

# Multiformat, Multistandard Portable Waveform Monitor

## WFM2200A Datasheet



The WFM2200A Portable Video Waveform Monitor provides an ideal solution for video installation and maintenance applications with an integrated high-brightness, low-power consumption LED backlit display in a convenient portable form factor. This versatile instrument can operate with an internal battery and DC input through an AC-DC converter unit.

### Key features

- Portable instrument that is ideal for field production setup and troubleshooting
- Operates with internal, rechargeable, and replaceable battery unit; external recharger kit and a battery unit for replacement are available as an option
- Optical SDI input and output monitoring compliant to SMPTE297 (Option SFP)<sup>1</sup>
- HDMI signal monitoring (Option SFP-HDMI)<sup>1</sup>
- Coaxial cable simulation test loop for secure system installation

<sup>1</sup> Only one SFP module (Option SFP or Option SFP-HDMI) can be installed in the instrument at a time.

<sup>2</sup> Audio Surround Sound Display licensed from Radio Technische Werkstätten GmbH and Co. KG (RTW).

- One SDI input and one MULTI input with multiformat, multistandard support
  - The MULTI input can be configured as SDI, AES or LTC input
  - Standard support for Dual link (SMPTE372) format using both SDI inputs
  - Upgradeable to include 3G-SDI (Level a and level b) format support (Option 3G)
- 3G/HD/SD color bar and pathological signal generator with genlock and moving picture for troubleshooting signal paths and equipment; test signals to adjust a picture monitor are also available
 

(Note: SD/HD SDI generation is standard; Option 3G is required for 3G-SDI signal generation; Option SFP is required for optical signal generation)
- Comprehensive audio monitoring tool
  - Up to 16 channel embedded AES/EBU audio
  - Multichannel surround sound<sup>2</sup> display and flexible lissajous display
  - Audio loudness meter available in audio display (Option LOUD)
  - Dolby E metadata decode and peak level metering (Option DBE)
  - Dolby E guard band meter with user-defined limits (Option DBE)
- AES audio test tone generator for embedded and AES output
- Dolby E test stream generation for embedded and AES output (Option DBE)
- Audio/Video Delay measurement and Propagation Delay measurement with the test signal generation (Option ADVP)
- Ability to display analog waveform of external reference signal and LTC signal for quick diagnosis of the potential issues in sync and time distribution system
- Tektronix-patented Diamond and Arrowhead displays for color Gamut Compliance monitoring
- Comprehensive data monitoring helps to quickly resolve difficult content quality and reliability issues (Option DATA)
  - Simultaneous CEA708/608 closed caption monitoring; teletext and OP47 subtitle monitoring
  - Detect and decode ANC data including AFD, WSS, video index, TSID, V-Chip, broadcast Flag/CGMS-A, VITC, LTC, and ANC TC
  - ARIB STD-B35/B37/B39, TR-B22, and TR-B23 support
  - ANC data inspector and SDI data analysis display helps troubleshoot ANC data and SDI data problems

- Variety of monitoring displays
  - Tektronix-patented timing and lightning displays makes facility and interchannel timing easy
  - Extensive alarms, status reporting, and error logging for 10,000 events simplifies error correction tasks
  - Voltage and timing cursor for precise measurement
  - User-definable safe area graticules and AFD graticule facilitate editing and format conversion tasks
- Unmatched display versatility
  - Flexible quad tile display tailored to various application needs to increase productivity
  - Full screen mode that maximizes display size for precise adjustments
  - Thumbnail picture for content verification
- Unmatched usability
  - 32 presets for quick recall of instrument settings
  - USB port enables easy transfer of presets, screenshots, and error log
  - Internal speaker and headphone port for easy monitoring of audio channels
  - Intuitive menu structure and context-sensitive help
  - High-brightness display with crisp, high-resolution LED backlight, ideal for indoor and outdoor usage
  - SNMP capability facilitates centralized monitoring and control
  - Super lightweight and low power consumption design for portable, battery-powered applications

### Applications

- Field production setup including installation and maintenance troubleshooting
- System check tool in distribution and broadcast
- Portable engineering tool in manufacturing

### WFM2200A waveform monitor

Standard configuration provides multiformat support for HD-SDI (SMPTE 292), SD-SDI (ITU-R BT.601), and Dual Link (SMPTE 372) signal formats. The instrument provides automatic format detection, and with Option 3G supports Level A and Level B SMPTE 425/424 formats. The SMPTE 297 compliant optical interface (Option SFP) offers an input and output connection through an SFP transceiver module. Option SFP-HDMI provides support for HDMI signals that are unencrypted.

The cable simulator/stress capability helps the engineer to perform cable margin testing to ensure that the signal can be transmitted from point A to point B.

Audio monitoring support for up to 16 channels of Embedded AES/EBU Audio provides a variety of audio level bar monitoring, multichannel surround sound display <sup>2</sup>, and flexible Lissajous display. With Option DBE, Dolby E audio streams can be monitored and a peak level audio bar displays and metadata information are available. Also, an internal speaker or headphone port can be used for easy compliance verification of digital audio without the need for an additional piece of equipment.



This instrument provides the reliability of the Tektronix waveform monitors family in a portable, basic monitoring product. It offers uncompromised monitoring quality with sharp CRT-like traces, patented Gamut displays, picture thumbnail, display freeze, and an error log for 10,000 events for efficient content compliance verification.

- Video monitoring standards and formats
  - 3G-SDI Level A and Level B (Option 3G)
  - HD-SDI
  - SD-SDI
  - Dual Link (SMPTE372)
  - SMPTE297 optical interface (Option SFP) <sup>1</sup>
  - HDMI interface (Option SFP-HDMI) <sup>1</sup>

- Color gamut monitoring
  - Arrowhead display
  - Diamond and Split Diamond displays
- Digital audio support
  - 16-channel digital AES/EBU (embedded)
  - AES/EBU input and output
  - Audio bar displays
  - Lissajous display
  - Surround Sound display<sup>2</sup>
  - AES test tone generation for embedded and AES output
  - Dolby E metadata analysis, peak level bar meter with metadata, no decode (Option DBE)
  - Dolby E test stream generation (Option DBE)
  - Loudness meter (Option LOUD)
- Measurement and analysis
  - Simultaneous CEA708/608 closed caption monitoring; teletext and OP47 subtitle monitoring (Option DATA)
  - SDI digital data analysis (Option DATA)
  - ANC Data Inspector (Option DATA)
  - Various test signal generation, with AES audio channel pair tone generator that can be applied to all 16 channels of embedded audio, and Moving Test Signal
  - Audio/Video delay and Propagation Delay measurement with the test signal generation (Option AVDP)

## Ease of use

The intuitive user interface provides backlit buttons and online help. 32 user-configurable presets allow users to recall commonly used configurations tailored to your personal work practices. These presets can be transferred to and from other units (same model) using the USB port. An Ethernet port allows for easy download of screenshots and the Error Log.



## See and Solve with Tektronix displays

The “See and Solve” displays in Tektronix video monitors simplify video monitoring tasks such as calibration, error detection, and content correction allowing the user to detect errors at a glance and troubleshoot them efficiently.

Tektronix displays offer the sharpest CRT-like trace quality for clear waveform monitoring with the look and feel of an analog display. The familiar video waveform display can show SD/HD/3G-SDI signals in RGB, YPbPr, YRGB, or pseudo composite. Signal components can be displayed in either Parade or Overlay mode. Cursors within the waveform display allow precise measurement of Voltage and Time to be made. The vector display offers user-selectable graticules, color targets (75% or 100%), and color axis.

With several sweep rates and easy control of vertical gain and horizontal magnification, you can efficiently monitor and measure video waveform parameters.

