Tektronix

**WFM700 Series
Waveform Monitors**

071-0916-08

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WFM700 Series Waveform Monitors User Manual

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:

CAUTION
Refer to Manual

WARNING
High Voltage

Protective Ground
(Earth) Terminal

Preface

This user manual provides the basic information you need to install and operate the WFM700 Series Waveform Monitor. Listed below are related documents that contain information about the instrument.

Related Reference Documents

The following reference documents are available:

- *WFM700 Series Release Notes* (English). Describes both the new features provided by a firmware release and any known problems or behaviors that you might encounter while using the waveform monitor.

- *WFM700 Series User Documentation CD-ROM*. Located on the back cover of the user manual, contains PDF files of the following documents:

    - *WFM700 Series User Manual* (English). A bookmarked PDF version of the printed user manual.

    - *WFM700 Series Technical Reference* (English). Contains the following technical information about the instrument:

        - Electrical and physical specifications, including a list of certifications and compliances

        - Descriptions of each menu selection, the status displays, and the Option DG audio displays

        - Instructions for operating the instrument using remote control, including the ground closure, Web server, and SNMP interfaces

        - Procedures for checking the basic functions of the instrument, for upgrading the instrument firmware, and for performing the user-service tasks such as cleaning and maintenance, cabinet and rack adapter installation, and module installation or replacement

    - *WFM700 Series SNMP MIB Reference* (English). Describes the syntax of the variables and traps for remotely controlling the instrument over a network using SNMP.

- *WFM700 Series Service Manual* (English). Provides servicing information for the instrument and is intended for qualified service personnel only.

Non-English Language Documents

The following non-English language documents are available:

■ *WFM700 Series User Documentation Package* (Japanese). Contains a printed Japanese language user manual and the CD-ROM described on the previous page.

■ *WFM700 Series User Documentation Package* (Korean). Contains a printed Korean language user manual and the CD-ROM described on the previous page.

■ *Preventing Illegal Colors*. This application note describes how the Diamond, Arrowhead, and Lightning displays can be used to help prevent the undesired impact of color gamut violations and to simplify the assessment of proper gamut compliance.

■ *Understanding Colors and Gamut*. This poster provides a large visual display of how the Diamond, Arrowhead, and Lightning displays can be used to help prevent the undesired impact of color gamut violations.

■ *A Guide to Standard and High Definition Digital Measurements*. This book is a primer for understanding the basics for making standard and high-definition, digital-video measurements.

■ *Analog and Digital Audio Monitoring.* This application note describes how to monitor analog and digital audio signals. Also discussed are specific differences in the methods used to monitor analog audio versus digital audio, and how to plan the transition from monitoring analog audio to monitoring digital audio.

■ *Audio Monitoring.* This application note describes balanced and unbalanced audio signals, and explains the physical and electrical characteristics and the specific strength and weaknesses of the different digital audio signal formats.

■ *Monitoring Surround Sound Audio*. This application note describes the basics of 5.1-channel surround sound audio and how to use the Surround Sound display to visualize key audio-level and phase relationships in this audio format.

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 the *WFM700 Series Technical Reference* document on the CD-ROM.

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. 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:

- One 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 Option DG audio module to any of the three base-model waveform monitors.

Standard Accessories

Listed below are the standard accessories shipped with each waveform monitor:
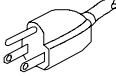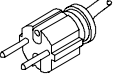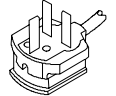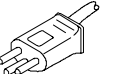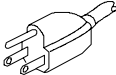
Documents   The following documents are shipped with each waveform monitor:

- *WFM700 Series Release Notes*, Tektronix part number 061-4247-XX.

- *WFM700 Series User Documentation Package*, Tektronix part number 020-2532-XX. This package contains the following items:

  - *WFM700 Series User Manual*, Tektronix part number 071-0916-XX.

  - *WFM700 Series User Documentation CD-ROM,* Tektronix part number 063-3720-XX. The CD-ROM, located on the back cover of the user manual, contains PDF files of the following documents: *WFM700 Series User Manual*, the *WFM700 Series Technical Reference*, and the *WFM700 Series SNMP MIB Reference*.

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-A008-00
	China	AC	161-0304-00
	No power cord supplied.	A99	------

Optional Accessories

If you ordered any of the following optional accessories, they were shipped with your waveform monitor.

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

NOTE. *You can have a maximum of two video modules and one Option DG audio module installed.*

- ■ WFM7HD. Serial digital video monitor module for HD.

- ■ WFM7A. Serial digital video monitor module for SD and HD.

- ■ WFM7M. Serial digital video measurement module for SD and HD.

- ■ WFM7DG. AES digital audio measurement module.

Cabinets   You can order any of these cabinets:

- ■ WFM7F02 Portable Cabinet

- ■ WFM7F03 Plain Cabinet

- ■ WFM7F05 Rack Adapter

Documents   The following documents are optional accessories:

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

- ■ Option L5. Japanese language *WFM700 Series User Manual*, Tektronix part number 020-2607-XX.

- ■ Option L9. Korean language *WFM700 Series User Manual*, Tektronix part number 020-2608-XX.

Installation and Power On

This section contains information about installing and powering on the wave-form monitor. Instructions for performing firmware upgrades are located in the *WFM700 Series Technical Reference* document on the CD-ROM.

Hardware Installation

NOTE. *Instructions for installing or removing the waveform monitor from a cabinet, and for adding or removing a module from the instrument are located in the* WFM700 Series Technical Reference *document on the CD-ROM.*

The waveform monitor is shipped in a wrap-around chassis 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 or rack adapter. 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--4. Attempting to do so can damage the waveform monitor and the cabinet.*

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.

■ Adhere to the clearance requirements that are listed in the specification tables of the *WFM700 Series Technical Reference* document on the CD-ROM.

⚠ **CAUTION.** *Failure to provide adequate airflow to the waveform monitor could cause the instrument to shut down (refer to Table 2--2 on page 2--3 for LED fault codes). If the airflow is blocked and the instrument does not shut down, the instrument could be seriously damaged.*

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. *To avoid serious personal injury from electric shock, do not operate the instrument with the cover removed. 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 1–2 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 the product specification tables in the *WFM700 Series Technical Reference* document on the CD-ROM 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 1–2 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.

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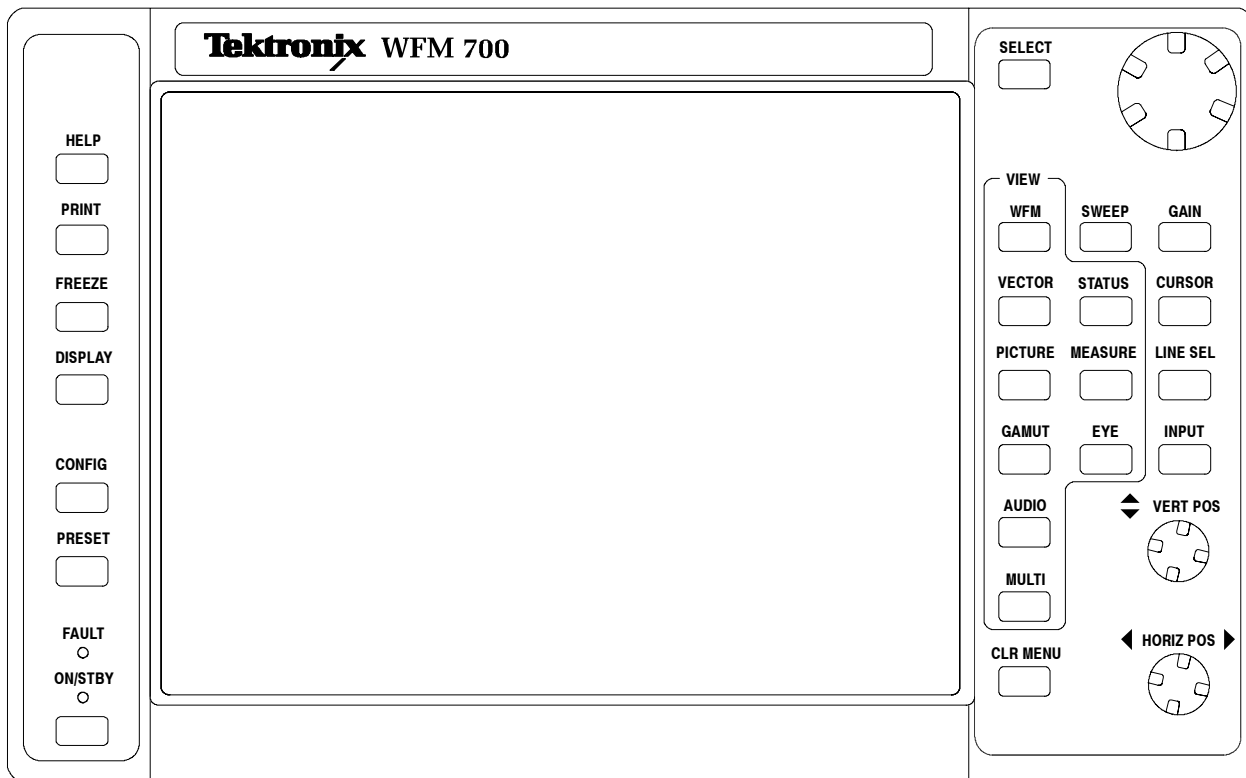
Figure 2-1: Waveform monitor front panel

Front Panel Knobs and Indicators

Table 2-1 describes the knobs and indicators on the waveform monitor:

Table 2-1: Front-panel knobs and indicators

Knob / Indicator	Description
General purpose knob	Located in the upper right corner of the front panel, navigates among menu choices or changes 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.
	You can use this knob with the following functions:
	■ Select button. 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 indicates that you can press the Select button to toggle the general purpose knob between controlling two items.
	■ Line Select. Use the knob to select the desired video line. In some cases, the knob will automatically return to Line Select mode after being assigned to another function.
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 illuminates whenever the instrument is powered on.
FAULT LED Indicator	This red LED illuminates 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 and do not report input signal problems. Table 2-2 lists the LED status conditions and what they mean.

Table 2-2: LED fault codes

State	ON/STBY LED	Fault LED	Main power relay	Description / suggested action
Standby	Off	Off	Off	No power. Press the ON/STBY switch for normal operation. Check that the instrument power cord is plugged into the local power supply.
On	On	Off	On	Normal operation.
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

Refer to *Menus* beginning on page 2--11 for a description of the menus accessed by pressing the front-panel buttons. Table 2--3 describes the different categories of front-panel buttons.

Table 2--3: Front-panel buttons

Category	Description	Buttons
Major mode	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. *NOTE: The Eye button is functional on WFM700M instruments only.*	WFM VECTOR PICTURE GAMUT AUDIO MULTI STATUS MEASURE EYE HELP CONFIG
Minor mode	These buttons activate a function that works with one or more major modes and 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.	SWEEP GAIN CURSOR LINE SEL FREEZE DISPLAY INPUT PRESET
Misc.	These buttons perform their function depending on the current mode. ■ Press the SELECT button to make a menu selection. ■ Press the PRINT button to print the instrument display. ■ Press the CLR MENU button to clear a menu display.	SELECT PRINT CLR 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 and change with the instrument mode. The soft keys function as follows:

- Some soft keys toggle between two settings, such as enable and disable.

- Some soft keys act as a linked group in which only one button can be selected at a time (mutually exclusive).

Readouts

Various on-screen readouts inform you of instrument settings and conditions, depending on the current state of the instrument (see Table 2–4). When a menu is displayed, the readouts on the lower part of the screen move above the menu.

Table 2‑4: Readout descriptions

Readout	Location	Description
Current reference (Ref)	Lower left	Text indicates the current source of the video reference: INT (active input signal) or EXT (signal applied on the external reference connector). Also displays the type and status of the reference.
Vector graticule type (Bars:)	Lower left	Text indicates the current setting of the Vector Graticule, 75% or 100%.
Horizontal gain (HGain)	Lower left	Text displays the variable horizontal gain value in yellow to indicate that it is not standard.
Vertical gain (VGain)	Lower left	Text displays which calibrated vertical gain you have selected, such as 1x or 5x. If you select variable gain, the readout displays the gain value in yellow.
Selected input / input format	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.
Gamut threshold settings	Lower left	Text indicates the current gamut limit settings for the selected display: Arrowhead, Diamond, or Split Diamond. For the Arrowhead display, the following readouts are displayed: Y+C Hi, Y+C Lo, Y Hi, and Y Lo. For the Diamond and Split Diamond displays, the following readouts are displayed: High and Low.
Color standard	Lower center	Text indicates the current colorimetry standard. Not present in all modes.
Audio channels	Lower center	If enabled in the Audio Displays submenu of the Configure menu, 16 characters indicate embedded audio channel status; one character for each channel. The codes are as follows: P = Present — = Not Present
Waveform components	Lower center	Text indicates the currently displayed waveform color components. Non-displayed components are indicated by dashes. For example, an RGB display with G deselected would appear as R–B.

Table 2- 4: Readout descriptions (Cont.)

Readout	Location	Description
Magnification (Mag)	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.
Sweep rate	Lower center	Text indicates the selected sweep rate.
Closed caption presence	Upper left	When the instrument detects the presence of a closed caption signal, CC is displayed on the screen.
Timecode	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.
Ancillary data	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.
Program rating	Upper left	Text indicates the V-chip (Content Advisory) rating of the program.
Eye measurements	Upper left and center	When the eye measurements are turned on in the Eye display, the current values of the following eye measurements are displayed: amplitude, rise overshoot, fall overshoot, rise time, fall time, and rise-fall time delta.
Gamut error	Top center	When gamut errors occur, the readout (if enabled) will display either "RGB," "Y+C," or "Lum" for RGB, Composite, or Luminance gamut errors, respectively.
Current date and time	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.
Field and line	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.
Sample	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.
Cursor	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).

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 Menu* on page 2-21.
	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 described in Table 2–5.
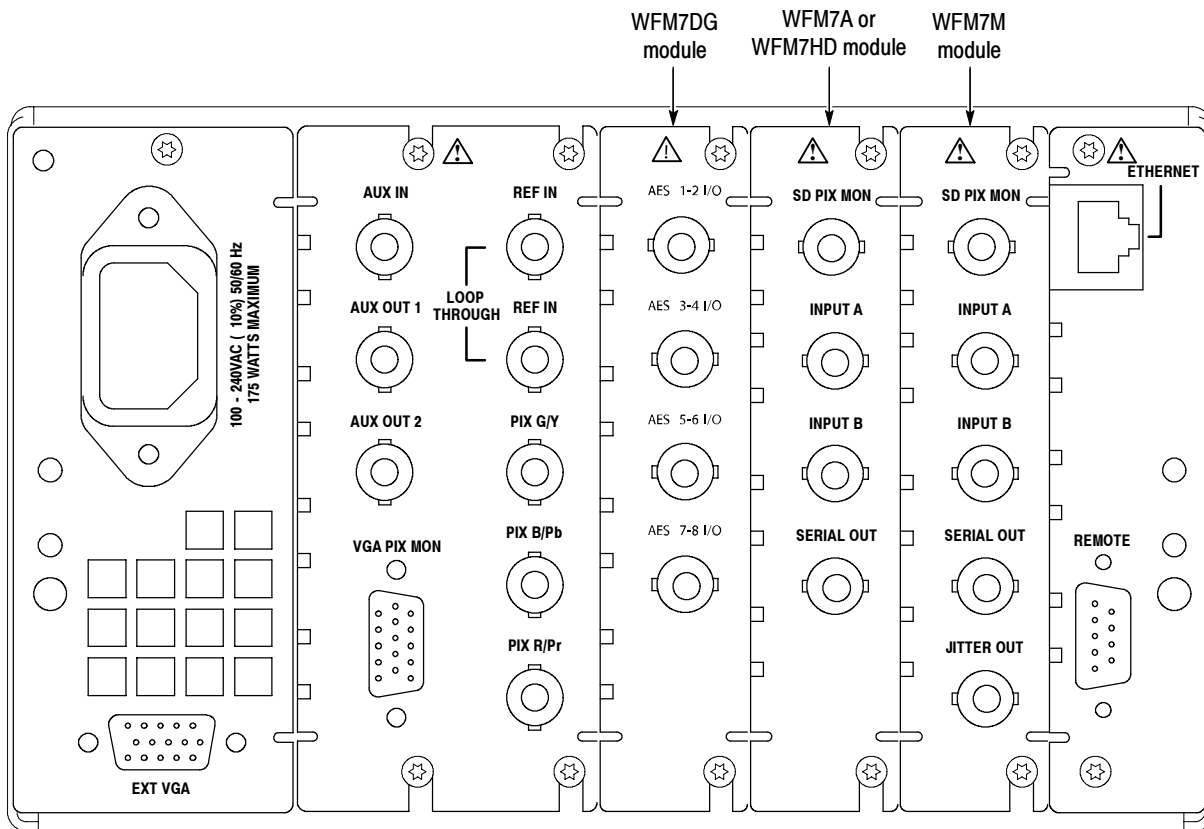

Figure 2‑2: WFM700 rear panel

Table 2‑5: Rear-panel connectors

Connector(s)	Description
Power	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, $\pm 10\%$.
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 and INPUT B. Digital, 75 Ω terminating 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. 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. Use the Audio Inputs/Outputs submenu of the Configure menu to configure these connectors.

