condition does not apply to the current configuration. For example, the RP165 EDH status alarm is set to N/A when an HD signal is present because RP165 is only valid in SD signals.
Missing	An optional feature is not present in the input signal. For example, the RP165 EDH status alarm is set to Missing when the input is SD but there are no RP165 packets present in the signal (EDH is an optional signal feature).
12345678	In the Audio Alarm Status display, this indicator may appear to show which audio channels have errors. In Figure 3-26, --34--78 is displayed indicating that channels 3,4, 7, and 8 have silence errors. This indicator is logical, after remapping, and not physical.

General Alarms
status display

Serial Alarms
status display

Audio Alarms
status display

Figure 3-26: Alarm status displays

RGB and Composite Gamut Error Indicators. When RGB errors and/or Composite Gamut errors are detected, the associated lines in the Alarm Status display have characters on the right side that indicate which gamut threshold(s) are exceeded for each component. Table 3–5 lists the error codes that may be displayed. Refer to *Gamut Menu* on page 2–65 for information about setting threshold limits.

If the high threshold is exceeded, a capital letter is displayed. If the low threshold is exceeded, a lower case letter is displayed. One of more code letters will appear depending on which component(s) goes above or below the threshold limits.

The displayed letter corresponds to the first letter of the video component with the error. For example, if the Red signal is too large, the RGB gamut error will display an "R." If the Green signal goes below the low threshold, a "g" is displayed. For composite signals, if the chroma signal is too large, a "C" is displayed. The "C" will always be a capital because there are only upper threshold limits for composite signals.

Table 3-5: Alarm Status display error indicators

Indicator	Description
R	Signal exceeds the high gamut limit for the red component (RGB gamut)
r	Signal exceeds the low gamut limit for the red component (RGB gamut)
G	Signal exceeds the high gamut limit for the green component (RGB gamut)
g	Signal exceeds the low gamut limit for the green component (RGB gamut)
B	Signal exceeds the high gamut limit for the blue component (RGB gamut)
b	Signal exceeds the low gamut limit for the blue component (RGB gamut)
C	Signal exceeds the high gamut limit for the chroma component (composite gamut)

Sweep Mode

Use the Sweep mode to select horizontal timing optimized to display one full line (line), two lines consecutively (2 Line), all of the lines in one video field (Field), or all of the lines in two video fields consecutively (2 Field).

***NOTE**. The SWEEP button is operational only in modes that support the Sweep and Mag function: Waveform, Eye, Jitter, and Lightning (Mag only).*

Parade / Overlay

In Parade mode, all selected components of the signal are displayed from left to right, in the same order as they appear on the soft key (for example, in the RGB display, "R" is on the left, followed by "G" and then "R"). In Overlay mode, all selected components of the signal are overlaid.

***NOTE**. Do not use the time cursors to measure time between components in a paraded waveform display. Parade mode is a special display format that represents all displayed components in a single screen, irrespective of the time relationship between components.*

Line / Field Sweeps

Press the corresponding soft key in the Sweep menu to select the following sweep modes:

NOTE. *In waveform mode, the instrument does not maintain separate sweep settings for the different color space selections. Changing the sweep selection in one color space setting changes the sweep mode in all color space settings.*

The composite color space does not support 2 Line and 2 Field sweeps.

Time/div varies with format and sweep type to keep the displayed waveform a reasonable size.

Line Select mode is automatically disabled when Field sweep is selected.

Line. One horizontal line is displayed. Use the Line Select function to choose one line out of a field or frame.

2 Line. (Overlay mode only) Two consecutive horizontal lines are displayed.

Field. All lines for one video field are displayed.

2 Field. (Overlay mode only) All lines for two video fields are displayed.

Mag Sweep

When Mag sweep is on, the horizontal scale is magnified about the center of the screen. In the magnified mode, the waveform extends off both sides of the CRT. Use the horizontal position knob to pan left and right on the waveform.

NOTE. *Timing cursors operate correctly in the magnified mode, although one or both may be off screen during measurements.*

When operating in two line sweep mode, MAG factors are chosen that optimize the evaluation of the horizontal blanking interval. To utilize this feature, perform the following steps:

1. Ensure that the waveform display is in OVERLAY mode.
2. Select 2LINE sweep.
3. Use the horizontal position control to adjust the waveform so that the blanking interval is aligned with the horizontal graticule indicating the center of the screen.
4. Select MAG sweep.

Vector Mode

In the Vector menu, you can select two related displays: Vector and Lightning. The Vector display is a traditional vector plot of the color difference signals Pb and Pr. The Lightning display is a Tektronix proprietary display combining a vertical luminance axis with horizontal chrominance information. The Vector and Lightning displays both have targets suitable for determining conformance using 75% or 100% color bar patterns.

Several alpha-numeric text messages may appear on the screen in Vector mode, for example, Bars, Gain, and color standard. For information about individual readouts, refer to *Readouts* on page 2-7.

For information about the Vector menu options, refer to *Vector Menu* on page 2-101.

Vector Display

The Vector display allows you to view the signal as a complex vector of color components, with no luminance information included. The radial magnitude represents saturation and the phase angle represents hue.

You can use the Vector menu to select either a component or composite vector graticule. When the component graticule is selected, you can turn the compass rose graticule on or off (default setting) and you can turn the I/Q axis on (default setting) or off using the Graticule Setup settings in the Configuration menu. When the composite graticule is selected, the compass rose graticule is always displayed.

***NOTE**. The component vector graticule is provided to allow comparison with other equipment with similar displays. For a more accurate representation of hue shift, use the composite vector representation.*

Plotting the Vector Display. The Vector display plots the two color difference signals, Pb and Pr, similar to a composite vectorscope. Figure 3–27 shows how the color difference signals are plotted to create the Vector display. Figure 3–28 on page 3–68 shows the actual polar graticule with trace lines indicating how a trace would appear on the graticule.

The polar display permits measurements of hue in terms of the relative phase of the chrominance signal. Amplitude of chrominance is the displacement from center (radial dimension of amplitude) towards the color point.

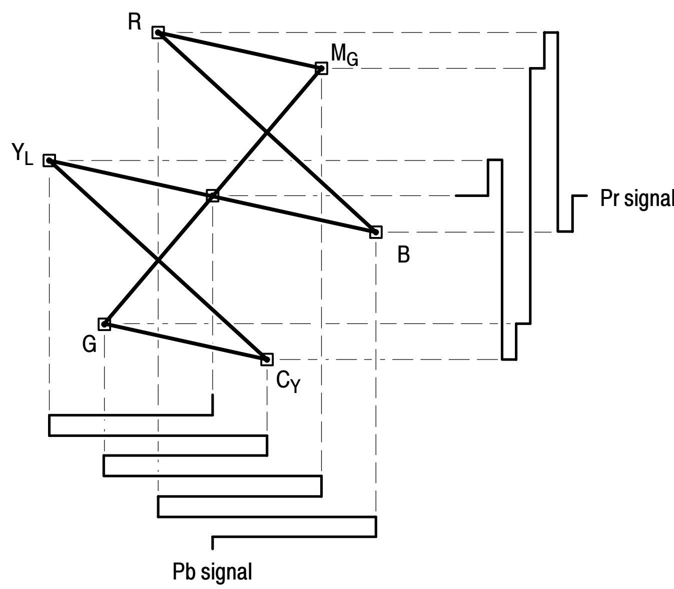


Figure 3-27: Vector display relationship of the Pr and Pb signals

Vector Graticules. There are two Vector graticules available. Figure 3-28 shows the component graticule and Figure 3-29 shows the composite graticule. Refer to *Composite Color Space* on page 3-73 for more information about using the composite graticule.

Use the Graticule Setup submenu of the Configure menu to turn the vector I/Q axis on and off and to turn on the compass rose for the component vector graticule.

Each chrominance vector of a Color Bar signal terminates as a bright dot in a target. The distance from the center box to the target box corresponds to the amplitude for the color being measured. The dot brightness corresponds to the duration of the color bar. The dimension of each target box represents 2% (±14 mV) of a 700 mV amplitude. The displayed amplitude allows comparison to the Color Bar targets.

The dashed-vector line labeled "I" is for evaluating flesh tones. Increasing radial amplitude along this axis indicates increasing flesh-tone saturation. Increasing angle change from this axis indicates increasing flesh-tone hue change.

Phase and Amplitude Measurements. With the Vector display, you can check the encoder accuracy for both phase and amplitude errors. When taking measurements, make certain that your source signal amplitude matches the Vector graticule. For example, if the source is a 75% Color Bar signal, then choose the 75% graticule in the WFM/VEC Configuration menu. The current graticule selection appears beside the graticule.

Vector Timing Measurements. In the composite domain, the transitions between the vector end points display timing differences. But, because these timing differences include the delay in the decoder output filtering, you can usually ignore them. In the component domain, there is no decoding required, and therefore the color bar transitions contain useful timing information. These timing differences appear as looping or bowing of the transitions.

***NOTE**. While the Vector display allows you to visualize interchannel timing errors, use the Lightning display to quantify the amount of timing error.*

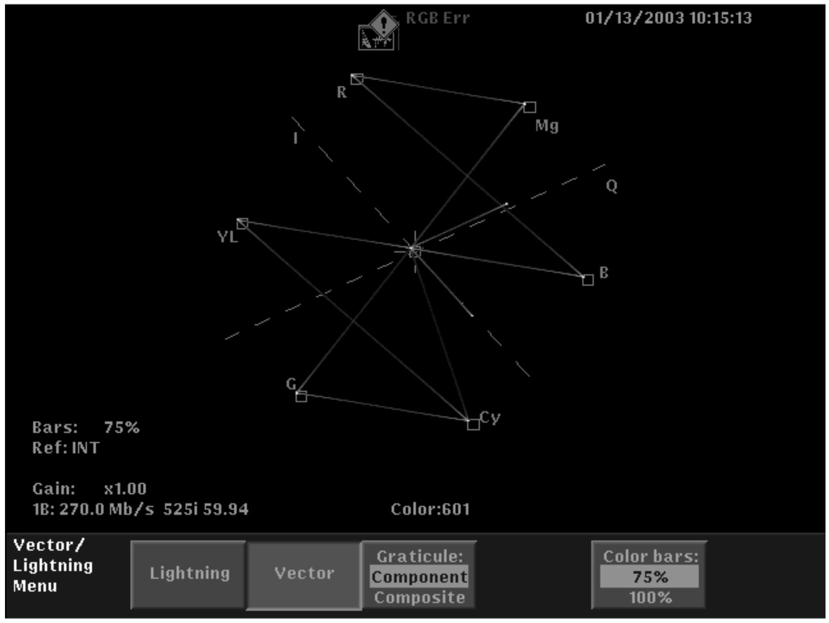


Figure 3-28: Vector display with component graticule selected and with compass rose turned off

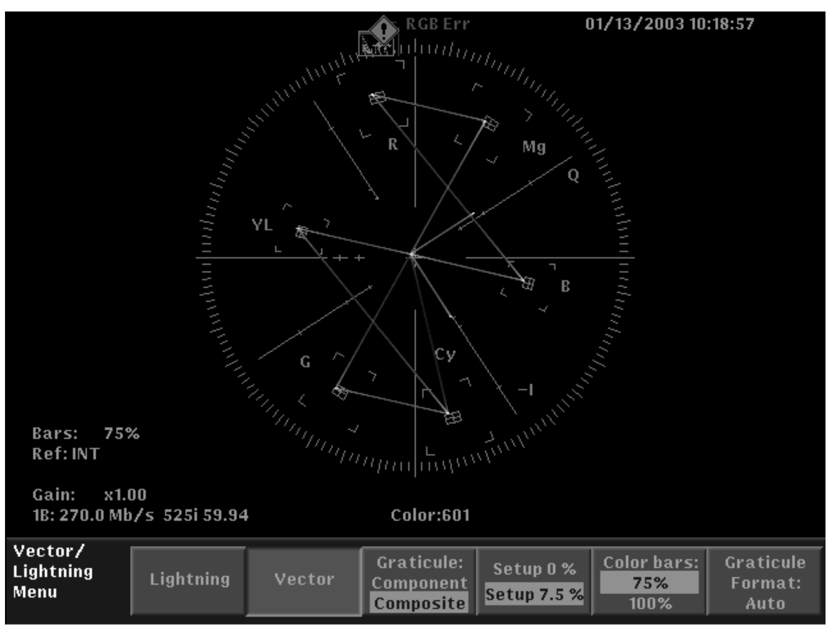


Figure 3-29: Vector display with composite graticule selected

Lightning Display

The Lightning display uses an array of horizontally dispersed points to show chrominance components, and uses the vertical axis to show luminance components.

Plotting the Lightning Display. The Lightning display plots the color difference signals, Pb and Pr, with the luminance (Y) signal. In the top half of the Lightning display, Pb is plotted against Y, and on the bottom half, Pr is plotted against inverted Y. The vertical center is the 0 V or black-clamp point. Figure 3-30 shows how the waveform monitor plots the Lightning display from the three component signals.

The three signals are back-porch clamped and identically low-pass filtered to provide a common point and identical delay through the system. The color difference signals are line alternated, and the luminance signal is inverted on alternate lines.

The information available from the Lightning display is color difference signal accuracy (horizontal displacement of either half of the display), luminance gain (vertical displacement between the black and white levels), timing delay between either color difference signal and luminance (bending of the green/magenta transitions). Figure 3-31 on page 3-71 shows the Lightning graticule with the measurement targets and timing delay scales.

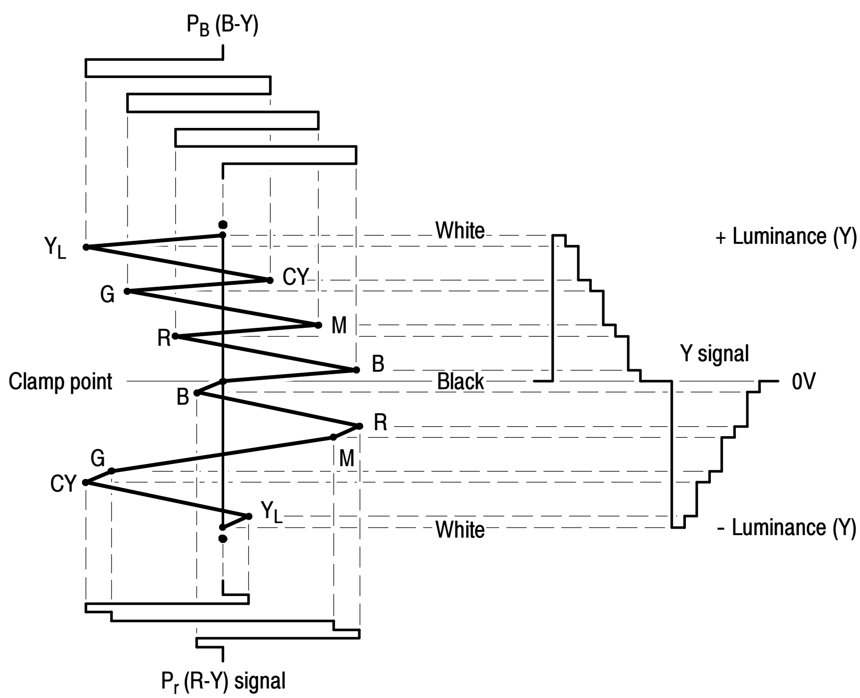


Figure 3-30: Construction of the Lightning display

Lightning Graticule. The Lightning graticule (see Figure 3–31) has two sets of small cross-hairs that bisect the green-magenta transitions on a color bar signal. The calibration of the marks is shown in Table 3–6. The electronic graticule eliminates the effects of CRT nonlinearity.

Table 3-6: Lightning graticule marks

SD cross-hair timing error calibration[1]		HD cross-hair timing error calibration[1]	
Graticule mark	**Description**	**Graticule mark**	**Description**
Center	Aligned	Center	Aligned
1st mark	20 ns	1st mark	2 ns
2nd mark	40 ns	2nd mark	5 ns
3rd mark	74 ns (one luma sample time)	3rd mark	13.5 ns (one luma sample time)
4th mark	148 ns (one chroma sample time)	4th mark	27 ns (one chroma sample time)

[1] **The graticule calibration is only correct if the color bar signal lands in the targets.**

The graticule marks help you quantify any chroma-to-luma timing errors. Since luma is plotted relative to the blue color difference signal on the top half of the display, the cross-hairs on the upper transition indicate timing errors between Y and Pb. Similarly, timing errors between Y and Pr are evident on the cross-hairs on the lower green-magenta transition.

If chroma-to-luma timing is correct, the traces for the green-magenta transition on the color bar signal pass through the center cross-hair as it crosses the vertical luma axis. If errors are present, the traces for the transition bow upward or downward. If chrominance is ahead of luminance, it shows as an upward bowing on the upper transition and a downward bowing on the lower transition. If luminance is ahead of chrominance, the direction of bowing is reversed.

Figure 3–31 shows a signal with proper interchannel timing. In Figure 3–32, the Lightning display shows that the signal has Y–Pb and Y–Pr timing errors. The graticule shows that luminance is ahead of chrominance by 40 ns between Y and Pb, and is ahead by 20 ns between Y and Pr. Refer to Table 3–6 for the timing error related to each graticule mark.

You can adjust the vertical and horizontal gain (in the Gain menu) to normalize signal amplitude. You can also use the fixed gain and the mag function (in the Sweep menu) to expand the scale of the display to better view the small timing graticule cross-hairs.

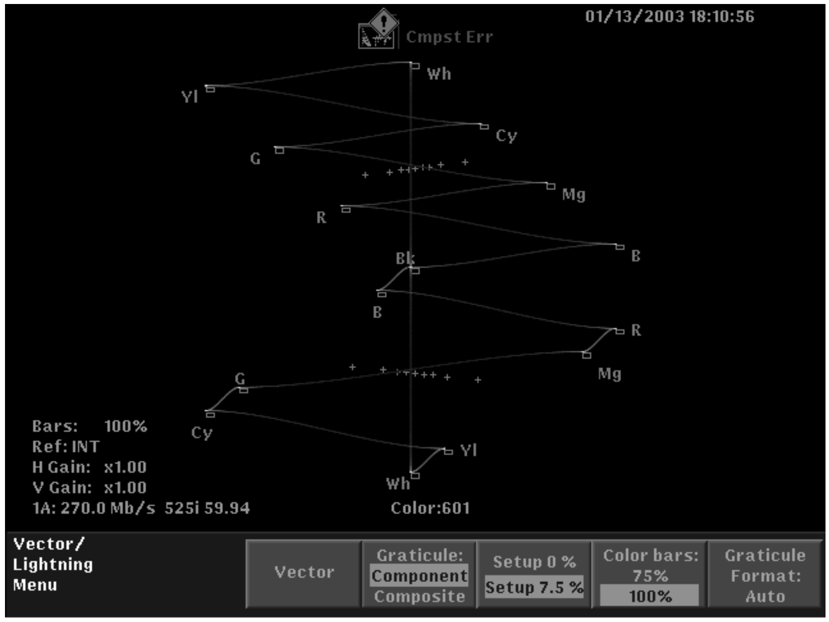
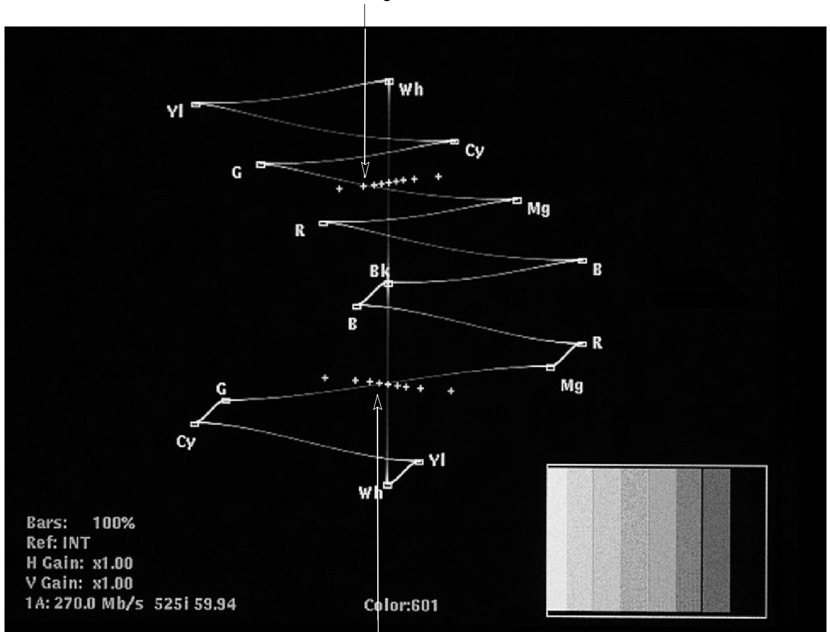


Figure 3-31: Lightning display showing proper interchannel timing

40 ns timing error



20 ns timing error

Figure 3-32: Lightning display showing interchannel timing errors

Luminance Gain Measurement. The signal is driven along the vertical axis above and below the center box by the luminance signal. The lower half is driven down from the center. The luminance gain is correct when the center dot (clamped black level) is centered in the target box and the positive and negative excursions end at the top and bottom of the graticule. Perfect monochrome signals appear as a thin vertical line. Any deviation or bending off the center line indicates a color variation from the monochrome setup of the display monitor.

Interchannel Timing Measurement. The scale (sequence of dots) between the green and magenta targets provides a way to check interchannel timing (CH-2 to CH-1 and CH-3 to CH-1) or signal delay. If the color difference signal is not coincident with luminance, the transitions between color dots will bend. The amount of this bending represents the relative signal delay between luminance and the color difference signal. The upper half of the display measures the P_b-to-Y timing, while the bottom half measures the P_r-to-Y Timing. If the transition bends in toward the vertical center or black region, the color difference signal is delayed with respect to luminance. If the transition bends out toward white, the color difference signal is leading the luminance signal.

Pr and Pb Gain Measurement. The horizontal deflection of the top half of the display is an indication of the P_b gain and the lower half indicates the P_r gain. If the color bar signal dots are within the horizontal dimensions of the appropriate graticule targets, the P_b and P_r gains are within 2% of the correct amplitude.

Since the vertical and horizontal dimensions of the graticule target boxes indicate 2% luminance and color difference gain errors, respectively, you can evaluate each color bar for encoding accuracy with these limits. The Lightning display shows the relative level or coding accuracy for Y, P_b, and P_r for each of the eight primary colors much better than the Parade display mode.

Waveform Mode

In Waveform mode, the selected components are displayed in a voltage versus time plot. You can display the signal in Parade mode (see Figure 3-33) or Overlay mode (see Figure 3-34). You can also apply flat or low pass filters and choose the color space (such as RGB or composite). In component color space modes, you can turn the individual components on or off. For information about these menu options, refer to *Waveform Menu* on page 2-105.

NOTE. *Do not use the time cursors to measure time between components in a paraded waveform display. Parade mode is a special display format that represents all displayed components in a single screen, irrespective of the time relationship between components.*

Composite Color Space

The waveform monitor provides a composite representation of both SD and HD component signals.

The SD composite mimics NTSC or PAL, depending on the input standard. For HD, a scaled version of subcarrier was chosen to provide a similar number of subcarrier cycles per horizontal line.

The composite representation of the component waveform is useful to people who are skilled in composite signal manipulation, especially when facilities are converting to digital. Viewing the waveform in a familiar form provides confidence that you are delivering a correct signal. You can then compare the familiar composite display to more exact and powerful displays such as Diamond, Arrowhead and YPbPr waveform. Over time, you can become more comfortable using component displays to more completely evaluate the signal.

You might also find it easier to perform certain operations, such as live camera balancing, in composite waveform mode. By looking at the nulling of the subcarrier, an experienced operator can dynamically adjust the white, black, and knee settings on a camera control unit during a live shoot. This is possible using other displays, but you might prefer composite mode.