Specialized displays provide summarized, yet comprehensive reports of alarms, session, and status of content. Powerful displays such as Video Status show a condensed view of error statistics, signal format, presence of ancillary data, and more. These Tektronix-exclusive displays simplify monitoring tasks by providing important content information at a glance.

Errors in the displays can automatically be logged in the Error Log and provided as a report.

## Wide variety of interface support

In modern broadcast facilities, there are a wide variety of video and audio signal formats that require multiple tools to monitor the signal. The WFM2200A is able to support SD/HD/3G-SDI, AES/EBU digital audio, composite black burst or tri-level sync reference signals, optical SDI (Option SFP), and HDMI (Option SFP-HDMI), which provides a one-instrument solution for a wide variety of formats.

The SDI A input supports SD/HD/3G-SDI (Option 3G) video signals. For a Dual Link SDI signal, both the SDI A and MULTI IN inputs are used.

The MULTI IN input also supports SDI, AES/EBU and LTC signals so that the user can easily determine the type of signal present on a cable.

The AES OUT and SDI OUT connectors are test signal outputs that can be configured as loop through outputs. The individual outputs for Audio and Video in conjunction with the SDI A and MULTI IN inputs allow the user to evaluate the variety of Audio/Video equipment that may require the audio/video signal with separate path.



Variety of interface support (Picture display, Audio Phase display of AES/EBU input with Loudness Meter, Waveform display of external reference input, SFP Module Status display of optical input).

The REF IN connector is used for receiving the analog composite or tri-level sync signal to measure the timing or check the sync status between sync signal and SDI signals. It is also used as a Genlock signal source for the generator function. In addition, the analog reference signal connected to this connector can be displayed as a waveform to quickly check the quality of the sync signal.

The optical SDI interface (Option SFP) is supported with a transceiver SFP module. The transceiver module provides both an input and output that can be used simultaneously. The output can be configured as loop output or as a test signal output. The HDMI interface (Option SFP-HDMI) is supported with an HDMI type-D receiver SFP module. The SFP status display shows the module model name, mode, temperature and other status of the SFP module.

The STRESS LOOP connectors are a bi-directional passive signal path that can be used with a SDI test signal generated by the WFM2200A to test a signal path, or to add an additional cable length to a signal path to provide simple margin testing.

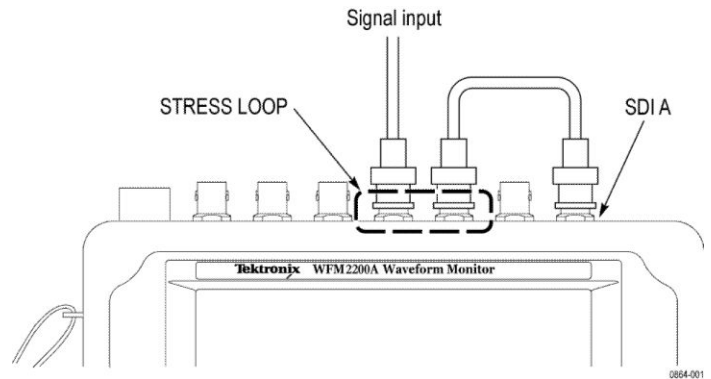


WFM2200A top panel connectors.

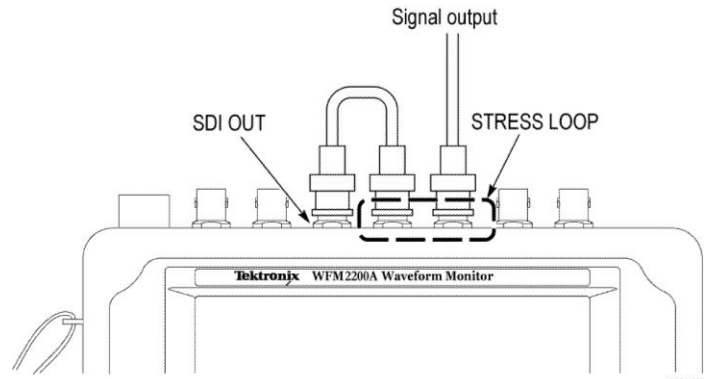
## Quickly diagnose and isolate an installation issue

Within a broadcast facility, to maintain the SDI system it is important to ensure the health of the signal so that the clock and data are decoded correctly. CRC detection within the SDI signal can be used to count the CRC errors if present in the system.

The cable stress loop adds an additional 20 meters of Belden 1694A cable to the signal path. The use of the stress loop with CRC detection simplifies how to determine the cable margin of a system so that the user can quickly check they do not reach the “digital cliff” where the transmission error rate significantly increases.



Stress loop connections for a monitored signal.



Stress loop connections for a generated signal.

## Alarms, quality statistics, and logging – thorough and fast content verification

This instrument offers a variety of displays designed to show status at a glance, in addition to the status bar continually displayed at the bottom of the screen.

A comprehensive overview of the video content status is presented in the Video Session display. Offering a time-based summary of information, this screen is ideal for presenting evidence of compliance after content screening. Information on input format and session time is presented, along with statistics on Error Detection and Handling (EDH) / Cyclic Redundancy Check (CRC) and gamut errors.

The Alarm Status display provides continuous information on the state of each condition currently being monitored by the instrument.

To support unattended monitoring and QC applications, as well as provide documentation for service-level agreements, these instruments maintain an error log of 10,000 events, which facilitates the detection and correction of problems. Log entries are recorded with date, time of day, and time code (VITC, LTC, ANC). The error log can be downloaded to a USB flash drive or through a network connection to .TXT or .HTM formats for easy record keeping and processing on spreadsheets or database software.

The screenshot displays the WFM2200A interface with three main panels:

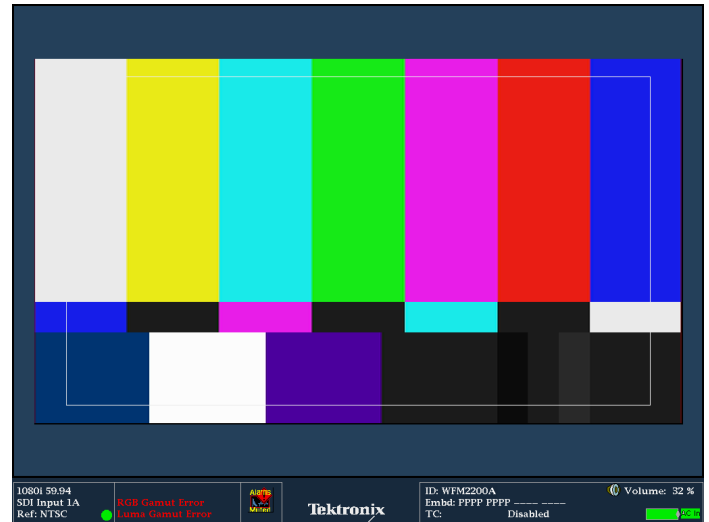
- Alarm Status (Alarm Muted):** Shows a list of alarms with their status (OK, Error, Unlocked) and additional information. Alarms include HW Fault, Input Missing, Input Signal Lock, Reference Missing, Ref Lock, Ref Fmt Mismatch, Reference Gamut Error, RGB Gamut Error, Composite Gamut Error, Luma Gamut Error, Video Fmt Change, Video Fmt Mismatch, Vid Ref Mismatch, Video Not HD, Dual Link Format Mismatch, Line Length Error, Field Length Error, EAV Place Error, SAV Place Error, and Arrow Left/Up/Down/Next page.
- Video Session:** Displays input details (SDI Input 1A - 3Ga, Signal: 1080p 59.94), selected format (Auto Format - Auto Structure - Auto Transport), SEM Payload (89h CAh 00h 01h), SAV Place Err, Field Length Err, Line Length Err, Line Number Err, Ancillary Data (Y Present), and a table of statistics for RGB Gamut Error, Composite Gamut Error, Luma Gamut Error, Y Chan CRC Error, C Chan CRC Error, and Anc Checksum Error.
- Active Log:** A table of error events with columns for Source, Error Status, Timecode, and Time. It lists various SDI 1A errors such as SDI Fmt (Auto 1080p 59.94), Video Length Error (Frame), Audio Channel Count (1), Audio Signal Loss, and Audio Channel Count (4).