Table 2-5: Rear-panel connectors (Cont.)

Connector(s)	Description
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 instrument display to drive an external monitor.
	REMOTE. 9-pin subminiature D-type connector used as a Ground Closure interface for remote control.
	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.
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 Configure 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 describes the various menus you can access in the instrument and provides menu diagrams showing the location of the available selections. The menu diagrams are organized in alphabetical order.

Refer to the *WFM700 Series Technical Reference* document on the CD-ROM for a detailed description of each menu selection.

Making Menu Selections

The menu system uses several different methods for entering measurement and monitoring parameters.

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.

Numeric Value Menus
Some configuration parameters use a numeric value box.

- The knob icon appears in the value box and the parameter value is outlined.

- Use the general purpose knob to change the numeric value.

Checkbox Tables
In the Configure menu, some configuration parameters use check box tables. Touch the box on the screen to change selections.

List Box
Some configuration parameters show a list of items that you can scroll through using the general purpose knob. Select items by using the SELECT button or by touching the desired item on the screen.

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 Configure 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.

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 <...> .
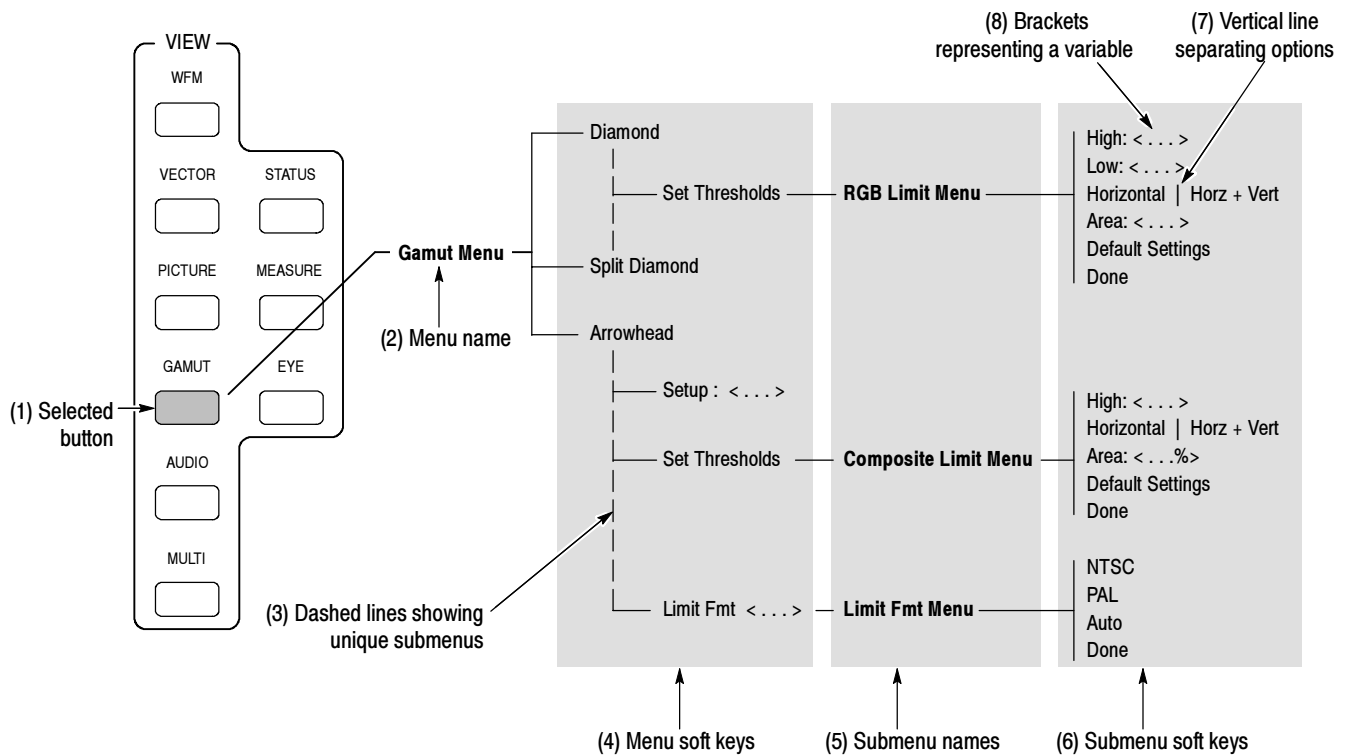
Figure 2‑3: Example menu diagram showing components of the diagram

WFM700 Series Waveform Monitors User Manual

Audio Menu (Option DG Only)

Press the AUDIO button to enter the Audio mode. If your instrument has only video modules installed, the instrument displays the Embedded Audio Status screen and has no menu. If your instrument has the Option DG audio module installed, the Audio menu shown in Figure 2-4 is displayed.
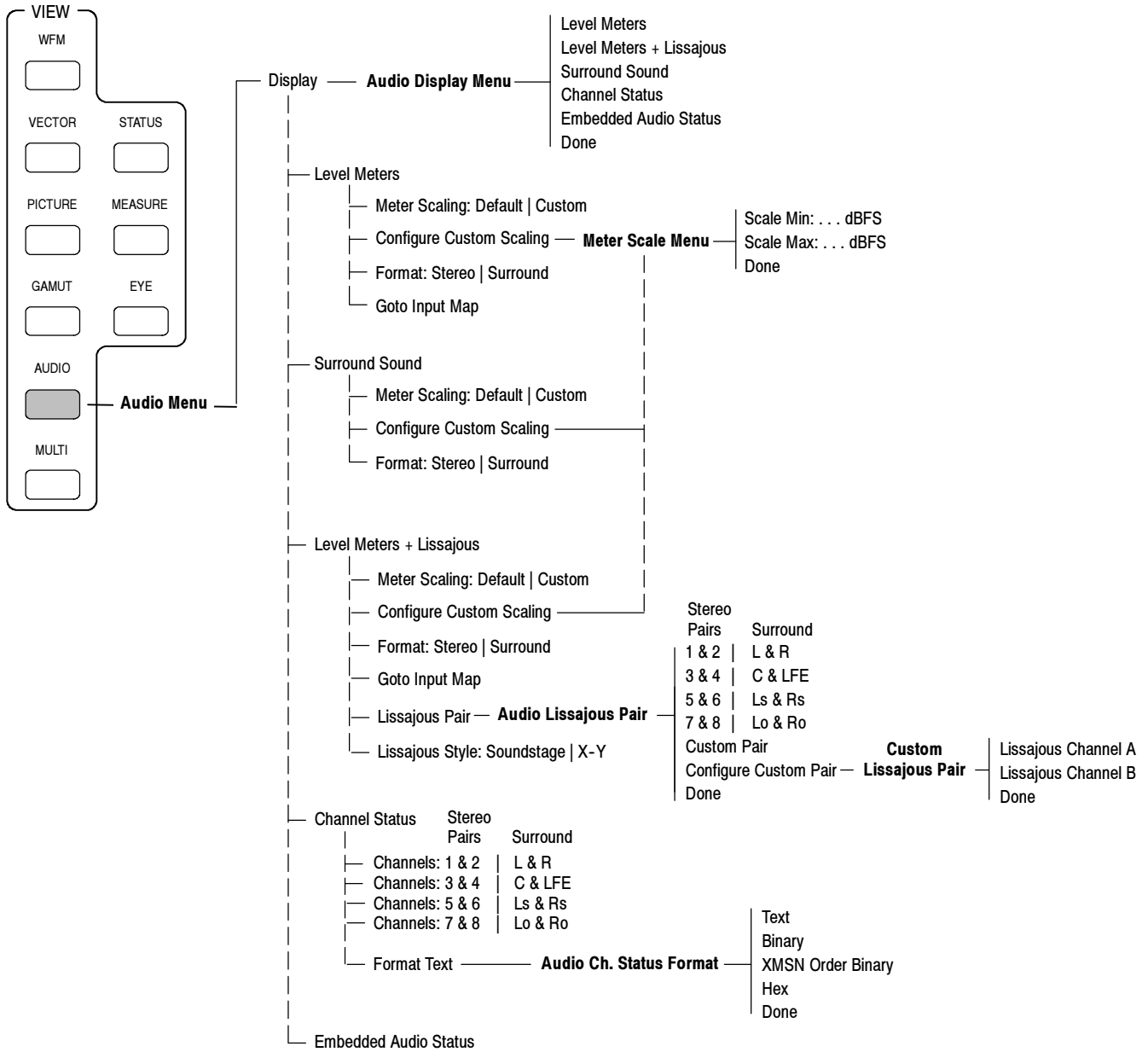

Figure 2-4: Audio menu diagram (Option DG only)

Configure Menu

Press the CONFIG button to open the Configure menu, which is shown in Figures 2–5 through 2–7. The configuration parameters for the instrument are grouped into functional submenus within the Configure menu. Use the general purpose knob and/or the touchscreen to navigate within the menu.

CAUTION. *To prevent a misadjustment of the instrument, do not use the adjustment menu selections in the Calibration submenu without referring to the WFM700 Series Service Manual (Tektronix, Inc. part number 071-0915-XX).*

HELP

PRINT

FREEZE

DISPLAY

CONFIG

Configure Menu

PRESET

Configure Alarms

Configure menu continues in Figure 2–6

General Alarms
RGB Gamut
Composite Gamut
Luminance Gamut
Video Signal Missing
Video Format Change
Video Format Mismatch
Video-Ref Format Mismatch
Ext Ref Signal Missing
Ext Ref Format Mismatch
Input Signal not HD

Serial Alarms
RP165 EDH Status
RP165 FF CRC
RP165 AP CRC
SMPTE292 Y CRC
SMPTE292 C CRC
SDI Code Word Violation
SDI Line Length Error
SDI Field Length Error
SDI SAV Placement
292M Line Mismatch

Audio Alarms (Option DG Audio module only)
Emb. Audio Presence
AES Audio Unlocked
AES Audio Parity
Validity Bit
Professional CRC
Audio Mute
Audio Clip
Audio Silence
Audio Over
Emb. Group Sample Phase

Auxiliary Alarms
Closed Caption Presence
Closed Caption Changes
Closed Caption Parity
Closed Caption Protocol
V-Chip Presence
V-Chip Rating Change
Anc Data Presence
Anc Data Parity
Anc Data Checksum
ARIB STD-B39 Presence

Physical Alarms (WFM700M only)
Eye Amplitude
Eye Rise Time
Eye Fall Time
Eye Rise-Fall Delta
Eye Rise Overshoot
Eye Fall Overshoot
Jitter

Figure 2-5: Configuration menu diagram - part 1

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Configure menu continued
from Figure 2–5

Vec I/Q Axis: Off | On | On (if SD)

Vec Compass Rose: Off | On

Wfm Graticule Units (non-50 Hz): Auto | mV | IRE | % Full-Scale

Gamut Threshold Default: Tek | EBU-R103

Grat / Gamut
Default Setup

Closed Caption Display: Enabled | Disabled

Closed Caption Type: Auto Detect | EIA-608 (VBI) | EIA-608 (ANC) | EIA-608 (708)

Closed Caption Service (608): CC1 | CC2 | CC3 | CC4 | TEXT1 | TEXT2 | TEXT3 | TEXT4

VBI Captions Line Number: Auto Detect | Line < . . . >

B39 Did/Sdid Address: ARIB | ITU

HELP

PRINT

FREEZE

Strip EAV/SAV (WFM): Pass | Strip

DISPLAY

Page 1
Auto Select
NTSC
PAL
1080i : 59.94   Page 2
Ext Ref Format: 1080i : 60   1080i : 50   The 1080i: 50 format appears
720p : 59.94   only when a version B
1080p : 23.97   Ext. Ref. module is installed.
1080p : 24

CONFIG

Configure Menu

PRESET

Video
Inputs/Outputs

Page 1   Page 2
Any Supported   1080p : 30
525i : 59.94   1080p : 29.97   Page 3
625i : 50   1080p : 25   720p: 24
Video Input Format: 1080i : 59.94   1080i : 50   720p : 23.98
1080i : 60   1035i : 60   720p: 60
720p : 59.94   1035i : 59.94   720p: 50
1080p : 23.98   1080sf : 24
1080p : 24   1080sf : 23.98

HD Colorimetry: Auto Select | ITU-R BT.709-2 | SMPTE 240M

Brightup Line/Sample: Off | On

Brightup RGB Gamut: Off | On

Brightup Composite Gamut: Off | On

Brightup Luminance Gamut: Off | On

Output Colorimetry HD: Auto | BT.709 | SMPTE 240

Output Active for HD: Off | YPbPr | RGB

Output Active for SD: Off | YPbPr | RGB

Configure menu continues
in Figure 2–7

Timecode: Auto | VITC | ATC | Off

Figure 2-6: Configuration menu diagram - part 2

Configure menu continued
from Figure 2-6

HELP

PRINT

FREEZE

DISPLAY

CONFIG

Configure Menu

PRESET

Audio Inputs/Outputs
(Option DG audio
module only)

AES Connectors: Input | Output
Audio Program Type: Stereo Pairs | Surround
AES Alarms: Change AES Alarm
Embedded Alarms: Change Embedded Alarms
AES Input Map: Change AES Input Map

Embedded Input Map: Change Emb. Input Map

272M Group Phase Align: Disabled | Enabled | Auto
299M Group Phase Align: Disabled | Enabled | Auto

Embedded Groups
Audio In/Out Menu
Top Menu

Groups 1 & 2
Groups 3 & 4
Groups 1 & 3
Groups 2 & 4
Groups 1 & 4
Groups 2 & 3
Done

Audio Displays

Audio Presence Readout: Off | On

Meter Ballistics: VU | PPM | True Peak
Peak Hold Time: 2 sec
Peak Hold Display: Off | On
Set 0dB Mark To: dBFS | Peak Program Level | Test Level
Lissajous AGC: Off | On
Dominance Indicator: Disabled | Enabled
Surround Sound Filter: Linear (RMS) | A-Weighting

These menu selections
appear only when an
Option DG audio
module is installed.

Audio Thresholds
(Option DG audio
module only)

Test Level: -18 dB
Peak Program Level: -8 dB
# of Samples for Clip: 1
# of Samples for Mute: 10
Silence Level: -60 dB
Over Level: -8 dB
Duration for Silence/Over: 5 sec

Figure 2-7: Configuration menu diagram - part 3

Configure menu continued
from Figure 2–7

HELP

PRINT

FREEZE

DISPLAY

CONFIG

PRESET

Configure Menu

Printing/Event Log

Print Layout: Portrait | Landscape
Print Format: Postscript COLOR | Postscript B&W
Paper Size: A4 | Letter
LPD Print Server IP Address: Press to Edit IP Address
LPD Print Queue Name: raw | Press to Edit Queue name
Ink Saver: On | Off
When Event Log Full: Overwrite Old Events | Stop Logging
Event Log Storage Mode: Log for Resolution | Log for Duration

Communications

Config Mode: Manual Mode | DHCP Server
IP Address: Press to Edit IP Address
Subnet Mask: Press to Edit Subnet Mask
Gateway Address: Press to Edit Gateway Address
Remote Control Port: Enabled | Disabled
Remote Web Interface: Enabled | Disabled
Remote SNMP Mode: Disabled | Read-Only | Enabled
SNMP Traps: Disabled | Enabled
SNMP Public Comm. String: Press to Edit Public Community String
SNMP Private Comm. String: Press to Edit Public Community String
SNMP Trap Destinations: Press to Select Trap Destination to Edit
Instrument Name: Press to Edit Instrument Name

Calibration

Touchpanel Calibration

Eye Gain Adjust
SD Jitter Gain Adjust
HD Jitter Gain Adjust
Eye Loop BW Adjust (10 Hz)
Eye Loop BW Adjust (100 Hz)
Eye Loop BW Adjust (1 kHz)
Jitter HPF Adjust
Eye Sig BW Test

These menu selections appear only
on the WFM700M and are intended
for service personnel only

System

Current Time: Press to Edit System Time
Time Format: 12 Hour | 24 Hour
Current Date: Press to Edit System Date
Date Format: mm/dd/yyyy | dd/mm/yyyy
Powerup Diagnostics: Brief | Full

Diagnostics

Install Upgrade: Start Firmware Installation

Run Full Powerup Diagnostics
Run Internal Digital Path Diagnostics
Run Audio Path Diagnostics (Option DG module only)

View Diagnostic Log

Print Diagnostics Log

Erase NVRAM Log
View Prev Log Page
View Next Log Page
Back to Diags Menu

Figure 2‑8: Configuration menu diagram ‑ part 4

Cursor Menu

If the instrument is in a mode that supports measurement cursors (Waveform, Eye, or Jitter modes), the Cursor menu shown in Figure 2–9 is displayed when you press the CURSOR button. 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.
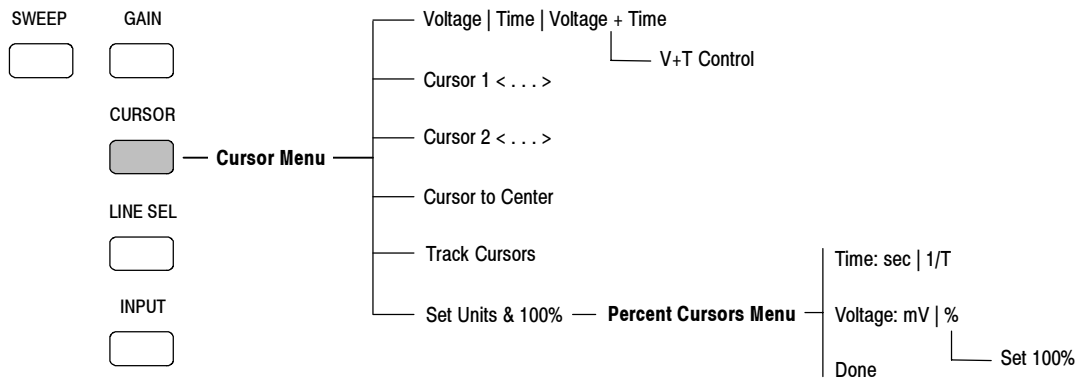
Figure 2-9: Cursor menu diagram

Moving the Cursors The selected (active) cursors are red and the 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.