NOTE. *The composite signal is not available as an output; it is strictly a processed version of the input for viewing in waveform mode. The sync and burst are synthetic and do not relate to any aspect of the input signal. The vertical interval does not conform to normal conventions.*

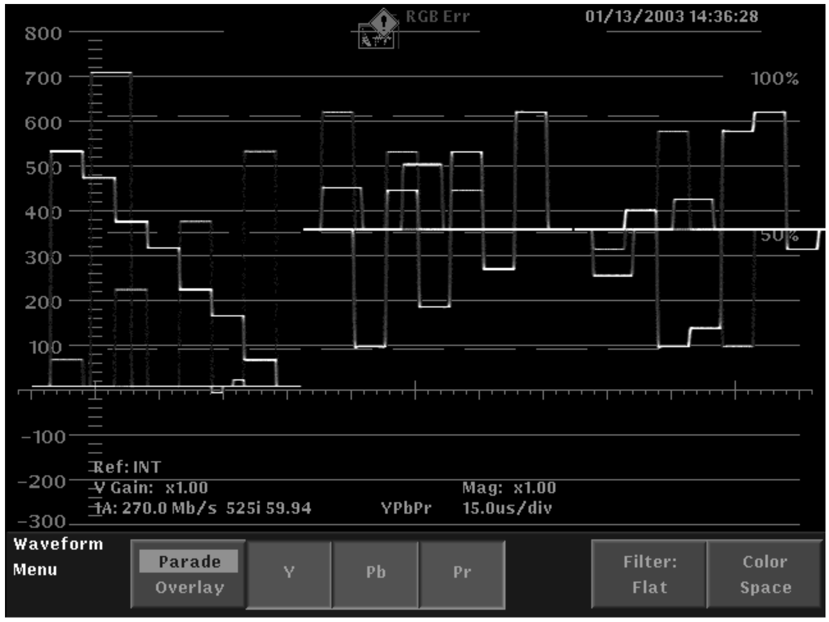


Figure 3-33: Waveform mode showing a YPbPr Parade display

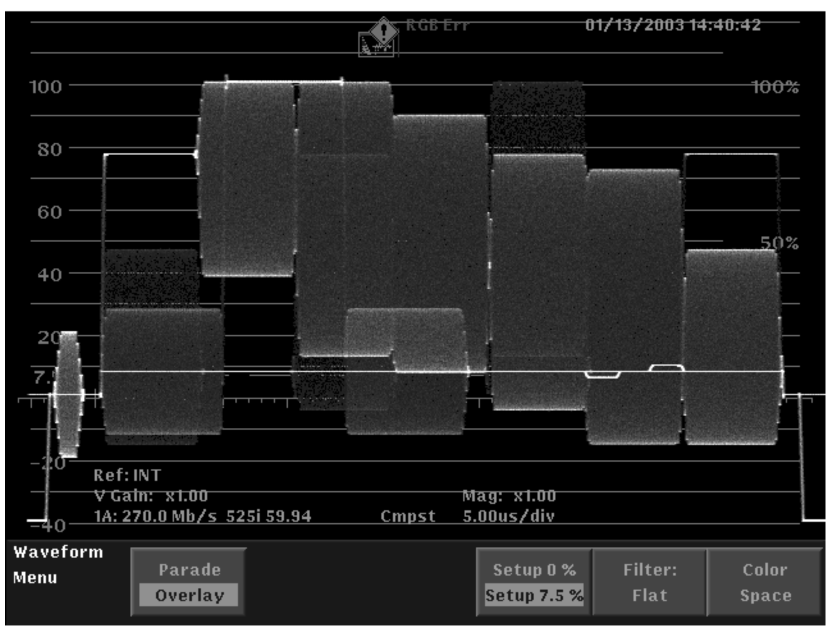


Figure 3-34: Waveform mode Overlay display showing the Composite graticule with 7.5% setup selected

Chroma Offset

Chroma Offset | Aligned (YPbPr only) determines the vertical position of the color difference signals.

When you select Offset, the chroma is offset by 350 mV from the luminance zero level. The color difference signals will occupy the same vertical range as the luma.

When you select Aligned, the chrominance zero levels are aligned with the luminance zero level. The Color Difference signals will extend below luminance, but Gain will expand around the zero levels.

Secondary Modes

You can apply several secondary modes while in Waveform mode. The secondary menu will overlay the Waveform menu. To remove the Line Select menu or the Cursor menu from the screen without affecting the signal display and knob assignment, press the CLR MENU button.

Cursors. You can use cursors to measure time and amplitude. Refer to the *Cursor Menu* on page 2–53.

Line Select. You can use Line Select to select part of the video signal to display and measure. For information on the Line Select menu choices, refer to the *Line Select Menu* on page 2–72. For additional information about using Line Select, refer to *Line Select Mode* on page 3–39.

Gain. Vertical gain is available through the Gain menu and is valid during cursor measurements.

Sweep. You can choose the horizontal display mode and turn Mag on or off.

Freeze. You can use the Freeze feature to capture (freeze) the active signal and compare the frozen signal to the live signal.

Configuration

You can modify the waveform by turning the EAV/SAV stripping on and off. Refer to *Input Config* on page 2–36.

Readouts

Several alpha-numeric text messages may appear on the screen in Waveform mode; for example, cursor readouts, the format of the External Reference signal, Gain setting and Line Select. For information about individual readouts, refer to page 2–7.

Measuring Relative Timing Between Two Serial Component Signals

One advantage digital equipment has over analog equipment is that digital equipment is a little more forgiving when dealing with timing. A digital switcher usually has partial automatic timing of the inputs and it can compensate for timing errors, provided the signal is within a specified range of 30 to 150 μs, depending on the equipment. However, care is still needed to ensure vertical timing because of the large processing delays in some digital equipment. Analog black burst is still the predominant reference signal, although a SDI Black signal can be used on some digital equipment.

To measure the timing of two digital signals using a digital waveform monitor such as the Tektronix WFM700, use the following procedure:

NOTE. *To prevent inaccurate timing measurements, be sure to terminate all signals correctly.*

---

1. Connect the two SDI signals to be measured to Input A and Input B on the waveform monitor.
2. Select Input A to display on the waveform monitor.
3. Verify that the waveform monitor is externally referenced to a black burst or tri-level sync signal (as appropriate).
4. In the Video Inputs/Outputs submenu of the Configure menu on the waveform monitor, set Strip EAV/SAV to Pass. This mode allows the 3FF, 000, 000, XYZ values to be displayed on the waveform monitor, as shown in Figure 3-35.

NOTE. *The transition from 3FF to 000 and 000 to XYZ produces ringing on the display when passed through the appropriate SD or HD filter. The SAV or EAV pulse can be used as a timing reference by positioning it on a major tick mark of the waveform graticule display and comparing it to the other SDI signals, ensuring that they are positioned at the same mark.*

There are no vertical pulses in the digital domain; digital systems calculate their video position based on the values of F, V, and H. Therefore, a reference point must be defined in order to measure vertical timing. For simplicity, the first line of active video can be used as the reference, because the vertical blanking lines are normally blank.

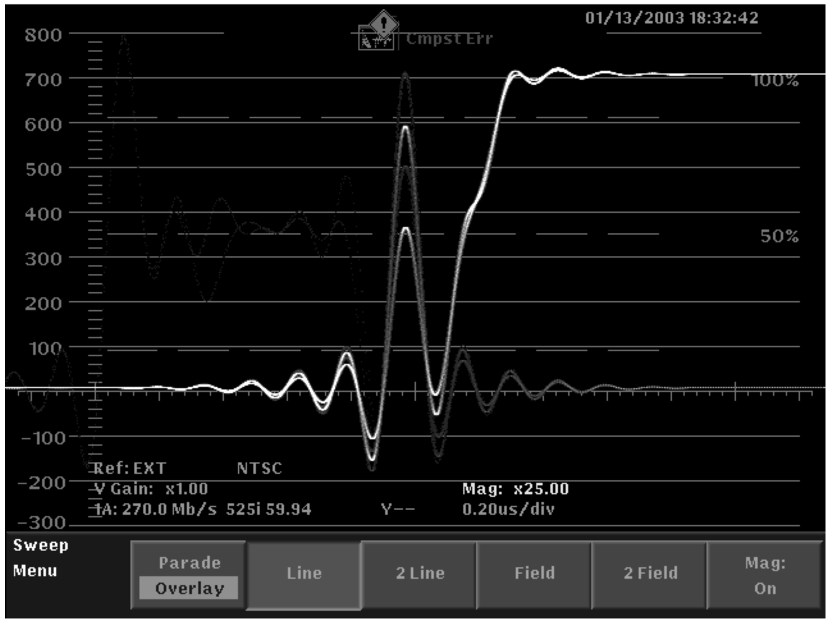


Figure 3-35: XYZ pulse of Y channel with pass through selected

5. To measure vertical timing, perform the following steps:

   a. Set Line Select and Sweep for two-line mode.

   b. Select Field 1 and line select at the setting that will display the last line in the vertical interval and the first line of active signal (Input A).

      The line select setting should be line 20 for 1080 Interlaced HDTV, 41 for 1080 progressive formats, 25 for 720 progressive, 19 for 525 interlace, or 22 for 625 interlace. If necessary, adjust the vertical timing of the source until the display is correct.

   c. Select Input B and make sure the last vertical and first active lines are displayed. If necessary, adjust the vertical timing to align both vertical positions to the start of active video.

   d. Switch back to Input A and set MAG to ON, noting the amplitude of the SAV pulses.

   e. If the amplitudes of both pulses are identical, they are in the same field. If not, the two signals are in opposite fields and timing adjustments should be made to align the sources to the same starting point.

6. To measure horizontal timing, perform the following steps:

   a. Switch to Input A and set the waveform monitor to one line sweep.

   b. Use the horizontal position knob to set the SAV pulse to a major graticule tick mark, or use cursor mode and set a cursor on the SAV pulse.

   c. Compare the timing to the signal on Input B by selecting Input B and adjusting the fine timing controls to match the timing position of Input A.

Audio Reference (Option DG Only)

This section describes the features that are available when your instrument has the Option DG audio module installed. The instrument provides several measurement functions for monitoring audio signals:

- You can measure levels, monitor phase, and display phase correlation
- You can specify whether the audio alarms are triggered, and if so, what actions are performed
- You can specify meter ballistics and scales, set the Test and Peak Program indicator levels, and specify how phase is displayed

Selecting Which Audio Input to Monitor

Use the Input menu to select which audio input the instrument will monitor.

To select the audio input to be monitored:

1. Press the Input button to display the Input menu.
2. Touch the Audio In: soft key to select either Embedded or Ext AES. The Audio In: soft key lists the current selection. Select Embedded to monitor the audio signal embedded in the video-input signal, or select Ext AES to monitor the AES audio signal(s) connected to the Option DG audio module.

***NOTE**. When you set the function of the AES connectors to output, the Audio In soft key in the Input menu is not available. In this situation, embedded audio is automatically selected as the audio input source. You cannot monitor audio signals on the AES connectors until their function is set to input (use the Audio Inputs/Outputs submenu of the Configure menu).*

When you select Embedded as the audio source to monitor, the instrument maps the audio signal to the level-meter bars as configured in the Embedded Input Map. You can specify which audio channels map to which level-meter bars using the Audio Inputs/Outputs submenu of the Configure menu.

When you select Ext AES as the audio source to monitor, the instrument maps the audio signal to the level-meter bars as configured in the AES Input Map. You can specify which AES audio inputs map to which level-meter bars using the Audio Inputs/Outputs submenu of the Configure menu.

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3. If you are monitoring embedded audio, use the input soft keys to select which video signal input you want to monitor.

Selecting the Audio Display Type

The instrument can present audio information using either level meters (with or without a Lissajous display) or a text screen that displays channel status. Perform the following steps to select the audio display type:

1. Press the Audio button to display the Audio menu.
2. Touch the Display: soft key to open the Audio Display menu.
3. Touch the desired soft key to select from the following audio displays: Level Meters, Level Meters + Lissajous, Channel Status, or Embedded Audio Status.
4. Touch the Done soft key to activate the selected audio display.

Elements of the Level Meter Audio Display

The audio screen can be set to display level meters, and if you choose, you can display level meters with a Lissajous display. When you choose to display the Lissajous display (also known as a phase plot), the left portion of the Audio screen displays the level meters (in a compressed format) and the right portion of the screen displays the Lissajous display. See Figure 3-36.

The audio display consists of the following elements:

- **Level Meter Scale and units:** By default, the zero dB mark is at digital full scale, and units are in dB relative to full scale (dBFS). You may also set the 0 dB mark to either the Peak Program level or the Test level.
- **Level Meter Ballistics Readout:** Displays the selected dynamic response characteristic.
- **Session Time:** The elapsed time for the current session. The format for the time display is hours:minutes:seconds:frames.
- **Embedded Group Sample Phase Readout:** For HD signals, indicates the misalignment, in microseconds, between the audio samples of the two selected embedded audio groups. The readout turns red when the misalignment exceeds about 0.625 audio samples. The readout displays N/A if one or both of the selected audio groups is missing, or if the video signal is SD.
- **In Phase label:** Indicates the location on the X-Y display of “in phase” for the displayed channels.
- **Level Meters:** Indicate the amplitude of selected audio channels.
- **Level Meter Labels:** Identify the signal in each meter bar, appear below the level meters.

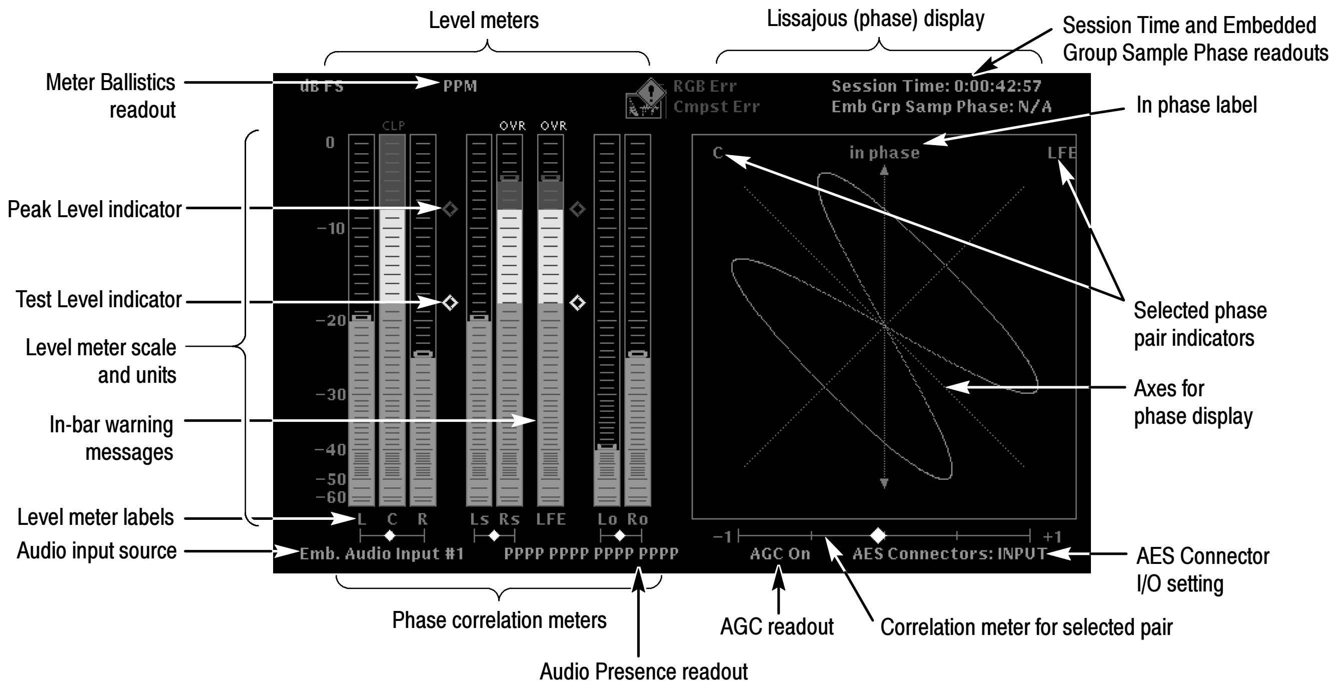


Figure 3-36: Audio Level Meters + Lissajous display

- **Test level and Peak Program Level Indicators:** Diamond-shaped markers between the level bars that indicate the configurable limits set up for the display. Above the Test level the bar displays in a yellow color. Above the Peak level the bar displays in a Red color. Test level is also known as Reference level or Line-up level.
- **Lissajous (Phase) Display:** Plot of one channel versus the other in a pair.
- **Axes for Phase display:** Show the orientation of the two audio signals.
- **Phase correlation meters:** Displays phase correlation between the two channels of each appropriate pair. They are located under the level-meter bars for the same audio channels and are duplicated under the Phase display.
- **AGC Readout:** Indicates whether Automatic Gain Control is On or Off. AGC keeps the Lissajous pattern visible and within the bounds of the phase display for signal levels between 0 dBFS and approximately –40 dBFS. When the AGC is off, full scale is equivalent to the Peak Program level. AGC does not affect the correlation meter.
- **Audio Input Source:** Indicates the current audio source.
- **AES Connector Setting:** Indicates whether the connectors are configured as inputs or outputs.

- **Audio Presence Readout:** Appears near the bottom center of the screen, if enabled in the Config menu. For embedded audio input, this readout groups the 16 audio channels into fours sets of four. If audio is present on a channel, the readout displays a "P" (present) for that channel. If no audio audio is present, a dash is displayed. If the audio input is from the AES connectors, the readout displays AES. If audio is expected, but missing, the readout displays "Audio Input Missing". If no audio input is expected, the readout displays "No Audio Selected".
- **In Bar Warning Messages:** Messages that appear within the level meter bars. Higher priority messages preempt lower priority messages. The messages are displayed for as long as the error condition lasts.

Phase Correlation Meters

The phase correlation meters that appear below the level meter bars show the true mathematical phase correlation (mono compatibility) between the two channels of the phase pair, independent of the signal amplitude. You might find it easier to interpret the correlation meter than the Lissajous pattern. The position of the diamond-shaped pointer indicates the correlation between the two selected channels. A reading of +1 indicates that the channels contain identical signals (frequency and phase). A reading of –1 indicates that the channels have the same frequency (or frequencies) but are 180 degrees out of phase. A reading of 0 (center scale) indicates uncorrelated, or random, signals.

In-bar Warning Messages

The WFM700 displays warning messages within the level meter bars. The warning messages that can appear are described below in order of priority.

NOT SELECTED. This message appears when the specified channel was not mapped to any AES-input or embedded-input channel. Use the Audio Inputs/ Outputs submenu of the Configure menu to map the audio inputs.

SD NOT SUPPORTED. This message appears when you try to view embedded audio from an SD feed on a WFM7HD module.

UNLOCKED. The instrument is not locked to an incoming signal on the indicated input channel. Data cannot be decoded and all data and other errors are ignored. This means that if an AES input is selected, nothing recognizable is present on the input, or if embedded audio is selected, the VIDEO input is unrecognizable.

NO EMB AUDIO. Embedded audio has been selected as a source, and a valid video signal is present, but it doesn't contain any audio.

AES PARITY. The incoming subframe does not have even parity as specified by the digital audio standards. The data sample is unreliable and is ignored. The level meters and Lissajous display treat the sample as a zero sample.

AES CRC ERROR. The CRC code in the AES channel status packet is incorrect. Sometimes the CRC code is set to zero, indicating that the signal is missing; when this is the case, this message is not displayed.

MUTE. This is displayed if the number of consecutive all-zero samples equals or exceeds the # Samples for Mute setting.

SILENCE. This is displayed if the number of consecutive samples is at or below the specified Silence level.

CLIP. This is displayed if the number of consecutive samples equals or exceeds the # Samples for Clip setting.

OVER. This is displayed if the signal level exceeds the specified Over level.

AES V BIT. This message indicates that the Validity bit is set high for one or more data samples. In the AES/EBU standard, a set validity bit indicates that the sample is not suitable for conversion to audio.

Level Meter Scaling

Meter scaling can be set to Default Scale or Custom Scale. At the Default Scale setting, the meter scale is set to a 70 dB range, with the actual values at the top and bottom of the meter depending on how Set 0dB Mark to: is set. The Custom Scale setting has two parameters: Scale Min and Scale Max. When you touch Custom Scale, both are enabled. When using Custom Scale, the range of the meters can be as little as 10 dB or as great as 90 dB.

The upper 20 dB of the level meter scale is linear in dB, the scale is progressively compressed below –20 dBFS. The upper limit of the meter scale is the anchor for compression or expansion of the scale; the top scale number remains the same during expansion or compression. It may not be visible on screen, but it does not change.

To change the meter scaling:

1. Touch the Meter Scaling: soft key to display the Meter Scale menu.
2. To set the meter scaling to the factory-default scale:
   a. Touch the Default Scale soft key.
   b. Touch the Done soft key to save the changes.
3. To set the meter scaling to a custom, user-defined scale:
   a. Touch the Custom Scale soft key. This enables the Scale Min and Scale Max soft keys.
   b. Touch the Scale Min soft key to set the minimum value for the meter scale. Use the general purpose knob to adjust the value. Note that the meter scale changes as you turn the knob.
   c. Touch the Scale Max soft key to set the maximum value for the meter scale. Use the general purpose knob to adjust the value.
   d. After you have adjusted the custom scale settings as desired, touch the Done soft key to save the changes.

Lissajous (Phase) Display

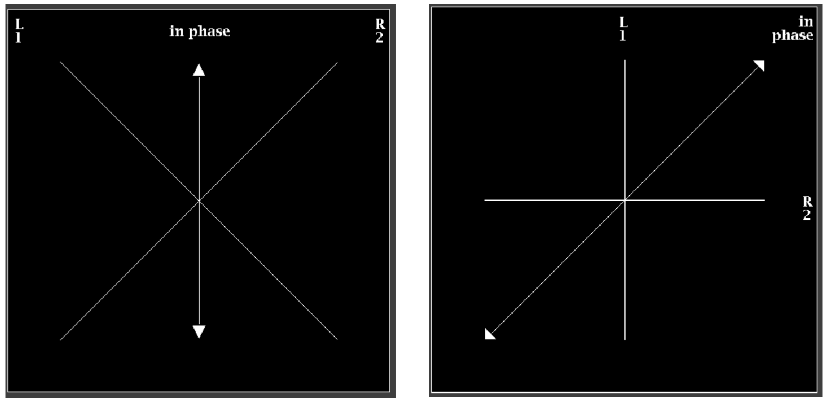
The WFM700 provides the ability to display the phase relationship between channel pairs. It can display the phase of one input pair with a Lissajous pattern display and it can display relative phase on all four pairs of inputs with correlation meters.

Setting the Axis Style of the Lissajous Display

The Lissajous display is a plot of one channel against another on an orthogonal pair of axes. Use the Lissajous Style soft key in the Audio menu to select which axis style will be used in the Lissajous display: soundstage or X–Y. See Figure 3–37.

The soundstage representation has the two channels plotted at 45 degree angles with the mono combination appearing on the vertical axis. The soundstage orientation is more like a left – right image in a studio.

The X-Y orientation plots left channel data along the vertical axis and right channel data on the horizontal axis, emulating the conventional X-Y display of an oscilloscope.



Soundstage axis

X-Y axis

Figure 3-37: Axis styles used by the Lissajous display

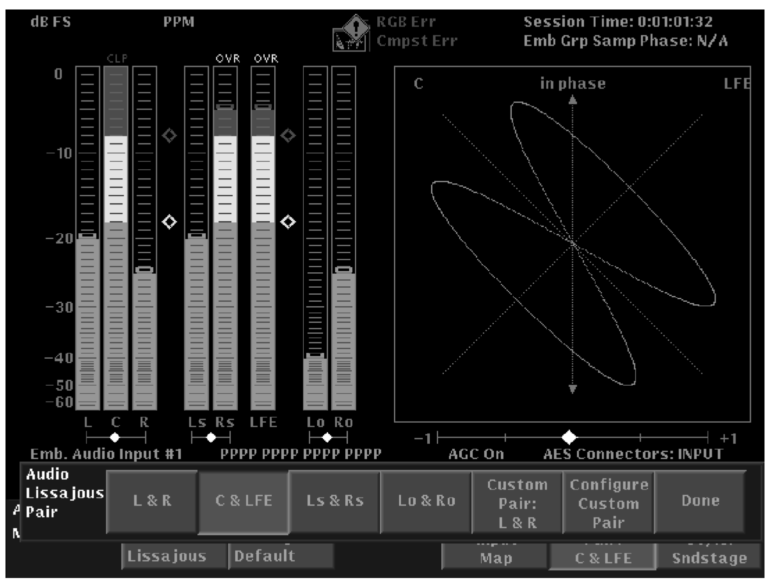


Figure 3-38: Audio Lissajous Pair menu with channel pairs C & LFE selected

Setting the Channel Pair for the Lissajous Display

To select which channel pair is displayed on the Lissajous display:

1. Select the Level Meters + Lissajous display from the Audio menu, and then touch the Lissajous Pair: soft key to open the Audio Lissajous Pair menu. See Figure 3-38 on page 3-85.
2. Select a channel pair by performing one of the following actions:

NOTE. *The channel pair labels depend on the Audio Program Type setting (surround or stereo pairs) in the Configure menu.*

- Touch the soft key corresponding to one of the four default channel pairs. The display updates after you touch the soft key so you can preview the Lissajous display.
- Touch the Custom Pair: soft key to select the custom channel pair you specified using the Configure Custom Pair soft key. The currently specified custom channel pair is shown on the Custom Pair: soft key.
- Touch the Configure Custom Pair soft key to open the Custom Lissajous Pair menu where you can use the general purpose knob in conjunction with the Lissajous Channel soft keys to specify which audio channel is displayed in each Lissajous channel.