At the bottom, the status bar shows: 1080p 59.94, SDI Input 1A, Ref: NTSC, RGB Gamut Error, Luma Gamut Error, Tektronix logo, ID: WFM2200A, Embd: PFFF PFFF, TC: Disabled, and Volume: 32%.

Quad Tile display of Alarm Status, Error Log, Video and Audio Sessions.

## Picture display – quick visual confirmation and precision content adjustment

For a qualitative view of the content, a full-color Picture display is offered, which can be displayed as a full-screen presentation. This display is compatible with all input formats and features automatic adjustment for aspect ratio and number of active lines.



Picture display with Safe Area Graticule.

You can select bright-up conditions that show the location of RGB or composite gamut errors on the Picture display. The Line Select mode shows the location of the line currently selected within the Picture display.

Users can choose from several Safe Action and Safe Title graticules on the Picture display which help editors and operators easily identify incorrectly positioned video content such as graphics, titles, or logos.

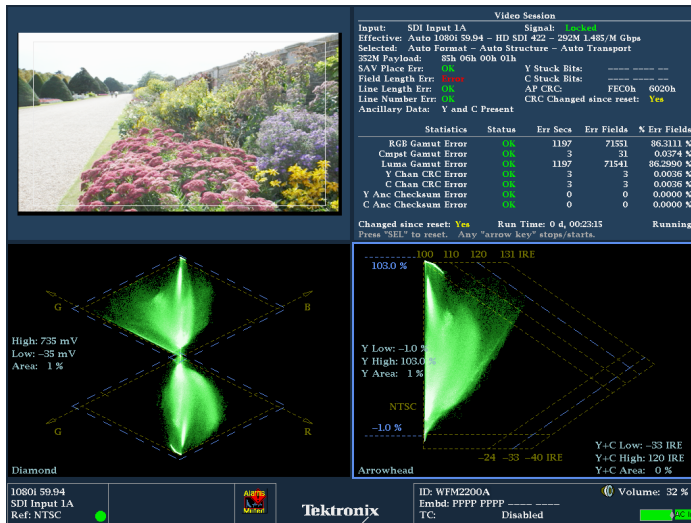
Graticule choices include the Safe Action and Safe Title graticules defined in SMPTE RP218, ITU, and ARIB standards, plus two sets of completely flexible, user-definable graticules. These graticules facilitate editing tasks and reduce the need for format conversions.

## Patented Tektronix gamut displays – efficiently detect and allow correction of gamut problems

The Tektronix-patented Diamond, Split Diamond, and Arrowhead displays simplify the process of verifying gamut compliance and are ideal for colorists, editors, and operators to visualize whether the content is RGB or Composite Gamut compliant with a single glance. Plus, they are designed to help isolate the Out-of-Gamut component just as easily.

For SDI component content that is destined for broadcast in composite systems, the unique Tektronix Arrowhead display can be used to monitor Composite Gamut compliance without the need for a separate encoder. Within this display, a separate upper and lower luma-only gamut limit can be applied.

Each of these displays offers user-selectable gamut thresholds so that operators can set monitoring limits appropriate to their specific operation and include a preset for EBU-R103. You can also select bright-up conditions to see the location of gamut errors on the Picture display. In addition, gamut monitoring is fully integrated with the powerful alarm logging and reporting capabilities of the instrument.

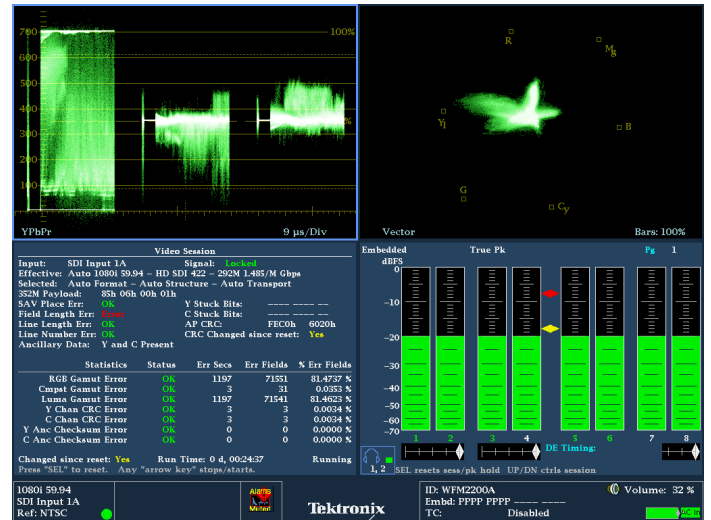


Diamond and Arrowhead gamut displays.

## Quad Tile display – flexible monitoring configuration customized to suit your application

Tektronix offers multiple display options to suit a variety of applications that can be customized to the user's needs. The Quad Tile display provides flexibility to increase your productivity. The user can configure four different displays within the one instrument. A maximum of two traces can be displayed, along with picture, status, and audio bars to create flexible monitoring configurations that can be saved as presets for quick and easy recall. For instance, a waveform parade, vector, picture, and audio bar display can be configured to monitor the audio and video signal simultaneously within the Quad Tile display.

Unlike instruments with predetermined view combinations, Quad Tile lets you create a Quad Tile display tailored to your specific needs and work practices. Each tile can be configured to enable easy signal analysis such as multiple alarm and status screens, different Safe Area Graticules and cursors on each tile, and more.

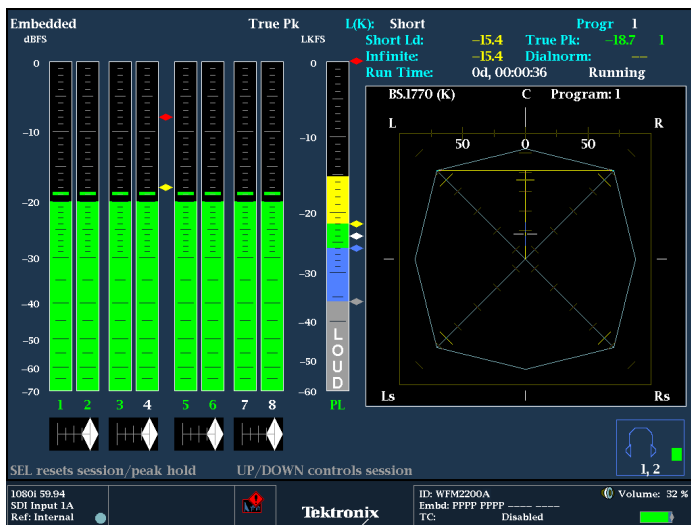


Quad Tile display allows for displays to be viewed simultaneously.

## Digital audio and video monitoring in one instrument

High-quality digital filtering and oversampling by the monitor ensures precise, reliable, and repeatable audio measurements. The instrument provides 16-channel embedded digital audio monitoring with Audio Bars, Lissajous Displays, Surround Display <sup>2</sup>, and a headphone port for easy compliance verification of digital audio without the need for an additional piece of equipment. Flexible mapping of the embedded audio inputs to the audio bar displays allows for a variety of audio mixes to be supported from multiple stereo signals to surround and stereo support.