Display Menu

Press the DISPLAY button to open the Display menu shown in Figure 2--10. Use the Display menu to adjust various display parameters.

HELP

PRINT

FREEZE

DISPLAY

Display Menu

CONFIG

PRESET

Thumbnail Picture

Trace Settings
Waveform < . . . >
Color: Green | White
Done

Graticule Settings
Intensity < . . .%>
Color: GLD | RED
Rendition: Additive | Overlay
Done

Sleep Mode
[Note: To exit Sleep Mode, press any button, turn any knob, or touch the screen]

Readouts & Backlight
Readout: Enabled | Disabled
Readout < . . .%>
Backlight < . . .%>
Done

Button Illum.

Figure 2--10: Display menu diagram

Eye Menu (WFM700M Only)

Press the EYE button to enter the Eye mode and display the Eye menu shown in Figure 2‑11. Refer to *Eye Mode (WFM700M Only)* on page 3‑17 for more information about using the Eye and Jitter measurement displays.

```
VIEW
  WFM

  VECTOR    STATUS

  PICTURE   MEASURE

  GAMUT     EYE

  AUDIO

  MULTI
```

Physical Display Menu — Eye
                        Jitter
                        Event Log
                        Done

Display —

Eye Meas: Off | On

    3 Eye — 10 Eye (SD signals)
            20 Eye (HD signals)

    Clock BW : < . . . > — Clock BW Menu — 10 Hz
                                           100 Hz
                                           1 kHz
                                           Done
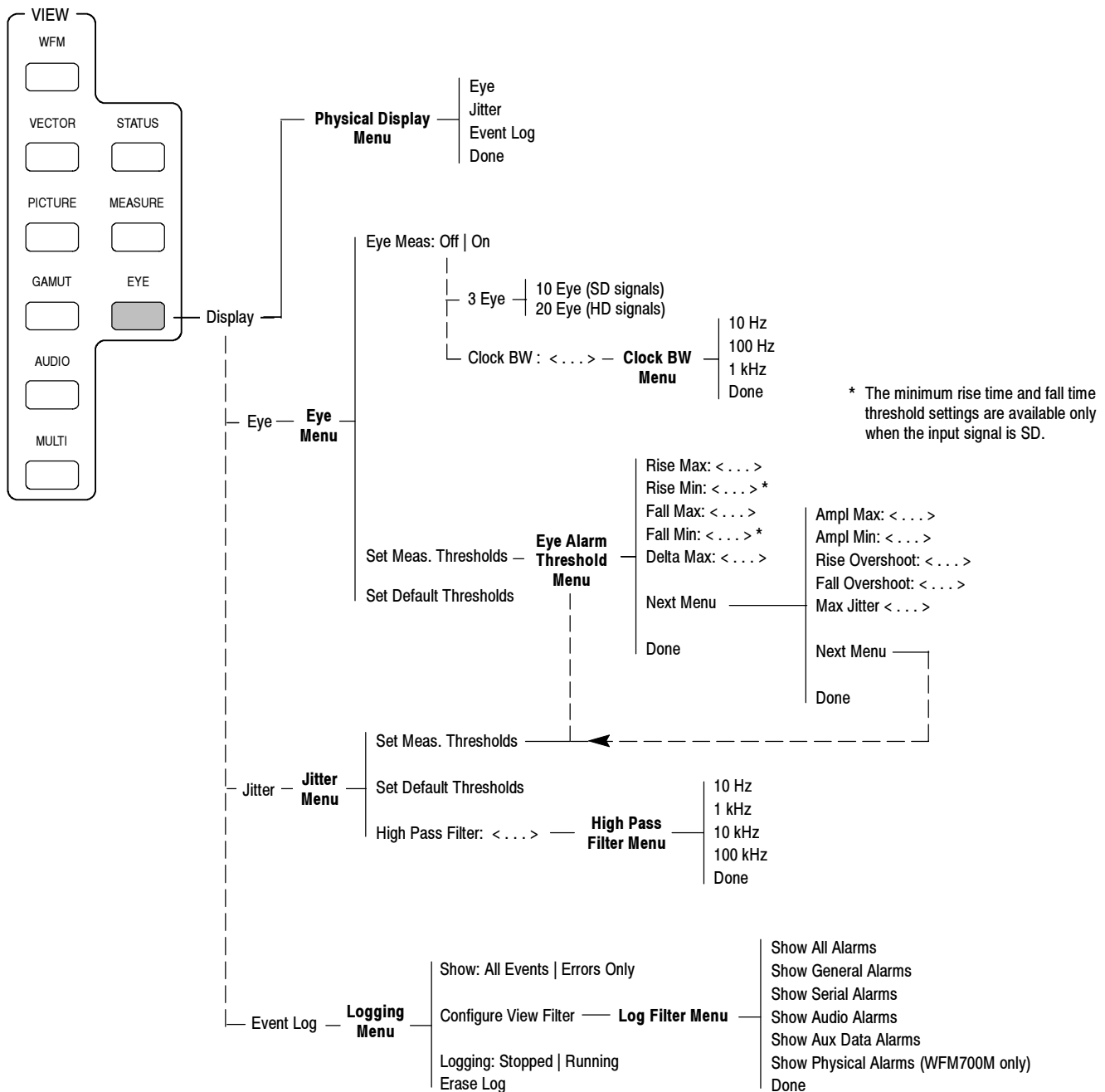
* The minimum rise time and fall time threshold settings are available only when the input signal is SD.

Eye — Eye Menu

Set Meas. Thresholds — Eye Alarm Threshold Menu — Rise Max: < . . . >
                                                  Rise Min: < . . . > *
                                                  Fall Max: < . . . >
                                                  Fall Min: < . . . > *
                                                  Delta Max: < . . . >

                                                  Next Menu — Ampl Max: < . . . >
                                                              Ampl Min: < . . . >
                                                              Rise Overshoot: < . . . >
                                                              Fall Overshoot: < . . . >
                                                              Max Jitter < . . . >

                                                              Next Menu
                                                              Done
                                                  Done

Set Default Thresholds

Jitter — Jitter Menu

Set Meas. Thresholds
Set Default Thresholds
High Pass Filter: < . . . > — High Pass Filter Menu — 10 Hz
                                                      1 kHz
                                                      10 kHz
                                                      100 kHz
                                                      Done

Event Log — Logging Menu

Show: All Events | Errors Only

Configure View Filter — Log Filter Menu — Show All Alarms
                                          Show General Alarms
                                          Show Serial Alarms
                                          Show Audio Alarms
                                          Show Aux Data Alarms
                                          Show Physical Alarms (WFM700M only)
                                          Done

Logging: Stopped | Running
Erase Log

Figure 2‑11: Eye menu diagram

Freeze Menu

Press the FREEZE button to open the Freeze menu shown in Figure 2-12. 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.

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 and display performance.

HELP

PRINT

FREEZE ── **Freeze Menu** ─┬─ Capture Screen
  │   ├─ Display Captured
  │   ├─ Display Both
  │   └─ Delete Capture
  └─ Display Live

DISPLAY

CONFIG

PRESET
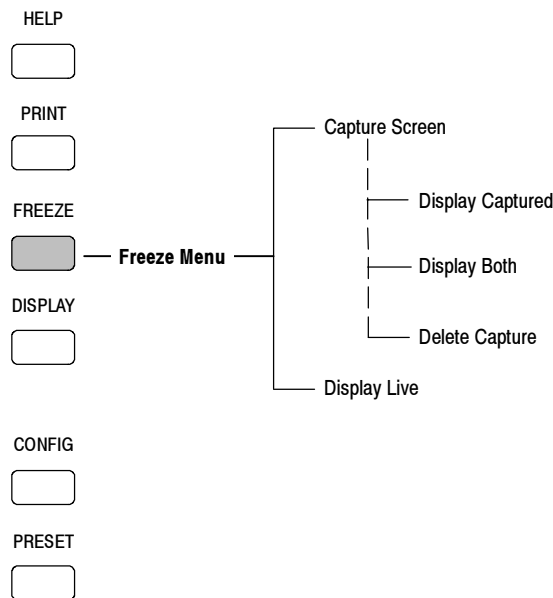
Figure 2-12: Freeze menu diagram

Gain Menu

Press the GAIN button to display the Gain menu shown in Figure 2‑13. 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.

In variable gain modes, use the general purpose knob to set the gain. The variable gain modes work together with the fixed settings. 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. When variable gain is enabled in Waveform, Jitter, and Eye modes, 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.
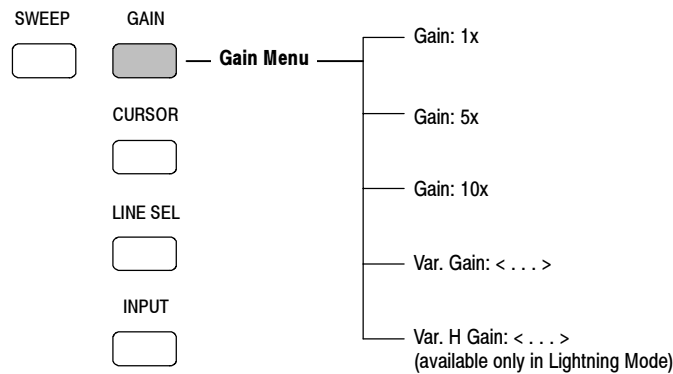
Figure 2‑13: Gain menu diagram

Gamut Menu

Press the GAMUT button to enter the Gamut mode and display the Gamut menu shown in Figure 2‑14. Use the Gamut menu to view the Diamond, Split Diamond, or Arrowhead displays, and to set the gamut measurement limits. Refer to *Gamut Measurements* on page 3‑27 for more information.

VIEW
WFM

VECTOR   STATUS

PICTURE   MEASURE

GAMUT   EYE

AUDIO

MULTI

Gamut Menu

Diamond

— Diamond: Standard | Split

— Set RGB Thresholds ——— **RGB Limit Menu**

RGB High: < . . .mV >
RGB Low: < . . .mV >
Horizontal | Horz + Vert
Area: < . . .% >
Default: . . . . .
Done

Arrowhead

— Set Luma Thresholds — **Luminance Limit Menu**

Luma High: < . . .mV >
Luma Low: < . . .mV >
Horizontal | Horz + Vert
Area: < . . .% >
Default: . . . . .
Done

— Setup 0% | Setup 7.5%

— Set Y+C Thresholds ——— **Composite Limit Menu**

Y+C High: < . . . >
Y+C Low: < . . . >
Horizontal | Horz + Vert
Area: < . . .%>
Default: . . . . .
Done

— Limit Fmt < . . . > ——— **Limit Fmt Menu**

NTSC
PAL
Auto
Done

Figure 2‑14: Gamut menu diagram

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Help Menu

Press the HELP button to display online help about the current operating mode and to display system information such as the software version, the installed options and board versions, and the network parameters (see Figure 2-15).
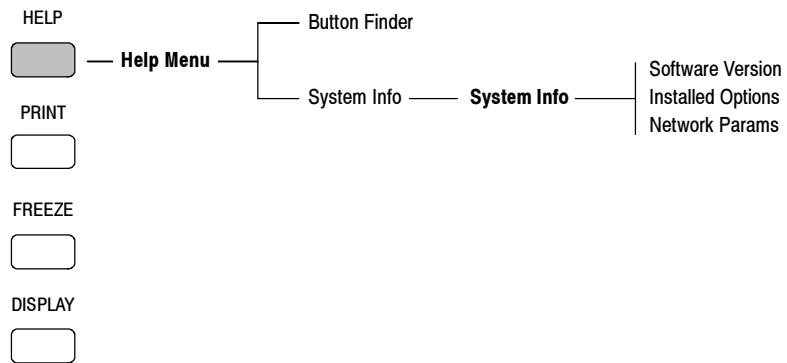
Figure 2-15: Help menu diagram

Input Menu

Press the INPUT button to display the Input menu shown in Figure 2-16. Use the Input menu to select which video input to monitor, the reference signal source (internal or external), and which audio input to monitor.
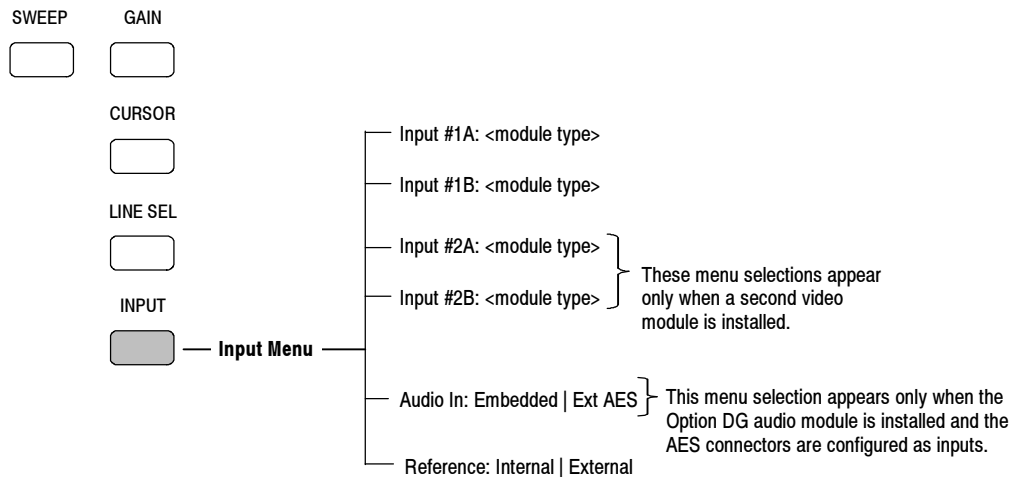
Figure 2-16: Input menu diagram

Line Select Menu

Press the LINE SEL button to enable the Line Select mode and open the menu shown in Figure 2‑17. Operating modes that support the line select function are Waveform, Vector, Gamut, Jitter, Eye, and Data. Refer to *Line Select Mode* on page 3‑31 for more information.
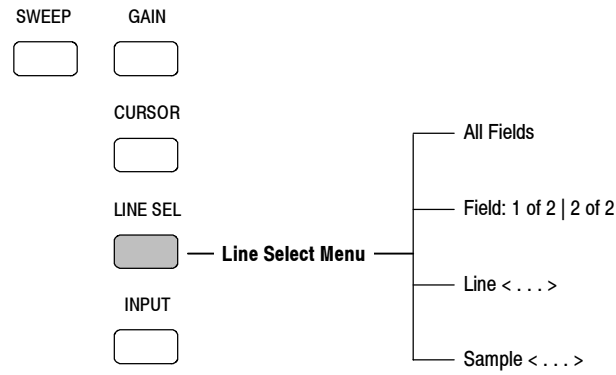
Figure 2‑17: Line Select menu diagram

Measure Mode Menu (WFM700A and WFM700HD Only)

For instruments with only WFM7A and/or WFM7HD video modules installed, press the Measure button to access the Bowtie mode. Refer to *Bowtie Mode* on page 3-14 for more information.

Measure Mode Menu (WFM700M Only)

To access the Measure menu, 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 2-18. Use the Data Display mode to view the actual data that the instrument used for measurements. Refer to *Data Display (WFM700M Only)* on page 3-15.