3. Touch the Done soft key to save your selection.

NOTE. *For SD embedded audio only:*
Preservation of audio-sample phase between different AES channel pairs or across embedded audio groups is not supported by SMPTE 272M alone. The Lissajous Custom Pair display may not correctly represent audio phase unless the following extensions to SMPTE 272M are observed:

1. *The selected audio channels must be embedded with exactly the same audio sample frequency.*
2. *The intended sample alignment must be represented by the average embedded sample position.*
3. *Most lines should carry phase-aligned samples and should have an equal number of samples from each group. This minimizes the number of attempts needed to reestablish correct alignment.*

These are not requirements of SMPTE 272M and some embedders do not meet these criteria. Furthermore, some de-embedding equipment may not make use of these characteristics, even if present. In these cases, there may be variation in the displayed audio phase between different AES channels. The variation is typically ± 1 audio sample, but may be greater depending on random startup conditions and the design of the embedder/de-embedder.

Elements of the Channel Status Display

The audio screen can be set to display channel status information that is embedded in the AES3-1992 (professional) or IEC-60958-3 (consumer) digital audio channels. See Figure 3-39.

Figure 3-39: Channel Status display in Text format

Display Format

The Channel Status screen displays the status for one channel pair at a time. You can select from four display formats:

- **Text:** Displays the audio channel status in standard English format.
- **Binary:** Displays the audio channel status in binary format, with the most significant bit displayed first. In Binary format, you can use the general purpose knob to highlight bits or blocks, which are then decoded into standard English on the screen. The decoded text appears near the bottom of the screen.
- **XMSN Order Binary:** Displays the channel status in binary format, but with the least significant bit displayed first, which corresponds to the transmission order. In XMSN Order Binary format, you can also use the general purpose knob to highlight bits or blocks, which are then decoded into standard English on the screen.
- **Hex:** Displays the channel status in hexadecimal format.

Text Format Display Elements

The Channel Status display in Text format (see Figure 3-39) contains the following display elements:

- **Format**: Indicates the format of the display (Text).
- **Source**: Identifies the audio source selected for display (embedded or AES).
- **Field Name**: Indicates the name of the status field.
- **Channel A / Channel B**: Identifies the column listing for the selected channel.

Binary Format Display Elements

The Channel Status display in Binary format (see Figure 3-40) contains the following display elements:

- **Format**: Indicates the format of the display (Binary).
- **Source**: Identifies the audio source selected for display (embedded or AES).
- **Byte**: Identifies the byte for which the status is displayed.
- **b7......b0**: Indicates the bit order for the column.
- **Channel**: Indicates which channel is being displayed. Press the Select button to toggle the status display between the two channels of the selected channel pair.

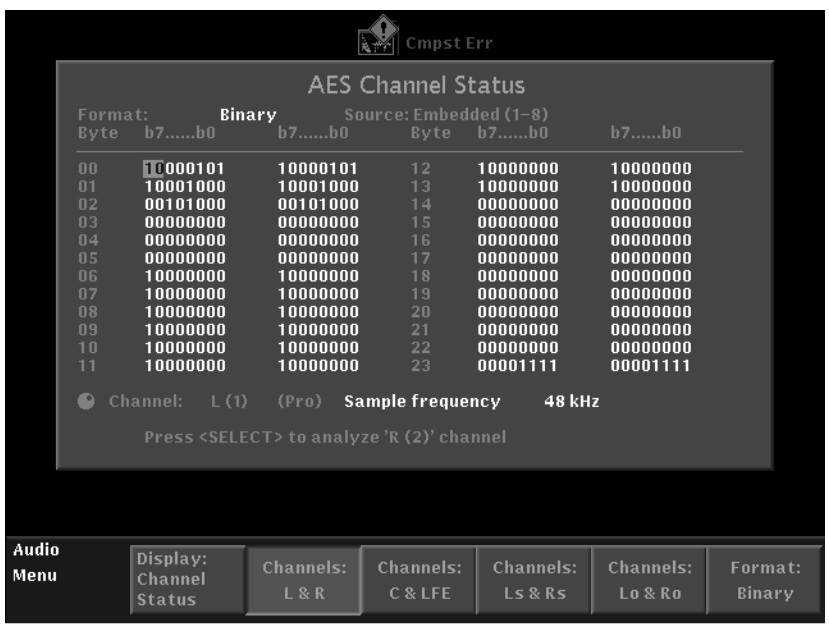


Figure 3-40: Channel Status display in Binary format

XMSN Order Binary Format Display Elements

The Channel Status display in XMSN Order Binary format (see Figure 3-41) contains the following display elements:

- **Format**: Indicates the format of the display (XMSN Order Binary).
- **Source**: Identifies the audio source selected for display (embedded or AES).
- **Byte**: Identifies the byte for which the status is displayed.
- **b0......b7**: Indicates the bit order for the column.
- **Channel**: Indicates which channel is being displayed. Press the Select button to toggle the status display between the two channels of the selected channel pair.

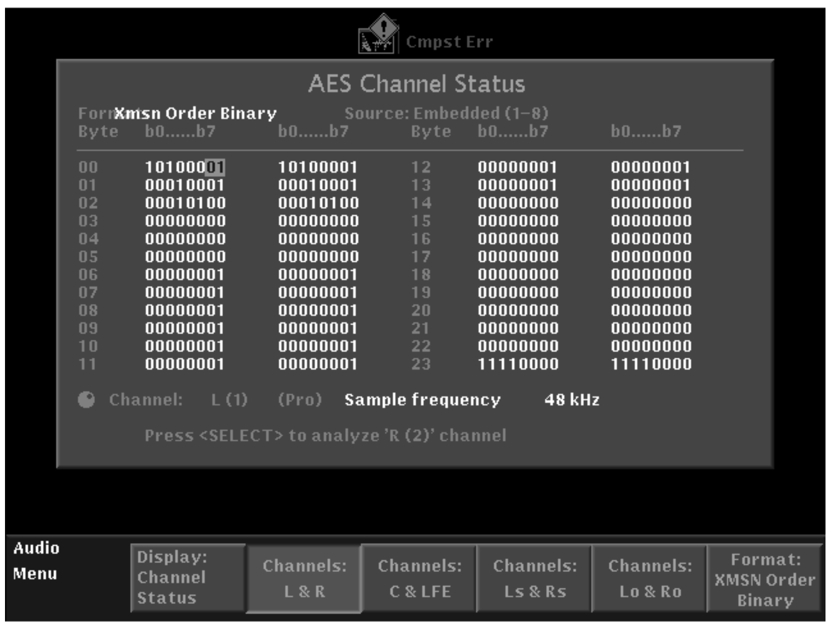


Figure 3-41: Channel Status display in XMSN Order Binary format

Hex Format Display Elements

The Channel Status display in Hex format (see Figure 3-42) contains the following display elements:

- **Format**: Indicates the format of the display (Hex).
- **Source**: Identifies the audio source selected for display (embedded or AES).
- **Byte**: Identifies the byte for which the status is displayed.
- **Channel A / Channel B**: Identifies the column listing for the selected channel.

Figure 3-42: Channel Status display in Hex format

Elements of the Embedded Audio Status Display

This display (see Figure 3-43) reports the following information:

- Which video input is the source of the embedded audio
- The standard used by the embedded audio signal
- Which audio groups are selected (use the Embedded Input Map to change)
- The embedded group sample phase (HD signals only)

***NOTE**. For HD signals, the Embedded Group Sample Phase readout indicates the misalignment, in microseconds and samples, between the audio samples of the two selected embedded audio groups. The readout turns red when the misalignment exceeds about 0.625 audio samples. The readout displays N/A if one or both of the selected audio groups is missing, or if the video signal is SD.*

Refer to Table 2-5 on page 2-34 for information about setting the Embedded Group Sample Phase alarm. Refer to 272M Group Phase Align (SD Signals Only) *and* 299M Group Phase Align (HD Signals Only) *on page 2-42 for information about setting the instrument response to any detected misalignment in the embedded audio samples.*

- Whether the header indicates that audio is present on each pair of channels (Status = Present or Not Present).

  The Embedded Audio Status readout groups the 16 audio channels into eight pairs of two channels. If audio is present on a channel pair, the readout displays "Present" for that channel pair. If no audio is present, the readout displays "Not Present" for that channel pair.

Figure 3-43: Embedded Audio Status display with HD signal

Configuring the Instrument for Audio Measurements

This subsection provides an overview of how to configure the instrument for audio measurements using various submenus in the Configure menu.

Audio Inputs/Outputs Submenu Settings

Table 3-7 lists the selections available in the Audio Inputs/Outputs submenu of the Configure menu. Refer to *Audio Inputs / Outputs (Option DG Only)* on page 2-39 for detailed information about using these menu selections.

NOTE. *When you set the function of the AES connectors to output, the Audio In soft key in the Input menu is not available. In this situation, embedded audio is automatically selected as the audio input. You cannot monitor audio signals on the AES connectors until this menu selection is set to Input.*

Table 3-7: Settings in the Audio Inputs/Outputs configuration menu

Menu selection	Values / Default value
AES Connectors	Input / Output Default value: Input
Audio Program Type	Stereo Pairs / Surround Default value: Surround
AES Alarms	Enable / disable alarms for level meter bars Default values: L&R, C&LFE, Ls&Rs, Lo&Ro bars enabled
Embedded Alarms	Enable / disable alarms for level meter bars Default values: L&R, C&LFE, Ls&Rs, Lo&Ro bars enabled
AES Input Map	Map audio channels to level meter bars Default mapping: 1&2 - L R, 3&4 - Ls Rs, 5&6 - C Lfe, 7&8 - Lo Ro
Embedded Input Map	Map embedded audio channels to level meter bars Default mapping: 1&2 - L R 3&4 - C Lfe 5&6 - Ls Rs 7&8 - Lo Ro
272M Group Phase Align	Disabled / Enabled / Auto Default value: Auto Refer to *272M Group Phase Align (SD Signals Only)* on page 2-42 for more information.
299M Group Phase Align	Disabled / Enabled / Auto Default value: Auto Refer to *299M Group Phase Align (HD Signals Only)* on page 2-42 for more information.

Audio Displays Submenu Settings

Table 3–8 lists the selections available in the Audio Displays submenu of the Configure menu. Refer to *Audio Displays (Option DG Only)* on page 2–43 for detailed information about using these menu selections.

Table 3-8: Settings in the Audio Displays configuration menu

Menu selection	Values / Default value
Audio Presence Readout	On / Off Default value: Off
Meter Ballistics	VU / PPM / True Peak Default value: PPM
Peak Hold Time	Range: 1 to 10 seconds Default value: 2 seconds
Peak Hold Display	On / Off Default value: On
Set 0dB Mark To:	dBFS / PPL / Test Default value: dBFS
Auto Gain Control	On / Off Default value: On

Audio Thresholds Submenu Settings

Table 3–9 lists the selections available in the Audio Thresholds submenu of the Configure menu. The Audio Thresholds settings control the levels at which audio alarms are triggered. Refer to *Audio Thresholds (Option DG Only)* on page 2–45 for detailed information about using these menu selections.

Table 3-9: Settings in the Audio Thresholds configuration menu

Setting	Values / Default values
Test Level	0 to -60 dBFS Default value: -18 dBFS
Peak Program Level	0 to -30 dBFS (cannot be set greater than the Test Level) Default value: -8 dBFS
# Samples for Clip	Range: 1 to 100 Default value: 1 sample
# Sample for Mute	Range: 0 to 100 Default value: 10 samples
Silence Level	Range: 0 to -90 dBFS Default value: -30 dBFS
Over Level	Range: 0 to -30 dBFS Default value: -10 dBFS
Duration for Silence/Over	Range: 1 to 100 seconds Default value: 5 seconds

Audio Alarms Submenu Settings

Using the Audio Alarms submenu of the Configure menu (see Figure 3-44), you can select which audio error conditions you will monitor and how you will be notified in the event of an error.

The four columns labeled OnSc (on-screen), Beep, Log (logging), and Gnd (ground closure) indicate the current settings for alarm notification. An "X" indicates that a condition is selected, and an "O" indicates that the condition is not selected. Touch the list of general alarms or the Next Menu soft key to change the settings of the alarms indicators.

Refer to *Possible Alarm Actions* on page 2-32 and *Audio Alarms (Option DG Only)* on page 2-34 for more information.

Figure 3-44: Audio Alarms submenu in the Configure menu

Appendices

Appendix A: Specifications

The tables in this appendix list the specifications for the Tektronix WFM700 Standard Definition/High Definition Multiformat Video Waveform Monitor. Items listed in the Performance Requirement column are generally quantitative, and can be tested by the *Performance Verification* procedure in the service 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.

Electrical Specifications

Table A-1: Waveform vertical deflection

Characteristic	Performance requirement	Reference information
Vertical Measurement Accuracy, YPbPr 1X	±0.5% of 700 mV full scale mode	Limited by the screen resolution and internal processing. Fully digital system.
5X	±0.2% of 700 mV full scale mode	
10X	±0.1% of 700 mV full scale mode	
Gain	X1, X5, and X10	
Variable Gain Range, Typical		0.25X to 14X
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		0.35%, nominal
Step Response, Typical Preshoot SD HD Overshoot SD HD Ringing SD HD		Sine-squared bars ≤ 0.3% peak (2T5 bar) ≤ 0.5% peak (2T30 bar) ≤ 0.3% peak (2T5 bar) ≤ 0.5% peak (2T30 bar) ≤ 0.4% peak-peak (2T5 bar) ≤ 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 WFM700 is close to the theoretical limit of a perfect sinx/x reconstruction filter.

Table A-1: Waveform vertical deflection (Cont.)

Characteristic	Performance requirement	Reference information
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 WFM700 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 Digital to Analog Conversion, Data and Filter Requirements, SMPTE Journal Mar 1995, Vol. 104, Fibush, Baker, Penny.
Interpolation Filter Group Delay, Typical		
HD		1 ns
SD		1 ns
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
Offset, Typical		Pr and Pb can be displayed aligned to Y or offset by 350 mV.

Table A-2: Serial digital video interface

Characteristic	Performance requirement	Reference information
Video Inputs		Two per video module; only one input active at a time.
Format		Each input compatible with SMPTE 292M/BTA-S004B and 270 Mbs/s SMPTE 259M
Input Type		75 Ω BNC, internally terminated
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, typically 400 m.
HD	0 to 20 dB attenuation	Equivalent to approximately 80 m of Belden 8281 at 1.485 Gb/s, typically 120 m.
Allowed Serial Source Amplitude		
With Max Specified Cable Loss		800 mV ± 10%
Up to 20 dB Cable Loss		800 mV ± 30%
Jitter Tolerance, Typical		0.4 UI p-p above 2 MHz. Increases proportional to 1/f below 2 MHz.
Return Loss	> 15 dB to 1.5 GHz	
Isolation Between Inputs	> 45 dB to 1 GHz	

Table A-3: Switched serial video output (serial out)

Characteristic	Performance requirement	Reference information
Format		1.485 Gb/s, 1.4835 Gb/s, or 270 Mb/s repeat of selected input. Functionally follows active input if on this input module.
Output Level	800 mV, ± 5% into 75 Ω load	
Return Loss	15 dB to 1.5 GHz	

Table A-4: Eye pattern display

Characteristic	Performance requirement	Reference information
Type		Equivalent Time Sampler
Signal Bandwidth	50 KHz to 2.5 GHz at -3 dB point	
Time Base Jitter		
SD		150 ps p-p in 1 kHz high-pass filter mode
HD		70 ps p-p in 1 kHz high-pass filter mode
Eye Clock Recovery Bandwidth Settings		Clock recovery bandwidth can be set to 10 Hz, 100 Hz, or 1000 Hz high pass filter
Eye Clock Recovery Bandwidth Accuracy	Actual -3 dB frequency within 10 % of nominal	
Jitter Attenuation Error		
10 Hz or 100 Hz Bandwidth	< 10% for frequencies greater than 2 times the Clock BW setting	
1 kHz Bandwidth	<-10%, +20 % for frequencies from 2 KHz to 10 kHz; <10% for frequencies above 10 kHz	
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 and line sync. Useful for observing jitter correlated to line rate and 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 and line sync. Useful for observing jitter correlated to line rate and word clock.
Deflection Factor		
Vertical	800 mV ±5% with an 800 mVp-p input signal	
Horizontal		±1%, fully digital system

Table A-5: Jitter display

Characteristic	Performance requirement	Reference information
Type		Demodulated recovered clock, per SMPTE RP184 specifications.
High-Pass Filter Settings		Can be set to 10 Hz, 1 kHz, 10 kHz, or 100 kHz. Applies to digital readout, jitter waveform, and jitter output.
High-Pass Filter Attenuation	-2 dB to -4 dB at specified frequency.	Applies to digital readout, jitter waveform, and jitter output.
High-End Frequency Response, Typical		-3 dB at > 5 MHz. Applies to digital readout, jitter waveform, and jitter output.
Dynamic Range, Typical Maximum is a function of jitter frequency and standard:		Applies to digital readout, jitter waveform, and jitter output.
10 Hz to 50 kHz, HD		9 UI_{p-p}
10 Hz to 50 kHz, SD		7 UI_{p-p}
100 kHz to 5 MHz		Decreasing linearly to 0.2 UI_{p-p} at 5 MHz
Minimum (noise floor) is a function of high-pass filter selection:		
10 Hz, HD		60 ps typical
1 kHz, 10 kHz, HD		60 ps typical
100 kHz, HD		30 ps typical
All HPF settings, SD		200 ps typical
Digital Readout Type		Indicates timing jitter or alignment jitter, depending on high-pass filter selection.
Digital Readout Error, Typical		< 0.1 UI, +10% of reading for jitter frequences from 3 times high-pass filter selection to 1 MHz.
Resolution		0.01 UI
Jitter Waveform Gain Error, Typical		< 0.1 UI +10% for jitter frequencies from 3 times high-pass filter selection to 1 MHz
Scale Horizontal Modes		1 Line, 2 Line, 1 Field, 2 Field
Vertical Modes		1 UI / div, 0.2 UI / div, 0.1 UI / div
Jitter Output		100 mV / UI, ± 10%, into 75 Ω load. In Jitter Mode only

Table A-6: Data error detection (EDH / Status)

Characteristic	Performance requirement	Reference information
Reporting Means		Data errors shown in Video Status/Session and Alarm Status displays. On-screen notification, audible beep, logging, and ground-closure remote output can also be enabled through the Configure menu.
Data Integrity		
SD	Both active picture and full field checks. Field rate resolution. Complies with SMPTE RP165.	Indicates CRC check-word errors for signals including EDH (Error Detection and Handling).
HD	Both Y and Color Difference checks. Field rate Resolution.	
Error Statistics		Indicates errored fields, % errored fields, and asynchronous errored seconds. Active picture and full field statistics are compiled separately.
Ancillary Data		Indicates the presence of ancillary data (other than audio and EDH) and indicates parity or checksum errors.
Bit Activity		Indicates if any of the 10 data bits are stuck high or low during the active picture of an entire field.
Signal Format		Indicates bit rate and detected format.
Format Errors		Indicates serial signal format errors. Detected Errors: SAV placed incorrectly relative to EAV Line length error Field length error SDI code word violation 292M line mismatch (HD only)
Input Signal Unlocked		Indicates input unlocked due to degraded, missing or inappropriate input signal.

Table A-7: Data display mode

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

Table A-8: External reference

Characteristic	Performance requirement	Reference information
Operational		Locks to analog bi-level and tri-level signals of formats listed in *Appendix B*. Reference must have a frame rate compatible with input. WFM mode and Line Select derive timing from the external sync information. Picture mode does not use timing from the external reference.
Analog Sync Format	PAL 1080i 60 Hz 720p 59.94 Hz NTSC 1080i 59.94 Hz 1080p 23.98 Hz 1080p 24 Hz	External reference is tested with PAL 1080i 60 Hz and 720p 59.94 Hz signals. This guarantees operation with all specified formats.
Input Signal Level, Typical		- 6 dB to + 6 dB
Maximum Operating Input Voltage, Typical		± 15 V DC
Absolute Maximum Input Voltage, Typical		± 15 V DC
Inband Input Impedance, Typical		≥ 15 KΩ
Return Loss	> 40 dB to 30 MHz	
Hum Tolerance, Typical		Operates with 500 mV_{p-p}
Signal/Noise Tolerance, Typical		Operates to 25 dB

Table A-9: Waveform horizontal deflection

Characteristic	Performance requirement	Reference information
Sweep		
Accuracy	± 0.5%, all rates	Fully digital system
Linearity	0.2% of time displayed on screen	Fully digital system
Timing Cursor Registration and Readout Accuracy, Typical		± 0.5% of sweep time displayed on screen
Rates		1, 2, 3, or 4 line or field depending on mode.
Line Select		Selected Line in 1 Line Selected first line in 2 Line or Parade

Table A-10: Component Vector mode

Characteristic	Performance requirement	Reference information
Vertical Bandwidth, Typical		
SD		1.2 MHz
HD		4.5 MHz
Vertical Gain Accuracy	± 0.5%	Fully digital system
Horizontal Gain Accuracy	± 0.5%	
Display to Graticule Registration	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 A-11: Freeze/Capture function

Characteristic	Performance requirement	Reference information
Delay Time from Button Push		< 3 frames at input frame rate
Saved Capture Size		1 frame at VGA display rate
Number of Captures		1

Table A-12: Lightning and Diamond modes

Characteristic	Performance requirement	Reference information
Vertical Gain Accuracy	±0.5%	Fully digital system
Electronic Graticule Display		
Diamond		RGB deflection axis indicated
Split Diamond		Offsets the top and bottom diamonds horizontally for better viewing of black gamut space.
Lightning		Displays signal components as follows: Y vertically Pb horizontally on top half of display P_r horizontally on bottom half of display

Table A-13: RGB GAMUT error detection

Characteristic	Performance requirement	Reference information
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	

Table A-14: Arrowhead mode (NTSC/PAL composite limit display)

Characteristic	Performance requirement	Reference information
Signal to Graticule Accuracy	±1%, 100 IRE (700 mV), and 131 IRE	(PAL values in parenthesis)
Composite Limit Cursor Accuracy	±0.5% at 100 IRE, 110 IRE, 120 IRE, and 131 IRE (700 and 950 mV)	(PAL values in parenthesis)
Composite Limit Detection Level Accuracy	Detection level ±7 mV 90% to 135% in 1% steps	

Table A-15: Bowtie mode

Characteristic	Performance requirement	Reference information
Common Mode Rejection Ratio		
SD	≥ 34 dB at 2.5 MHz	With SD 2.5 MHz, 350 mV Bowtie test signal. Null amplitude measured with cursors at 10x gain.
HD	≥ 40 dB at 5 MHz	With HD 5 MHz, 700 mV Bowtie test signal. Null amplitude measured with cursors at 10x gain.
Interchannel Timing Match		
SD	± 0.5 ns	With SD 2.5 MHz, 20 ns markers Bowtie test signal. In H MAG, null within 0.5 division of center marker.
HD	± 0.1 ns	With HD 5 MHz, 1 ns markers Bowtie test signal. In H MAG, null within 0.5 division of center marker.

Table A-16: Closed caption detection

Characteristic	Performance requirement	Reference information
Sources		Any selected video input; detects presence of EIA 608, EIA 708, Closed Captioning

Table A-17: Timecode decoding

Characteristic	Performance requirement	Reference information
Sources		Any selected video input
SD		Extracts and decodes VITC (SMPTE 12M)
HD		Extracts and decodes VITC (SMPTE 12M) and ancillary timecode (SMPTE RP188)

Table A-18: Ethernet

Characteristic	Performance requirement	Reference information
IP Address Mode		Supports manual and DHCP
Printer Support		Prints to Postscript 2 format printers on TCP/IP network
Connector Type		RJ-45 LAN connector supporting 10/100 Base-T

Table A-19: Audio mode (without Option DG)

Characteristic	Performance requirement	Reference information
Embedded Audio		Identifies the presence of up to 16 channels of AES/EBU digital audio. Presence is detected by looking at AES protocol.