The Surround Sound <sup>2</sup> display provides intuitive graphical representation of channel interaction in a surround sound system. The Bars display provides indication for faults, audio levels, and provides indication of the presence of a Dolby format. The flexible Lissajous display allows the selection of any two audio channels.



Audio display with Surround Sound monitoring.

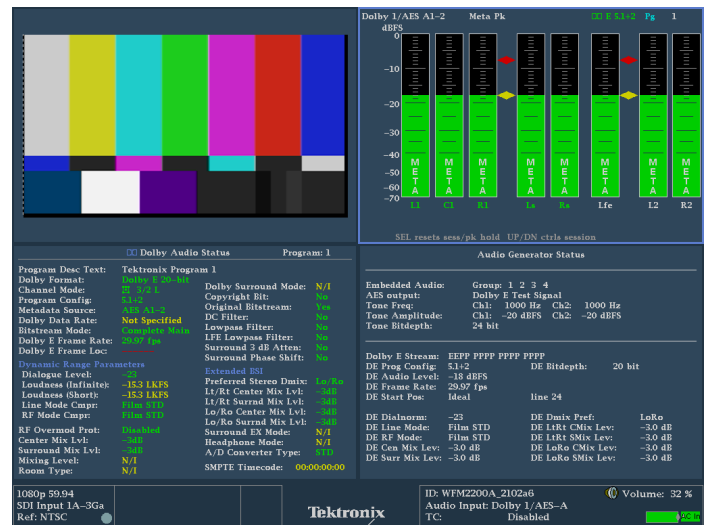
Loudness monitoring in a portable platform allows the user to verify on location that the audio levels are within the loudness measurement limits. A Loudness meter is available within the Audio display that provides Short and Infinite Loudness measurements. Within the Configuration menu, there are simple Loudness presets for the various standards such as ATSC A/85, EBU R128, and ARIB TR-B32.

Specialized audio displays provide deeper inspection of the signal and make the instrument a comprehensive compact waveform and audio monitor. The audio session displays summarize levels, faults, and number of active bits for each channel. These instruments also feature Audio Control Packet Data and Channel Status displays.

With Option DBE, the Dolby Status display gives an in-depth view of discrete audio or VANC metadata and Dolby E Guard Band timing and synchronization. User-configurable thresholds for the Dolby E Guard Band timing measurement are available as well as triggering alarms based on their specific guard band parameters. The peak level data in the Dolby metadata is also displayed as a bar graph for checking the presence of the signal.

In addition, Option DBE supports Dolby E audio generation, which provides easy access to Dolby E audio reference and test signals within modern broadcast facilities. These signals include test tones at different levels (-18 dB, -20 dB and Multitone) with frame rates compatible with the respective video signals. The Dolby E stream can be output from the SDI output as embedded audio or from AES/EBU output.

The user can set the Dolby E audio frame start locations (Early, Ideal, Late, or Custom) to test the error handling ability of the signal processing equipment in the signal path. Dolby E metadata is also inserted in the test stream, which can test the performance of signal processing equipment downstream. The user can configure each of the three D's of Dolby (dialnorm, dynamic range and downmix parameters). The Dolby E program configurations of 8x1 mono, 4x2 stereo, surround 5.1, 5.1+2 and 7.1 audio are supported.



Optional Dolby E signal generation and metadata monitoring.

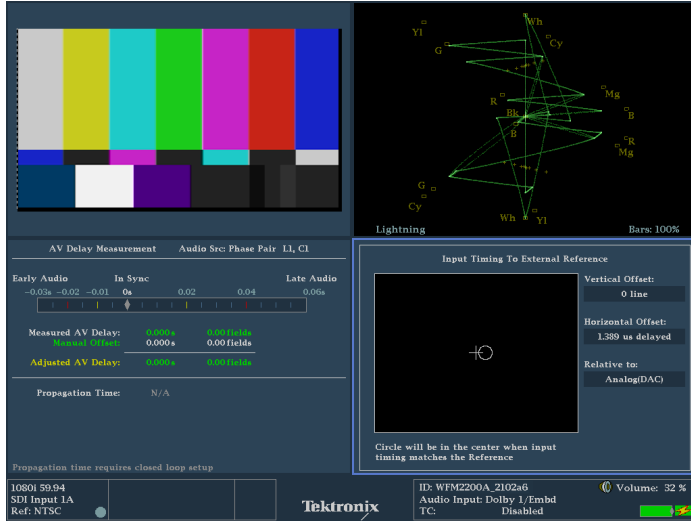
## Facility timing made easy

Audio/Video synchronization is an important challenge in the processing of video materials. With Option AVDP, the A/V delay is displayed on a graphical bar indicator. The measurement readout gives facility engineers the necessary tools to ensure system integrity and facilitate A/V delay compliance. This feature provides out-of-service measurement of A/V delay for digital audio and video formats and requires the use of the internally generated test signal to create the flash pop sequence. Alternatively, a Tektronix SPG8000 with Option SDI or a TG700/TG8000 with an SDI7 module can be used to generate the test signal.

When using the embedded test signal generator, a propagation delay measurement can be made in a closed loop by measuring the time between the video signals leaving and returning to the instrument. This propagation delay measurement makes it easy for the facility engineer to align the timing of the multiple incoming videos, check the delay of a CODEC system and/or a video signal path, including satellite feed.

The Tektronix-patented SMPTE RP168 compliant Timing display makes facility timing easy through a simple graphical representation which shows the relative timing of the input signal and the reference signal (or a saved offset reference) on an X-Y axis.

The Lightning display shows luma and chroma amplitudes and helps users verify interchannel component timing using a color-bar signal. The Tektronix-patented Bowtie display complements the timing measurement capability of the Lightning display. Using a special Bowtie test signal in component format, this display helps make precise, accurate measurements of interchannel amplitude and timing.

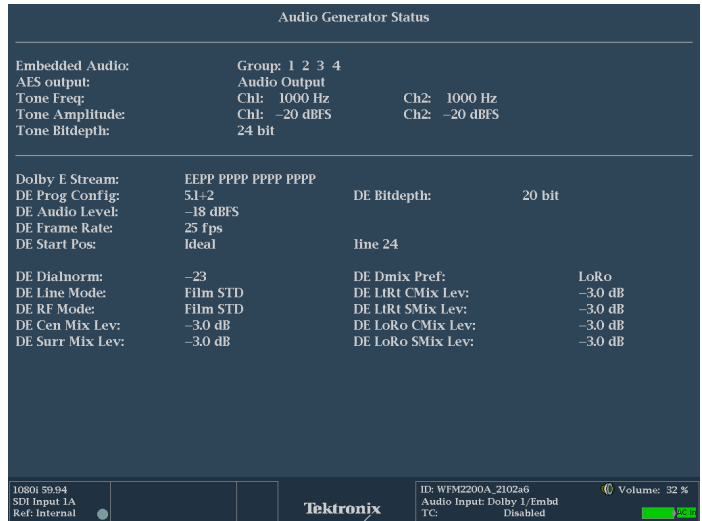


Timing, Lightning, and AV Delay/Propagation Delay displays simplify timing tasks.

### Troubleshooting signal paths

A test signal can be generated from the SDI output that produces a variety of test signals with the ability to Genlock the test signal output to the External Reference Input. Audio test tones and/or a Dolby E test signal stream (Option DBE) can be generated at the AES output or embedded in the SDI test signal output.

The user can change the test signal patterns, video format, whether the test signal is moving or static, audio test tone, and audio level. The moving test signal allows the user to easily identify whether the test signal is active "live" or still and helps determine problems within the signal path that are caused by equipment freezing on the last frame. This can be useful for troubleshooting a signal path or piece of equipment without the need to carry an additional generator.



Audio Generator Status display.