From the Data menu, press the Measure Menu soft key to open the Measure menu, where you can access the following displays:

- Bowtie mode (refer to *Bowtie Mode* on page 3-14)

- Ancillary Data display (refer to *Ancillary Data Display* on page 3-4)

- ARIB STD-B39 display (refer to *ARIB STD-B39 Display* on page 3-6)
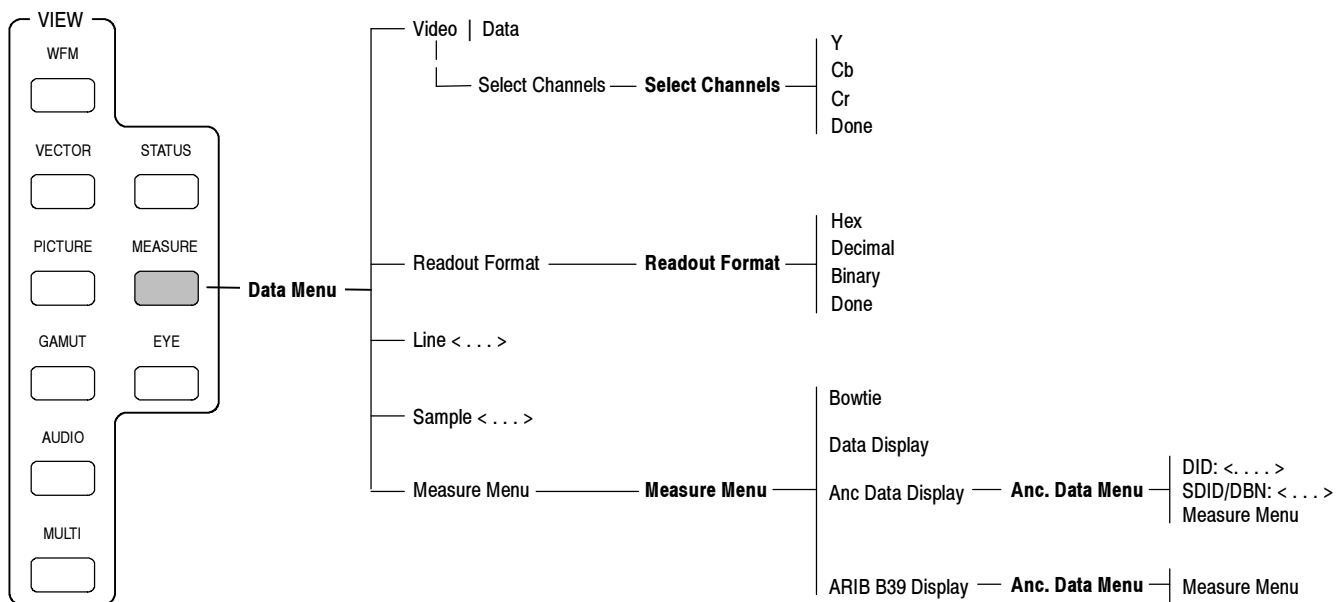
Figure 2-18: Data menu diagram

Multi Menu

Press the MULTI button to enter Multi mode, which displays the Multi menu shown in Figure 2‑19. Multi mode shows two different views of the same input signal side-by-side. You must use the Input menu to select a different input signal to display. Refer to *Multi Mode* on page 3‑34 for more information.
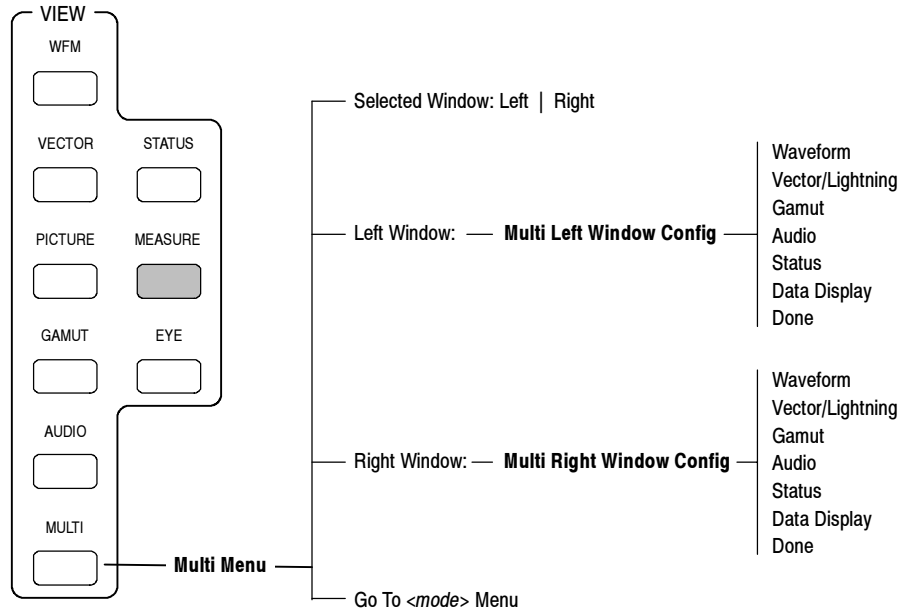
Figure 2‑19: Multi menu diagram

Picture Menu

Press the PICTURE button to enter the Picture mode. Picture mode displays a full screen representation of the video signal present at the selected input. After you enter the Picture mode, press the PICTURE button again to toggle the Picture menu shown in Figure 2-20 on and off.

Use the Safe Area soft key to turn the Safe Action and Safe Title graticules on and off. The safe area graticules do not appear in the thumbnail picture.

Since the full-size SD picture display is cropped, use the SD Picture Half Size setting to view the complete picture when you are monitoring SD signals.
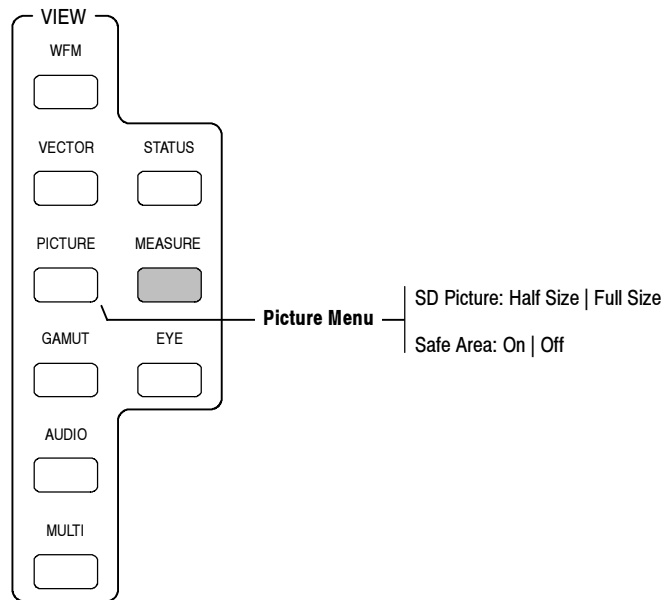
Figure 2-20: Picture menu diagram

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Preset Menu

Press the PRESET button to open the Preset menu shown in Figure 2–21. The Preset menu allows you to store and recall instrument configuration settings.

There are 42 user-programmable presets available in addition to the Restore 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 using the remote control port.

Refer to the *WFM700 Series Technical Reference* document on the CD-ROM for information about using the remote control port and for a listing of the instrument settings reset by the Restore Factory menu selection.
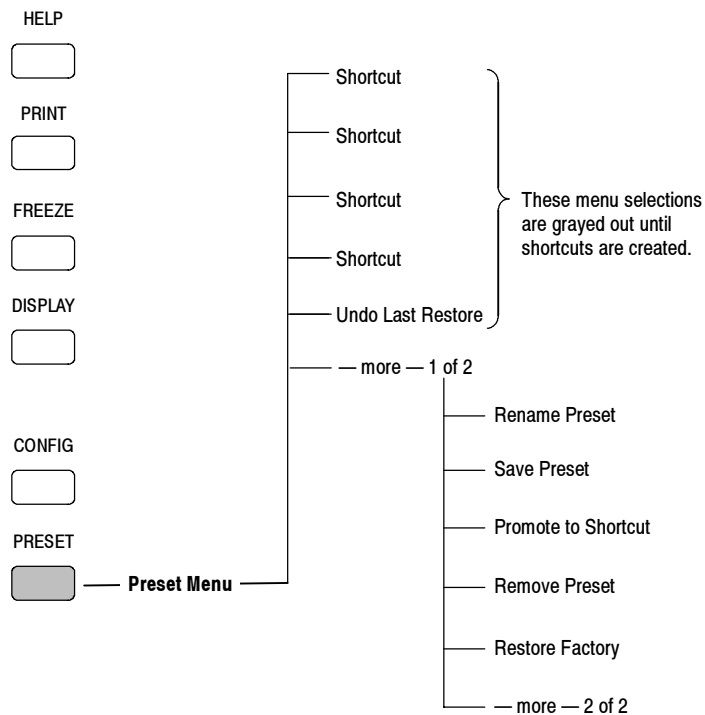
Figure 2‑21: Preset menu diagram

2‑29

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 2-22. 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 auxiliary data in the selected video 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 *Logging* on page 3-32 and *Status Displays* on page 3-37.
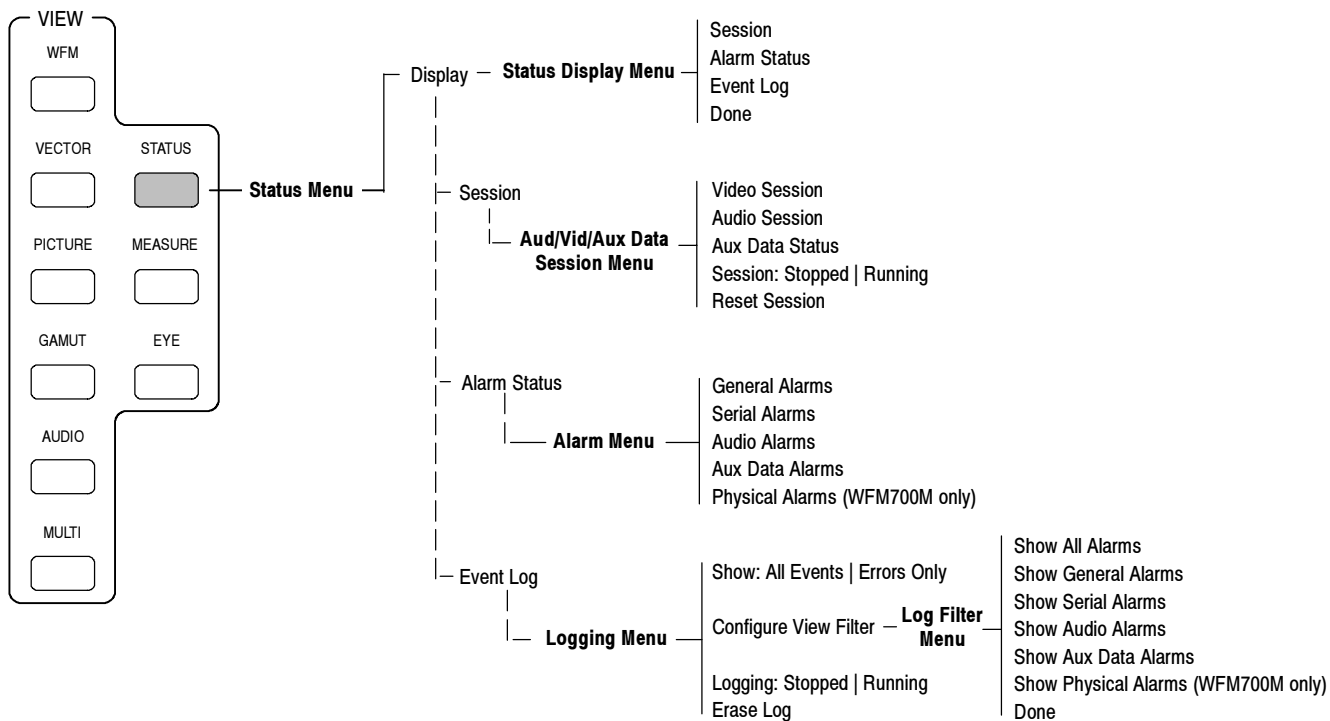
Figure 2-22: Status menu diagram

Sweep Menu

Press the SWEEP button while in Waveform mode to display the Sweep menu shown in Figure 2-23. The Sweep menu is also functional in the Vector and Eye operating modes.
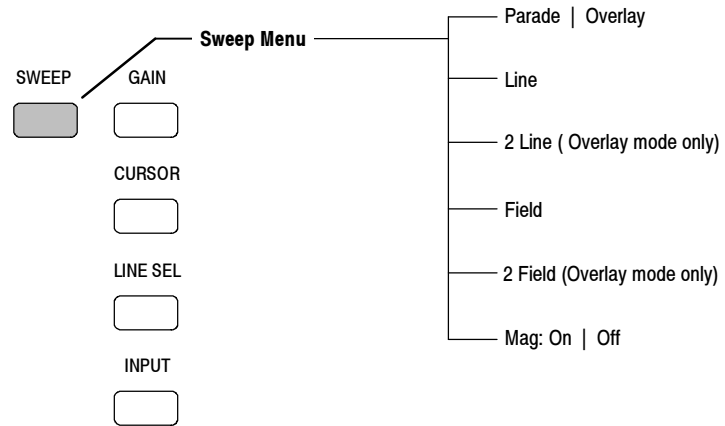
Figure 2-23: Sweep menu diagram

Vector Menu

Press the VECTOR button to enter the Vector mode and display the Vector menu shown in Figure 2-24. Refer to *Vector Mode* on page 3-40 for more information.
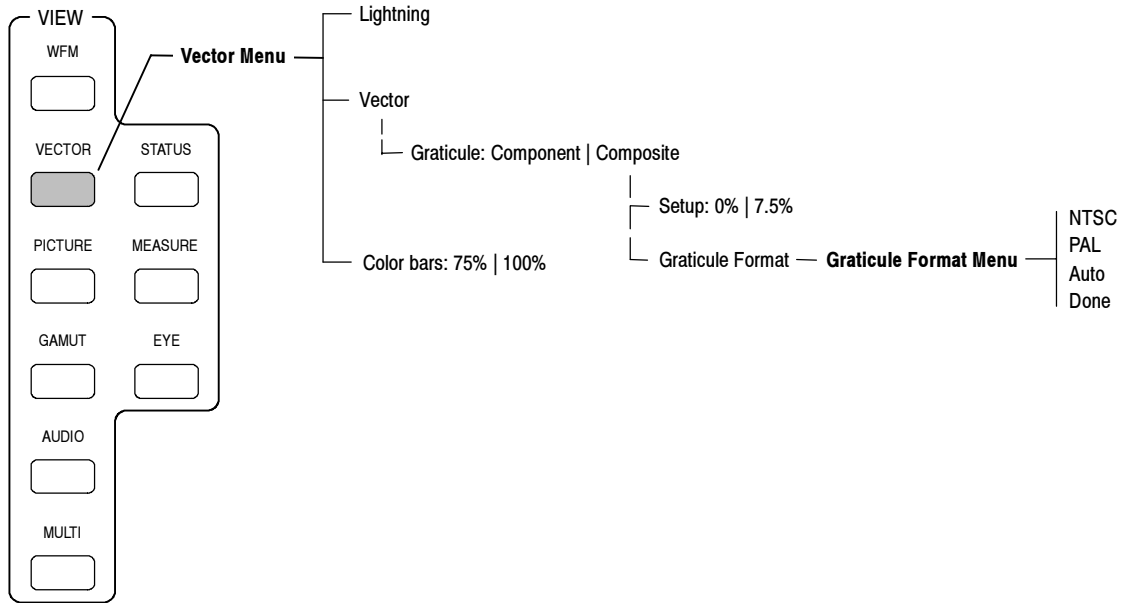
Figure 2-24: Vector menu diagram

Waveform Menu

Press the WFM button to open the Waveform mode and display the Waveform menu shown in Figure 2‑25. Refer to *Waveform Mode* on page 3‑44 for more information.
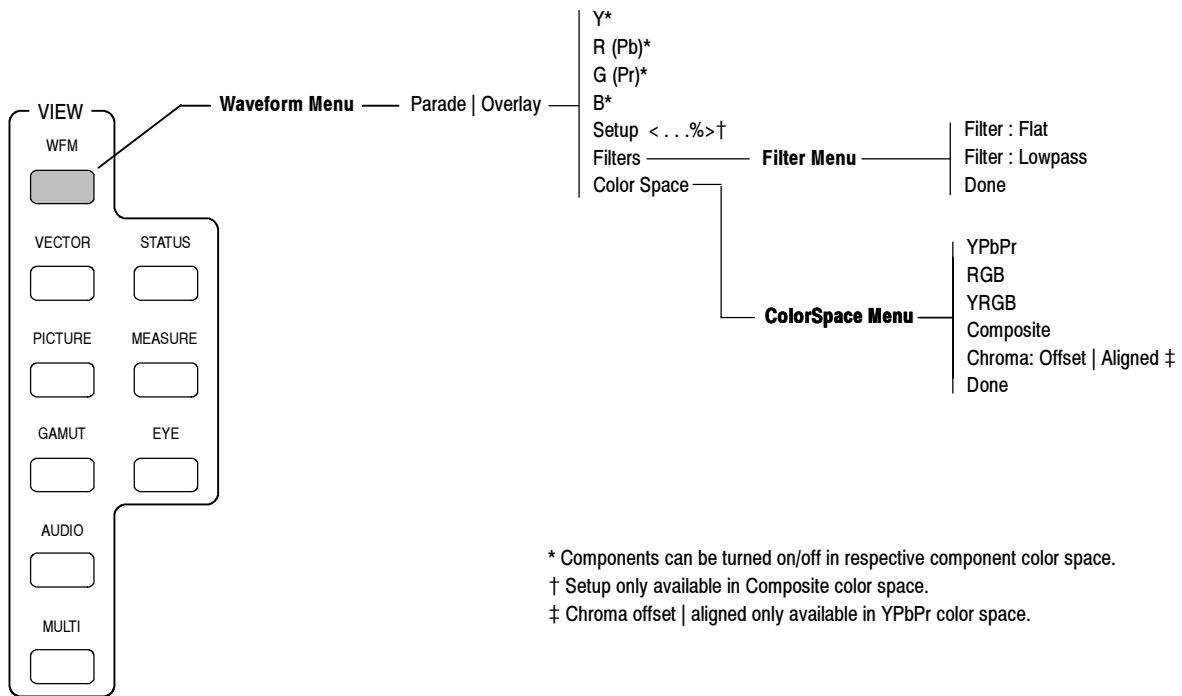
* Components can be turned on/off in respective component color space.
† Setup only available in Composite color space.
‡ Chroma offset | aligned only available in YPbPr color space.