Table A-20: Audio level meter displays (Option DG only)

Characteristic	Performance requirement	Reference information
Bar Modes		The user can configure the response dynamics (ballistics), reference levels, peak hold, and scale of the meters to suit the monitoring needs of the particular installation or situation. Each pair has a phase correlation meter.
Stereo Pairs		All 4 channel pairs with phase correlation meters
Surround		8 channels (L, C, R, Ls, Rs, LFE, Lo, Ro) with phase correlation meters for L & R, Ls & Rs, and Lo & Ro.
Audio Sources		Monitoring the signal levels and stereo phase of AES/EBU digital audio or digital audio embedded in serial digital video
Level Meter Resolution		0.05 dB steps at 10 dB scale, for from full scale to -40dB FS 0.25 dB steps at 0 to -70 dB scale, for signals above -40 dB FS
Metering Ballistics		Selectable from true peak, PPM, and Extended VU
Peak Program Meter		Per IEC 268-10A and IEEE std. 152-1991
True Peak		PPM decay characteristics, no attack delay
Extended VU		VU meter as defined in IEEE 152-1991, but with an extended dB-linear scale
Peak Hold		True peak indicator remains at the most recent peak for 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 Only the 16 most significant bits are checked for 0x7FFF or 0x8000 to identify a full-scale sample
Mute Indication Delay Count		Consecutive “0” samples for Mute Indication, user selectable Off or 1 to 100
Clip/Mute Hold Time		1 to 30 seconds, user selectable

Table A-20: Audio level meter displays (Option DG only) (Cont.)

Characteristic	Performance requirement	Reference information
Silence Indication Threshold		Audio level below which the signal will be considered “silent.” User selectable from 0 dB FS to -90 dB FS. Used to trigger on-screen indication and alarms
Over Level Indication Threshold		Audio level above which the signal will be considered “over level.” User selectable from 0 dB FS to -90 dB FS. Used to trigger on-screen indication and alarms
Silence / Over Indication Delay		Off or 1 to 30 seconds, user selectable Indication and alarm will not be asserted until signal stays below silence threshold or above over threshold for this number of consecutive seconds
Adjustable Peak Program Level		Range 0 to -30 dBFS
Adjustable Test Level		Range 0 to -60 dBFS
Set 0 dB Mark		Selections are Digital Full-Scale (dBFS), Peak Program (dB), or Test Level (dB)

Table A-21: Audio lissajous display (Option DG only)

Characteristic	Performance requirement	Reference information
Description		Lissajous display is available in combination with either Bar mode (see Table A-20).
Axis Orientation		Selections are X-Y or Sound Stage (Sound Stage is rotated 45 degrees counterclockwise from X-Y)
Automatic Gain Control (AGC)		Automatic gain control may be on or off
Manual (Fixed) Scaling		When AGC is off, level at perimeter of display follows Peak Program Level on Bar display

Table A-22: Audio session display (Option DG only)

Characteristic	Performance requirement	Reference information
Audio Session Display		Allows capturing of the following parameters. User can start, stop and reset the session.
Sample Frequency		Measured audio sample rate (approximate)
Invalid Data		Occurrence of AES samples with the validity bit set
Detected Receive Errors		Occurrence unlocked condition or AES samples with parity error
Active Bits		Identifies audio bits that are not always zero. Indicates 16, 20 or 24. 16: 16 or fewer active bits 20: 17 to 20 active bits 24: 21 to 24 active bits
Highest True Peak		Peak value of interpolated input data. This gives the best representation of level in reconstructed audio program.
Highest Level Reading		Peak value using selected level meter ballistic
Highest Non-interpolated Peak		Peak value of digital input data. This gives the best representation of peak data values encountered by digital equipment.
Number of		
Clips		Total clips as defined in Table A-20
Mutes		Total mutes as defined in Table A-20
Overs		Total overs as defined in Table A-20
Silences		Total silences as defined in Table A-20
Time Since Reset		Elapsed time since the session was last reset

Table A-23: Audio channel status display (Option DG only)

Characteristic	Performance requirement	Reference information
Channel Status		Decodes the AES channel status bits

Table A-24: AES audio inputs (Option DG only) [1]

Characteristic	Performance requirement	Reference information
Inputs		4 inputs, 8 audio channels, meets requirements of AES-3id-2001
Input Connector		BNC, terminated, unbalanced
Input Impedance		75 Ω
Input Return Loss	>25 dB from 0.1 to 6 MHz	
Input Amplitude Range		0.2 V to 2 V peak-to-peak
Input Sample Rate	32k to 96k samples/sec	
Input Lock Range		> ± 5%. If input sample rate changes more than 5%, then the instrument may search again for a new lock point.
Level Meter Accuracy Over Frequency	0.2 dB from 20 Hz to 20 kHz with 0 to -40 dBFS sine wave input, PPM ballistic mode except for within 7 Hz of some submultiples of the 192 kHz internal over-sampling frequency. For example: 192/14 = 13.714 kHz + 7 Hz, (-0.22 dB) 192/12 = 16 kHz + 7 Hz, (-0.3 dB) 192/10 = 19.2 kHz + 7 Hz, (-0.43 dB)	May not display full amplitude on fast transients due to sampled nature of digital signal.

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

Table A-25: AES audio outputs (Option DG only) [1]

Characteristic	Performance requirement	Reference information
Source		From embedded audio only
Number of Outputs		Up to 8 channels
Output format		48 kHz, 20 bit, meets requirements of SMPTE 276M-1995 (AES 3-ID)
Output Connector		BNC, terminated, unbalanced
Output Impedance		75 Ω
Output Return Loss	>25 dB from 0.1 to 6 MHz	
Output Amplitude	0.9 V to 1.1 V peak-to-peak into 75 Ω	
Output Sample Rate		Locked to embedded sample rate (nominally 48 kHz)
Output Jitter, Typical		Meets AES3-1997: <0.025 UI peak as measured with 700 Hz intrinsic jitter measurement filter

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

Table A-26: Audio alarms (Option DG only)

Characteristic	Performance requirement	Reference information
Audio Level Alarms		Warns of mute, clip, silence or over condition on an audio channel
Audio Error		Warns of CRC and parity errors and of validity bit set
Audio Unlocked		Warns of unlocked condition on an AES input
Group Sample Phase		Warns of sample phase errors between the two selected embedded audio groups

Table A-27: Picture mode

Characteristic	Performance requirement	Reference information
Format		Picture can be viewed in all formats: In SD, picture is cropped from 720 to 640 pixels wide. In HD, picture is downsampled to fit into 640 X 480 size. In low frame rate formats, frames are repeated as needed to achieve VGA speed; this is similar to 3:2 pulldown on some frame rates.
Synchronization		Picture mode always uses internal timing. It is not affected by external sync.

Table A-28: LCD display

Characteristic	Performance requirement	Reference information
Display Area		
Horizontal		13 cm
Vertical		10 cm
Resolution		640 (H) x 480 (V) pixels
Color Palette		6 bits per component. LSB is dithered to improve picture.
Pixel Defects	≤ 6 bad pixels	

Table A-29: Picture monitor outputs

Characteristic	Performance requirement	Reference information
Signal Format		
BNC outputs SD and HD		Y, Pb, Pr with sync on Y RGB with sync on all components. HD sync is tri-level.
VGA DSUB outputs		Same signals as on BNC outputs, also have TTL H and V drive.
DAC Resolution		10 bit
Impedance, Typical		75 Ω unbalanced
Active Video Accuracy, Y-Pb-Pr mode	700mV ±5% peak-to-peak	
Black (Blanking) Output Level SD and HD	0 mV ±25 mV	
Frequency Response, Typical		Response changes between systems with 1 video module and systems with 2 video modules installed. Response degrades if driving both BNC and VGA outputs.
SD		Y, G, B, and R ±5% to 5.5 MHz
HD		Y, G, B, and R ±8% to 30 MHz
Non-Linearity	≤0.5%	
Group Delay Error, Typical		
SD		±10 ns to 5.5 MHz
HD		±6 ns to 27 MHz
Interchannel Timing Match, Typical		
SD		Y-to-Pb and Y-to-Pr ±3.0 ns
HD		Y-to-Pb and Y-to-Pr ±4.0 ns
Sync Amplitude Accuracy, Typical		
SD		-300 mV ±5 %
HD		300 mV on positive transition 400 mV on negative transition
S/N inband, Typical		
SD		60 dB to 5.5 MHz on quiet line RMS relative to 700 mV
HD		50 dB to 30 MHz on quiet line RMS relative to 700 mV
Return Loss on BNCs	>40 dB to 30 MHz	
Transcoder Accuracy		9 bit

Table A-30: Serial SD only monitor outputs (SD PIX MON)

Characteristic	Performance requirement	Reference information
Content – Follows active input with brightups (SD Only)		Gamut brightups appear one line below error. Digital version of RGB/YPbPr analog pix monitor output on Ref board.
Rate		270 Mbit/s
Signal Level	800 mV ±5% into 75 Ω	Internal adjustment
Return Loss	>20 dB, 5 MHz to 270 MHz	

Table A-31: External VGA output (EXT VGA)

Characteristic	Performance requirement	Reference information
Content		Identical to front-panel LCD display
Output Levels		1 V for RGB signals, 3.3 V for H and V sync signals
Resolution		640 (H) x 480 (V) pixels
Color Palette		6 bits per component. LSB is dithered to improve picture.
Connector Pin Assignments		Pin 1: R Pin 6: GND Pin 11: NC Pin 2: G Pin 7: GND Pin 12: NC Pin 3: B Pin 8: GND Pin 13: HSync Pin 4: NC Pin 9: NC Pin 14: VSync Pin 5: GND Pin 10: NC Pin 15: NC

Table A-32: Remote port

Characteristic	Performance requirement	Reference information
Alarm Output		
Type		Open collector NPN switching transistor; Emitter grounded; Fused, 0.3 A
Maximum Voltage		-0.3 V, +15 V
Maximum Current		50 mA
Preset Inputs		
Type		Active high logic inputs
Maximum Voltage		±15 V
Input Resistance		3 kΩ to 5 kΩ to ground
Input Signal Requirements		Input high voltage: 2 V minimum Input low voltage: 0.8 V maximum
Connector Pin Assignments		Pin # Signal 1 Out; -10 V DC (not used) 2 Out; +10 V DC for pull-up use; typical source impedance: 750 Ω 3 In; TTL high, 15 V maximum [1] 4 In; TTL high, 15 V maximum [1] 5 Ground 6 Not used 7 In; TTL high, 15 V maximum [1] 8 Out; +10 V DC for pull-up use; typical source impedance: 750 Ω 9 Out; Active low when any enabled alarm condition occurs

[1] **Refer to Table C-2 on page C-3 for a listing of the instrument presets recalled using pins 3, 4, and 7 with ground closure.**

Table A-33: Power source

Characteristic	Performance requirement	Reference information
Electrical Rating	100 - 240 VAC, 50/60 Hz, 175 Watts max.	Tested to 90 - 264 VAC, 50/60 Hz. 2.6 A max.
Supply Connection		Detachable cord set
Power Consumption, Typical		< 150 VA (100 Watts) with 1 video module and 125 Watts with 2 video modules
Power Consumption, Option DG Maximum		13 Watts
Standby Power Consumption, Typical		1 Watt at 110 or 240 VAC
Surge, Typical		5 amps at 90 V 2.5 amps at 240 V
Fuse Rating	T3.5, 250 V	Not operator replaceable. Refer servicing to qualified service personnel.

Physical Specifications

Table A-34: 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 A-35: 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	Top None Bottom None Left side 2 in (51 millimeters) Right side 2 in (51 millimeters) Front None Rear 2 in (51 millimeters)

Certifications and Compliances

Table A-36: Certifications and compliances

Category	Standards or description	
EC Declaration of Conformity - EMC	Meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:	
	EN 55103	Product family standard for audio, video, audio-visual and entertainment lighting control apparatus for professional use.[2]
	Environment	E2 - commercial and light industrial
	Part 1 Emission	
	EN 55022	Class B radiated and conducted emissions
	EN 55103-1, Annex A	Radiated magnetic field emissions
	EN 55103-1, Annex B	Inrush current; I peak = 2.19 amps
	EN-55103-1, Annex E	Conducted emissions, signal/control ports
	Part 2 Immunity	
	IEC 61000-4-2	Electrostatic discharge immunity
	IEC 61000-4-3	RF electromagnetic field immunity
	IEC 61000-4-4	Electrical fast transient / burst immunity
	IEC 61000-4-5	Power line surge immunity
	IEC 61000-4-6	Conducted RF Immunity
	IEC 61000-4-11	Voltage dips and interruptions immunity
	EN 55103-2, Annex A	Radiated magnetic field immunity
	EN 55103-2, Annex B	Balanced ports common mode immunity
	EN 61000-3-2	AC power line harmonic emissions
Australia / New Zealand Declaration of Conformity - EMC	Complies with EMC provision of Radiocommunications Act per the following standard(s):	
	AS/NZS 2064.1/2	Industrial, Scientific, and Medical Equipment: 1992
FCC Compliance	Emissions comply with FCC Code of Federal Regulations 47, Part 15, Subpart B, Class A Limits.	
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities:	
	Low Voltage Directive 73/23/EEC, amended by 93/68/EEC	
	EN 61010-1:1993/A2:1995	Safety requirements for electrical equipment for measurement control and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	UL3111-1	Standard for electrical measuring and test equipment.
Canadian Certification	CAN/CSA C22.2 No. 1010.1	Safety requirements for electrical equipment for measurement, control, and laboratory use.

2 **Use only high-quality shielded cables.**

Table A-36: Certifications and compliances (cont.)

Category	Standards or description	
Additional Compliance	IEC61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use.
	ISA S82.02.01:1999	Safety standard for electrical and electronic test, measuring, controlling, and related equipment.
Installation (Overvoltage) Category Descriptions	Terminals on this product may have different installation (overvoltage) category designations. The installation categories are:	
	CAT III	Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location.
	CAT II	Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected.
	CAT I	Secondary (signal level) or battery operated circuits of electronic equipment.
Pollution Degree Descriptions	A measure of the contaminates that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.	
	Pollution Degree 1	No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.
	Pollution Degree 2	Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.
	Pollution Degree 3	Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.
	Pollution Degree 4	Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.
Equipment type	Test and Measurement	
Safety Class	Class I	
Overvoltage Category	CAT II	
Pollution Degree	Pollution Degree 2	

Appendix B: Supported Video Standards

Table B–1 lists the video standards supported by the WFM700 instruments. Table B–2 lists the supported input/reference format combinations.

Table B-1: Supported video standards

Standard	Image Format	Field/Frame Rate							
		60 Hz	59.94 Hz	50 Hz	30 Hz	29.97 Hz	25 Hz	24 Hz	23.98 Hz
274M	1920x 1080i	x (D-292)[1]	x (E-292)[1]	x (F-292)[1]					
	1920x 1080p				x (G-292)[1]	x (H-292)[1]	x (I-292)[1]	x (J-292)[1]	x (K-292)[1]
	1920x 1080sF				x[2]	x[2]	x[2]	x	x
240M/260M	1920x 1035i	x (A-292)[1]	x (B-292)[1]						
296M	1280x 720p		x (M-292)[1]					x	x
ITU-R BT.601	720x 576i (625)			x (C-259)[3]					
	720x 483i (525)		x (C-259)[3]						

1 **SMPTE 292M format support.**

2 **These segmented-frame format signals are detected as their corresponding interlaced format.**

3 **SMPTE 259M support level C - 270 Mbyte/s, 525/625 component.**

Table B-2: Allowed references for input formats

Input format, digital	Allowed reference, analog						
	Bi-level sync		Tri-level sync				
	NTSC	PAL	1080i 59.94 Hz	1080i 60 Hz	720p 59.94 Hz	1080p 23.98 Hz	1080p 24 Hz
274M, 1080i, 60 Hz				x			
274M, 1080i, 59.94 Hz	x		x		x[1]		
274M, 1080i, 50 Hz		x					
274M, 1080p, 30 Hz				x			
274M, 1080p, 29.97 Hz	x		x		x[1]		
274M, 1080p, 25 Hz		x					
274M, 1080p, 24 Hz				x[2]			x
274M, 1080p, 23.98 Hz	x[2]		x[2]		x[2]	x	
RP211, 1080sf, 30 Hz				x			
RP211, 1080sf, 29.97 Hz	x		x		x[1]		
RP211, 1080sf, 25 Hz		x					
RP211, 1080sf, 24 Hz				x[2]			x
RP211, 1080sf, 23.98 Hz	x[2]		x[2]		x[2]	x	
240M 1035i, 59.94 Hz	x		x				
240M 1035i, 60 Hz				x			
296M 720p, 59.94 Hz	x[3]		x[3]		x		
296M 720p, 24 Hz				x[2]			x
296M 720p, 23.98 Hz	x[2]		x[2]		x[2]	x	
BT601 576i, 50 Hz (625)		x					
BT601 483i, 59.94 Hz (525)	x		x		x		

1 **Digital input frame rate is divided by a factor of two.**

2 **Every fifth frame of reference matches the fourth frame of digital input.**

3 **Reference frame rate is divided by a factor of two.**

NOTE*. The WFM700 does not use the SMPTE 318M 10 Field Sequence flag. This causes inconsistent operation for combinations of input and reference format whose frame rates are not related by an integer multiplier. The inconsistent operation causes multiple possible timing orientations to be shown on the Waveform. The display is similar to that shown when a timing offset is present. The number of possible waveform orientations is related to the ratio of the input and reference frame rates.*

Appendix C: Remote Control

The waveform monitor provides the following two methods for remotely controlling the instrument:

- The Ground Closure interface allows you to monitor events for enabled alarms and to recall up to seven presets (stored instrument settings) using the rear-panel, 9-pin remote connector.
- The Web Server interface allows you to communicate with the instrument using a Web browser, such as IE (Internet Explorer), on your PC.

This section describes how to operate the functions available with these remote control interfaces.

Ground Closure Interface

The REMOTE connector serves as an interface to allow you to perform the following tasks:

- Send a ground-closure signal to external equipment when a monitored alarm condition has occurred. The connector provides a logic-high output level for pull-up use by external switches, allowing for a passive-only external circuit.

  Each monitored alarm can be individually configured for ground closure notification using this interface. Refer to *General Alarms* on page 2-30, *Serial Alarms* on page 2-32, and *Audio Alarms (WFM7DG Only)* on page 2-34 for information about configuring alarms for ground closure notification.

- Recall instrument presets 36 to 42 by sending logic high signals to the instrument.

  You must enable the remote preset function in the Configure menu before you can use the Ground Closure interface to recall presets. Refer to *Remote Control Port* on page 2-50 for information about enabling the remote preset function. Refer to *Preset Menu* on page 2-81 for information about configuring the instrument presets.

Remote Connector Pin Assignments

The REMOTE connector is a 9-pin, D-type connector with socket contacts as shown in Figure C–1.

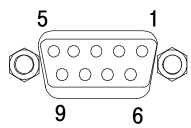


Figure C-1: REMOTE connector pin diagram

Table C–1 lists the pin assignments for the remote connector.

Table C-1: REMOTE connector pin assignments

Pin	Signal direction	Function	Signal requirement	Notes
1	Output	Logic low	Supplies -10 V, DC	Not used.
2	Output	Logic high	Supplies 10 V, DC	This logic-high output level is provided for pull-up use by external switches, allowing for a passive-only external circuit. Source resistance typically 750 Ω.
3	Input	Recall 0	TTL high, 15 V max	Used alone, recalls preset 36 when pulled high. Used in conjunction with Pin 4 and Pin 7, recalls presets 37 to 42 as shown in Table C-2.
4	Input	Recall 1	TTL high, 15 V max	Used alone, recalls preset 37 when pulled high. Used in conjunction with Pin 3 and Pin 7, recalls presets 36 to 42 as shown in Table C-2.
5	---	Ground		
6	---	Not used		
7	Input	Recall 2	TTL high, 15 V max	Used alone, recalls preset 39 when pulled high. Used in conjunction with Pin 3 and Pin 4, recalls presets 36 to 42 as shown in Table C-2.

Table C-1: REMOTE connector pin assignments (Cont.)

Pin	Signal direction	Function	Signal requirement	Notes
8	Output	Logic high	Supplies 10 V, DC	This logic-high output level is provided for pull-up use by external switches, allowing for a passive-only external circuit. Source resistance typically 750 Ω.
9	Output	Alarm	True low	Ground closure when enabled alarm condition occurs.

Remote Connector Pin Assignments

Table C-2 lists the instrument presets recalled by pulling pins 3, 4, and 7 high in different combinations.

Table C-2: Ground closure preset recall map

Recall preset number	Pin 3 (Recall 0)	Pin 4 (Recall 1)	Pin 7 (Recall 2)
----	0	0	0
36	1	0	0
37	0	1	0
38	1	1	0
39	0	0	1
40	1	0	1
41	0	1	1
42	1	1	1

Remote Web Interface

The waveform monitor can be accessed two ways over an Ethernet network: using just a Web browser or by running a Java applet.

PC and Web Browser Requirements

Using a PC with only Web browser software, you can remotely view the diagnostics logs and view the system events and alarms logs.

If you install the Java Runtime Environment (JRE) on your PC, you can run a Java applet from the Web browser that provides a virtual front-panel you can use to remotely control the instrument and view the instrument display. Refer to *Installing Java* on page C–10 for instructions on how to install the JRE.

The Remote Web Interface was tested with the PC configuration listed below.

***NOTE**. PC configurations and Web browsers other than those listed below were not tested. However, other PC configurations and Web browsers may be able to operate the Remote Web Interface.*

- Operating System: Microsoft Windows 2000 Version 5.00.2195
- Service Pack: Windows 2000 Service Pack Version 3
- JRE Version: Java 2 Runtime Environment Standard Edition v1.4.1_01
- Web Browsers: Internet Explorer 5, version 5.00.3502.1000
Netscape 6, version 6.1

Launching the Web Browser

Perform the following steps to connect a Web browser to the instrument:

***NOTE**. To connect to the instrument, the PC and browser must meet the requirements listed above.*

---

1. Connect the instrument to your IP network using the Ethernet connector.
2. Assign the waveform monitor an IP address using one of the two following methods:
   - Perform the *Manually Assigning an IP Address* procedure on page C–7 if your local network requires fixed IP addresses.
   - Perform the *Using DHCP Service to Assign an IP Address* procedure on page C–8 if your local network supports DHCP service, which dynamically assigns an IP address to connected equipment.

3. Enable the instrument for remote operation with a Web browser:

   a. On the waveform monitor, press the CONFIG button to display the Configure menu.

   b. Touch the Communications soft key to display the submenu, and then touch the submenu to display the Network Setup menu.

   c. Touch the Remote Web Interface soft key, and then touch the Enabled soft key to allow remote access.

   d. Touch the Top Menu soft key to return to the Configure menu (the Communications submenu will still be displayed).

4. Note the IP Address of the instrument shown in the submenu display.

5. From your PC, launch your Web browser. Type the network address of the waveform monitor into the URL entry box like this:

   http://123.123.123.123/

***NOTE**. If the IP address assigned to your instrument contains a number less than 100, such as 123.123.076.032, enter the URL address in the Web browser without the "0" character. I.E.: 123.123.76.32.*

---

6. Check that the Web browser connects to the instrument as shown in Figure C–2.

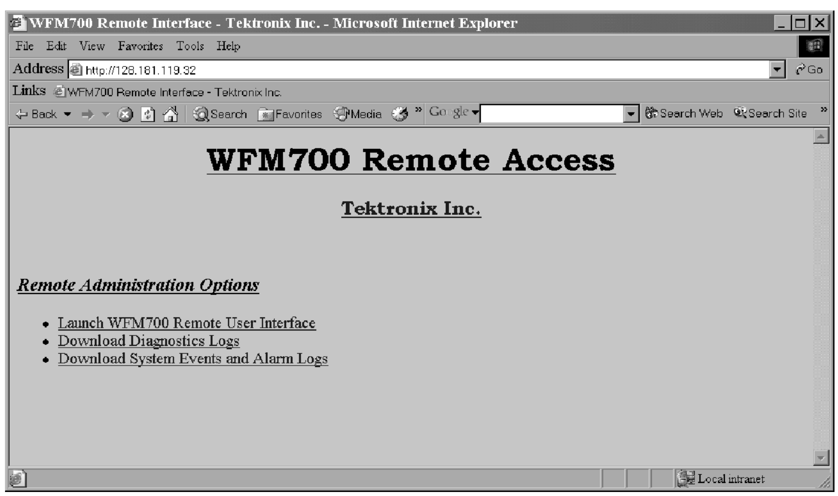


Figure C-2: Accessing the WFM700 remote interface with a Web browser

The following table describes the function of each of the links displayed in the Web browser window (see Figure C-2).

