

# Service Manual



## **WFM90D and WFM91D Handheld Waveform, Vector, Picture, and Audio Monitor**

**071-1143-01**

This document applies to firmware version 2.13 and above.

### **Warning**

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

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# General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

*Only qualified personnel should perform service procedures.*

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

**Connect and Disconnect Properly.** Do not connect or disconnect probes or test leads while they are connected to a voltage source.

**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.

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

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

**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.**

**Symbols and Terms**

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



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

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

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

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

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

CAUTION indicates a hazard to property including the product.

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



# Service Safety Summary

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

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

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

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

To avoid electric shock, do not touch exposed connections.



# Preface

This manual provides instructions for servicing the WFM90D and WFM91D Handheld Waveform, Vector, Picture, and Audio Monitors. This manual describes features and specifications that are common to all generator modules. These include system configuration and the common control interface.

## About This Manual

This manual is composed of the following sections:

- *Specifications* lists the electrical and environmental specifications and provides a general product description.
- *Operating Information* describes installation and front panel operation of the instrument.
- *Theory of Operation* contains a module-level description based on block diagrams of the instrument circuitry.
- *Performance Verification* provides procedures for verifying instrument performance.
- *Adjustment Procedures* provides procedures for adjusting the instrument to meet performance levels listed in *Specifications*.
- *Maintenance* contains instructions for cleaning the instrument, procedures for removal and replacement of instrument modules, and troubleshooting procedures.
- *Options* lists all of the options that you might find on your instrument.
- *Replaceable Mechanical Parts* lists the part numbers of the replaceable electrical and mechanical parts and assemblies.
- *Diagrams* contains the instrument interconnect diagram.

## Related Manuals

The *WFM90D & WFM91D Handheld Waveform, Vector, Picture, & Audio Monitor User Manual* (Tektronix part number 071-1142-XX) describes in detail how to operate the instrument.

## Contacting Tektronix

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<b>Web site</b>	<a href="http://www.tektronix.com">www.tektronix.com</a>
<b>Sales support</b>	1-800-833-9200, select option 1*
<b>Service support</b>	1-800-833-9200, select option 2*
<b>Technical support</b>	<a href="http://www.tektronix.com/support">www.tektronix.com/support</a> 1-800-833-9200, select option 3* 6:00 a.m. - 5:00 p.m. Pacific Standard Time

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





# Specifications



# Specifications

This section includes the following information:

- Product description
- Specifications tables

## Product Description

The handheld, self-contained, Tektronix WFM90D and WFM91D television waveform monitors can monitor analog and digital signals. The monitors provide composite and component waveform displays as well as vector and picture displays.

These monitors can be used in the traditional in-house applications of television production, post-production, and signal transmission. In addition, their portability allows them to be used in non-traditional applications such as field production and system maintenance.

### Key Features

- Accepts NTSC/PAL composite video or 525/625 Component 270 Mbit serial digital video signals
- Automatic detection of analog or serial digital signals
- Built-in color display (TFT LCD)
- Viewing angle control
- Electronic graticules
- Battery or AC adapter powered
- Menu-assisted monitoring operation
- Audio signal input/output
- Waveform, Vector, Picture, Audio, and Waveform-in-Picture display modes
- Line select lets you view any single line of video
- Selectable time out for backlight or instrument power
- Signal level alarm mode for waveform and audio displays
- Preset menu to store/recall front panel and menu setups
- Instrument adjustments from front panel (see service manual)

## Characteristics Tables

The tables use the following abbreviations:

**Performance Requirement (Req).** All performance requirements in the specification tables are identified with **Req**, and can be assured by completing the Performance Check Procedure located in the service manual. Allow a warm-up time of 20 minutes.

Performance requirements in the electrical specifications are valid over an ambient temperature range of +20° C to +30° C. The Performance Requirement tolerances listed in the Electrical Specification are doubled over the temperature range of 0° C to +40° C, unless otherwise specified. Test equipment used to verify Performance Requirements must be calibrated and working within the limits specified in the service manual Equipment Required List.

**Reference Information.** Information that amplifies a performance requirement or is of special importance is indicated by **REF**. There is no need to check these items to a specific tolerance.