Figure 2‑25: Waveform menu diagram

Reference

Reference

NOTE. *Refer to* Related Reference Documents *on page vi for a list of reference documents that are available on the WFM700 Series User Documentation CD-ROM located on the back cover of this manual and/or at the Tektronix, Inc. Web site (www.tektronix.com).*

The topics in *Reference* listed below are organized alphabetically:

- Alarms
- Ancillary Data display
- ARIB STD-B39 display
- Audio mode
- Audio mode (Option DG only)
- Bowtie mode
- Composite display
- Data display (WFM700M only)
- Diagnostics
- Eye/Jitter mode (WFM700M only)

- Gamut measurements
- Line Select mode
- Logging
- Measure mode (WFM700M only)
- Multi mode
- Picture mode
- Printing
- Status displays
- Vector mode
- Waveform mode

Alarms

Use the Configure Alarms submenu of the Configure menu to select which error conditions you will monitor and how you will be notified in the event of an error. The alarms are organized into the following groups to help you locate a desired alarm: General, Serial, Audio (Option DG only), Auxiliary, and Physical (WFM700M only).

The top level of the submenu display shows which notification methods are enabled. An "X" indicates that a notification method is selected and an "O" indicates that the notification method is not selected.

Refer to the *WFM700 Series Technical Reference* document on the CD-ROM for a description of each alarm condition.

Possible Alarm Actions   For each available alarm, you can select one or more notification methods:

NOTE. *If you do not select a notification method for an error, you will not be notified if that error occurs.*

■ On-screen. An icon appears at the top of the current display. This notification method is disabled when the Configure menu is open.

■ Beep. The instrument makes an audible alarm.

■ SNMP. The instrument sends an SNMP trap out the Ethernet port for a remote notification that an alarm condition occurred. You must enable and configure the instrument for SNMP control using the Communications submenu of the Configure menu before SNMP traps can be sent.

    Refer to the *WFM700 Series Technical Reference* document and the *WFM700 Series SNMP MIB Reference* on the CD-ROM for more information about using SNMP alarm notifications.

■ Logging. The instrument makes an entry in the Event Log. Refer to *Logging* on page 3-32 for more information.

■ Ground Closure. The instrument sends a signal out the Remote port for a remote notification that an alarm condition occurred. You must enable the Remote Control Port in the Communications submenu of the Configure menu before notifications can be sent.

Viewing Alarm Status   Use the Status Display mode to view current alarm conditions. Use the Event Log to view past alarm conditions. Refer to *Status Displays* on page 3--37 and *Logging* on page 3--32 for more information.

Error Detection Limitations   When the instrument is in the Eye / Jitter operating mode, all enabled alarms are detected and reported except for the following alarms: RGB Gamut, Composite Gamut, and Closed Caption Presence. 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.

Eye Measurement Alarms. When enabled, the eye measurement alarms will be reported to the Event Log in only the following two conditions:

■   When the Eye display is selected and the eye measurement readout is turned on

■   When the Event Log or Alarm Status displays are selected after the eye measurement readout is turned on

That is, if you enter the Eye display and turn on the eye measurements, and then you use the STATUS button to view the Event Log or Alarm Status displays, the eye measurement alarms will be active. If you select another display mode such as Jitter or Waveform, the eye measurement alarms will be disabled.

Jitter Measurement Alarm. When enabled, the Jitter alarm will be reported to the Event Log in only the following two conditions:

■   When the Jitter display is selected

■   When the Event Log or Alarm Status displays are selected after the Jitter display is selected

That is, if you enter the Jitter display and then use the STATUS button to view the Event Log or Alarm Status displays, the jitter measurement alarm will be active. If you select another display mode such as Eye or Waveform, the jitter measurement alarm will be disabled.

Ancillary Data Display

The Ancillary Data display (see Figure 3–1) shows the raw (undecoded) data words in the selected ancillary data packets. The ancillary data is shown only in hexadecimal format. Since the display is updated at approximately 2-second intervals, rapid data changes cannot be detected.

Use the DID and SDID/DBN soft keys in conjunction with the general purpose knob to select the DID and/or SDID values for the type of ancillary data packet to be monitored. DID and SDID values have the following characteristics:

■ DID and SDID values range between 0x01 and 0xff.

■ For DID values in the range 0x00 – 0x7F (Type 2 packets), the SDID values are used.

■ For DID values in the range 0x80 – 0xFF (Type 1 packets), there are no SDID values used (the SDID soft key is greyed out).

Table 3–1 lists the DID and SDID values that are defined for common types of ancillary data.
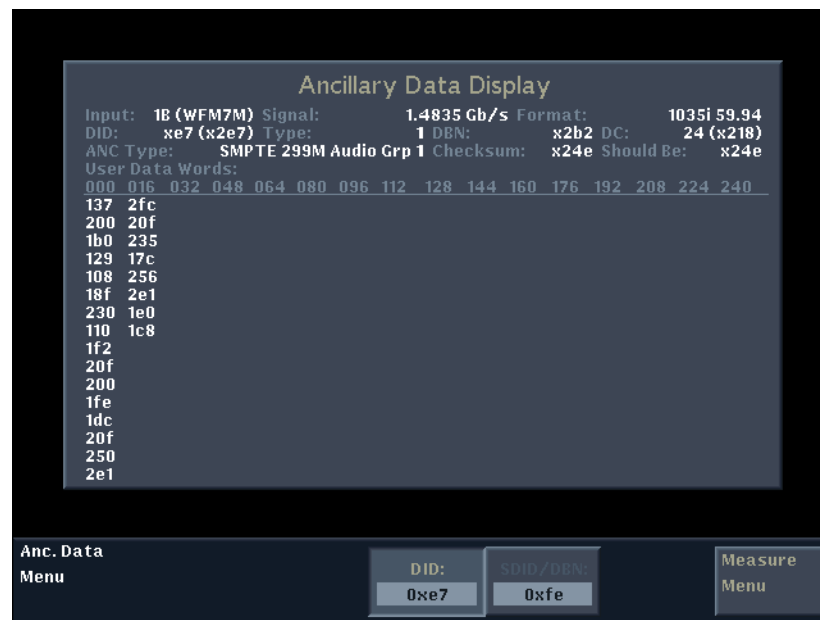
Figure 3‑1: Ancillary Data display

Table 3-1: DID and SDID values for common ancillary data types

Ancillary data type	DID value	SDID value
ARIB TR-B22, Sub Information of transmitting materials	0x5F	0xE0
ARIB TR-B23, Line 20 User Data – 1	0x5F	0xFC
ARIB TR-B23, Line 20 User Data – 2	0x5F	0xFB
Video Payload Identifier	0x41	0x01
ARIB STD-B35 Trigger Signal for Data Broadcasting	0x5F	0xFD
ARIB STD-B37 Closed Captioning 　　Analog signal 　　SD signal 　　HD signal	0x5F 0x5F 0x5F	0xDD 0xDE 0xDF
ARIB STD-B39 Inter Stationary Control Data 　　ARIB specification 　　ITU specification	0x5F 0x43	0xFE 0x01
SMPTE RP-188 Time Code	0x60	None
EIA-608 Closed Captioning	0x61	0x02
EIA-708 Closed Captioning	0x61	0x01
Program Description	0x62	0x01
AES Audio Group 1	0xFF	None
SD Embedded Audio 　　Group 1 　　Group 2 　　Group 3 　　Group 4	0xFF 0xFD 0xFB 0xF9	None None None None
SD Extended Audio Packets 　　Group 1 　　Group 2 　　Group 3 　　Group 4	0xFE 0xFC 0xFA 0xF8	None None None None
HD Embedded Audio 　　Group 1 　　Group 2 　　Group 3 　　Group 4	0xE7 0xE6 0xE5 0xE4	None None None None

ARIB STD-B39 Display

The ARIB STD-B39 display (see Figure 3–2) shows the decoded data for video signals using ancillary data compliant with ARIB STD-B39. When this display is selected, the instrument searches the signal for ARIB STD-B39 packets using the DID/SDID combinations defined by one of the following standards organizations: ITU or ARIB. Use the Grat/Gamut Default Setup submenu of the Configuration menu to select which standard is used.

The decoded ancillary data includes the following:

- Transmitting station code and transmitting station time

- Video mode and video mode countdown

- Audio mode and audio mode countdown

- Trigger counter and trigger countdown

- Status bits

- Error correcting code

Figure 3-2: ARIB STD-B39 display

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Audio Mode

For instruments with only video modules 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)

Audio Mode (Option DG Only)

NOTE. The information below describes the Audio mode display for instruments with the Option DG audio module installed.

Configuring the Instrument for Audio Measurements

Use the following submenus of the Configure menu to set the various instrument parameters for audio measurements: Audio Inputs/Outputs, Audio Displays, and Audio Thresholds. Use the Configure Alarms submenu to configure the audio alarms.

Selecting Which Audio Input to Monitor

Use the Input menu to select which audio input the instrument will monitor. Select Embedded to monitor the audio signal embedded in the selected video signal input, or select Ext AES to monitor the audio signal(s) connected to the Option DG audio module.

NOTE. When you set the function of the AES connectors to output, 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 or Ext AES as the audio input source, the instrument maps the audio signal to the level-meter bars as configured by the Embedded Input Map or the AES Input Map in the Audio Inputs/Outputs submenu of the Configure menu.

Selecting the Audio Display Type

Use the Display soft key to select one of the following audio displays:

- Level Meters

- Level Meters + Lissajous

- Surround Sound

- Channel Status

- Embedded Audio Status

Elements of the Level Meters + Lissajous Display

When you select the Level Meters + Lissajous display (see Figure 3‑3), the left portion of the screen displays the level meters and the right portion of the screen displays the Lissajous display (also known as a phase plot).
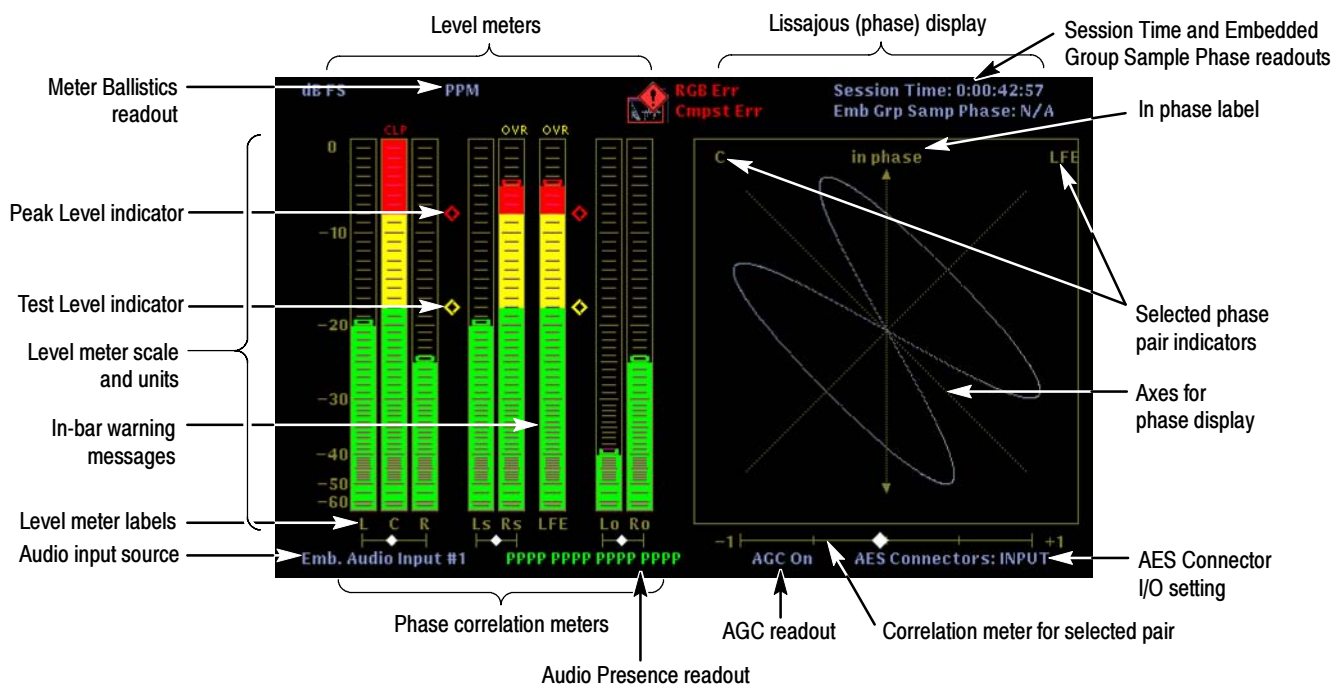
Figure 3‑3: Audio Level Meters + Lissajous display

Selecting the Channel Pair for the Lissajous Display

To select which channel pair is displayed on the Lissajous display:

NOTE. The channel pair labels depend on the Audio Program Type setting (surround or stereo pairs).

---

1. Touch the Lissajous Pair: soft key to open the Audio Lissajous Pair menu.

2. Select a channel pair by performing one of the following actions:

   ■ Touch the soft key for one of the four default channel pairs.

   ■ Touch the Custom Pair: soft key to select the custom channel pair you specified using the Configure Custom Pair soft key.

   ■ Touch the Configure Custom Pair soft key to open the Custom Lissajous Pair menu where you can 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 Surround Sound Display

When you select the Surround Sound display (see Figure 3-3), the left portion of the screen displays the level meters and the right portion of the screen displays the Surround Sound display. Use the Audio Displays submenu of the Configure menu to enable or disable the Dominance indicator and to select the type of Surround Sound filter: Linear (RMS) or A-weighting.

NOTE. *Audio Surround Sound display courtesy of Radio-Technische Werkstaetten GmbH & Co. KG (RTW) of Cologne, Germany.*

Audio Input Mapping Restrictions for Surround Sound Display

The Surround Sound display is restricted to using signals from only certain audio input channels. The factory default settings for mapping the audio inputs are the correct settings for using the Surround Sound display.