Table C-3: Functions of the Web browser interface links

Selection	Description
Launch WFM700 Remote User Interface	Starts the Java applet for the WFM700 Remote User Interface
Download Diagnostics Logs	Downloads and displays the Diagnostics log
Download System Events and Alarms Logs	Downloads and displays the system events and alarm log.
Tektronix Inc.	Connects to the Tektronix, Inc. Web site

Manually Assigning an IP Address. To manually assign to the waveform monitor the IP address provided by your local network administrator, perform the following procedure:

NOTE. *Depending on the operating system and how your PC is configured, you may need to have Administrator privileges on the PC before you can view or edit the IP address on the PC. Contact your local network administrator if you are unable to view or change the IP address on the PC.*

---

1. Press the CONFIG button on the waveform monitor.
2. Touch the Communications soft key, and then touch the Next Menu soft key.
3. Touch the Config Mode soft key, and then touch the Manual Mode soft key.
4. Touch the IP Address soft key, and then touch the Press to Edit IP Address soft key.

CAUTION. *Entering an incorrect IP address, gateway address, or subnet mask address into the WFM700 waveform monitor can create problems with other networked devices and prevent network communication with the instrument.*

Be sure to consult with your local network administrator before you enter these addresses into the waveform monitor.

---

5. Use the general purpose knob and the Select button or use the soft keys (Increase/Decrease Value and Move Left/Right) to enter the IP address, gateway address, and subnet mask assigned to your waveform monitor by your local network administrator.
6. Touch the Save IP Address soft key to save the changed address. The new IP address is displayed in the top soft key.

Using DHCP Service to Assign an IP Address. To use DHCP service to assign the waveform monitor an IP address, perform the following procedure:

NOTE. *In order to use the DHCP Server option on the waveform monitor, your local network must support DHCP service. If necessary, refer to your local network administrator for assistance in determining which method to use when assigning your waveform monitor an IP address.*

---

1. Press the CONFIG button on the waveform monitor.
2. Touch the Communications soft key, and then touch the Next Menu soft key.
3. Touch the Config Mode soft key, and then touch the DHCP Server soft key.
4. Touch the IP Address soft key.
5. The top soft key will display the message “Waiting for DHCP Server” while the waveform monitor waits for an IP address to be assigned by the DHCP server.

NOTE. *It will usually take only several seconds for the DHCP server to assign an IP address. The waveform monitor will time out from waiting for an address after approximately 45 seconds.*

If the waveform monitor times out while waiting for an IP address to be assigned, contact your local network administrator for assistance. Either there is a problem with your local network or your network does not support DHCP service.

---

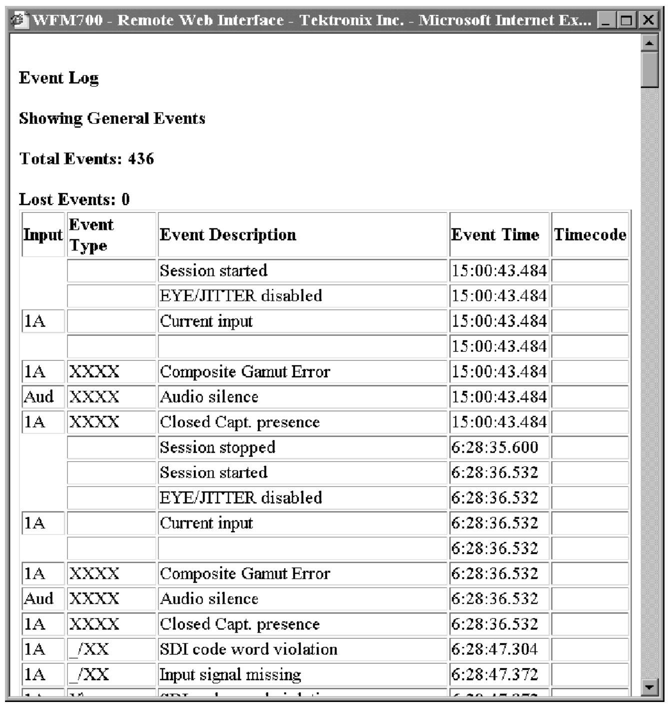
6. After an IP address has been assigned to the waveform monitor by the DHCP server, the top soft key will display the assigned address.

Downloading the Diagnostics Logs

To download the Diagnostics log, which contains the log of the last diagnostic test that was run, click on Download Diagnostics Logs. The Web browser will launch a new window and display the Diagnostics Log.

Downloading the System Events and Alarm Logs

To download the System Events and Alarms log, click on Download System Events and Alarms Logs. The Web browser will launch a new window and display the log. See Figure C–3.



Event Log

Showing General Events

Total Events: 436

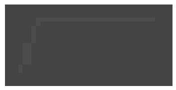
Lost Events: 0

Input	Event Type	Event Description	Event Time	Timecode
		Session started	15:00:43.484	
		EYE/JITTER disabled	15:00:43.484	
1A		Current input	15:00:43.484	
			15:00:43.484	
1A	XXXX	Composite Gamut Error	15:00:43.484	
Aud	XXXX	Audio silence	15:00:43.484	
1A	XXXX	Closed Capt. presence	15:00:43.484	
		Session stopped	6:28:35.600	
		Session started	6:28:36.532	
		EYE/JITTER disabled	6:28:36.532	
1A		Current input	6:28:36.532	
			6:28:36.532	
1A	XXXX	Composite Gamut Error	6:28:36.532	
Aud	XXXX	Audio silence	6:28:36.532	
1A	XXXX	Closed Capt. presence	6:28:36.532	
1A	_/XX	SDI code word violation	6:28:47.304	
1A	_/XX	Input signal missing	6:28:47.372	

Figure C-3: Downloaded event log

The downloaded event log is displayed as a table that identifies the input on which the event occurred, the event type, an event description, the time the event occurred and the timecode when the event occurred (if present in the signal). Table C–4 details the meaning of the possible event types that can occur.

Table C-4: Event Log error status icons

On-screen icon	Remote Web Interface symbols	Description
	XXXX	Identifies a persistent (more than one video field) alarm condition that was present when logging started. The on-screen icon is red.
	_/XX	Identifies an alarm condition that persisted for more than one video field. The on-screen icon is red.
	_/_	Identifies a momentary (pulse) alarm condition that persisted for less than or equal to one video field. The on-screen icon is red.
	X__	Identifies an alarm condition that cleared for more than one video field. The on-screen icon is green.
	X\/X	Identifies an alarm condition that cleared for less than or equal to one video field. The on-screen icon is red.
	/\/\	Identifies an intermittent alarm condition (one field on, one field off). The on-screen icon is red.

Using the Java Applet for the Remote Interface

The Java applet provides a virtual front panel for the waveform monitor. The virtual front-panel allows you to control the waveform monitor by clicking on buttons as if you were pressing buttons on the instrument. The virtual front-panel includes the display which is automatically refreshed every 15 seconds.

Installing Java. To use the Remote Interface Java applet, you must install the Java Runtime Environment.

To run the Remote Interface Java applet, you must have Version 1.41 (or later) of the Java Run-Time Environment (JRE) from Sun Microsystems installed on your PC. To download the JRE (Java Run-Time Environment) plug-in from Sun Microsystems, go to the following URL, and download the appropriate code:

http://java.sun.com/j2se/1.4/

Once you download the executable file, launch the installation software and follow the instructions.

Launching the Java Applet. When you launch the Java applet, it is downloaded from the waveform monitor and launched. There is no software install required to use the applet (other than the Java Run-Time Environment noted previously).

To launch the Java applet:

1. Launch the Web browser as described in *Launching the Web Browser* on page C–4.

2. Once the WFM700 Remote Access page appears, click on Launch WFM700 Remote User Interface.

The Java applet will be launched and a screen like that shown in Figure C–4 will appear (depending on the actual settings of the waveform monitor).

Controlling the waveform monitor from the Java applet is much like using the actual instrument front panel. To perform a button press on the waveform monitor, click the same button on the virtual front-panel.

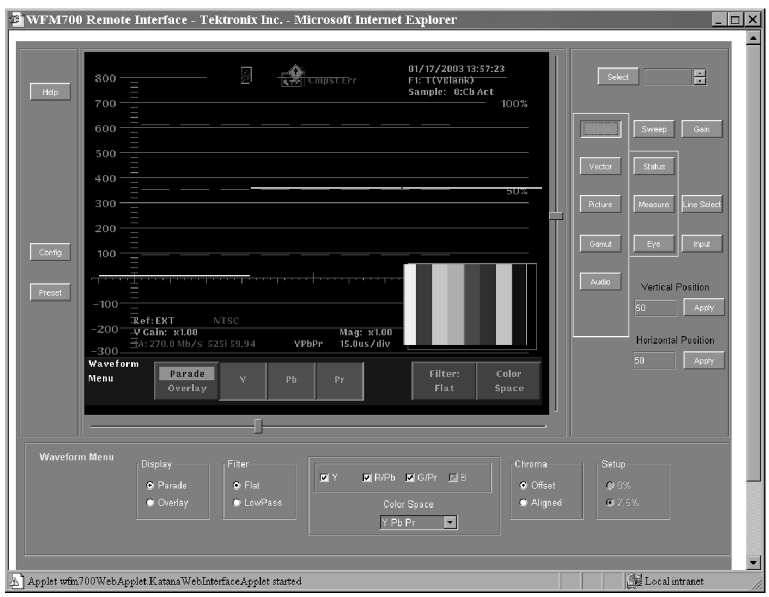


Figure C-4: Java applet showing the WFM700 Remote User Interface display

Elements of the Java Applet Interface. The Java applet interface mimics the front panel of the waveform monitor. There is a display screen and control buttons that you use to change the waveform monitor settings. The screen is refreshed automatically. The area below the screen changes depending on the selected button. See Figure C-5.

You control the waveform monitor by clicking the buttons and changing the settings that appear below the display. The Remote Web Interface includes controls for most, but not all, of the buttons that appear on the waveform monitor front panel.

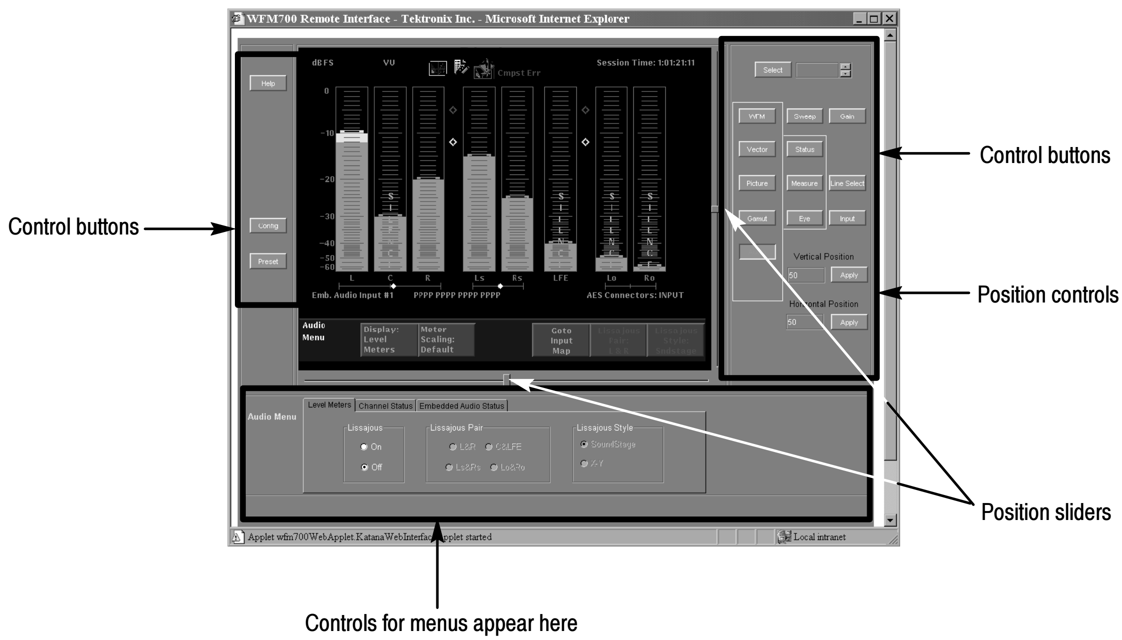


Figure C-5: Elements of the Java applet display

Changing the Instrument View. To change the view on the waveform monitor, click on the desired View button. For example, to display the Audio screen, click on the Audio button.

Using the Position Controls. There are two ways to change the position of a signal on the display:

- Move the horizontal and vertical position sliders
- Type a value into the Vertical or Horizontal Position boxes and click Apply

When you use the Horizontal Position or Vertical Position controls, the range of values is 0 – 100. For the horizontal position, 0 represents the left edge of the display, 100 represents the right edge of the display, and 50 represents the middle of the display. In the same way, 0 for the vertical position represents the bottom of the display, 100 represents the top of the display, and 50 represents the middle of the display.

Changing Instrument Settings. The controls used to change instrument settings appear below the display screen, as shown in Figure C–5. In this area, there are several types of controls used to change settings, such as option buttons and drop-down lists. The controls that appear in this area change depending on which button was last clicked. All of these controls represent the parameters that can be changed using the soft keys on the waveform monitor display.

Changing the Instrument Configuration. You can change several of the instrument configuration settings by using the CONFIG button. When you click the CONFIG button, the Java applet launches a new window. See Figure C–6.

To make changes to the Configuration settings, click check boxes as desired. Changes are sent to the instrument as you make them. Click the Close box to remove the window after you have completed the changes.

***NOTE**. You cannot change all of the configuration settings for the instrument using the remote interface. Some of the settings can be changed only by using the instrument front panel and touchscreen.*

Displaying Help. You can display help by pressing the HELP button. This launches a new window that displays the online help from the instrument.

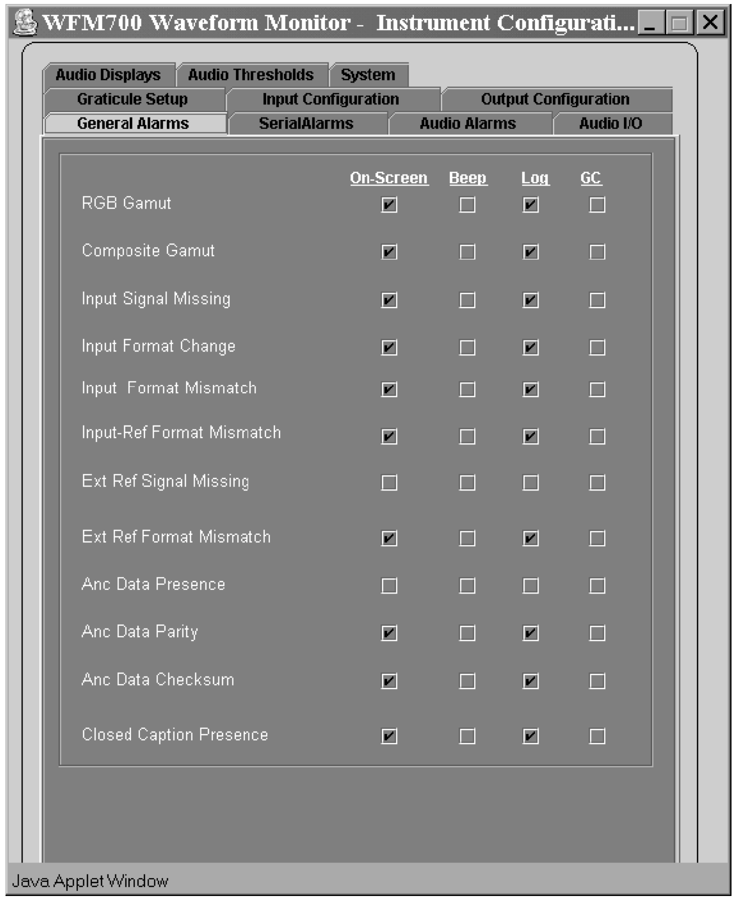


Figure C-6: Changing the instrument configuration using the Remote User Interface

Appendix D: User Service

This appendix contains procedures for cleaning the instrument and performing preventive maintenance on the waveform monitor.

Cleaning

General Care

Protect the instrument from adverse weather conditions. The instrument is not waterproof.

CAUTION. *To avoid damage to the instrument, do not expose it to sprays, liquids, or solvents.*

Do not use chemical cleaning agents; they may damage the instrument. Avoid chemicals that contain acetone, benzene, toluene, xylene, or similar solvents, because they may damage the plastic.

WARNING. *Remove the power cord before cleaning the instrument.*

Cleaning the Exterior

Remove the power cord before cleaning the instrument. Clean the exterior surfaces of the instrument with a dry, lint-free cloth or a soft-bristle brush. If dirt remains, use a cloth or swab dampened with a 75% isopropyl alcohol solution. A swab is useful for cleaning in narrow spaces around the controls and connectors. Do not use abrasive compounds on any part of the instrument.

CAUTION. *Do not allow moisture inside the instrument. During exterior cleaning, use only enough solution to dampen the cloth or swab.*

The touch panel on the LCD is a soft plastic surface. Observe the following precautions when cleaning:

- *Do not use abrasive cleaners or commercial glass cleaners.*
- *Do not spray liquids directly on the surface.*
- *Do not scrub the surface with excessive force.*

Preventive Maintenance

Preventive maintenance mainly consists of periodic cleaning. Periodic cleaning reduces instrument breakdown and increases reliability. Clean the instrument as needed, based on the operating environment. Dirty conditions may require more frequent cleaning than computer-room conditions.

Check the waveform monitor once a year to verify that the instrument still meets its functional requirements. Refer to the *Functional Check* on page 1–17.

Yearly performance verification is recommended. Refer to the *WFM700 Service Manual* for the Performance Verification procedure.

Appendix E: Firmware Upgrade

Firmware upgrades for the waveform monitor will become available periodically. Check with your Tektronix representative for more information.

Required Equipment

***NOTE**. The firmware upgrade utility and the updated firmware image are available at the www.tektronix.com website.*

To upgrade your waveform monitor firmware, you need the following:

- Firmware Upgrade Utility (transfer.exe)
- Image file of the new firmware version (*a.fmw or *b.fmw; step 4 on page E–3 describes how to determine which image file to use)
- A networked PC with the following minimum configuration:

  Processor: Pentium, 167 MHz
  RAM: 64 MB
  OS: Windows 95 or Windows NT
  Free space on hard drive: 8 MB

- One of the following Ethernet cables:
  - Standard RJ45 Ethernet cable. Use this type of cable if you are connecting the waveform monitor to a PC through a local network or through an Ethernet hub.
  - Ethernet crossover cable. Use this type of cable if you are connecting the waveform monitor directly to the Ethernet card on a PC.

Instrument Setup

To prepare the waveform monitor for a firmware upgrade, perform the following steps:

1. Connect the waveform monitor to your PC using one of the following three methods:

   - Connect the waveform monitor to your local network using a standard RJ45 Ethernet cable.
   - Connect the waveform monitor to the PC through an Ethernet hub using a standard RJ45 Ethernet cable.
   - Connect the waveform monitor directly to the Ethernet card on the PC using an Ethernet crossover cable.

NOTE. *You must use an Ethernet crossover cable if you are connecting the waveform monitor directly to the Ethernet card on the PC.*

---

2. Turn on the waveform monitor.
3. Assign the waveform monitor an IP address using one of the two following methods:

   - Perform the *Manually Assigning an IP Address* procedure on page E-4 if your local network requires fixed IP addresses or if you are connecting the waveform monitor directly to the Ethernet card on the PC.
   - Perform the *Using DHCP Service to Assign an IP Address* procedure on page E-6 if your local network supports DHCP service, which dynamically assigns an IP address to connected equipment.

NOTE. *In order to use the DHCP Server option on the waveform monitor, your local network must support DHCP service. If necessary, refer to your local network administrator for assistance in determining which method to use when assigning your waveform monitor an IP address.*

---

4. Determine which version of the Real Time Display board is installed in your instrument:

NOTE. *The firmware upgrade package that is downloaded from the Tektronix, Inc. Web site contains two versions of the firmware file: *a.fmw or *b.fmw. You must use the *a.fmw file if your instrument contains the "A" version of the Real Time Display board or you must use the *b.fmw file if your instrument contains the "B" version of the board.*

---

a. Press the Help button, touch the System Info soft key, and then touch the Installed Options soft key.

b. Use the *a.fmw firmware file if one of the following statements is true:

- The Installed Options display lists four slots (Acq. 1, Acq. 2, Aux, and Ref).
- The Installed Options display lists five slots, and the name of the module in the Vid. Proc slot is "RTD v.A."

c. Use the *b.fmw firmware file if the Installed Options display lists five slots, and the name of the module in the Vid. Proc slot is "RTD v.B."

Manually Assigning an IP Address

To manually assign to the waveform monitor the IP address provided by your local network administrator, perform the following procedure:

***NOTE**. If the waveform monitor is already connected and operating on your local network, you will not need to reassign the instrument a new IP address. In this case, proceed to* Firmware Upgrade Procedure *on page E-7.*

Depending on which operating system you use and how your PC is configured, you may need to have Administrator privileges on the PC before you can view or edit the IP address on the PC. Contact your local network administrator if you are unable to view or change the IP address on the PC.

---

1. Press the CONFIG button on the waveform monitor.
2. Touch the Communications soft key (firmware versions 2.x.x) or the Network Settings soft key (firmware versions 1.x.x), and then touch the Next Menu soft key.
3. Touch the Config Mode soft key, and then touch the Manual Mode soft key.
4. Touch the IP Address soft key, and then touch the Press to Edit IP Address soft key.

***CAUTION.** Entering an incorrect IP address, gateway address, or subnet mask address into the WFM700 waveform monitor can create problems with other networked devices and prevent network communication with the instrument.*

Be sure to consult with your local network administrator before you enter these addresses into the waveform monitor.

---

5. Use the general purpose knob and the Select button or use the soft keys (Increase/Decrease Value and Move Left/Right) to enter one of the following IP addresses:
   - If you connected the waveform monitor to your local network, enter the IP address, gateway address, and subnet mask assigned to your waveform monitor by your local network administrator.
   - If you connected the waveform monitor directly to the Ethernet card on your PC, enter the following IP address (you will not need to enter a gateway address or subnet mask):

     192.168.1.2
6. Touch the Save IP Address soft key to save the changed address. The new IP address is displayed in the top soft key.

7. If you connected the waveform monitor to your local network, proceed to *Firmware Upgrade Procedure* on page E–7.

8. If you connected the waveform monitor directly to the Ethernet card on your PC, perform the following steps to assign your PC an IP address:

NOTE. *If you connected the waveform monitor directly to the Ethernet card on your PC, you must assign the PC an IP address to allow the firmware upgrade process to operate properly.*

The following steps are for Windows 95 and Windows 98 operating systems. The steps are similar for Windows NT and Windows 2000 operating systems.

---

a. Open the Control Panel on your PC.

b. Open the Network and Dial-up Connections folder.

c. Right-click the Local Area Connection icon.

d. Click Properties.

e. Highlight Internet Protocol (TCP/IP).

f. Click Properties.

CAUTION. *If your PC already has a valid fixed IP address for your local network and you disconnected the PC from the network so that you could perform the firmware upgrade procedure, make a note of your IP address before you perform the following steps.*

Be sure to reset the PC's IP address back to the proper address before you reconnect the PC to your network (you will be reminded to do this at the end of the upgrade procedure).

---

g. Click the manual button for setting the IP address.

h. Enter the following IP address (you will not need to enter a gateway address or subnet mask):

    192.168.1.1

i. Save your changes and exit the Local Area Connection dialog box.

j. Close or minimize the Control Panel.

k. Proceed to *Firmware Upgrade Procedure* on page E–7.

Using DHCP Service to Assign an IP Address

To use DHCP service to assign the waveform monitor an IP address, perform the following procedure:

1. Press the CONFIG button on the waveform monitor.
2. Touch the Communications soft key (firmware versions 2.x.x) or the Network Settings soft key (firmware versions 1.x.x), and then touch the Next Menu soft key.
3. Touch the Config Mode soft key, and then touch the DHCP Server soft key.
4. Touch the IP Address soft key.
5. The top soft key will display the message “Waiting for DHCP Server” while the waveform monitor waits for an IP address to be assigned by the DHCP server.

***NOTE**. It will usually take only several seconds for the DHCP server to assign an IP address. The waveform monitor will time out from waiting for an address after approximately 45 seconds.*

If the waveform monitor times out while waiting for an IP address to be assigned, contact your local network administrator for assistance. Either there is a problem with your local network or your network does not support DHCP service.

---

6. After an IP address has been assigned to the waveform monitor by the DHCP server, the top soft key will display the assigned address.