## Electrical Specifications

**Table 1-1: Vertical deflection system**

Category	Description
Frequency Response Analog Input	<p><b>REF:</b> Specifications apply for full screen height video input signal, with VARIABLE GAIN off.</p> <p><b>REQ:</b> Flat Filter 1 V Full Scale: 50 kHz to 6 MHz within 2% of response at 50 kHz.</p> <p><b>REQ:</b> Flat Filter X5 Gain: 50 kHz to 6 MHz within 5% of response at 50 kHz.</p> <p><b>REF:</b> Low Pass Filter: ≥ 40 dB attenuation at 3.58 MHz NTSC, 4.43 MHz PAL.</p> <p><b>REF:</b> Response at 15 kHz does not vary between FLAT and LUM (low pass) filters by more than 1%.</p>
Digital Input	<p><b>REF:</b> Specifications apply for full screen height video input signal, with VARIABLE GAIN off.</p> <p><b>REQ:</b> Flat Filter 1 V Full Scale: 50 kHz to 4.5 MHz ± 4%.</p> <p><b>REQ:</b> Flat Filter X5 Gain: 50 kHz to 4.5 MHz ± 5%.</p> <p><b>REF:</b> Low Pass Filter: ≥ 40 dB attenuation at 3.58 MHz NTSC, 4.43 MHz PAL.</p> <p><b>REF:</b> Response at 15 kHz does not vary between FLAT and LUM (low pass) filters by more than 1%.</p>

**Table 1-1: Vertical deflection system (Cont.)**

Category	Description
Deflection Factor	<p><b>REQ:</b> Analog Input, 1 V Full Scale: 1 V input displayed within 1% of 140 IRE</p> <p><b>REF:</b> Flat filter selected.</p> <p><b>REQ:</b> Digital Input, 1 V Full Scale: 1 V input displayed within 2% of 140 IRE</p> <p><b>REF:</b> Flat filter selected.</p> <p><b>REQ:</b> X5 Gain: Gain accuracy within 5% with 1 V input signal.</p> <p><b>REF:</b> X5 Gain Registration: ≤ 1 major division of vertical shift from baseline between unmagnified and magnified signal.</p> <p><b>REQ:</b> Variable Gain Range: Input signals between 0.8 V and 2 V can be adjusted to 140 IRE (1.0 V) display. 160 mV to 400 mV for X5 Gain.</p> <p><b>REQ:</b> Position Range: 1 V signal can be positioned so that peak white and sync tip can be placed at blanking level, with the DC RESTORER on, regardless of gain setting.</p>
Transient Response Analog Input	<p><b>REF:</b> Specifications apply for full screen height video input signal, with VARIABLE GAIN off, 1 V Full Scale or X5 Gain selected, and FLAT filter selected.</p> <p><b>REF:</b> Pulse-to-Bar Ratio: X1: 0.99:1 to 1.01:1. X5: 0.98:1 to 1.02:1.</p> <p><b>REF:</b> Preshoot: ≤ 1%.</p> <p><b>REF:</b> Overshoot: X1: ≤ 2%. X5: ≤ 4%.</p> <p><b>REF:</b> Ringing: X1: ≤ 2%. X5: ≤ 4%.</p> <p><b>REF:</b> Field Rate Tilt: ≤ 1%.</p> <p><b>REF:</b> Line Rate Tilt: ≤ 1%.</p> <p><b>REQ:</b> Overscan: ≤ 2% variation in baseline of 100 IRE (700 mV) 12.5T (20T) modulated pulse as it is positioned over the middle 80% of the screen.</p>

**Table 1-1: Vertical deflection system (Cont.)**

Category	Description
Transient Response Digital Input	<p><b>REF:</b> Specifications apply for full screen height video input signal, with VAR GAIN off, 1 V Full Scale or X5 Gain selected, and FLAT filter selected.</p> <p><b>REF:</b> Pulse-to-Bar Ratio: X1: 0.99:1 to 1.01:1 X5: 0.98:1 to 1.02:1</p> <p><b>REF:</b> Preshoot: <math>\leq 1\%</math></p> <p><b>REF:</b> Overshoot: X1: <math>\leq 2\%</math> X5: <math>\leq 4\%</math></p> <p><b>REF:</b> Ringing: X1: <math>\leq 2\%</math> X5: <math>\leq 4\%</math></p> <p><b>REF:</b> Field Rate Tilt: <math>\leq 1\%</math></p> <p><b>REF:</b> Line Rate Tilt: <math>\leq 1\%</math></p>
Maximum Absolute Input Level	<p><b>REF:</b> <math>\pm 5</math> VDC plus peak AC.</p> <p><b>REF:</b> Displays in excess of 200 IRE (1.428 V) may cause frequency response aberrations.</p>
DC Input Impedance (Unterminated)	<p><b>REQ:</b> <math>\geq 15</math> k<math>\Omega</math>.</p> <p><b>REF:</b> With input switch in the HIZ position.</p>
Video Input Return Loss	<p><b>REF:</b> <math>\geq 40</math> dB from 50 kHz to 6 MHz <math>\geq 15</math> dB from 6 MHz to 270 MHz</p> <p><b>REF:</b> With 75 <math>\Omega</math> termination on.</p>
Video Out Return Loss (75 $\Omega$ )	<p><b>REF:</b> <math>\geq 30</math> dB from 50 kHz to 6 MHz.</p>
Video Out Differential Gain (50% APL)	<p><b>REF:</b> Within 1% with a 140 IRE (1.0 V PAL) unit display. Analog input only.</p>
Video Out Differential Phase (50% APL)	<p><b>REF:</b> Within 1° with a 140 IRE (1.0 V PAL) unit display. Analog input only.</p>