### Superior data analysis capabilities for operators and engineers

The ANC Data Inspector provides an industry-leading solution to help broadcasters easily and accurately ensure that all required VANC data is present and correctly configured through an intuitive ANC data display.

In contrast to other solutions, the ANC Data Inspector enables operators to quickly and easily ensure that the VANC data is present and free of errors. When errors are detected, engineers are quickly guided to a more detailed view of the data packet content for further analysis.



ANC Data Inspector provides detailed content analysis.

Closed Caption (CEA708/608) and individual Teletext subtitles can be simultaneously decoded and displayed within the Picture display. Teletext subtitle pages can be decoded in either WST or OP47 format.



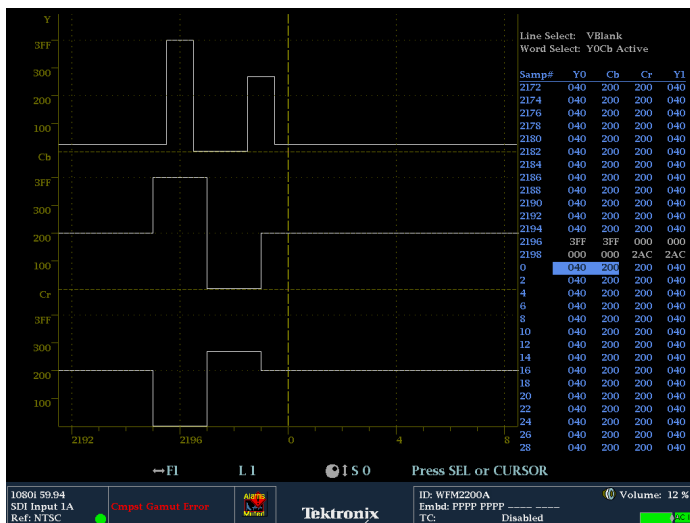
The Auxiliary Data Status display provides summary information on Active Format Description (AFD) per SMPTE 2016, Video Index Aspect Ratio, Wide Screen Signaling (WSS), V-Chip, TSID, CGMS-A, Broadcast Flag, CEA708/608 Closed Caption, Teletext, and Timecode information.



Monitoring of Ancillary data (Closed Caption, Time Code, and AFD) using Aux Data Status.

Today there is a wide array of metadata that provides information to a variety of equipment through the processing chain. Monitoring of this metadata is critical to ensure that the processing equipment correctly handles the signal. For instance, correct format of the AFD ensures that the aspect ratio on the display is correctly formatted and the automated AFD graticule is available for the Picture display, along with the binary data and text description, for easy monitoring.

The Datalist display provides detailed information on the actual data values in HD/SD-SDI and 3G-SDI (with Option 3G) input signals. Users can easily use this display to locate protocol errors in the input signals.



Datalist display provides detailed pixel-by-pixel information.

The right side of the display shows the data values in hexadecimal, decimal, or binary format and uses the following color coding for easy identification of data types and errors:

- Green – Active video data
- Blue – Data in horizontal or vertical blanking intervals
- White – EAV, SAV, and other reserved words
- Yellow – Data outside nominally allowed values
- Red – Data with illegal values

The left side of display shows uninterpolated digital values plotted against sample numbers as a digital waveform. You can configure this unique display in either Video mode or Data mode.

In Video mode, the display shows the Y, Cb, Cr values aligned temporally, but offset vertically. Like the waveform display, you can configure the display to show 1, 2, or all 3 components.

## Supported formats

This instrument accepts a wide variety of input signal formats and external references. It will automatically detect the signal format and establish the appropriate settings for the various displays.

### Video input and external reference supported formats

|        |            | External reference inputs |     |                |          |       |                 |       |       |          |       |                 |          |       |          |       |
|--------|------------|---------------------------|-----|----------------|----------|-------|-----------------|-------|-------|----------|-------|-----------------|----------|-------|----------|-------|
|        |            | Bi-level sync             |     | Tri-level 720p |          |       | Tri-level 1080p |       |       |          |       | Tri-level 1080i |          |       | 1080 SF  |       |
| Input  | SDI format | NTSC                      | PAL | 50 Hz          | 59.94 Hz | 60 Hz | 23.98 Hz        | 24 Hz | 25 Hz | 29.97 Hz | 30 Hz | 50 Hz           | 59.94 Hz | 60 Hz | 23.98 Hz | 24 Hz |
| 525i   | 59.94 Hz   | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
| 625i   | 50 Hz      |                           | x   | x              |          |       |                 |       |       |          |       | x               |          |       |          |       |
| 720p   | 23.98 Hz   | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
|        | 24 Hz      |                           |     |                |          | x     |                 | x     |       |          |       |                 |          | x     |          | x     |
|        | 29.97 Hz   | x                         |     |                | x        |       |                 |       |       |          |       |                 | x        |       |          |       |
|        | 30 Hz      |                           |     |                |          | x     |                 |       |       |          |       |                 |          | x     |          |       |
|        | 50 Hz      |                           | x   | x              |          |       |                 |       |       |          |       | x               |          |       |          |       |
|        | 59.94 Hz   | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
|        | 60 Hz      |                           |     |                |          | x     |                 | x     |       |          |       |                 |          |       | x        | x     |
| 1035i  | 59.94 Hz   |                           | x   | x              |          |       |                 |       |       |          |       | x               |          |       |          |       |
|        | 60 Hz      | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
| 1080i  | 50 Hz      |                           | x   | x              |          |       |                 |       |       |          |       | x               |          |       |          |       |
|        | 59.94 Hz   | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
|        | 60 Hz      |                           |     |                |          | x     |                 | x     |       |          |       |                 |          | x     |          | x     |
| 1080p  | 23.98 Hz   | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
|        | 24 Hz      |                           |     |                |          | x     |                 | x     |       |          |       |                 |          | x     |          | x     |
|        | 25 Hz      |                           | x   | x              |          |       |                 |       |       |          |       | x               |          |       |          |       |
|        | 29.97 Hz   | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
|        | 30 Hz      |                           |     |                |          | x     |                 | x     |       |          |       |                 |          | x     |          | x     |
|        | 50 Hz      |                           | x   | x              |          |       |                 |       | x     |          |       | x               |          |       |          |       |
|        | 59.94 Hz   | x                         |     |                | x        |       | x               |       |       | x        |       |                 | x        |       |          |       |
|        | 60 Hz      |                           |     |                |          | x     |                 | x     |       |          | x     |                 |          | x     |          |       |
| 1080sf | 23.98 Hz   | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
|        | 24 Hz      |                           |     |                |          | x     |                 | x     |       |          |       |                 |          | x     |          | x     |
|        | 25 Hz      | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
|        | 29.97 Hz   | x                         |     |                | x        |       | x               |       |       |          |       |                 | x        |       | x        |       |
|        | 30 Hz      |                           |     |                |          | x     |                 | x     |       |          |       |                 |          | x     |          | x     |

**Dual Link supported formats**

| Format      | Sample structure        | Frame/field rates  |
|-------------|-------------------------|--|
| 1920 x 1080 | 4:2:2 YCbCr 10 bit      | 60, 60/1.001, and 50 progressive   |
|             | 4:4:4 RGB               | 30, 30/1.001, 25, 24 and 24/1.001 progressive, PsF<br>60, 60/1.001, and 50 fields interlaced |
|             | 4:4:4:4 RGB +A 10 bit   |  |
|             | 4:4:4 RGB 12 bit        |  |
|             | 4:4:4 YCbCr 10 bit      |  |
|             | 4:4:4:4 YCbCr +A 10 bit |  |
|             | 4:4:4 YCbCr 12 bit      |  |
|             | 4:2:2 YCbCr 12 bit      |  |
|             | 4:2:2:4 YCbCr +A 12 bit |  |
| 2048 x 1080 | 4:4:4 RGB               | 30, 30/1.001, 25, 24, and 24/1.001 progressive, PsF  |
|             | 4:4:4:4 RGB +A 10 bit   |  |
|             | 4:4:4 RGB 12 bit        |  |
|             | 4:4:4 YCbCr 10 bit      |  |
|             | 4:4:4:4 YCbCr +A 10 bit |  |
|             | 4:4:4 YCbCr 12 bit      |  |
|             | 4:2:2 YCbCr 12 bit      |  |
|             | 4:2:2:4 YCbCr +A 12 bit |  |
|             | 4:4:4 XYZ 12 bit        |  |