Firmware Upgrade Procedure

After you have prepared the waveform monitor for the firmware upgrade as described in *Instrument Setup* on page E–2, perform the following procedure to upgrade the instrument firmware:

On Your PC

Perform the following steps on your PC:

1. Access the Tektronix, Inc. Web site at www.tektronix.com and download the following two files:
   - Firmware upgrade utility (transfer.exe)
   - Image file of new firmware version (*a.fmw or *b.fmw; step 4 on page E–3 describes how to determine which image file to use)
2. Save the upgrade files to a convenient location on your local hard drive.

On Your Waveform Monitor

Perform the following steps on your waveform monitor:

3. Power on the waveform monitor.
4. Push the CONFIG button.
5. Touch the System soft key, and then touch the Next Menu soft key.
6. Touch the Install Upgrade soft key, and then touch the Start Firmware Installation soft key.
7. Read the instructions displayed on the screen and touch the Continue soft key if you want to proceed with the firmware upgrade. Touch the Cancel soft key to exit without updating the instrument firmware.

***NOTE**. Upgrading the waveform monitor firmware will not delete any instrument configuration presets you have saved.*

On Your PC

Perform the following steps on your PC:

8. Locate the Upgrade Utility file (transfer.exe) you previously downloaded from the Tektronix Web site.
9. Double-click the transfer.exe file to start the Upgrade Utility program.
10. Click "Browse for Firmware Pathname" and browse to the *.fmw file you previously downloaded from the Tektronix Web site.
11. Enter the IP address of the waveform monitor into the appropriate boxes on the PC screen. (The IP address is displayed on the waveform monitor screen.)
12. Click Upgrade in the Firmware Upgrade Utility window.

    After the upgraded firmware has been downloaded to the waveform monitor, the "Firmware File Transfer Complete" message will be displayed in the Firmware Upgrade Utility window.

13. If the message in the Firmware Upgrade Utility window says "Instrument is not reachable!" do the following (otherwise proceed to step 14):
    a. Click OK on the PC.
    b. Touch the Cancel soft key on the waveform monitor.
    c. If you manually assigned the IP address to your waveform monitor, verify the IP address you used with your local network administrator, and then repeat the procedure in *Manually Assigning an IP Address* on page E–4.
    d. Exit the Upgrade Utility on your PC, and then restart this procedure from step 1 on page E–7.
    e. If you still get a message on your PC that says "Instrument is not reachable!," after performing these steps, contact your local network administrator.

On Your Waveform Monitor

Perform the following steps on your waveform monitor:

14. If there is a message on the waveform monitor that says "Upgrade Error," you likely attempted to upgrade using the wrong version (A or B) of the firmware image file. Repeat step 4 on page E–3 to determine which image file to use, and then return to step 4 on page E–7.

***NOTE**. If you attempt to upgrade your instrument using the wrong version (A or B) of the firmware image file, the instrument reports an error message and continues operation using the previously installed firmware.*

---

15. If you used the correct firmware image file, the waveform monitor screen presents two soft key choices: Continue and Cancel. If you do not want to proceed with the firmware upgrade, touch the Cancel soft key. This is your last opportunity to cancel the upgrade.

⚠ ***CAUTION.** Once you touch the Continue soft key, the instrument will erase the existing flash memory and will reprogram the instrument firmware. You cannot stop the upgrade process once you touch the Continue soft key.*

To prevent the corruption of the instrument firmware, do not turn off or interrupt the power to the instrument and do not touch any instrument soft keys or controls during the firmware upgrade process. If you interrupt the firmware upgrade process after you touch the Continue soft key, you must return the waveform monitor to a Tektronix Customer Service Center to have the instrument firmware reinstalled.

---

16. To start the firmware upgrade, touch the Continue soft key (the upgrade process takes about 5 minutes). Refer to the *Caution* note above.

17. When a message appears on the waveform monitor saying "Upgrade Complete," touch the Reboot soft key.

18. Verify the instrument firmware version as follows:

- **a.** Press the HELP button.
- **b.** Touch the System Info soft key.
- **c.** Make sure the new firmware version number appears correctly.
- **d.** Exit the Help Menu.

On Your PC

Perform the following steps on your PC:

19. Click Exit on the firmware upgrade screen.

20. Click Yes.

CAUTION. *If you changed the valid fixed IP address of your PC when you performed the Manually Assigning an IP Address starting on page E-4, be sure to reset the PC's IP address back to the proper address before you reconnect the PC to your network. If you misplaced your previous valid IP address, contact you local network administrator for assistance.*

Instrument Verification

This completes the upgrade procedure. If you want to verify proper instrument operation, perform the appropriate procedures in *Functional Check* starting on page 1-17.

NOTE*. There is no instrument calibration required after performing the firmware upgrade and there is no requirement that you verify instrument operation. If the firmware upgrade completes without any error messages, the instrument will operate properly.*

Updated versions of the WFM700 User Manual *and* WFM700 Release Notes *corresponding to your new firmware version are available from the Tektronix, Inc. Web site: www.tektronix.com.*

WARNING

The following servicing instructions are for use only by qualified personnel. To avoid injury, do not perform any servicing other than that stated in the operating instructions unless you are qualified to do so. Refer to all safety summaries before performing any service.

Appendix F: Cabinet and Rack Adapter Installation

This section provides instructions for mounting the WFM700 waveform monitor into the following available cabinets and rack adapter:

The information included in this section duplicates portions of the instructions that are sent with each of the installation kits. Included are installation instructions, cabinet dimension drawings, and replacement parts lists.

Preparation

These instructions are for personnel who are familiar with servicing the product. If you need further details for disassembling or reassembling the product, refer to the appropriate product manual. Contact your nearest Tektronix, Inc., Service Center or Tektronix Factory Service for installation assistance.

CAUTION. *To prevent static discharge damage, service the product only in a static-free environment. Observe standard handling precautions for static-sensitive devices while installing these kits. Always wear a grounded wrist strap, grounded foot strap, and static resistant apparel while installing these kits.*

WFM7F02 Portable Cabinet Installation

The WFM7F02 Portable Cabinet, shown in Figure F–1, is designed to house any of the 1/2 rack-width, WFM700 waveform monitors for desktop or portable applications. The cabinet has a carrying handle, two stationary rear feet, and two front feet that flip down to provide a stand.

If your WFM7F02 cabinet is missing any of the feet or if the handle is damaged, refer to Table F–2 on page F–5 for a list of replaceable parts.

CAUTION. *The ventilation holes and EMI shielding on the WFM7F02 cabinet are designed to meet the requirements of the WFM700 waveform monitor only. Do NOT attempt to install other instruments into the WFM7F02 cabinet.*

Conversely, do not install the WFM700 waveform monitor into the 1700F02 Portable Cabinet, because it does not provide the correct ventilation. Additionally, there are keying pins to exclude this application.

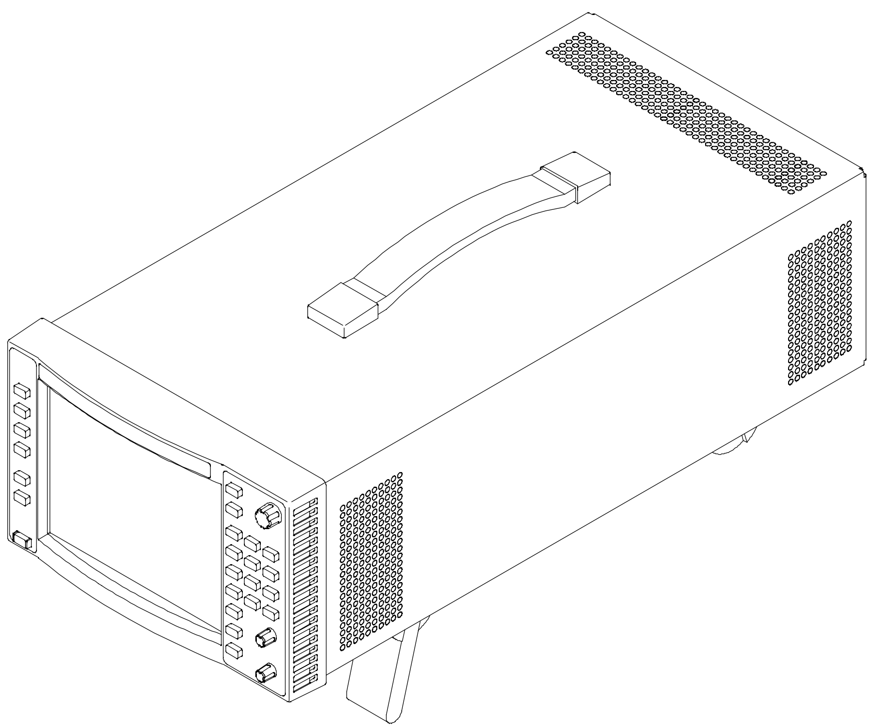


Figure F-1: WFM7F02 portable cabinet

WFM7F02 Cabinet Dimensions

The WFM7F02 cabinet dimensions, shown in Figure F-2, are provided for installation information only.

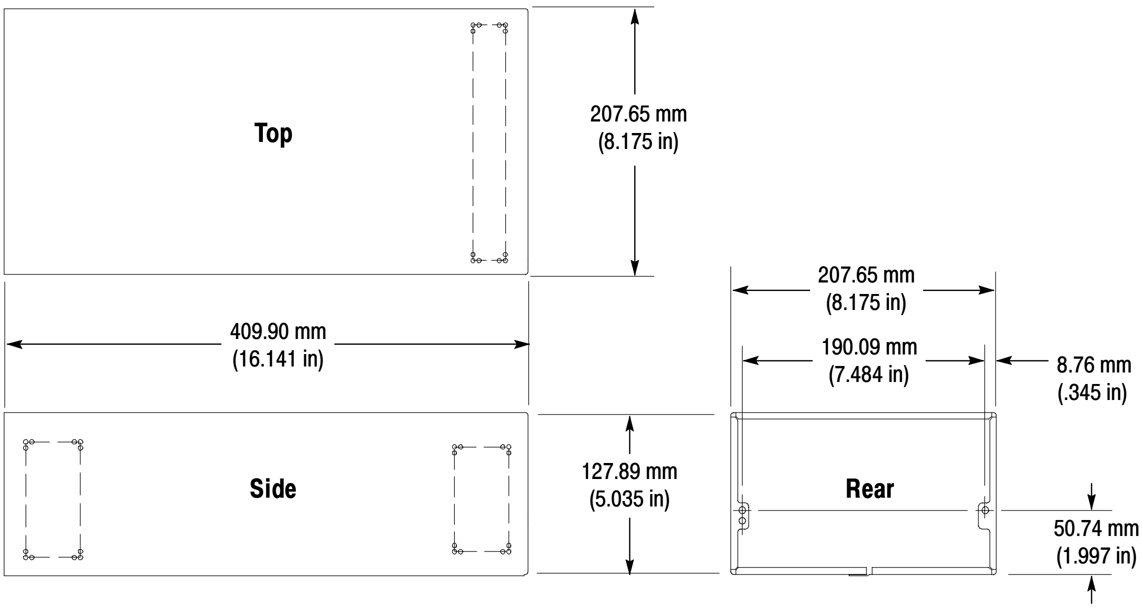


Figure F-2: WFM7F02 cabinet dimensions

WFM7F02 Minimum Tool and Equipment List

Table F-1 lists the tools and equipment you will need to install the WFM7F02 portable cabinet.

Table F-1: WFM7F02 required tools

Required tools and equipment	Part number
TORX driver (T-15)	NA

WFM7F02 Installation Instructions

Follow these instructions to install a WFM700 instrument into a WFM7F02 portable cabinet:

CAUTION. *The WFM7F02 cabinet is designed to accommodate the WFM700 waveform monitors only. Do NOT attempt to install any other products in the WFM7F02 cabinet. To do so may cause serious instrument damage and cause overheating problems.*

Do not force the instrument into the cabinet. Key pins on the WFM7F02 cabinet tabs (shown in Figure F-3) are designed work only with a WFM700 instrument. Attempting to force an instrument into the wrong cabinet may damage the tabs.

1. Position the instrument with the front panel down on a work surface, protecting the front panel with a pad or cover to prevent damage.
2. Slide the WFM7F02 cabinet over the instrument chassis and down to rest on the front panel frame.
3. At the rear of the cabinet, install the two attaching screws through the left and right tabs and into the instrument chassis. See Figure F-3.

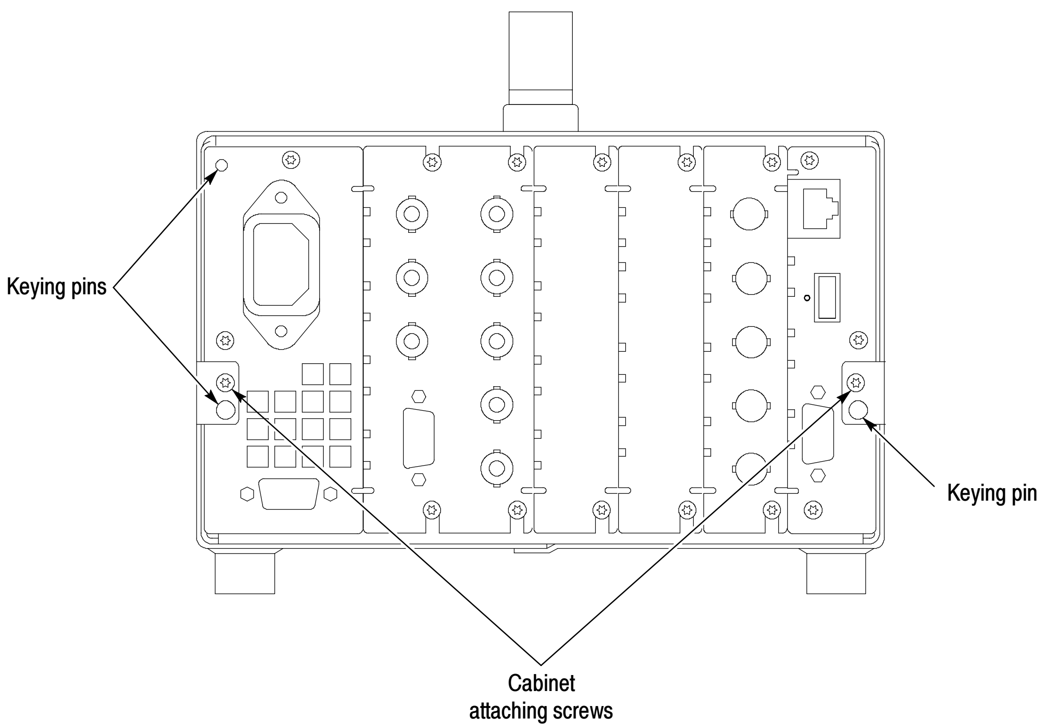


Figure F-3: WFM7F02 rear-panel attaching screws

WFM7F02 Replaceable Parts List

Table F-2 lists the replaceable parts for the WFM7F02 portable cabinet. The numbers in the Index Number column of the table refer to the index numbers in Figure F-4.

Table F-2: WFM7F02 replaceable parts

Index number	Quantity	Part number	Description
1	2 EA	344-0098-00	CLIP, DECORATIVE: CARRYING HANDLE
2	2 EA	213-0155-01	SCREW, SHOULDER: 10-32 X 0.355, 0.5 OD HD, STL CD PL, POZ
3	1 SET	348-1515-00	FEET, CABINET: SET OF 4
4	1 EA	200-4716-XX	COVER, FRONT: PROTECTIVE, PC/ABS, GRAY
5	1 EA	390-1212-XX	CABINET ASSY: WFM7F02, SILVER GRAY, W/FEET & HANDLE
6	1 EA	367-0037-03	HANDLE, CARRYING: 6.0 L, VINYL, GRAY
- - - - - - -	2 EA	211-0722-XX	SCREW, MACHINE; 6-32 X 0.250, PNH, STL, T-15 TORX (REAR PANEL ATTACHING SCREWS)
- - - - - - -	1 EA	071-1106-XX	MANUAL, TECH: KIT INSTRUCTIONS, PORTABLE CABINET, WFM7F02

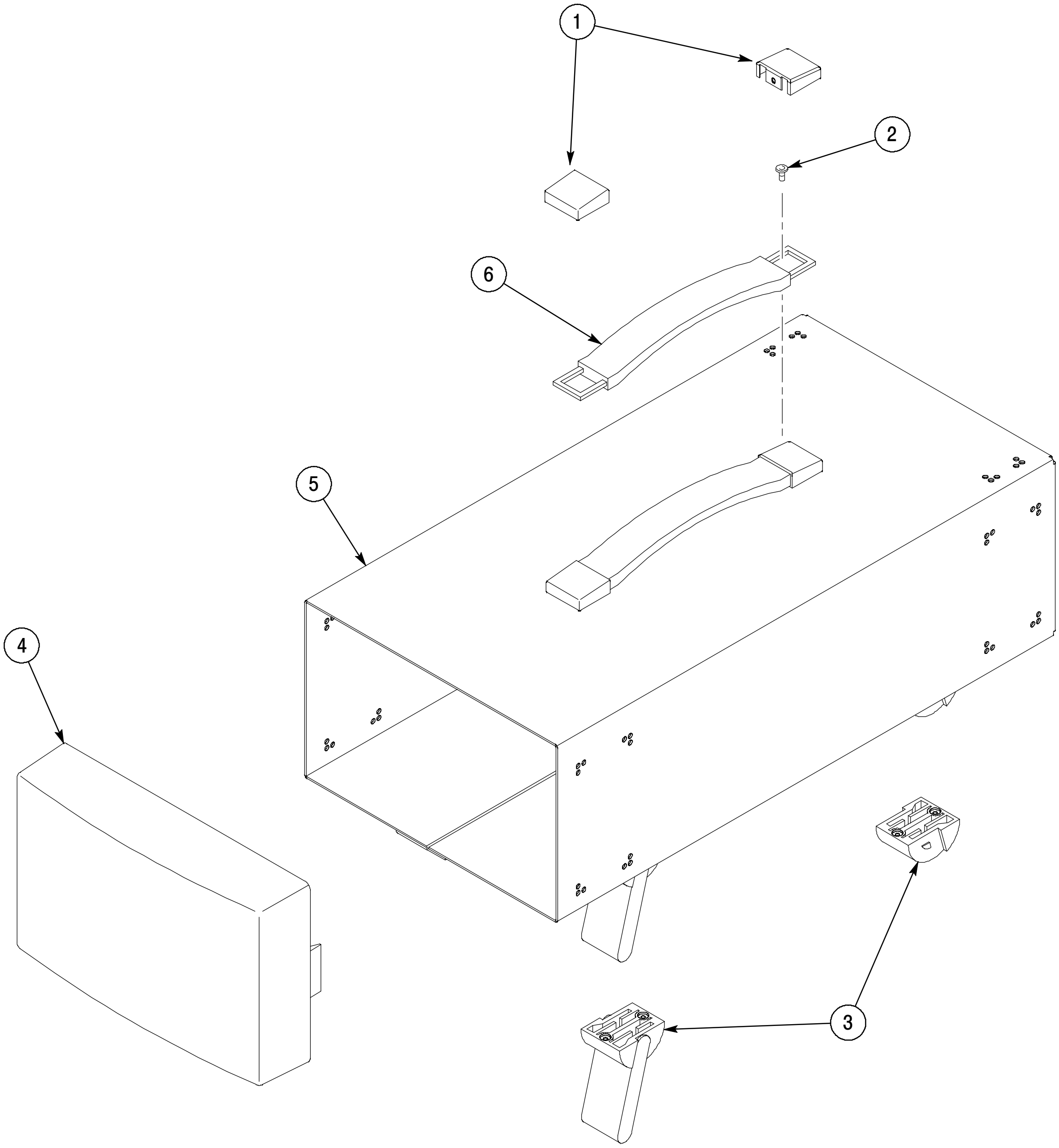


Figure F-4: WFM7F02 replaceable parts

WFM7F03 Plain Cabinet Installation

The WFM7F03 Plain Cabinet, shown in Figure F-5, is designed to house any of the 1/2 rack-width, WFM700 waveform monitors. The cabinet does not have any feet or carrying handle.

***NOTE**. The ventilation holes and EMI shielding on the WFM7F03 cabinet are designed to meet the requirements of the WFM700 waveform monitor only. Do NOT attempt to install other instruments into the WFM7F03 cabinet.*

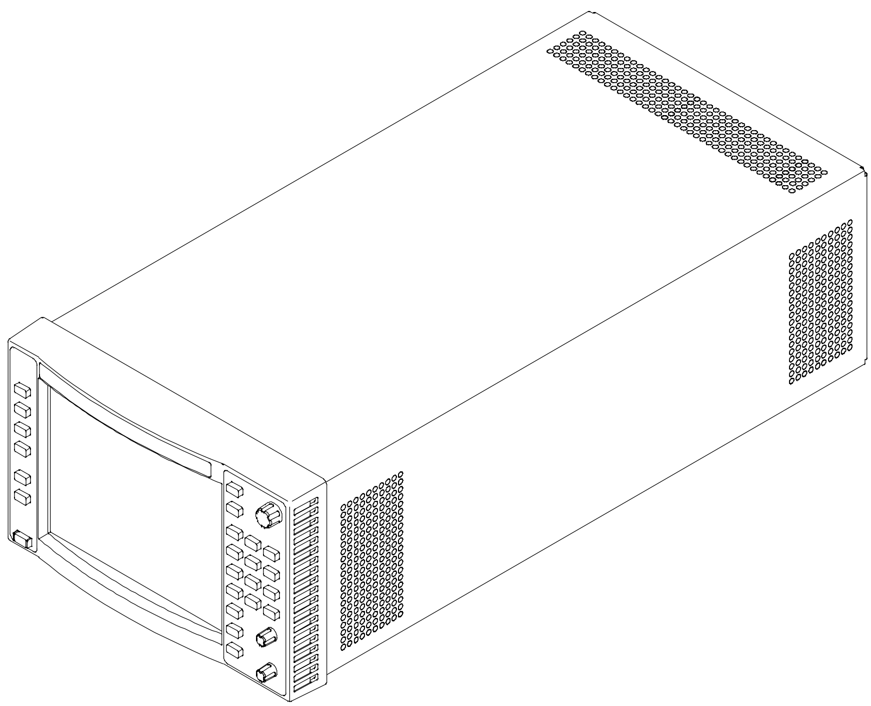


Figure F-5: WFM7F03 plain cabinet

WFM7F03 Minimum Tool and Equipment List

Table F-3 lists the tools and equipment you will need to install the WFM7F03 plain cabinet.

Table F-3: WFM7F03 required tools

Required tools and equipment	Part number
TORX driver (T-15)	NA

WFM7F03 Cabinet Dimensions

The WFM7F03 cabinet dimensions, shown in Figure F-6, are provided for installation information only.

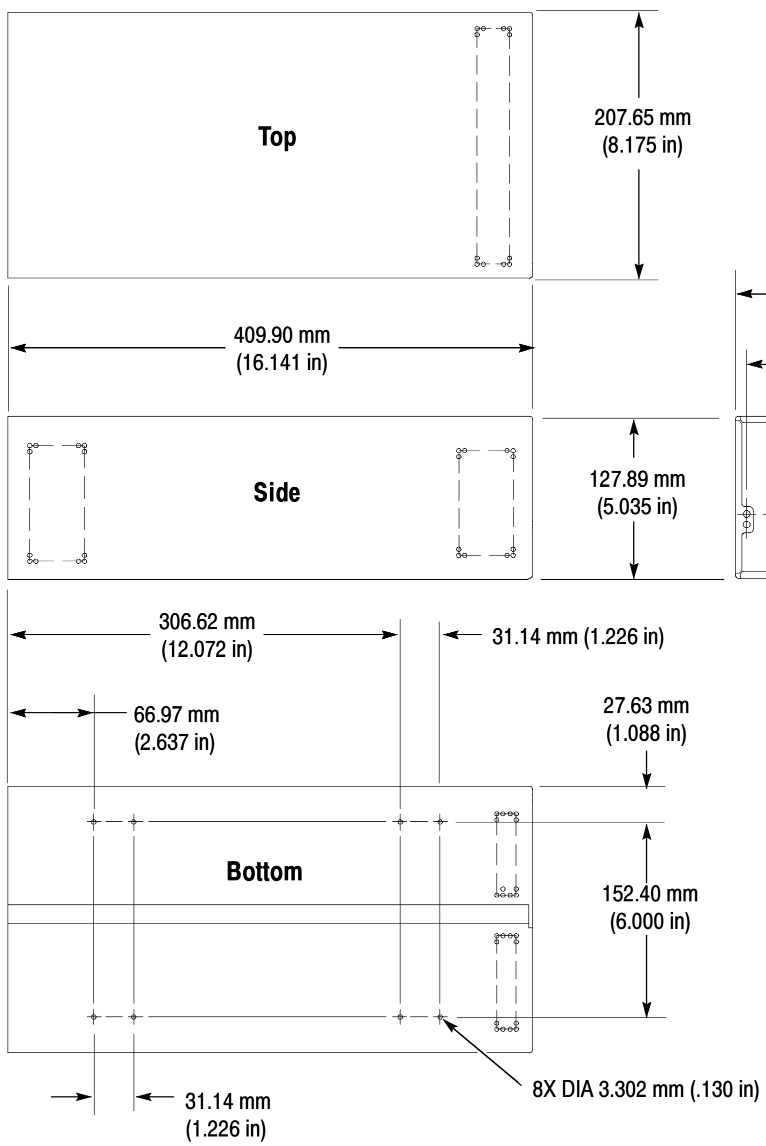


Figure F-6: WFM7F03 cabinet dimensions

WFM7F03 Installation Instructions

Follow these instructions to install a WFM700 instrument into a WFM7F03 plain cabinet:

***CAUTION.** The ventilation holes and EMI shielding on the WFM7F03 cabinet are designed to meet the requirements of the WFM700 waveform monitor only. Do NOT attempt to install any other products in the WFM7F03 cabinet. To do so may cause serious instrument damage and cause overheating problems.*

Do not force the instrument into the cabinet. Key pins on the WFM7F03 cabinet tabs (shown in Figure F-7) are designed work only with a WFM700 instrument. Attempting to force an instrument into the cabinet may damage the tabs.