For embedded audio groups 1 and 2, the display only works when channels 1 and 2 are mapped to the L-R bars, channels 3 and 4 are mapped to the C-Lfe bars (the Lfe channel is ignored), and channels 5 and 6 are mapped to the Ls-Rs bars. Channels 7 and 8 are always ignored. Similar rules apply for embedded audio groups 3 and 4 and for the external AES audio inputs. You cannot remap the audio inputs when you are using the Surround Sound display.
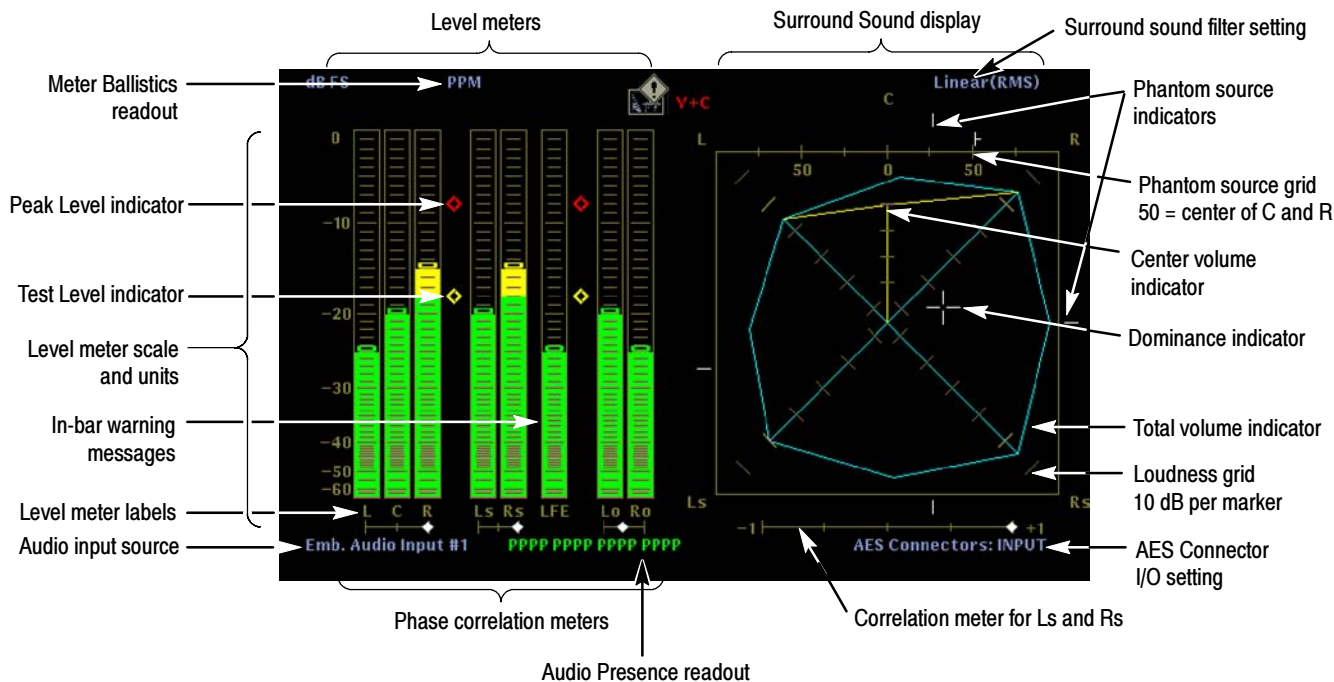
Figure 3- 4: Surround Sound audio display

Interpreting the Surround Sound Display

The Surround Sound display indicates the audio level balance among the left (L), right (R), left-surround (Ls), and right-surround (Rs) channels as cyan lines on the ruled scales radiating from the center. The scale has tic marks at 10 dB intervals. An additional tic mark indicates the –18 dB level. The –18 dB and –20 dB levels are typically used for aligning audio levels.

The cyan polygon formed by connecting the level indicator endpoints shows the total sound volume formed by the L, R, Ls, and Rs channels. This connecting line will bend away from the center if the two signals have a positive correlation, will bend towards the center if the signals have a negative correlation, and will not bend if the signals are uncorrelated.

The Center Volume indicator displays the sound volume of the center channel as a vertical yellow bar between the L and R channels, and connects the ends of the L, C, and R audio level indicators with straight lines.

Phantom Sound Indicators (PSI), located on each side of the Surround Sound display, indicate the location of potential phantom sound sources formed by adjacent channels. The white tic marks on these moving bar indicators show the phantom source locations. The bar length indicates the correlation between the adjacent channels. A short-to-medium length green bar indicates positive correlation between the channels, forming a localized phantom sound source located at the white tic mark. The bar grows to full length and changes color to yellow as the correlation moves to zero, indicating a wide, non-localized sound image. The bar changes color to red for adjacent channels with significant negative correlation. For negative correlations, the ends of the PSI for the L and R channels will continue to grow at a 45 ° angle while the other PSIs remain at full length.

A fifth PSI at the top of the display shows potential phantom sources formed by the LC channel pair and the CR channel pair. If the L, R, and C channels all have the same signal level, the white tic mark on the bar will appear directly above the C level indicator. The white tic mark will move right or left depending on the relative balance between the three channels. A short bar to the left of the white tic mark indicates a positive correlation between L and C. The bar will grow as the correlation decreases. Like the L–R PSI, the bar will continue to grow at a 45 ° angle for negative signal correlations. The bar to the right of the white tic mark behaves in the same way, depending on the C–R correlation. This PSI indicator uses the same color coding as the other PSI indicators.

Figure 3--5 shows examples of how the Surround Sound waveform appears for some typical signal types.
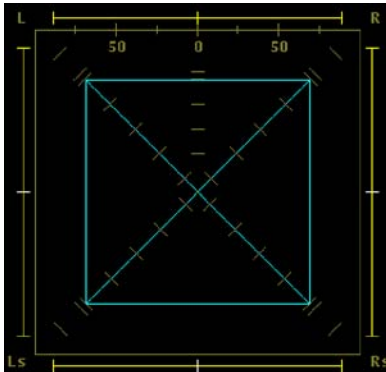
Uncorrelated signals; same level in the L, R, Ls, and Rs channels.
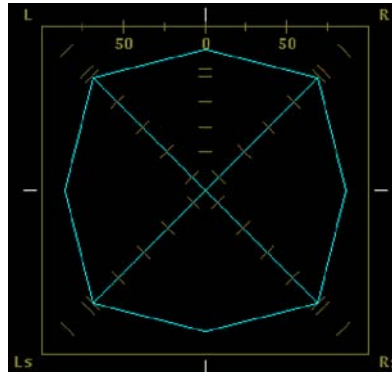
Sine wave test tone; same level in the L, R, Ls, and Rs channels. All signals are in phase, creating phantom sources between the adjacent channels.
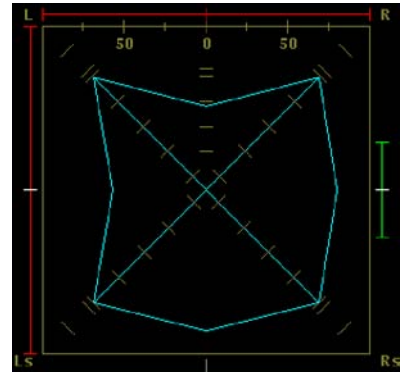
Sine wave test tone; same level in the L, R, Ls, and Rs channels. Channels R, Ls, and Rs are in phase, creating phantom sources between the adjacent channels. Channel L is out of phase.
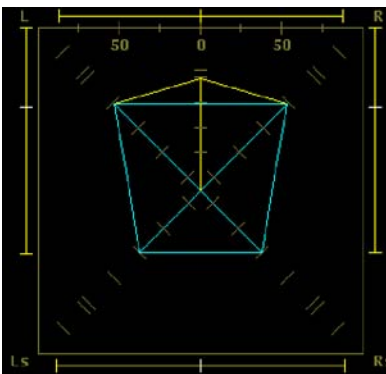
Surround sound program with strong center channel presence.
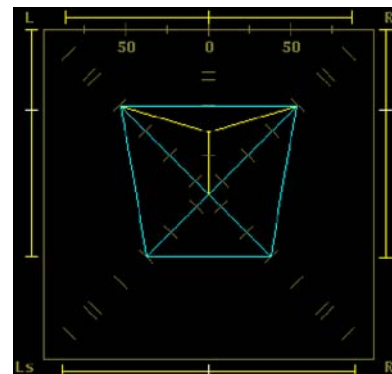
Surround sound program with weak center channel presence.
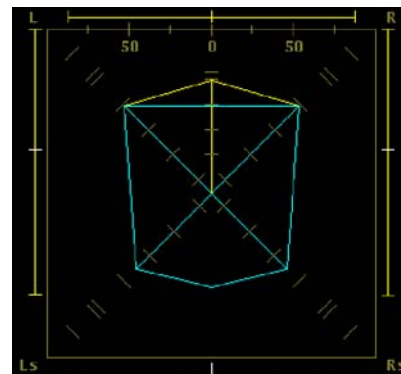
Monaural signal in channels Ls and Rs, creating a phantom source in the center, as in a 3--1 surround sound system.

Figure 3- 5: Typical waveforms on the Surround Sound display

Channel Status Display   The Channel Status display shows the channel status information, for one channel pair at a time, that is embedded in the AES3--1992 (professional) or IEC--60958-3 (consumer) digital audio channels. You can select from the following four display formats: Text, Binary, XMSN Order Binary, or Hex.

Embedded Audio Status Display   This display 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.

- Whether the header indicates that audio is present on each pair of channels (Status = Present or Not Present).

Bowtie Mode

The Bowtie display evaluates the relative amplitude and timing between the three video channels. To access the Bowtie mode, press the MEASURE button, touch the Measure Menu soft key, and then touch the Bowtie soft key.

The Bowtie display requires a special test signal to be sent from the monitored source. The Tektronix TG2000 Signal Generation Platform can produce a Bowtie test 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).

Measurements The Bowtie display is made up of two separate waveforms. The left waveform always compares CH 1 to CH 2. The right waveform always compares CH 1 to CH 3.

Timing Measurement. The timing measurement is based on the 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. In Figure 3-6, the chrominance channel, CH 3 (Pr), is advanced relative to the luminance channel by 20 ns.

Relative Gain Check. The relative gain check is based on the null point at the center of the Bowtie waveforms. If the gains are not equal, the center null point will not be a complete null. 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 3-6, the left waveform will be normal and the right one will not reach a complete null.

Shifted null point

Incomplete null

Waveform showing timing error in CH 3
(20 ns advanced)

Waveform showing gain error in CH 3
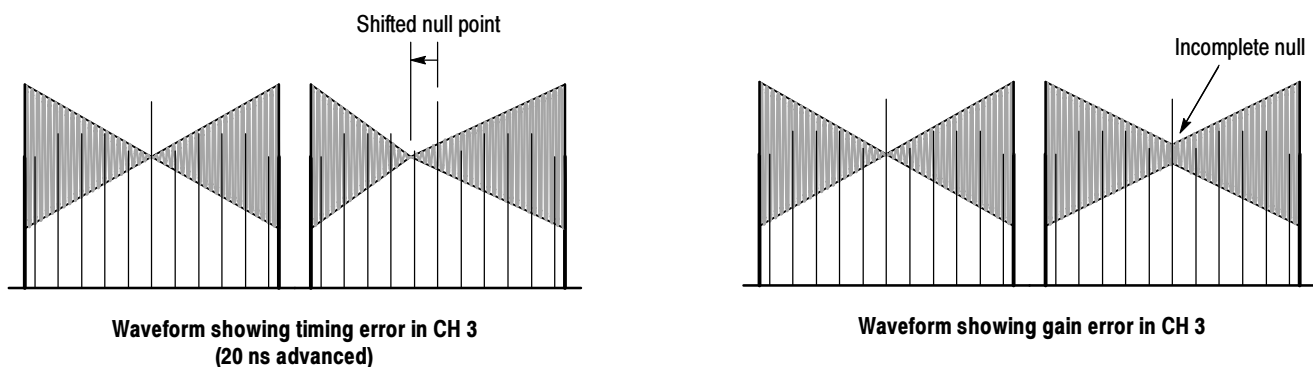
Figure 3‑6: Bowtie waveforms showing timing and relative gain errors

Composite Display

The instrument 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.

Data Display (WFM700M Only)

The Data Display mode shows the actual SD or HD input data without any interpolation.

Data Display Colors and Units

Different fields of the data stream are shown in different colors, as shown in Table 3--2. Use the Readout Format soft key to view the 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

Video / Data Selection

The instrument provides two modes for representing signal data: Video and Data.

Video Mode. Shows the data like the video YPbPr display in waveform mode, but without interpolation. 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. Use 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. 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 data 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.

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. You can also download the Diagnostic Log using the Remote Web Interface.

Powerup Diagnostics Setting

At power up, the instrument runs either full or brief diagnostics, depending on the setting in the System submenu of the Configure menu.

Running Diagnostics

You should run diagnostics after installing a new module, upgrading the instrument firmware, or when troubleshooting suspected instrument problems. Warning messages are displayed in yellow text; PASS and FAIL messages are labeled PASS (green text) or FAIL (red text). You have the following diagnostic choices:

Run Full Powerup Diagnostics. The instrument goes through all of the diagnostics and displays the results.

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. 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. After running this diagnostic, you must reboot the instrument to return to normal operation.

Eye / Jitter Mode (WFM700M Only)

Press the EYE button to access the Eye / Jitter menu and measurements.

Making Eye Measurements

The Eye pattern display presents a voltage-versus-time waveform composed of multiple sweeps of the SD or HD serial bit stream.

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). 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.

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 usefulness of the eye measurement decreases with long 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 measurement 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 a bandwidth setting is chosen, only jitter at frequencies above that bandwidth are observed.

You can turn on or off a readout that displays automatic measurements and a histogram of the eye waveform. Refer to *Automatic Eye Measurements* on page 3–18 for more information.

Setup for Eye Measurements. Perform the following steps to prepare the instrument for Eye measurements:

1. Connect a 100% Color Bar, serial video-signal to the instrument using a 75 Ω cable of two meters or less in length. Use high quality, low loss coaxial cable, such as Belden 8281.

2. Press the GAIN button and select 1x vertical gain.

3. Press the EYE button to select the Eye Pattern display.

Automatic Eye Measurements. When the Eye display is selected, you can use the Eye Meas. soft key to turn on or off a readout that displays automatic measurements of the eye waveform (see Figure 3-7). The measurement readouts are colored red when the eye waveform exceeds the defined thresholds.

Use the Set Default Thresholds soft key to set the eye measurement thresholds to the levels defined by the associated standard (SD signals: SMPTE 259M; HD signals: SMPTE 292M). Use the Set Meas Thresholds soft key to set custom threshold levels.

NOTE. The automatic eye measurements are based on the eye waveform display. To ensure the best eye measurement conditions, the instrument sets the clock recovery bandwidth set to 1kHz. While the automatic eye measurements are running, the instrument prevents you from adjusting the recovery bandwidth setting or from adjusting the following signal controls: vertical and horizontal position, sweep and gain settings, and Line Select mode.

Reporting Automatic Eye Measurement Errors. When enabled in the Physical Alarms submenu of the Configure menu, the eye measurement alarms will be reported to the Event Log in only the following two conditions:

- When the Eye display is selected and the eye measurement readout is turned on

- When the Event Log or Alarm Status displays are selected after the eye measurement readout is turned on

That is, if you enter the Eye display and turn on the eye measurements, and then you use the STATUS button to view the Event Log or Alarm Status displays, the eye measurement alarms will be active. If you select another display mode such as Jitter or Waveform, the eye measurement alarms will be disabled.
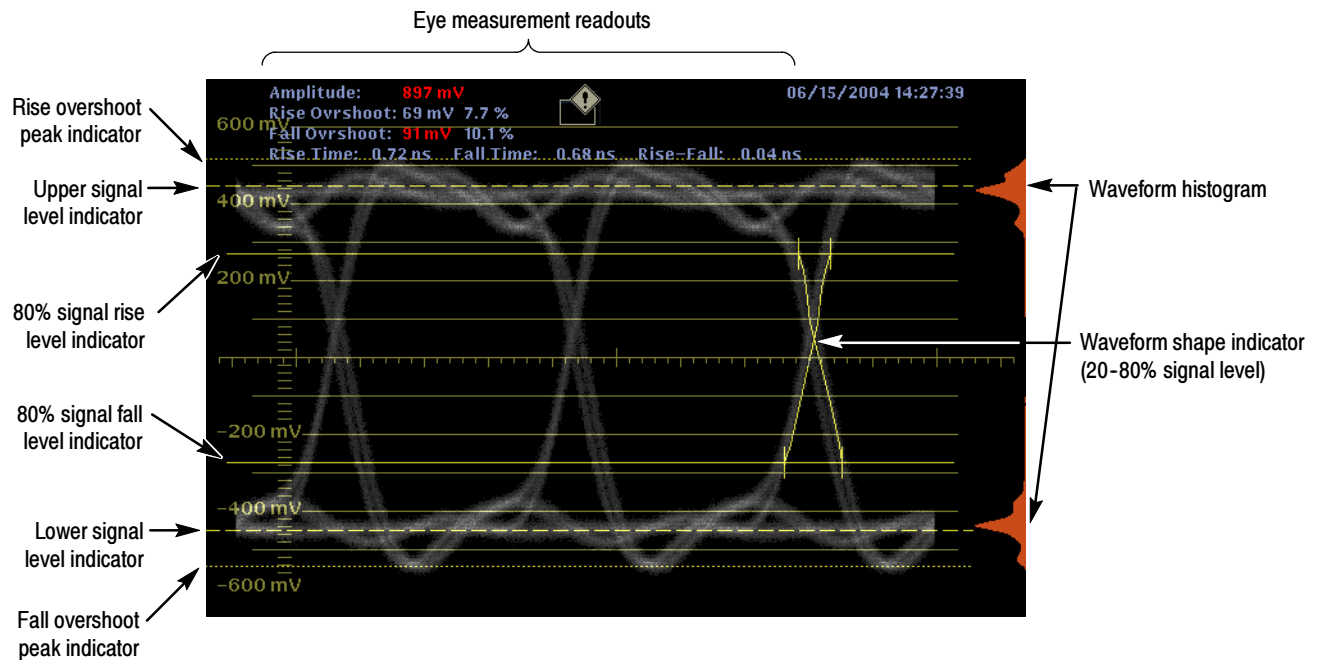
Figure 3-7: Eye display showing the automatic measurements

Measurement Accuracy Using the Measurement Cursors. If you use the measurement cursors to measure the eye waveform, you may measure a different result than that shown in the automatic eye measurements readout. This is because the internal peak detector can measure waveform excursions better than people can when using their eye to position the cursors.