**Table 1-2: DC restoration**

Category	Description
DC Restorer Clamp Time	<p><b>REF:</b> Back Porch.</p>
Frequency Response at 60 Hz (50 Hz PAL)	<p><b>REQ:</b> Attenuation of 60 Hz (50 Hz PAL) on Input Signal: Slow Mode: <math>\leq 20\%</math>. Fast Mode: <math>\geq 90\%</math>.</p> <p><b>REF:</b> Blanking Level Shift with 10% to 90% APL Change: APL changes from 50% to either 10% or 90% will cause blanking level shift of 1 IRE unit (7.14 mV PAL) or less.</p> <p><b>REF:</b> Blanking Level Shift Due to Presence or Absence of Burst: 1 IRE unit (7.14 mV PAL) or less shift from no color burst to presence of color burst.</p>

**Table 1-3: Audio mode**

Category	Description
Reference Levels	<b>REQ:</b> -10 dBu, 0 dBu, +4 dBu, +8 dBu. <b>REF:</b> Nominal MIC reference: -50 dBu.
Measurement Accuracy	<b>REQ:</b> 0.5 dB at 1 kHz.
Frequency Response	<b>REQ:</b> 0.5 dB from 50 Hz to 20 kHz.
Maximum Input Level Amplitude	<b>REF:</b> +18 dBu.
DC Input Impedance	<b>REF:</b> $\geq 15 \text{ k}\Omega$ .
Audio Output Connector	<b>REF:</b> Mini stereo headphone jack.
Maximum Power Output	<b>REF:</b> 250 mW.

**Table 1-4: Horizontal deflection system**

Category	Description
Sweep	<b>REQ:</b> Sweep will occur in all Horizontal mode settings with or without synchronization. <b>REF:</b> Sweep Length: Two Line and Two Field sweep length is nominally 12 divisions.
1LINE Sweep Repetition Rate	<b>REQ:</b> Equal to line-rate of applied video or external sync.
2LINE Sweep Repetition Rate	<b>REQ:</b> Equal to half line-rate of applied video or external sync.
2FLD Sweep Repetition Rate	<b>REF:</b> Displays 2 full fields, including the field-rate sync between them.
2FLD Sweep Magnification	<b>REF:</b> Approximately X20.
Sweep Magnifier Registration	<b>REF:</b> Magnification occurs about the center of the screen.
Timing Accuracy	<b>REF:</b> All timing and linearity specifications exclude the first and last major divisions of the unmagnified display. <b>REQ:</b> 10 $\mu\text{s}$ /division (2LINE): Within 2%. <b>REQ:</b> 5 $\mu\text{s}$ /division (1LINE): Within 2%. <b>REQ:</b> 1 $\mu\text{s}$ /division (2LINE + MAG): Within 2%. <b>REQ:</b> 0.5 $\mu\text{s}$ /division (1LINE + MAG): Within 3%.
Integral Linearity	<b>REQ:</b> Within 1%. <b>REF:</b> Measured between the 10 $\mu\text{s}$ and 110 $\mu\text{s}$ points on the 10 $\mu\text{s}$ /division (2LINE) sweep.
Horizontal Position	<b>REF:</b> Any portion of a synchronized video sweep can be positioned on-screen in all sweep modes.