1. Position the instrument with the front panel down on a work surface, protecting the front panel with a pad or cover to prevent damage.
2. Slide the WFM7F03 cabinet over the instrument chassis and down to rest on the front panel frame.
3. At the rear of the cabinet, install the two attaching screws, provided in this kit, through the left and right tabs and into the instrument chassis. See Figure F-7.

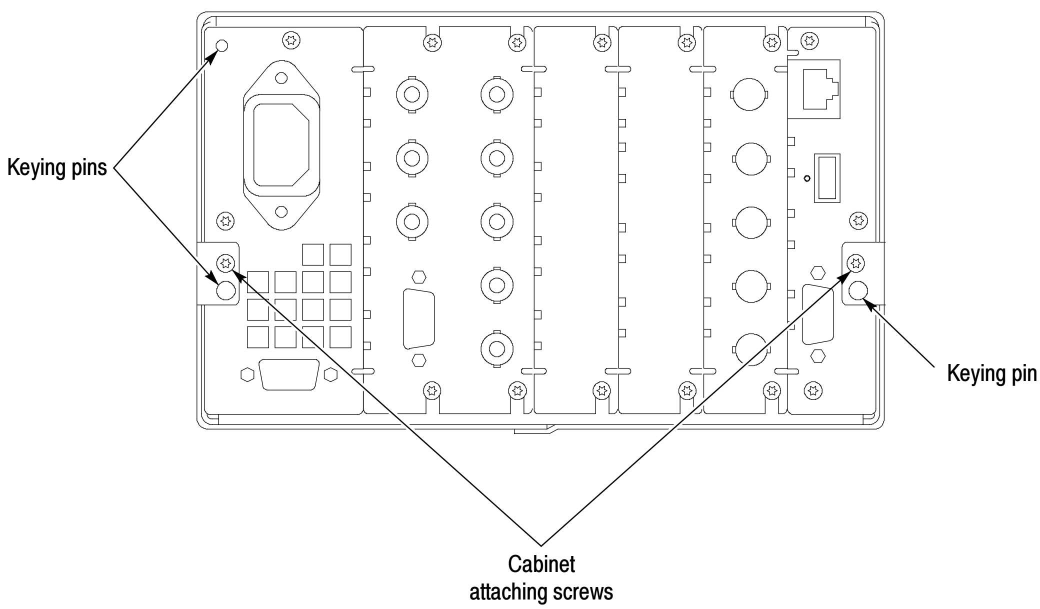


Figure F-7: WFM7F03 rear-panel attaching screws

WFM7F03 Replaceable Parts List

Table F-4 lists the replaceable parts for the WFM7F03 plain cabinet.

Table F-4: WFM7F03 replaceable parts

Quantity	Part number	Description
1 EA	390-1215-XX	CABINET, PLAIN WRAP AROUND HOUSING, 0.05 AL, SILVER GRAY
2 EA	211-0722-XX	SCREW, MACHINE; 6-32 X 0.250, PNH, STL, T-15 TORX (REAR PANEL ATTACHING SCREWS)
1 EA	075-0748-XX	MANUAL, TECH: KIT INSTRUCTIONS, PLAIN CABINET, WFM7F03

WFM7F05 Rack Adapter Installation

The WFM7F05 rack adapter, shown in Figure F-8, is designed to house two, 1/2 rack-width instruments side-by-side in a rack. The WFM7F05 accommodates various Tektronix products by using two types of sleeves (either sleeve can be mounted in either side of the adapter):

- The WFM7F00 sleeve is designed to properly fit only the WFM700 waveform monitors.
- The 1700F00A sleeve is designed to properly fit any of the following Tektronix instruments:
  - 1700 Series
  - WFM601 Series
  - WFM300 Series
  - 760 Series
  - 1420 Series
  - 528A
  - 764

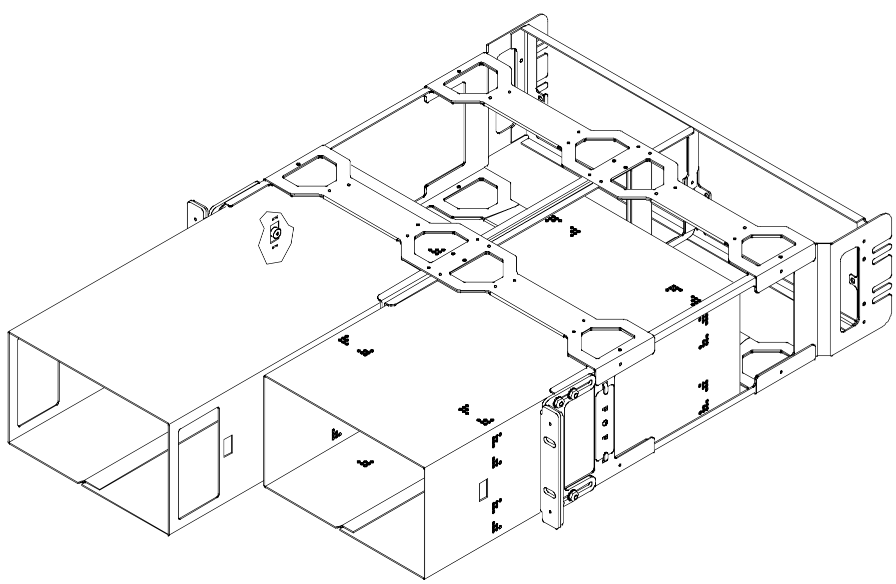


Figure F-8: WFM7F05 rack adapter

WFM7F05 Ordering Information

When ordered, the rack adapter is configured by which of the following sleeve configurations you order:

WFM7F05 Option OO. Includes two 1700F00A sleeves.

WFM7F05 Option NN. Includes two WFM7F00 sleeves.

WFM7F05 Option ON. Includes one 1700F00A sleeve and one WFM7F00 sleeve. You can install either sleeve in either side of the WFM7F05 rack adapter.

Other Options. You can also install a sleeve in one side of the WFM7F05 rack adapter and a blank panel (1700F06) or an accessory drawer (1700F07) in the other side to improve airflow and appearance.

WFM7F05 Cabinet Dimensions

The WFM7F05 cabinet dimensions, shown in Figure F-9 through Figure F-11, are provided for installation information only.

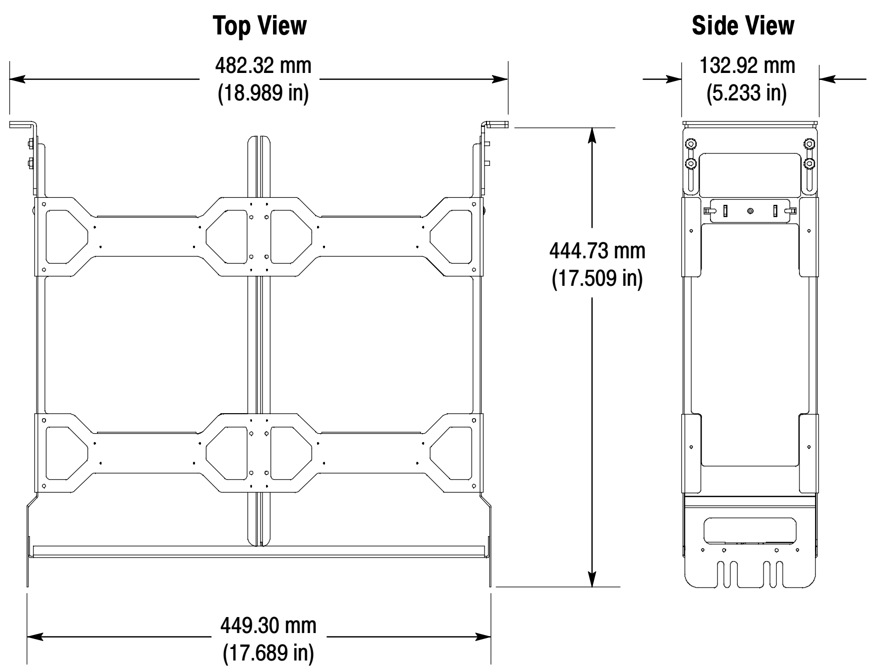


Figure F-9: WFM7F05 rack adapter dimensions

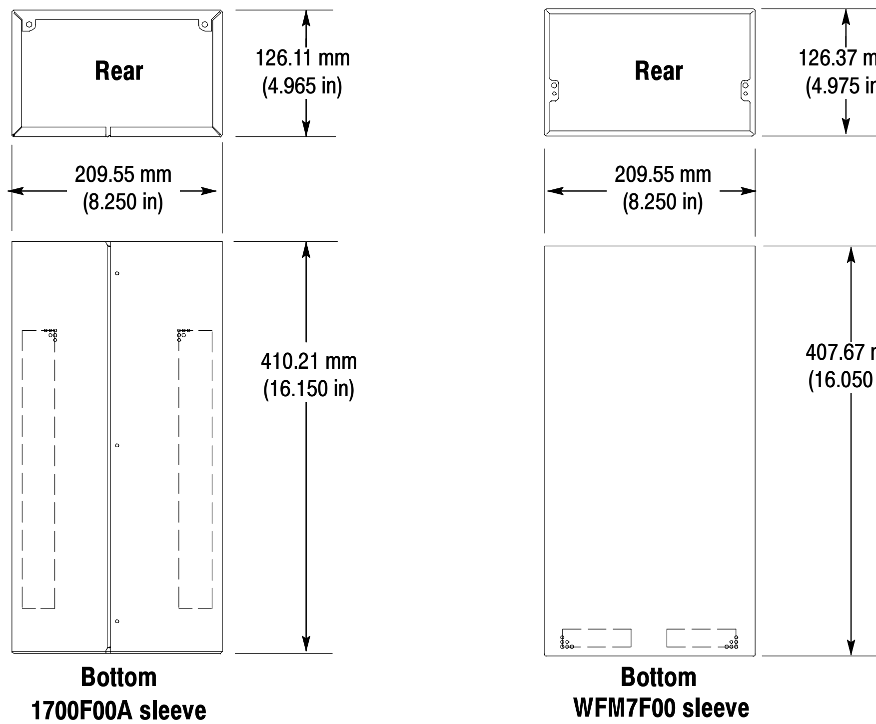


Figure F-10: WFM7F05 sleeve dimensions

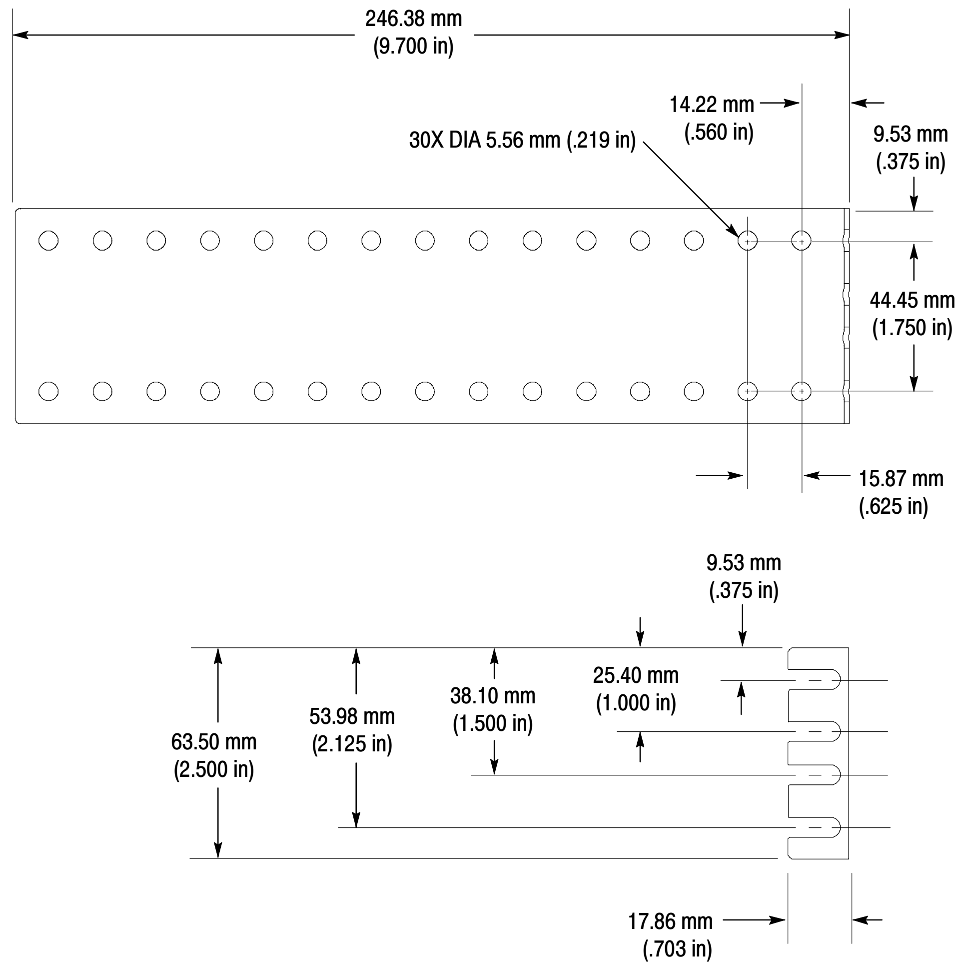


Figure F-11: Rear bracket guide dimensions

Installing the WFM7F05 into the Equipment Rack

Before you install an instrument into the rack adapter, install the adapter into the rack as follows:

***NOTE**. The numbers in brackets in the following procedure refer to the circled numbers in Figure F-15 and in the WFM7F05 adapter parts list.*

The WFM7F05 rack adapter is marked with the word "TOP" to indicate which side of the adapter should face up (see Figure F-12).

1. If there are any sleeves installed in the rack adapter, remove them as follows: Locate the button on the inside front of the rack adapter (see Figure F-12) and hold it in while pulling the sleeve forward and out of the adapter.
2. If desired, you can adjust the position of the handle brackets to mount the adapter flush with other equipment in the rack (see Figure F-12). To do this, loosen the nuts that attach the handle brackets to the rack adapter, adjust the position of the handle brackets as desired, and then tighten the nuts securely.
3. Secure the rack adapter assembly to the front frame of the rack using four screws and four shoulder washers.
4. Install one guide bracket to one side of the rear frame of the rack using the screws and nut bar provided in the kit.
5. Secure the guide bracket to the rack adapter, using the nut bar and attaching hardware. Use the holes in the bracket that will accommodate the depth of the instrument rack frame being used. Leave the screws loose.
6. Install the other guide bracket to the other side of the rear frame of the rack, using the screws and nut bar.
7. Secure the guide bracket to the rack adapter, using the nut bar and attaching hardware.
8. Tighten all attaching screws that were left loose in the previous steps.

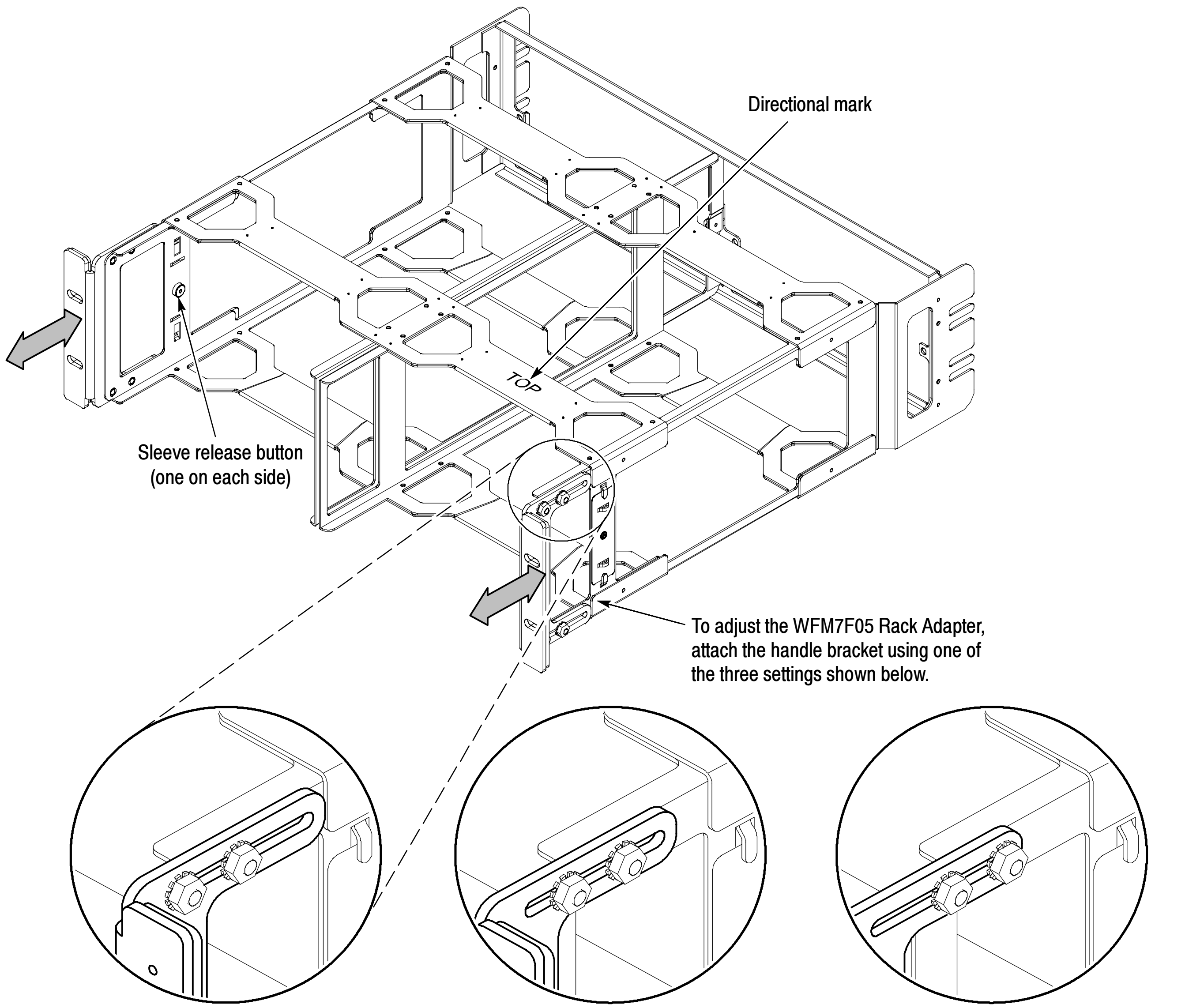


Figure F-12: Adjusting the position of the WFM7F05 rack adapter handles

Installing an Instrument into the WFM7F05 Rack Adapter

With the rack adapter already installed in the rack, install the instrument into the rack adapter as follows:

***CAUTION.** When working with instruments that are not enclosed in a chassis, you must observe static precautions. You must also be careful not to damage circuit board mounted components or interconnection wiring when sliding a sleeve over these products.*

Be sure to use the correct sleeve for your product. If you use the wrong sleeve, it could damage the instrument and cause overheating problems.

The ventilation holes and EMI shielding on the sleeves are specially designed to meet the requirements of the instruments for which they were intended.

1. Referring to Figure F-13, choose the appropriate sleeve in which to install your instrument:

   - The WFM7F00 sleeve is designed for WFM700 instruments only. The rear-panel attaching tabs are near the vertical center of the rear frame.
   - The 1700F00A sleeve is designed for 1700 Series, WFM300 Series, WFM600 Series, 760 Series, 1420 Series, and 528A instruments. The rear-panel attaching tabs are close to the top of the rear frame.

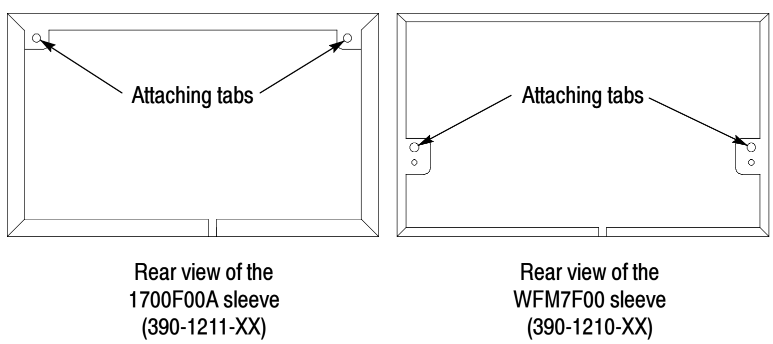


Figure F-13: Rear view of the WFM7F05 sleeves, showing the locations of the attaching tabs and screws

2. Slide the sleeve into the desired half of the rack adapter, depressing the button on the inside front of the rack adapter as needed to insert the sleeve. See Figure F-14.

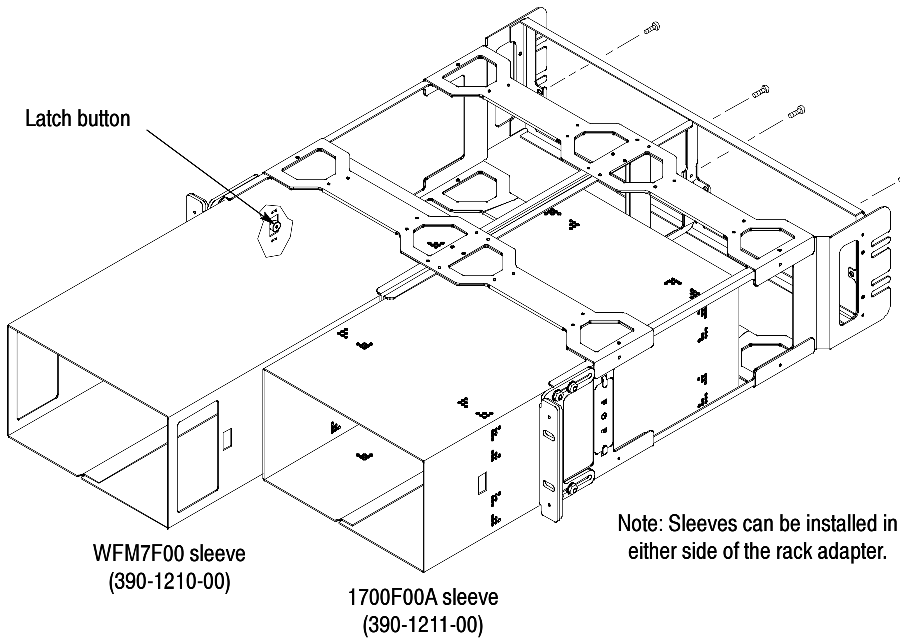


Figure F-14: Installing the sleeves into the WFM7F05 rack adapter

WARNING. *During installation, the instrument could slide out of the sleeve and cause instrument damage or injury. To prevent the instrument from sliding out of the sleeve, be careful to hold the instrument until it is secured.*

3. Make sure that the button pops back out and that it securely locks the sleeve in the rack adapter.

CAUTION. *Do not force the instrument into the cabinet. Keying pins on the tabs at the rear of the sleeves are designed to work only with the correct instrument. Attempting to force an instrument into the wrong sleeve may damage the tabs.*

4. Slide the instrument into the sleeve. Be careful not to let the instrument slide out of the sleeve until the two screws are attached on the rear.