Manually Measuring Amplitude. The following procedure shows you how to manually measure the signal amplitude using both the graticule and the Voltage Cursors.

1. Perform the initial settings for Eye measurements described in *Setup for Eye Measurements* above.

2. Use the CLOCK BW soft key to select the 1 kHz filter. This setting reduces the effects of timing jitter, which can obscure the amplitude measurement.

3. To measure amplitude, use the graticule (1x gain) or use the voltage cursors. Ignore any overshoot or undershoot on the rising or falling edges.

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. Higher gain settings help match the cursor to the waveform.

Signal sources should measure 800 mV$_{p-p}$ ±10%. Signal amplitudes outside of this range can degrade receiver performance.

Manually Measuring Aberrations. Serial sources should produce good signal transitions with a minimum of overshoot and ringing. To manually measure aberrations, perform the following steps:

1. Perform the steps in *Setup for Eye Measurements* on page 3–17.

2. Position one voltage cursor at the peak of the overshoot at the top horizontal part of the waveform.

3. Position the second voltage 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.

4. The Voltage Cursor readout provides the signal amplitude.

5. 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 since automatic equalizer circuits in receivers may be sensitive to larger aberrations.

Manually Measuring Rise Time. Rise time measurements of the eye waveform check the performance of sources and signal degradation by cabling. The following procedure provides two methods for manually measuring rise time. The first method uses variable gain to normalize the signal and the second method uses the percentage voltage cursors.

1. Perform the steps in *Setup for Eye Measurements* on page 3-17.

2. Method 1 - Use variable gain to measure rise time.

    a. Use Variable Gain to resize the waveform to 10 major divisions. Position the top and bottom of the waveform on graticule lines.

    b. Position the first timing cursor at the crossing of the rising edge of the Eye waveform and the graticule line two divisions above the bottom of the waveform as shown in Figure 3-8.

NOTE. You can use the horizontal MAG control in the Sweep menu for greater accuracy when adjusting the time cursors.

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    c. 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 as shown in Figure 3-8.

    d. The Delta time readout indicates the 20 - 80% rise time measurement.
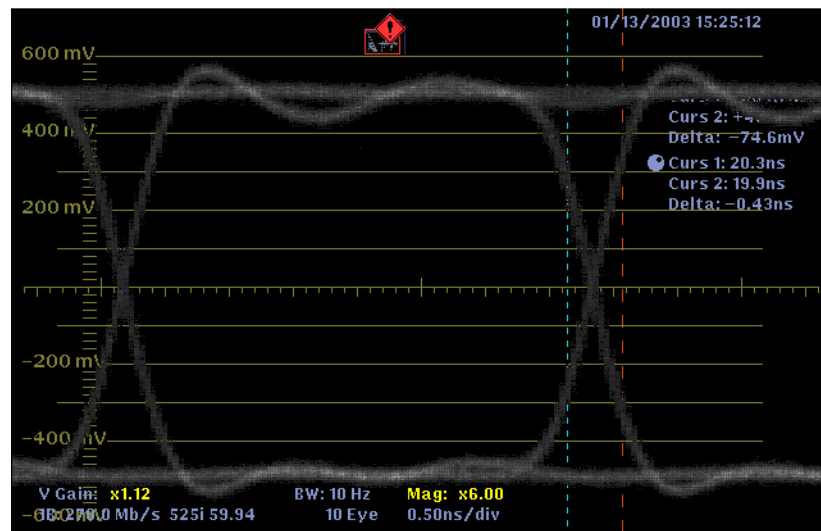
Figure 3-8: Timing Cursors alignment for measuring 20-80% rise time

3. Method 2 – Use the percentage voltage cursors to measure rise time:

   a. Turn on the voltage cursors and set the voltage cursor units to %.

   b. Position the first voltage cursor to the top of the signal, and then position the second voltage cursor to the bottom of the signal.

   c. Touch the Set 100% soft key.

   d. Position the first voltage cursor to where the readout lists 80%, and then position the second voltage cursor to where the readout lists 20%.

   e. Position the first timing cursor at the crossing of the rising edge of the Eye waveform and the 20% voltage cursor.

NOTE. You can use the horizontal MAG control in the Sweep menu for greater accuracy when adjusting the time cursors.

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   f. Position the second timing cursor at the crossing of the rising edge of the Eye waveform and the 80% voltage cursor.

   g. The Delta time readout indicates the 20 – 80% rise time measurement.

Making Jitter Measurements

The Jitter display mode 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.

Timing jitter is the deviation of signal transitions compared to those of a reference clock. Jitter results in Eye closure along the time axis, narrowing the window in which the data values can be accurately determined.

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. 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. The demodulator can detect jitter up to 5 MHz.

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.

Using Line Select. When Line Select is off, the jitter measurement reflects the maximum amount of jitter in the full field. When Line Select is on and Line sweep is selected, the jitter measurement displays "line *n* jitter," with *n* being the selected line number. The jitter measured on an individual line will always be equal to or less than the full field jitter measurement.

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.

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.

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. Many jitter problems in systems have resulted from 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. Use the appropriate BW Limit filter selection to include or reject genlock jitter from a measurement.

Reporting Jitter Measurement Errors. When enabled in the Physical Alarms submenu of the Configure menu, the Jitter alarm will be reported to the Event Log in only the following two conditions:

- When the Jitter display is selected

- When the Event Log or Alarm Status displays are selected after the Jitter display is selected

That is, if you enter the Jitter display and then use the STATUS button to view the Event Log or Alarm Status displays, the jitter measurement alarm will be active. If you select another display mode such as Eye or Waveform, the jitter measurement alarm will be disabled.

Use the Set Default Thresholds soft key to set the thresholds back to the default values for the type of signal you are monitoring: SD (SMPTE 259M) or HD (SMPTE 292M). The default value for the jitter measurement 0.2 UI, which is the maximum alignment jitter specification for both SD and HD signals and is the maximum timing jitter specification for SD signals (see Table 3–3).

Since the maximum timing jitter specification for HD signals is 1.0 UI, you must set the high-pass filter to 10 Hz and manually set the jitter threshold to 1.0 UI before the instrument will properly generate an alarm if the HD signal exceeds the SMPTE 292M timing jitter specification.

Use the Set Meas. Thresholds soft key to set a custom threshold level.

Table 3- 3: Jitter measurement alarm thresholds

Signal type	High pass filter setting	Alarm threshold
SD (SMPTE 259M)	10 Hz (timing jitter)	0.2 UI (740 ps)
	1 kHz (alignment jitter)	0.2 UI (740 ps)
HD (SMPTE 292M)	10 Hz (timing jitter)	1.0 UI (673 ps)
	100 kHz (alignment jitter)	0.2 UI (134 ps)

Measurement Accuracy Using the Measurement Cursors. If you use the measurement cursors to measure jitter, you may measure a different result than that shown in the jitter measurement box for the following reasons:

■   The internal 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

Manually Measuring Timing Jitter. Perform the following steps to manually measure the timing jitter:

1. Perform the steps in *Setup for Eye Measurements* on page 3–17.

2. Select the 3 EYE mode, which shows peak jitter at each eye crossing.

3. Select the 10 Hz bandwidth filter to measure the total broadband jitter (use this setting if composite D/A conversion is planned).

4. Position the timing cursors to measure the width of the Eye zero-crossing point (see Figure 3–9). If necessary, use the Gain and Sweep menus for better vertical and horizontal resolution.

5. 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)
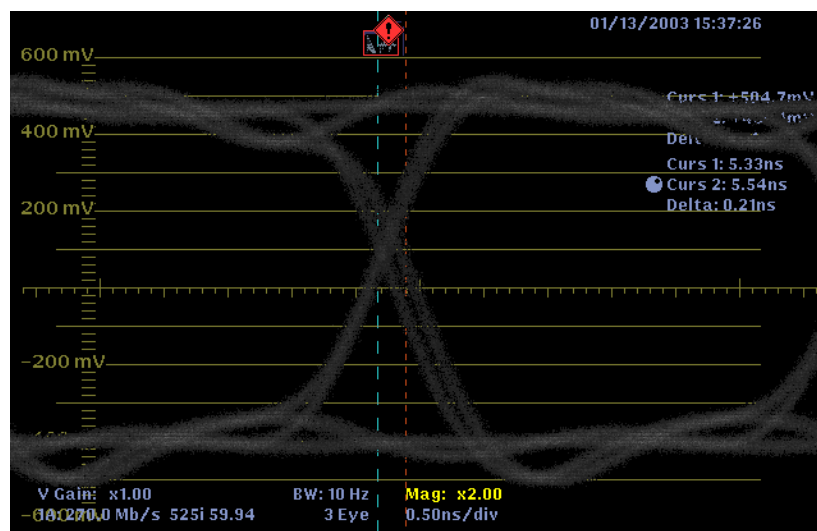
Figure 3‑9: Timing Cursors alignment for measuring timing jitter

Gamut Measurements

NOTE. Gamut error detection is disabled in Eye and Jitter display modes.

The waveform monitor features three types of gamut displays:

- The Diamond display shows the relationship between the R, G, and B video signals. The waveform monitor converts the Y, P_b, and P_r components of the signal into R, G, and B to form the Diamond display.

- 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.

NOTE. Refer to the reference document A Guide to Standard and High-Definition Digital Video Measurements *at the Tektronix, Inc. Web site (www.tektronix.com) for information about how the Diamond and Arrowhead displays are created and for information about defining legal and valid gamut signals.*

Checking RGB Gamut Use the Diamond or Split Diamond displays to check RGB gamut. For a signal to be in gamut, all signal vectors must lie within the G-B and G-R diamonds. 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. Use the Split Diamond display to see excursions below black in either of the G–B or G–R spaces.

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 3–10 shows out-of-gamut signals 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. The Diamond and Split Diamond displays allow you to visualize interchannel timing errors. Use the Lightning display in Vector mode to quantify the amount of timing error.

The Diamond and Split Diamond graticules have marks to indicate conformance using 75% color bars. The edge of the diamond is used for 100% color bars.

Example A:
R - Ok
G > 700 mV
B - Ok

Example B:
R - Ok
G - Ok
B > 700 mV

Example C:
R - Ok
G - Ok, 350 mV
B < 0 mV
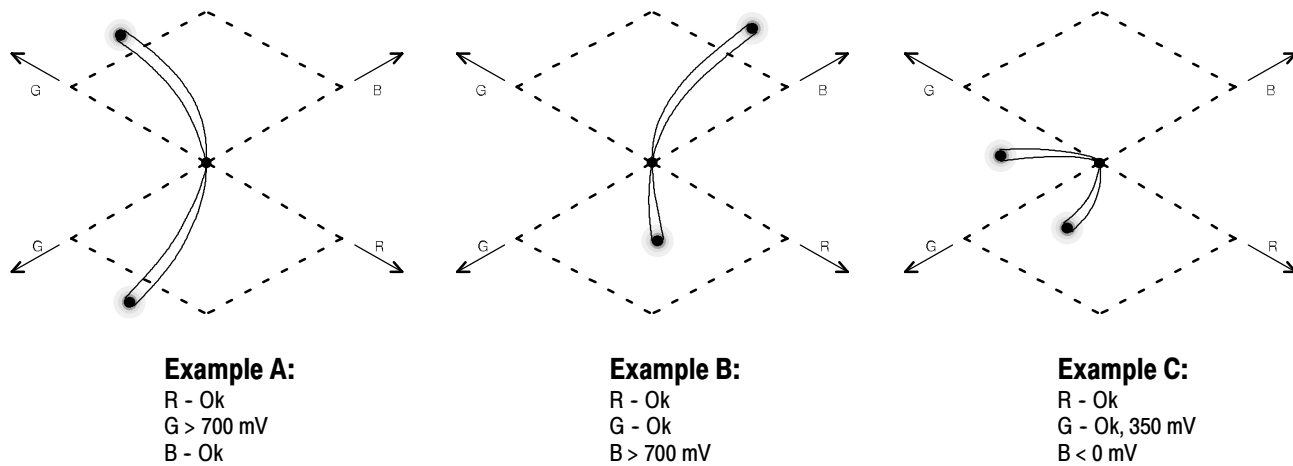
Figure 3- 10: Out-of-gamut signals on a Diamond display

Checking Composite Gamut

The Arrowhead display shows out of gamut conditions in composite color-space, without requiring a composite decoder. The 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 3–11), 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 3–12), 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.
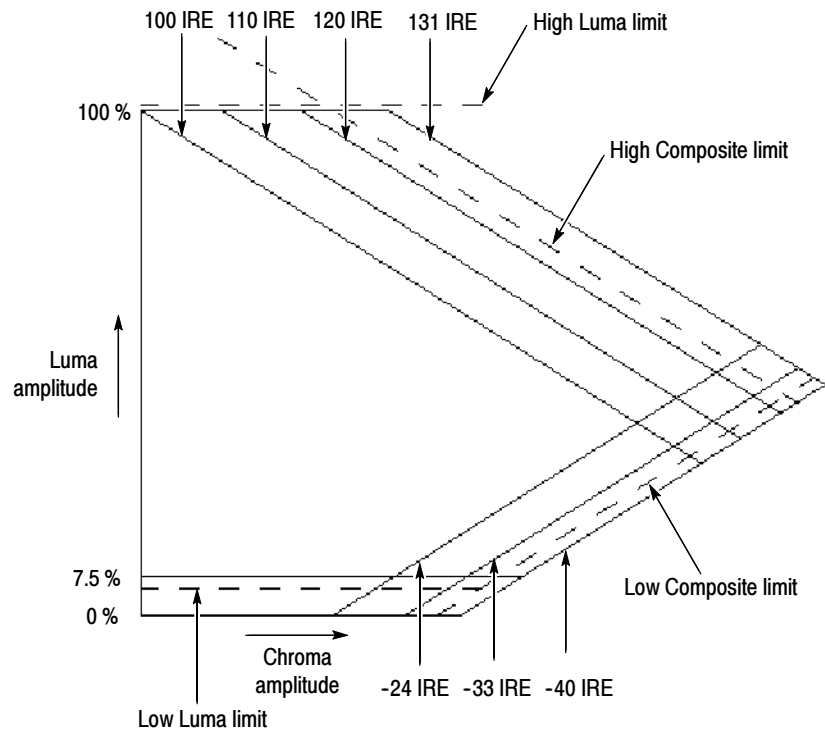
Figure 3- 11: NTSC Arrowhead graticule
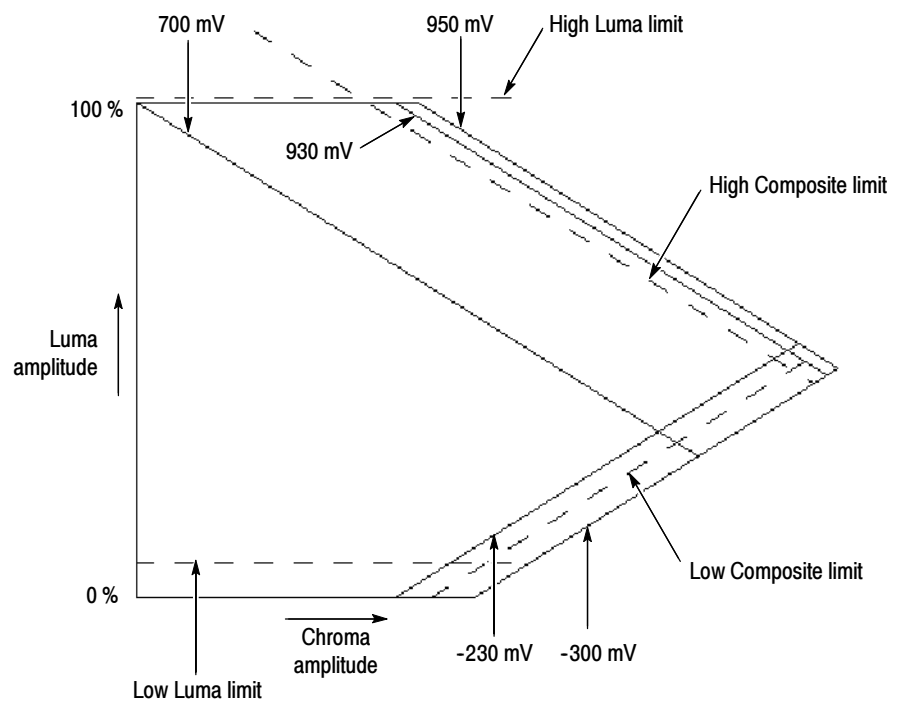
Figure 3- 12: PAL Arrowhead graticule

Setting Gamut Alarm Limits   Listed below are general guidelines for setting gamut alarm limits for the Diamond and Arrowhead displays.

Default Thresholds. Use the Grat / Gamut Default Setup submenu of the Configure menu to select the standard used for default gamut thresholds: Tek or IBU-R103. The Tek thresholds are the default gamut thresholds historically used by video monitoring equipment made by Tektronix, Inc. and are not intended to conform to an officially accepted video standard.