**3G-SDI Single Link supported formats**

| Format                      | Sample structure   | Frame/field rates  |
|-----------------------------|--|--|
| 1920 x 1080                 | 4:2:2 YCbCr 10 bit<br>Level A and level B                | 50, 59.94, 60 progressive  |
|                             | 4:2:2 YCbCr 10 bit<br>Level B                            | 23.98, 23.98sF, 24, 24sF, 25, 25sF, 29.97, 29.97sF, 30,<br>30sF progressive 50, 59.94, 60 interlaced |
|                             | 4:4:4 YCbCr 10 bit<br>4:4:4:4 YCbCrA 10 bit<br>Level B   |  |
|                             | 4:4:4 RGB 10 bit<br>4:4:4:4 RGB +A 10 bit<br>Level B     |  |
|                             | 4:4:4 RGB 12 bit<br>Level B                              |  |
|                             | 4:4:4 YCbCr 12 bit<br>4:2:2:4 YCbCr +A 12 bit<br>Level B |  |
|                             | 4:4:4 YCbCr 12 bit<br>Level B                            |  |
|                             | 2048 x 1080  |  |
| 4:4:4 XYZ 12 bit<br>Level B |  |  |
| 2 x HD<br>1920 x 1080       | 4:2:2 YCbCr 10 bit<br>Level B                            | 23.98, 23.98sF, 24, 24sF, 25, 25sF, 29.97, 29.97sF, 30,<br>30sF progressive 50, 59.94, 60 interlaced |
| 2 x HD<br>1280 x 720        | 4:2:2 YCbCr 10 bit<br>Level B                            | 23.98, 24, 25, 29.97, 30, 50, 59.94, 60 progressive  |

## Video signal generation and external reference supported formats

|                   |          | External reference inputs |     |                |          |       |                 |       |                 |          |       |          |       |
|-------------------|----------|---------------------------|-----|----------------|----------|-------|-----------------|-------|-----------------|----------|-------|----------|-------|
|                   |          | Bi-level sync             |     | Tri-level 720p |          |       | Tri-level 1080p |       | Tri-level 1080i |          |       | 1080 SF  |       |
| Output SDI format |          | NTSC                      | PAL | 50 Hz          | 59.94 Hz | 60 Hz | 23.98 Hz        | 24 Hz | 50 Hz           | 59.94 Hz | 60 Hz | 23.98 Hz | 24 Hz |
| 525i              | 59.94 Hz | x                         |     |                | x        |       | x               |       |                 | x        |       | x        |       |
| 625i              | 50 Hz    |                           | x   | x              |          |       |                 |       | x               |          |       |          |       |
| 720p              | 50 Hz    |                           | x   | x              |          |       |                 |       | x               |          |       |          |       |
|                   | 59.94 Hz | x                         |     |                | x        |       | x               |       |                 | x        |       | x        |       |
|                   | 60 Hz    |                           |     |                |          | x     |                 | x     |                 |          | x     |          | x     |
| 1080i             | 50 Hz    |                           | x   | x              |          |       |                 |       | x               |          |       |          |       |
|                   | 59.94 Hz | x                         |     |                | x        |       | x               |       |                 | x        |       | x        |       |
|                   | 60 Hz    |                           |     |                |          | x     |                 | x     |                 |          | x     |          | x     |
| 1080p             | 23.98 Hz | x                         |     |                | x        |       | x               |       |                 | x        |       | x        |       |
|                   | 24 Hz    |                           |     |                |          | x     |                 | x     |                 |          | x     |          | x     |
|                   | 25 Hz    |                           | x   | x              |          |       |                 |       | x               |          |       |          |       |
|                   | 29.97 Hz | x                         |     |                | x        |       | x               |       |                 | x        |       | x        |       |
|                   | 30 Hz    |                           |     |                |          | x     |                 | x     |                 |          | x     |          | x     |
|                   | 50 Hz    |                           | x   | x              |          |       |                 |       | x               |          |       |          |       |
|                   | 59.94 Hz | x                         |     |                | x        |       | x               |       |                 | x        |       | x        |       |
|                   | 60 Hz    |                           |     |                |          | x     |                 | x     |                 |          | x     |          | x     |
| 1080sf            | 23.98 Hz | x                         |     |                | x        |       | x               |       |                 | x        |       | x        |       |
|                   | 24 Hz    |                           |     |                |          | x     |                 | x     |                 |          | x     |          | x     |

## Specifications

All characteristics apply to all models unless noted otherwise.

## SDI IN input

**Inputs** SDI, auto-detection of 3G, Dual Link, HD, and SD signals  
(Option 3G required for 3G formats)

**Input type** BNC, internally terminated 75  $\Omega$

**Input level** 800 mV<sub>p-p</sub>,  $\pm 10\%$

## Input equalization

**270 Mb/s** Up to 315 m of type 1694A cable

**1.5 Gb/s** Up to 170 m of type 1694A cable

**3 Gb/s** Up to 115 m of type 1694A cable

**Return loss** >15 dB from 1 MHz to 1.5 GHz, power on or off  
>10 dB from 1.5 GHz to 3 GHz, power on or off

**MULTI IN input**

|                               |  |
|-------------------------------|--|
| <b>Inputs</b>                 | SDI, auto-detection of 3G, Dual Link, HD, and SD signals, AES/EBU, Linear Time Code<br>(Option 3G required for 3G formats) |
| <b>Input type</b>             | BNC, Auto termination (SDI, AES/EBU: 75 $\Omega$ , LTC: >1 k $\Omega$ )  |
| <b>SDI input level</b>        | 800 mV <sub>p-p</sub> , $\pm 10\%$   |
| <b>SDI input equalization</b> |  |
| 270 Mb/s                      | Up to 315 m of type 1694A cable  |
| 1.5 Gb/s                      | Up to 170 m of type 1694A cable  |
| 3 Gb/s                        | Up to 115 m of type 1694A cable  |
| <b>AES/EBU input</b>          | 48 kS/s, AES 3-ID, ANSI/SMPTE 276M   |
| <b>AES/EBU input level</b>    | 0.5 V <sub>p-p</sub> to 2 V <sub>p-p</sub>   |
| <b>LTC input</b>              | Linear Time Code per SMPTE 12M-1   |
| <b>LTC input level</b>        | 0.2 V <sub>p-p</sub> to 5 V <sub>p-p</sub>   |
| <b>Return loss</b>            | >15 dB from 1 MHz to 1.5 GHz, power on or off<br>>10 dB from 1.5 GHz to 3 GHz, power on or off                             |

**STRESS LOOP loop through**

|                        |   |
|------------------------|---|
| <b>Input type</b>      | 2 $\times$ BNC passive loop through, 75 $\Omega$ transmission |
| <b>Simulated cable</b> | 20 m, Belden 1694A  |

**SDI OUT output**

|               |   |
|---------------|---|
| <b>Output</b> | SDI Switched Output. Selectable, active input, or test signal |
|---------------|---|