5. On the rear panel, install and tighten the two attaching screws as follows:

   - For the WFM7F00, insert the screws through the rack adapter, through the tabs on the sleeve (Figure F-13), and then into the instrument rear panel.
   - For the 1700F00A, insert the screws through the holes on the top right and left of the sleeve (Figure F-13) and into the instrument rear panel. The screws do not attach to the rack adapter; this sleeve is held in place by the button on the inside front of the rack adapter.

WFM7F05 Replaceable Parts List

Table F-4 lists the replaceable parts for the WFM7F05 rack adapter (item numbers refer to the circled numbers in Figure F-15).

Number	Quantity	Part number	Description
1	1 EA	407-4892-XX	BRACKET: RACKMOUNT, DUAL SIDE-BY-SIDE, FOR WRAP-AROUND CABINETS
	1 EA	016-1908-XX	HDW KIT, RACK MOUNT, CONSISTING OF:
2	4 EA	211-0540-XX	SCREW, MACHINE: 6-32 x 0.5, TRH.STL
2	4 EA	212-0008-XX	SCREW, MACHINE: 8-32 x 0.5, PNH.STL
3	4 EA	213-0090-XX	SCREW, MACHINE: 10-32 X 0.5, HEX HD, STL
10	4 EA	210-1061-XX	WASHER, FLAT: 0.203 ID X 0.625 OD X 0.062
5	2 EA	407-3752-XX	BRACKET, GUIDE: LEFT & RIGHT REAR
6	4 EA	212-0509-XX	SCREW, MACHINE: 10-32 X 0.625, PNH, STL CDP
7	4 EA	381-0251-01	NUT BAR: 10-32 X 3.0 X 0.375 X 0.125
8	1 PR	407-4906-XX	BRACKET, HANDLE: ALUMINUM
9	8 EA	210-0458-00	NUT, PL, ASSEM WA: 8-32 X 0.344, HEX, STL, CD PL, W/EXT TOOTH LOCKWASHER
10	4 EA	210-1298-01	WSHR, SHLDR & REC: 0.195 ID X 0.195 THK
11	4 EA	212-0591-XX	SCREW, MACHINE: 10-32 x 0.75, OVH.STL
11	4 EA	213-0199-XX	SCREW, MACHINE: 12-24 x 0.75, OVH.STL
12	----	390-1211-XX	CABINET: WRAP-AROUND, FOR 1700 SERIES (QUANTITY DETERMINED BY OPTION)
13	----	390-1210-XX	CABINET: WRAP-AROUND, FOR WFM700 (QUANTITY DETERMINED BY OPTION)
----	1 EA	071-1107-XX	MANUAL, TECH: INSTRUCTIONS, WFM7F05

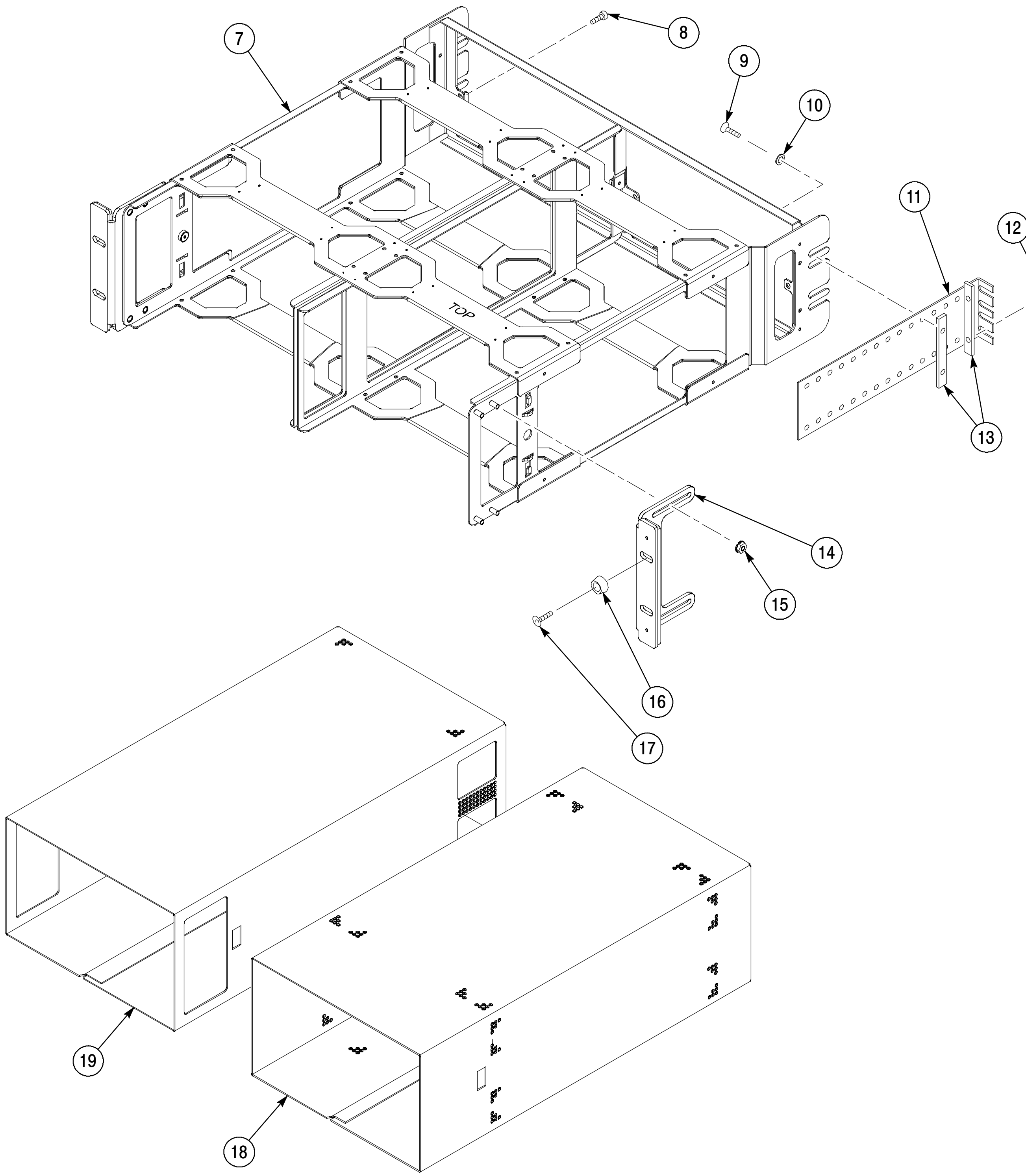


Figure F-15: WFM7F05 rack adapter replaceable parts

Appendix G: Module Installation

This section provides instructions for installing or replacing a WFM7HD, WFM7A, or WFM7M video module, or a WFM7DG audio module (Option DG) into a WFM700 instrument.

Preventing Electrostatic Discharge

When performing any service that requires internal access to the instrument, adhere to the following precautions to avoid damage due to electrostatic discharge (ESD):

- Minimize handling of static-sensitive circuit boards and components.
- Transport and store static-sensitive modules in static protected containers.
- Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules.
- Service static-sensitive modules only at a static-free work station.
- Do not allow anything capable of generating or holding a static charge on the work surface.
- Handle circuit boards by the edges or hold onto grounded shields when possible.
- Do not slide circuit boards over any surface.

Module Slot Assignments

Different modules can be installed in different slots. It is important to use the correct slot(s) for your module type. Figure G–1 shows the slot-number assignments for the WFM700.

CAUTION. *Install the module only in the appropriate slot as listed below. If you use a different slot, the module will not operate properly and will fail boot up diagnostics.*

Video Modules

The WFM7HD, WFM7A, and WFM7M video modules can only be installed in slot 2 or slot 3. The WFM700 must have a video module installed in slot 2 before you can install a video module in slot 3.

Audio Module (Option DG Only)

The WFM7DG audio module (Option DG) can only be installed in slot 4.

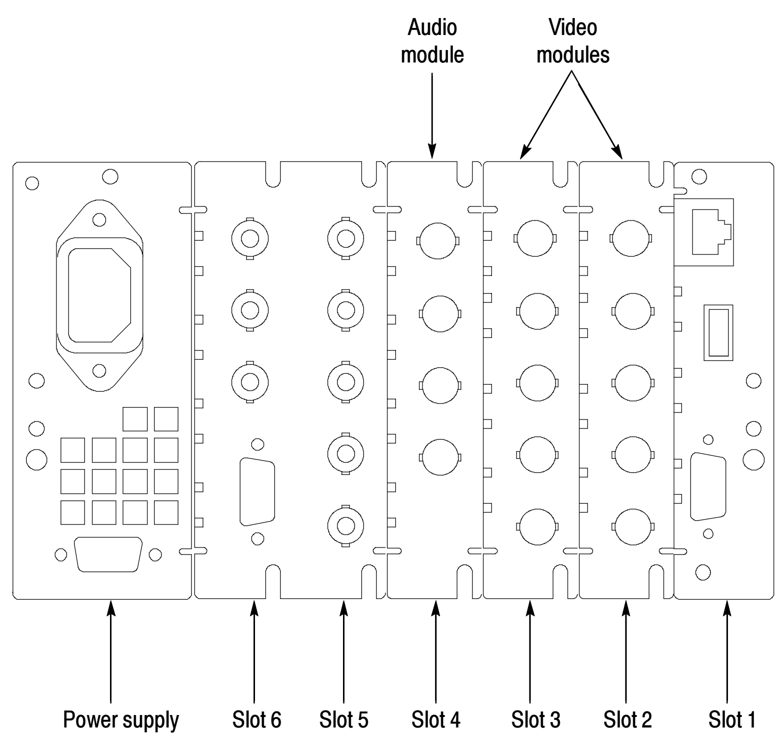


Figure G-1: WFM700 rear panel slot numbers (two video modules and one audio module installed)

Adding or Replacing a Module

Table G-1: Tools required for module installation or replacement

Name	Description
Torx screwdriver handle	Accepts Torx-driver bits
T-10 and T-15 Torx tips	Torx-driver bit for T-10 and T-15 screw heads

Use the following procedure to add a new module or replace a module.

WARNING. *Disconnect the power source from the WFM700 before beginning this or any procedure requiring you to remove the cover from the instrument chassis. Fan blades and other components inside the instrument could cause serious injury if power is on while the instrument chassis is open.*

1. Remove the instrument from the portable cabinet or rack adapter sleeve. If necessary, you can refer to *Hardware Installation* in the *WFM700 User Manual.*

2. Place the instrument on a static-safe work surface. Be sure to follow safe handling procedures to avoid electrostatic damage to the instrument or module (refer to *Preventing Electrostatic Discharge* on page G–1).

3. Remove the chassis cover as follows:

   a. Loosen three attaching screws (T-10) along the left side and three screws along the right side of the chassis cover (see Figure G–2). Loosen the screws sufficiently to free the cutouts in the cover (about 3 turns) or remove the screws if desired.

   b. Remove two screws (T-10) from the front of the chassis cover (see Figure G–2). Save the screws for reinstallation.

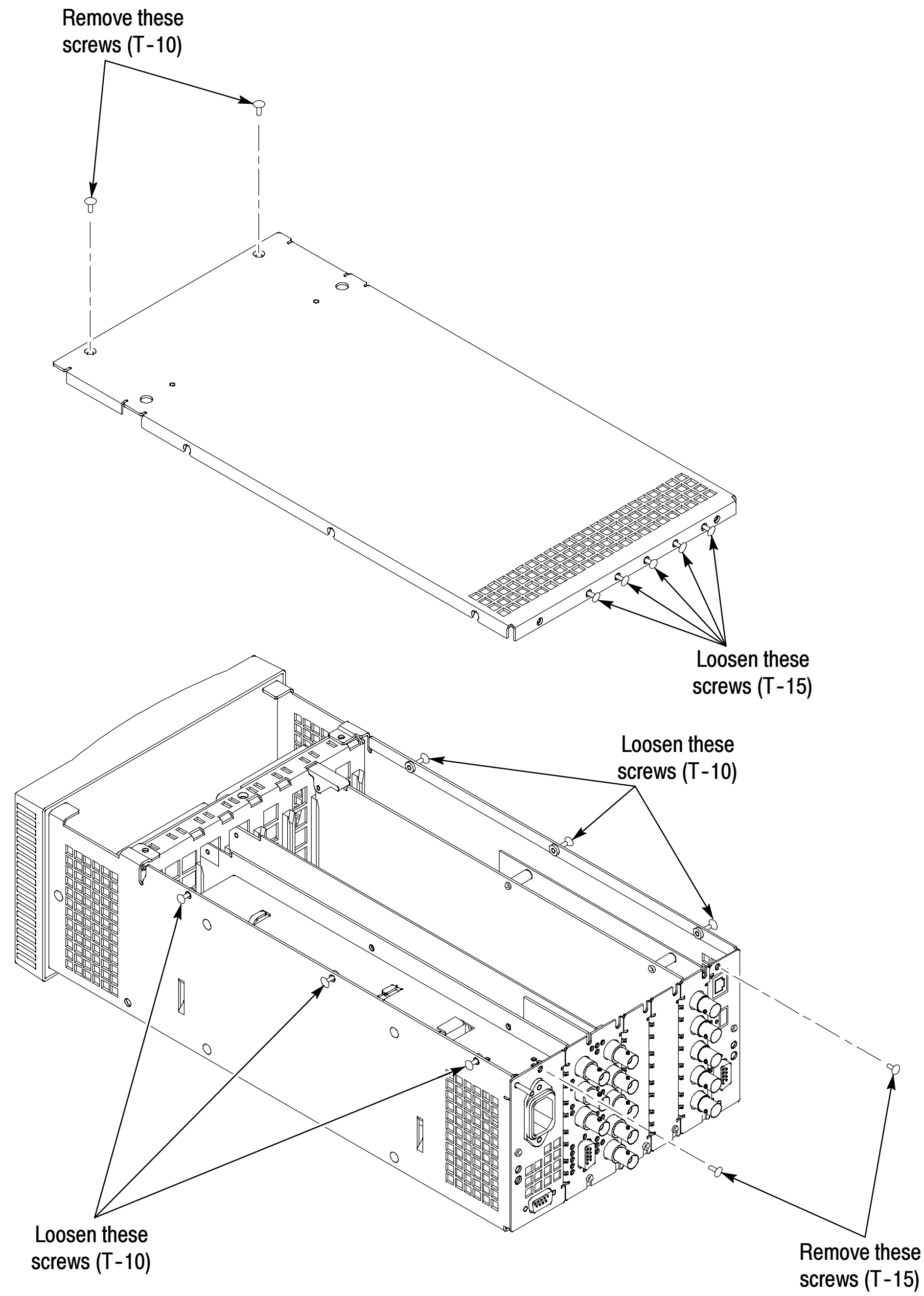


Figure G-2: WFM700 chassis, showing screws to loosen and remove

c. Loosen the attaching rear-panel screws (T-15) at the top of the module rear panels in slots 2 through 6 (see Figure G–2 for screw locations and Figure G–1 for slot numbering). Loosen the screws sufficiently to free the cutouts in the cover (about 3 turns) or remove the screws if desired.

d. Remove a screw (T-15) from slot 1 and from the power supply (see Figure G–2 for screw locations and Figure G–1 for slot numbers).

e. Lift the cover off the instrument. The rear-panel screws that you loosened will remain in the cover.

4. To add a module: Read this entire step before proceeding.

a. Referring to the instructions that were shipped with your module, identify an appropriate slot in which to install the module.

- Slot 2 or slot 3 for a WFM7HD, WFM7A, or WFM7M video module (slot 2 first video module; slot 3 second video module)
- Slot 4 for a WFM7DG audio module (Option DG)

b. Loosen the screw from the bottom of the unneeded rear panel spacer and pull it up and out of the instrument chassis.

CAUTION. *To prevent damage to the EMI flaps on the rear panels when you are inserting a module, slide the module straight down.*

Be sure that the white ejector lever is level with the module, so that it will not be jammed in the fan housing as you install the module.

---

c. Prepare to insert the module by lining it up with the plastic guide toward the front of the instrument and by placing the white ejector lever in the down position, level with the module. See Figure G–3.

d. Slide the module straight down, into the plastic guide, and line up the connectors on the module with the pins on the Main board below.

e. Applying firm pressure to both ends of the module, press it all the way down and into place.

f. Install and tighten the screw (T15) that attaches the bottom of the module rear panel to the instrument chassis.

g. If you are installing a second video module, install the grounding clip that was shipped with the module (see Figure G–4).

h. Proceed to Step 6 on page G–8.

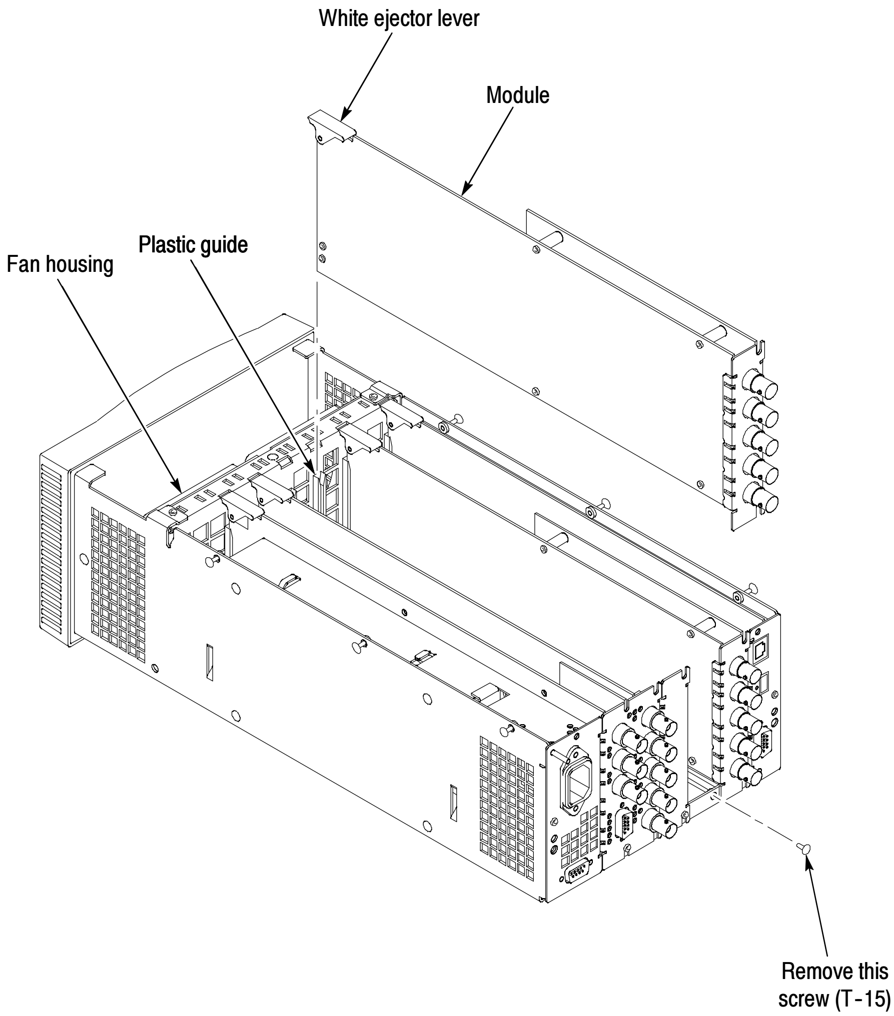


Figure G-3: Inserting the module into the chassis

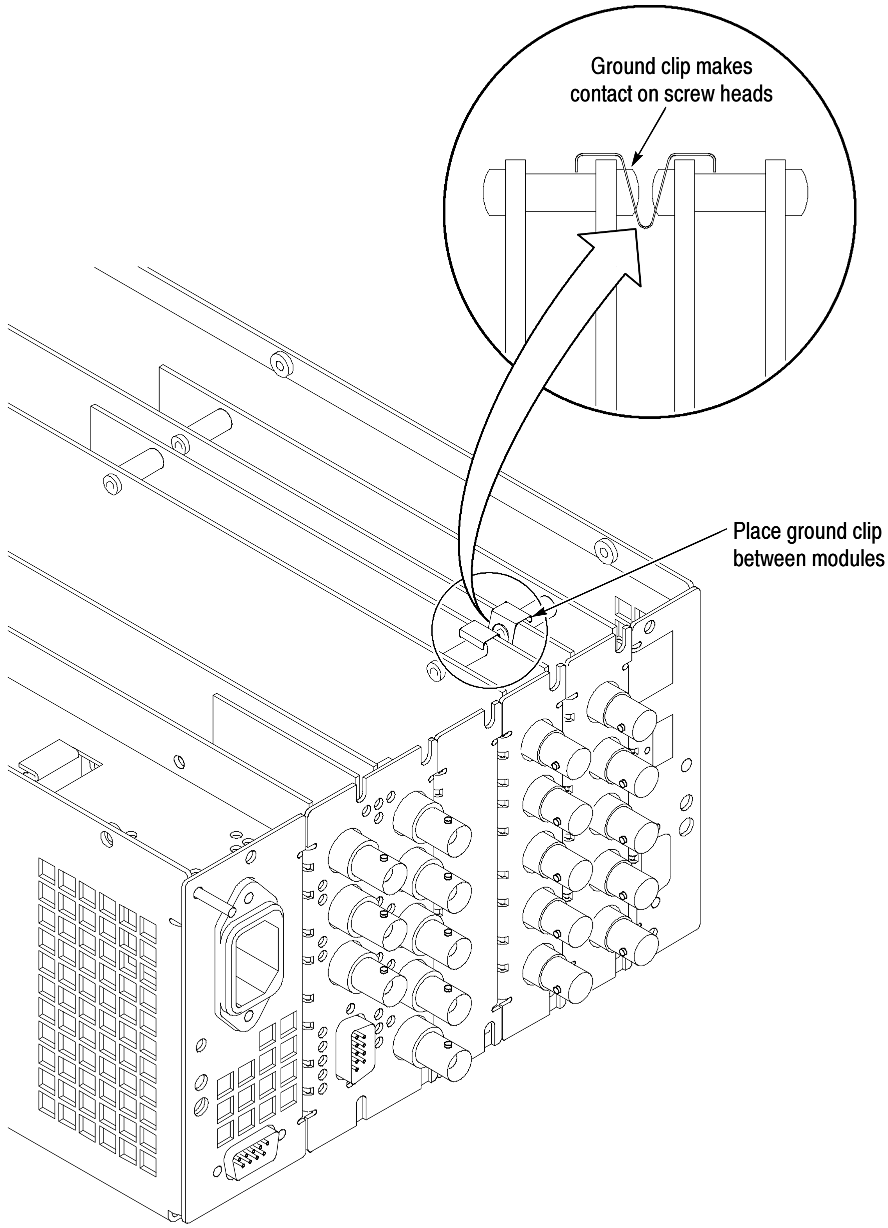


Figure G-4: Installing the grounding clip between two video modules

5. To remove a module: Read this entire step before proceeding.

   a. Loosen the bottom screw on the rear panel of the module you are going to remove.

   b. If you have two video modules with a grounding clip installed, remove the grounding clip (see Figure G–4).

CAUTION. *To prevent damage to the EMI flaps on the rear panels when you are removing a module, slide the module straight up.*

   c. Lift the white ejector lever located near the front of the module.

   d. Holding onto the lever and the rear panel BNC, carefully pull the module straight up and out of the instrument. Be careful not to damage the EMI flaps on the rear of the modules.

   e. If you are replacing the module with a new module, follow the instructions for adding a module in step 4.

6. Replace the chassis cover as follows:

   a. Insert the lip on the rear of the cover inside the rear panel, lining up the screws in the cover with the rear panel cutouts.

   b. Line up the screws along the left and right sides of the cover with the cutouts on the sides of the chassis.

   c. Install the two screws that you removed across the front edge of the chassis cover and the two screws that you removed from the slot 1 and power supply rear panels.

   d. Hold the cover on the chassis tightly, applying pressure to compress the foam underneath. Tighten the screws along the right and left sides of the chassis. (If it is easier for you, turn the instrument chassis on its side while tightening these screws.)

7. Reinstall the instrument into either a portable cabinet (WFM7F02) or a rack adapter (WFM7F05).
8. Install the power cord and power on the instrument.
9. Run the diagnostics (press the CONFIG button and select the Run Diagnostics soft key) to be sure there is no problem with the new module.
10. You can select the following menu sequence to see a list of all installed modules, including any new modules:

    [HELP button > System Info > Installed Modules]

This completes the module installation. To verify proper instrument operation, perform the appropriate functional check procedure(s). Refer to *Functional Check* on page 1–17.

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