NOTE. When you select the Tektronix default limits, the RGB, Luma, and Y+C gamut thresholds are reset to the default values defined by Tektronix. When you select the EBU-R103 default limits, only the RGB and Luma gamut thresholds are reset since the Y+C gamut limits are not defined by the EBU-R103 standard. When you touch the Default soft key in any of the Gamut Limit menus, all of the gamut limit thresholds are reset to the standard indicated on the soft key.

Diamond Display Gamut Limits. Use the Gamut menu to set the upper and lower RGB thresholds 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.

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. Use the Limit Format soft key to set the instrument for NTSC or PAL gamut measurements. For North American applications of NTSC video signals, set the Setup control to 7.5%. In addition, set the upper Y+C Composite threshold to 120 IRE because that is the level at which a TV transmitter starts to clip the signal. Set the lower Y+C Composite threshold to –24 IRE because that is the lower limit of chrominance excursions.

For the majority of PAL video signal applications, set the Setup control to 0%. Set the upper Y+C Composite threshold to 935 mV and the lower Y+C Composite threshold to –235 mV because those are the limits of chrominance excursion.

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.

Set the upper and lower luminance thresholds for a 3% tolerance (103% and –3%) to monitor excessive luminance excursions.

Filtering. Two filters allow you to 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.

Use the Horizontal filter setting to monitor for out-of-gamut errors within a single horizontal line using a low-pass filter (SD: < 1 MHz, HD: < 1.2 MHz).

Use the Horizontal + Vertical filter setting to monitor 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. Use this setting to accept horizontal artifacts, making the detection symmetrical in the picture domain.

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. The Area setting does not affect bright-up in the Picture display.

Line Select Mode

Use Line Select mode to select one line of the video signal to display and measure. Line Select stays active as you change between major modes. This enables you to select a line in Picture mode, and then go to other modes to view the same line.

The selected line is highlighted in Picture mode and in the thumbnail picture. The external picture monitor signals also contain a bright-up if enabled in the Video Inputs/Outputs submenu of the Configure menu.

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. Select All Fields to display 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 video line is viewed in Data Display mode (WFM700M only). Sample Select is also active in Picture and thumbnail modes to allow correlation of events between modes.

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.

Diagnostics Log   This log contains the results of the last diagnostic test that was performed.

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, events are time-stamped with the timecode embedded in the video signal.

> ⚠ *CAUTION. The time-of-day time stamps in the Event Log are based on the system time of the instrument when the logging process starts. If you update the system time of the instrument while the Event Log is in the Running mode, the time stamps will not start using the new system time setting. You must stop and restart the Event Log before the time stamps will use the new system time.*

Controlling the Size of the Event Log. The event log can contain up to 10,000 entries. Recording each individual event separately would quickly fill the log. To handle this problem, the instrument classifies 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 submenu of the Configure menu to set the event log storage mode:

   ■ Log for Duration. Logs intermittent events as one event to save space in the event log.

   ■ Log for Resolution. Logs intermittent events separately, which preserves time stamp information for each event, but quickly fills up the event log.

By default, most of the possible alarms are enabled for logging. Use the Configure Alarms submenu of the Configure menu to limit the number of monitored error conditions.

Configuring the Event Log Full Condition. Use the Printing/Event Log 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.

Viewing and Printing the Event Log. You can view the Event Log using the Status menu or using the Remote Web Interface. In the Status menu, use the Configure View Filter soft key to show only the events you want to view.

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.

The Event Log uses icons to indicate the type and duration of detected signal conditions. Table 3–4 shows the icons you may encounter as they appear on-screen and in the Event Log file downloaded using the Remote Web Interface.

Table 3‑4: 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.

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 3-15 for more information.

From the Measure submenu of the Data Display menu, you can access the following three display modes:

■ Bowtie. Use this display to evaluate the relative amplitude and timing between the three video channels. Refer to *Bowtie Mode* on page 3-14 for more information.

■ Ancillary Data. Use this display to view the raw (undecoded) data words in the selected ancillary data packets. Refer to *Ancillary Data Display* on page 3-4 for more information.

■ ARIB STD-B39. Use this display to view the decoded data for video signals using ancillary data compliant with ARIB STD-B39. Refer to *ARIB STD-B39 Display* on page 3-6 for more information.

Multi Mode

Press the MULTI button to enable the Multi mode display, which shows two different views of the same input signal side-by-side. You must use the Input menu to select a different input signal for display.

The front-panel controls affect only the display mode in the currently selected Multi-mode window. Menu changes you make while the instrument is in Multi mode remain in effect when you exit Multi mode.

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 or Surround Sound is the selected Audio-mode display, the Lissajous or Surround Sound display will appear when you select Audio as one of the Multi mode displays. You must select Level Meters as the Audio-mode display to view the audio level meters in Multi 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.

Picture Mode

Press the PICTURE button to display a full screen representation of the video signal present at the selected input.

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.

Press the PICTURE button again to display the Picture menu. Use the Safe Area soft key to display the Safe Action and Safe Title graticules, which comply with SMPTE RP218. The safe area graticules do not appear in the thumbnail picture. Since the full-size SD picture display is cropped, use the SD Picture Half Size setting to view the complete picture when you are monitoring SD signals.

Use the Grat/Gamut Default Setup submenu of the Configuration menu to enable the display of decoded closed captioning text in Picture mode.

Use the Video Inputs/Outputs submenu of the Configure menu to enable or disable bright-ups, or contrast patterns, to show areas that are out of gamut, or to show the selected line or sample.

Use the Display menu to enable a thumbnail picture that appears in other display modes.

Printing

NOTE. The instrument formats print output in Postscript color, or Postscript black and white formats. The selected printer must support LPD protocol.

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.

■ Diagnostics Log file. To print the Diagnostic Log file, use the System submenu of the Configure menu.

Status Displays

Press the STATUS button and then touch the Display soft key to select from the following status displays:

- Session. Use this selection to view the Video Status/Session, Audio Status/Session, or Auxiliary Data Status displays.

- Alarm Status. Use this selection to view the status of the General, Serial, Audio (Option DG only), Auxiliary Data, or Physical (WFM700M only) alarms.

- Event Log. Use this selection to enable, disable, configure, and view the event log.

Status Display Colors

Messages and values in the different status displays use the following colors to help indicate signal status:

- White. Identifies items that represent changes in the instrument state.

- Green. Indicates error conditions that have cleared.

- Yellow. Indicates a warning condition that might require attention but does not meet the requirements of an error condition.

- Red. Indicates signal information that has been found to be in an ongoing error state.

Video Status and Session Display

The Video Status portion of the display (left side) shows the current status of the video signal being monitored. The Video Session portion of the display (right side) 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.

Refer to the *WFM700 Series Technical Reference* document on the CD-ROM for descriptions of the status display elements.

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.

Audio Status and Session Display (Option DG Only)

The Audio Status/Session display 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.

Refer to the *WFM700 Series Technical Reference* document on the CD-ROM for descriptions of the status display elements.

Auxiliary Data Status Display

The Auxiliary Data Status display provides detailed information about the auxiliary data embedded in the video signal.

Refer to the *WFM700 Series Technical Reference* document on the CD-ROM for descriptions of the status display elements.

Event Log Display

Refer to *Logging* on page 3−32 for information about using the Event Log.

Alarm Status Displays   The instrument provides the following five alarm status displays which correspond to the categories of alarms provided in the Configure menu: general, serial, audio (Option DG only), auxiliary data, and physical (WFM700M only).

An "X" appears in the Enabled column for each of the enabled alarms. The Status column indicates the status of each alarm, whether or not that alarm condition has been enabled. Table 3--5 lists the status indicators that may appear.

Table 3- 5: 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. For example, --34--78 would be displayed to indicate that channels 3, 4, 7, and 8 have errors. This indicator is logical, after remapping, and not physical.

RGB and Composite Gamut Error Indicators. When RGB and/or Composite Gamut errors are detected, the associated lines in the Alarm Status display have characters that indicate which gamut threshold(s) are exceeded for each component. Table 3--6 lists the error codes that may be displayed.

Table 3- 6: 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)
c	Signal exceeds the low gamut limit for the chroma component (composite gamut)
Y	Signal exceeds the high gamut limit for the luma component (composite gamut)
y	Signal exceeds the low gamut limit for the luma component (composite gamut)

Vector Mode

Press the VECTOR button to enter the Vector mode, where you can select two related displays: Vector and Lightning. Both displays have targets for determining conformance using 75% or 100% color bar signals.

NOTE. Refer to the reference document A Guide to Standard and High-Definition Digital Video Measurements *at the Tektronix, Inc. Web site (www.tektronix.com) for information about how the Vector and Lightning displays are created.*

Vector Display The Vector display allows you to view the signal as a complex vector of color components, with no luminance information included. The display is a traditional vector plot of the color difference signals Pb and Pr. The radial magnitude represents saturation and the phase angle represents hue. With the Vector display, you can check the encoder accuracy for both phase and amplitude errors.

Vector Graticules. 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 and the I/Q axis on or off using the Grat / Gamut Default Setup submenu in the Configure menu.

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.

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 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.

Vector Timing Measurements. In the composite domain, the transitions between the vector end points display timing differences. 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. Therefore, the color bar transitions contain useful timing information. These timing differences appear as looping or bowing of the transitions. While the Vector display allows you to visualize interchannel timing errors, use the Lightning display to quantify the amount of timing error.

Lightning Display

The Lightning display is a Tektronix, Inc. proprietary display combining a vertical luminance axis with horizontal chrominance information. 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.

Lightning Graticule. The Lightning graticule (see Figure 3–13) 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 3–7. The electronic graticule eliminates the effects of CRT nonlinearity.

You can adjust the vertical and horizontal gain using the Gain menu and the Sweep menu to normalize signal amplitude and to expand the scale of the display to better view the small timing graticule cross-hairs.

Table 3‑7: 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.**
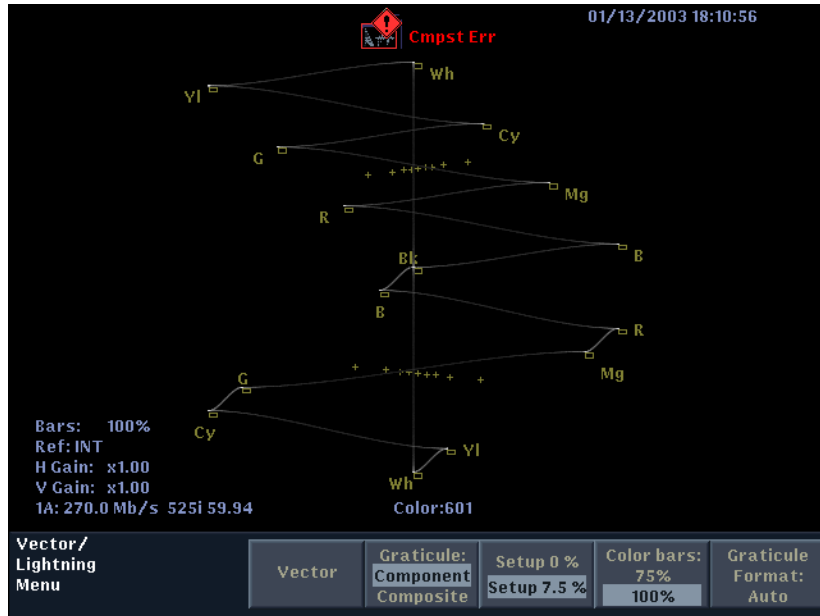
Figure 3- 13: Lightning display showing proper interchannel timing

40 ns timing error
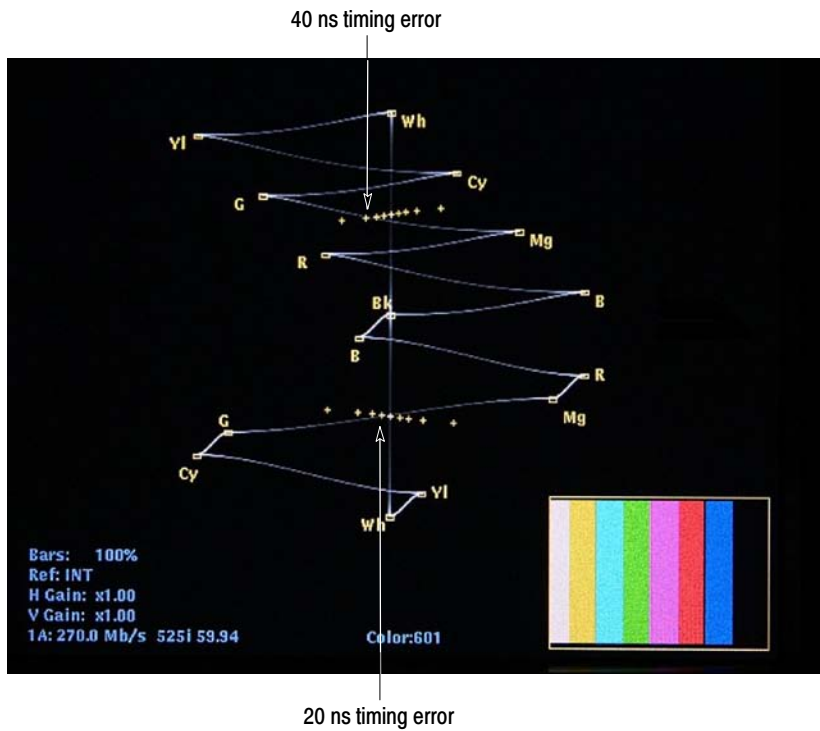
20 ns timing error

Figure 3- 14: 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 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 Pb-to-Y timing, while the bottom half measures the Pr-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.

Figure 3–13 shows a signal with proper interchannel timing. In Figure 3–14, the Lightning display shows that the signal has Y–Pb and Y–Pr timing errors.

Pr and Pb Gain Measurement. The horizontal deflection of the top half of the display is an indication of the Pb gain and the lower half indicates the Pr gain. If the color bar signal dots are within the horizontal dimensions of the appropriate graticule targets, the Pb and Pr 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.

Waveform Mode

Press the WFM button to enter the Waveform mode. In Waveform mode, the selected components are displayed in a voltage versus time plot. You can apply flat or low pass filters and choose the color space modes (such as RGB or composite). In component color space modes, you can turn the individual components on or off.

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.

Configuration

Use the Video Inputs/Outputs submenu of the Configure menu to modify the waveform by turning the EAV/SAV stripping on and off. Use the Grat / Gamut Default Setup submenu of the Configure menu to select the graticule units used in the waveform display (mV, IRE, or % full-scale).

Secondary Modes

You can use the following secondary modes while in Waveform mode:

Gain. Use the Gain menu to adjust the vertical gain of the signal display.

Cursors. Use the cursors to measure time and amplitude.

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 Select. Use the Line Select function to select part of the video signal to display and measure.

Freeze. Use the Freeze feature to capture (freeze) the active signal and compare the frozen signal to the live signal.

Sweep. Use the Sweep menu to select from the following sweep modes:

■ 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. Turns the Mag function on and off.

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.

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.

Measuring Relative Timing Between Two Serial Component Signals

To measure the timing of two digital signals, use the following procedure:

1. Connect the two terminated 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, set Strip EAV/SAV to Pass. This mode allows the 3FF, 000, 000, and XYZ values to be displayed on the waveform monitor as shown in Figure 3-15.

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.

---

5. To measure vertical timing, perform the following steps:

   a. Set Line Select and Sweep for two-line mode.

   b. Select Field 1 and set 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 signal 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.
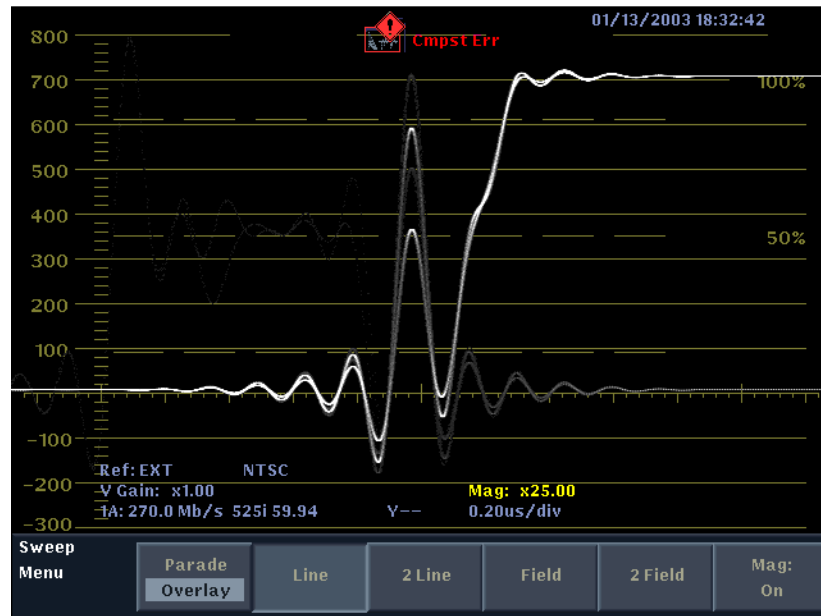
Figure 3‑15: XYZ pulse of Y channel with pass through selected

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.

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