**AES OUT output**

|                     |   |
|---------------------|---|
| <b>Output</b>       | 48 kS/s, AES 3-ID, ANSI/SMPTE 276M                            |
| <b>Output type</b>  | BNC, 75 $\Omega$  |
| <b>Output level</b> | 0.9 V <sub>p-p</sub> to 1.1 V <sub>p-p</sub> into 75 $\Omega$ |

**External reference**

|                     |  |
|---------------------|--|
| <b>Sync formats</b> | NTSC, PAL, and tri-level sync          |
| <b>Input type</b>   | BNC, 75 $\Omega$ internally terminated |
| <b>Return loss</b>  | >40 dB to 6 MHz<br>>35 dB to 30 MHz    |
| <b>Lock range</b>   | $\pm 50$ ppm                           |

**Serial digital waveform vertical characteristics****Vertical measurement accuracy**

|                |                                  |
|----------------|----------------------------------|
| <b>1x gain</b> | $\pm 0.5\%$ of 700 mV full scale |
| <b>5x gain</b> | $\pm 0.2\%$ of 700 mV full scale |

|             |                                       |
|-------------|---------------------------------------|
| <b>Gain</b> | 1x, 5x, variable range 0.25x to >7.5x |
|-------------|---------------------------------------|

**Frequency response**

|           |   |
|-----------|---|
| <b>SD</b> | Luminance (Y) channel $\pm 0.5\%$ to 5.75 MHz<br>Color Difference channels (Pb, Pr) $\pm 0.5\%$ to 2.75 MHz |
| <b>HD</b> | Luminance (Y) channel $\pm 0.5\%$ to 30 MHz<br>Difference channels (Pb, Pr) $\pm 0.5\%$ to 15 MHz           |
| <b>3G</b> | Luminance (Y) channel $\pm 0.5\%$ to 60 MHz<br>Difference channels (Pb, Pr) $\pm 0.5\%$ to 30 MHz           |

**Waveform horizontal characteristics**

|                              |             |
|------------------------------|-------------|
| <b>Sweep timing accuracy</b> | $\pm 0.5\%$ |
|------------------------------|-------------|

|                        |             |
|------------------------|-------------|
| <b>Sweep linearity</b> | $\pm 0.2\%$ |
|------------------------|-------------|

**Audio characteristics**

|                               |  |
|-------------------------------|--|
| <b>Level meter resolution</b> | 0.056 dB steps at 30 dB scale from full scale to $-20$ dBFS<br>0.20 dB steps at 70 dB scale for signals above $-20$ dBFS |
|-------------------------------|--|

|                         |  |
|-------------------------|--|
| <b>Meter ballistics</b> | True peak, PPM type 1, PPM type 2, BBC PPM |
|-------------------------|--|

|   |   |
|---|---|
| <b>Defined/programmable level detection</b> | Mute, clip, user-programmable silence, over |
|---|---|

|                             |   |
|-----------------------------|---|
| <b>Level meter accuracy</b> | $\pm 0.1$ dB from 20 Hz to 20 kHz, 0 to $-40$ dBFS sine wave, Peak Ballistic mode |
|-----------------------------|---|

## SDI generator characteristics

|                                |  |
|--------------------------------|--|
| <b>Test signals</b>            | 100%/75%/SMPTE (EG1, EG432-1, RP219) Color Bars, 0%/50%/100% Flat field, 5/10 Step Staircase, Multiburst, Y Multiburst, Checkerboard, Clean Aperture, Convergence, Pluge and Luma Reference, Production Aperture, SMPTE 303M Color Reference, ChromaDuMonde, Pathological signal |
| <b>Output format</b>           |  |
| <b>525i</b>                    | 59.94 Hz   |
| <b>625i</b>                    | 50 Hz  |
| <b>720p</b>                    | 50 Hz, 59.94 Hz, 60 Hz   |
| <b>1080i</b>                   | 50 Hz, 59.94 Hz, 60 Hz   |
| <b>1080p</b>                   | 23.98 Hz, 24 Hz, 25 Hz, 29.97 Hz, 30 Hz, 50 Hz, 59.94 Hz, 60 Hz  |
| <b>1080sF</b>                  | 23.98 Hz, 24 Hz  |
| <b>Reference input signal</b>  | NTSC/PAL black burst<br>HDTV tri-level sync (720p, 1080i)  |
| <b>Lock range</b>              | ±30 ppm  |
| <b>Genlock time adjustment</b> |  |
| <b>Vertical offset range</b>   | ± half of the frame length where the frame length is the shorter frame of the generated video or reference signal  |
| <b>Horizontal offset range</b> | ±32 µs<br>Resolution: 37 ns<br>Accuracy: 100 ns of the setting   |

## Audio generator characteristics

|                               |   |
|-------------------------------|---|
| <b>Output</b>                 | AES OUT, SDI OUT (embedded audio)                                   |
| <b>AES OUT</b>                | Test signal, AES loopout, de-embedded audio                         |
| <b>Test tone</b>              |   |
| <b>Frequency</b>              | 100 Hz, 200 Hz, 400 Hz, 800 Hz, 1 kHz, 2 kHz, 4 kHz, 10 kHz, 18 kHz |
| <b>Level</b>                  | -60 to 0 dBFS   |
| <b>Bit depth</b>              | 20 / 24 bit   |
| <b>Dolby E stream playout</b> | Option DBE required   |
| <b>Modes</b>                  | 8x1, 7.1, 5.1+2, 5.1, 4x2   |
| <b>Levels</b>                 | -20 dBFS, -18 dBFS, Multi-tone                                      |
| <b>Features</b>               | Start position selection, selected metadata editing                 |

**Power adapter**

|                      |  |
|----------------------|--|
| <b>Input voltage</b> | Accepts 100 to 240 V AC $\pm$ 10% 50/60 Hz |
|----------------------|--|

|                       |                 |
|-----------------------|-----------------|
| <b>Output voltage</b> | 19 V DC nominal |
|-----------------------|-----------------|

**Input voltage**

|                      |   |
|----------------------|---|
| <b>Voltage range</b> | 19 V DC nominal<br>10.75 to 20 V DC min-max operating |
|----------------------|---|

|                          |                |
|--------------------------|----------------|
| <b>Supply connection</b> | 2.5/5.5 mm DIN |
|--------------------------|----------------|

|                          |                          |
|--------------------------|--------------------------|
| <b>Power consumption</b> | 24 W typical<br>35 W max |
|--------------------------|--------------------------|

|              |              |
|--------------|--------------|
| <b>Surge</b> | 20 A at 12 V |
|--------------|--------------|

|                    |                                   |
|--------------------|-----------------------------------|
| <b>Fuse rating</b> | 4 A, internal self-resetting fuse |
|--------------------|-----------------------------------|

|   |  |
|---|--|
| <b>Transient, over, and reverse voltage</b> | Reverse- and over-voltage protected to $\pm$ 30 V DC<br>The unit may power itself down in the presence of high transient voltages. This prevents damage to the unit and is not a fault |
|---|--|

**Physical characteristics**

|                   |                                       |
|-------------------|---------------------------------------|
| <b>Dimensions</b> | Including boot, excluding projections |
| <b>Height</b>     | 8.5 in. (216 mm)                      |
| <b>Width</b>      | 8.2 in. (208 mm)                      |
| <b>Depth</b>      | 1.4 in. (36 mm)                       |

|                              |                                       |
|------------------------------|---------------------------------------|
| <b>Weight</b>                | Including boot, excluding projections |
| <b>Net (with battery)</b>    | 4 lb. (1.8 kg)                        |
| <b>Net (without battery)</b> | 3 lb. (1.4 kg)                        |

**Environmental**

|                     |                  |
|---------------------|------------------|
| <b>Temperature</b>  |                  |
| <b>Operating</b>    | 0 °C to +40 °C   |
| <b>Nonoperating</b> | -20 °C to +60 °C |

|                     |   |
|---------------------|---|
| <b>Humidity</b>     |   |
| <b>Operating</b>    | 20% to 80% relative humidity at up to +40 °C, noncondensing |
| <b>Nonoperating</b> | 5% to 90% relative humidity at up to +60 °C, noncondensing  |

|                     |                             |
|---------------------|-----------------------------|
| <b>Altitude</b>     |                             |
| <b>Operating</b>    | Up to 10,000 ft. (3,000 m)  |
| <b>Nonoperating</b> | Up to 40,000 ft. (12,000 m) |



## Ordering information

### Models

|                 |   |
|-----------------|---|
| <b>WFM2200A</b> | Portable 3G/DL/HD/SD-SDI <sup>3</sup> Waveform Monitor/Generator, with Li-Ion Battery<br><br>Includes: Installation and Safety Instructions (Tektronix part number 071-3205-xx), WFM200BA Li-Ion Rechargeable Battery Pack, WFM200BA Li-Ion Rechargeable Battery Pack Instructions (Tektronix part number 075-1041-xx), AC Power Adapter (Tektronix part number 119-7910-xx), Power Plug <sup>4</sup> (See Power plug options.) |
| <b>WFM220UP</b> | Upgrade your existing WFM2200A with any of the available product options.   |

### WFM2200A and WFM220UP options

The following product options are available. When ordering a new WFM2200A, you must specify a power plug option. (See Power plug options.)

|                             |   |
|-----------------------------|---|
| <b>3G</b>                   | Adds support for 3G-SDI signal formats (Level A and Level B)  |
| <b>ADVP</b>                 | Adds out-of-service A/V delay measurement and propagation time measurement  |
| <b>DATA</b>                 | Adds Ancillary Data monitoring (including decoding of 708 and 608 Closed Captions, Teletext and OP47 Subtitles, AFD, and CGMS-A), and ANC Data Inspector  |
| <b>DBE</b>                  | Adds Dolby E analysis (including Metadata display, peak level indication, and Dolby E timing measurement) and Dolby E test signals (user-configurable parameters include: Tone (-18 dB, -20 dB and Multitone), Configuration (8x1 mono, 4x2 stereo, surround 5.1, 5.1+2 and 7.1), Metadata, and Dolby E audio frame start location) |
| <b>LOUD</b>                 | Adds Audio Loudness monitoring capabilities including Loudness Meter  |
| <b>SFP<sup>1</sup></b>      | Add Optical input/output SDI module support (includes one SFP module); an SFP module is available for additional purchase (Tektronix part number 119-8280-00)   |
| <b>SFP-HDMI<sup>1</sup></b> | Adds HDMI input module support (includes one SFP module), not HDCP compliant; an SFP module is available for additional purchase (Tektronix part number 119-8475-00)  |

### Power plug options

|                 |  |
|-----------------|--|
| <b>Opt. A0</b>  | North America power plug (115 V, 60 Hz)  |
| <b>Opt. A1</b>  | Universal Euro power plug (220 V, 50 Hz) |
| <b>Opt. A2</b>  | United Kingdom power plug (240 V, 50 Hz) |
| <b>Opt. A3</b>  | Australia power plug (240 V, 50 Hz)      |
| <b>Opt. A5</b>  | Switzerland power plug (220 V, 50 Hz)    |
| <b>Opt. A6</b>  | Japan power plug (100 V, 50/60 Hz)       |
| <b>Opt. A10</b> | China power plug (50 Hz)                 |
| <b>Opt. A11</b> | India power plug (50 Hz)                 |
| <b>Opt. A12</b> | Brazil power plug (60 Hz)                |
| <b>Opt. A99</b> | No power cord or AC adapter              |

<sup>3</sup> Option 3G is required for 3G-SDI support.

<sup>4</sup> If you ordered Option A99, no power cord is provided.

## Service options

|                  |   |
|------------------|---|
| <b>Opt. C3</b>   | Calibration Service 3 Years   |
| <b>Opt. C5</b>   | Calibration Service 5 Years   |
| <b>Opt. D1</b>   | Calibration Data Report   |
| <b>Opt. D3</b>   | Calibration Data Report 3 Years (with Opt. C3)  |
| <b>Opt. D5</b>   | Calibration Data Report 5 Years (with Opt. C5)  |
| <b>Opt. G3</b>   | Complete Care 3 Years (includes loaner, scheduled calibration, and more)  |
| <b>Opt. G5</b>   | Complete Care 5 Years (includes loaner, scheduled calibration, and more)  |
| <b>Opt. R3</b>   | Repair Service 3 Years (including warranty)   |
| <b>Opt. R3DW</b> | Repair Service Coverage 3 Years (includes product warranty period). 3-year period starts at time of customer instrument purchase. This option is available if the instrument is within product warranty. It is not available once instrument exits warranty period. |
| <b>Opt. R5</b>   | Repair Service 5 Years (including warranty)   |
| <b>Opt. R5DW</b> | Repair Service Coverage 5 Years (includes product warranty period). 5-year period starts at time of customer instrument purchase. This option is available if the instrument is within product warranty. It is not available once instrument exits warranty period. |

## Optional accessories

|                  |   |
|------------------|---|
| <b>WFM200BA</b>  | Rechargeable battery pack for replacement, includes instructions manual |
| <b>WFM200BC</b>  | External battery charger, includes instructions manual                  |
| <b>WFM200FSC</b> | Soft carry case for the waveform monitor                                |



WFM200BC External Battery Charger with WFM200BA Rechargeable Battery Pack.



WFM200FSC soft carry case.



Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

# WFM2200A Datasheet

**ASEAN / Australasia** (65) 6356 3900  
**Belgium** 00800 2255 4835\*  
**Central East Europe and the Baltics** +41 52 675 3777  
**Finland** +41 52 675 3777  
**Hong Kong** 400 820 5835  
**Japan** 81 (3) 6714 3010  
**Middle East, Asia, and North Africa** +41 52 675 3777  
**People's Republic of China** 400 820 5835  
**Republic of Korea** 001 800 8255 2835  
**Spain** 00800 2255 4835\*  
**Taiwan** 886 (2) 2656 6688

**Austria** 00800 2255 4835\*  
**Brazil** +55 (11) 3759 7627  
**Central Europe & Greece** +41 52 675 3777  
**France** 00800 2255 4835\*  
**India** 000 800 650 1835  
**Luxembourg** +41 52 675 3777  
**The Netherlands** 00800 2255 4835\*  
**Poland** +41 52 675 3777  
**Russia & CIS** +7 (495) 6647564  
**Sweden** 00800 2255 4835\*  
**United Kingdom & Ireland** 00800 2255 4835\*

**Balkans, Israel, South Africa and other ISE Countries** +41 52 675 3777  
**Canada** 1 800 833 9200  
**Denmark** +45 80 88 1401  
**Germany** 00800 2255 4835\*  
**Italy** 00800 2255 4835\*  
**Mexico, Central/South America & Caribbean** 52 (55) 56 04 50 90  
**Norway** 800 16098  
**Portugal** 80 08 12370  
**South Africa** +41 52 675 3777  
**Switzerland** 00800 2255 4835\*  
**USA** 1 800 833 9200

\* European toll-free number. If not accessible, call: +41 52 675 3777

**For Further Information.** Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit [www.tektronix.com](http://www.tektronix.com).

Copyright © Tektronix, Inc. All rights reserved. Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specification and price change privileges reserved. TEKTRONIX and TEK are registered trademarks of Tektronix, Inc. All other trade names referenced are the service marks, trademarks, or registered trademarks of their respective companies.



30 Mar 2015 2PW-29483-3

[www.tektronix.com](http://www.tektronix.com)

**Tektronix**<sup>®</sup>