**Table 1-5: Vector mode**

Category	Description
Chrominance Processing Nominal Subcarrier Frequency ( $F_{SC}$ )	<b>REF:</b> NTSC: 3.579545 MHz. PAL: 4.43361875 MHz.
Chrominance Processing Chrominance Bandwidth	<b>REQ:</b> Upper -3 dB Point: $F_{SC} + 500$ kHz, $\pm 100$ kHz.  Lower -3 dB Point: $F_{SC} - 500$ kHz, $\pm 100$ kHz.
Chrominance Processing +V Mode (Applicable to PAL operation only)	<b>REF:</b> +V-type display as selected by front-panel button. When pushed, V axis is inverted at a 1/2 line rate to produce a single vector display.
Display Vector Phase Accuracy	<b>REF:</b> $\pm 1.25^\circ$ . Analog input only. <b>REF:</b> Measured with color bar signal.
Display Vector Gain Stability	<b>REF:</b> Typically $\pm 2.5\%$ . Analog input only.
Display Quadrature Phasing	<b>REF:</b> Typically $\pm 0.5^\circ$ . Analog input only.
Display Differential Phase	<b>REF:</b> $\pm 1^\circ$ . Analog input only. <b>REF:</b> Measured with 140 IRE (1 V) linearity signal (5 step, 10 step, or Ramp) with 40 IRE (300 mV) of subcarrier.
Display Differential Gain	<b>REF:</b> $\pm 1\%$ . Analog input only. <b>REF:</b> Measured with 140 IRE (1 V) linearity signal (5 step, 10 step, or Ramp) with 40 IRE (300 mV) of subcarrier.
Subcarrier Regenerator Pull-In Range	<b>REQ:</b> NTSC: $\pm 50$ Hz of $F_{SC}$ . PAL: $\pm 10$ Hz of $F_{SC}$ . <b>REF:</b> Subcarrier Regenerator free-runs in absence of appropriate signal. Reference can be burst of either displayed signal or external reference signal.
Subcarrier Regenerator Pull-In Time	<b>REF:</b> Pull-In Time: Within 1 second, with subcarrier frequency within 50 Hz (10 Hz for PAL) of $F_{SC}$ .
Subcarrier Regenerator Phase Shift with Subcarrier Frequency Change	<b>REQ:</b> NTSC: $\pm 2^\circ$ from $F_{SC}$ to ( $F_{SC} + 50$ Hz), or $F_{SC}$ to ( $F_{SC} - 50$ Hz). PAL: $\pm 2^\circ$ from $F_{SC}$ to ( $F_{SC} + 10$ Hz), or $F_{SC}$ to ( $F_{SC} - 10$ Hz).
Subcarrier Regenerator Phase Shift with Burst Amplitude Change	<b>REQ:</b> $\pm 2^\circ$ from nominal burst amplitude to $\pm 6$ dB. <b>REF:</b> Internal or External burst reference.
Subcarrier Regenerator Phase Shift with Variable Gain Control	<b>REQ:</b> $\pm 1^\circ$ as gain is varied from +3 dB to -6 dB.
Subcarrier Regenerator Phase Control Range	<b>REF:</b> $360^\circ$ continuous rotation.
Subcarrier Regenerator Burst Jitter	<b>REF:</b> $0.5^\circ$ RMS or less. <b>REF:</b> With 140 IRE (1 V) composite video input. INT or EXT referenced.



**Table 1-6: Synchronization**

Category	Description
Input Requirements	<p><b>REQ:</b> Internal Reference Analog Input: Composite video or black burst with sync amplitudes 40 IRE (300 mV PAL) <math>\pm</math> 6 dB.</p> <p>Digital Input: 270 Mbit (259M).</p> <p><b>REQ:</b> External Reference: Sync amplitude between 143 mV and 4 V will synchronize sweeps.</p>
External Reference Input	<p><b>REQ:</b> DC Input Impedance (Unterminated): <math>\geq</math> 15 k<math>\Omega</math>.</p> <p><b>REF:</b> Return Loss (75 <math>\Omega</math>): <math>\geq</math> 40 dB from 50 kHz to 6 MHz. (With 75 <math>\Omega</math> termination on, instrument power on.)</p> <p><b>REF:</b> Absolute Maximum Input Voltage: <math>\pm</math> 12 VDC plus peak AC.</p>

**Table 1-7: Power source**

Category	Description
Battery	<b>REF:</b> 6 C-cell batteries or Tektronix NiMH battery pack (Tektronix part number 146-0107-01).
Battery Charge Time	<p><b>REF:</b> Fast Charge: 550 mA.</p> <p><b>REF:</b> Slow Charge: 150 mA.</p>
Power Consumption	<p><b>REF:</b> Picture Mode: 7 Watts.</p> <p>Waveform Mode 9 W.</p> <p>Vector Mode 9 W.</p>
External Power	<b>REQ:</b> DC Source of 11 - 18 V.

## Physical Characteristics

**Table 1-8: Physical characteristics**

Category	Description
Dimensions	<p><b>REF:</b> Instrument:            5 inches (127 mm).            3.15 inches (80.0 mm).            9.6 inches (243.8 mm).</p> <p>Shipping Box:            13.25 x 13.75 x 6 inside            14 x 14.25 x 6.25 outside</p>
Weight	<p><b>REF:</b> With batteries and pouch:            3 lb. 13 oz.</p> <p>Without batteries and pouch:            2 lb. 8 oz.</p> <p>Shipping weight with packaging:            6 lb. 8 oz.</p>

## Environmental Characteristics

**Table 1-9: Environmental characteristics**

Category	Description
Operating Altitude	<b>REQ:</b> To 9,842 feet (3000 meters).
Operating Temperature	<b>REQ:</b> 0°C to +40° C.
Vibration - Operating	<b>REF:</b> 15 minutes each axis at 0.015 inch, frequency varied from 10-55-10 Hz in 1-minute cycles with instrument secured to vibration platform. Ten minutes each axis at any resonant point or at 55 Hz if no resonant point is found.
Shock - Non-Operating	<b>REF:</b> 100 g's, 1/2 sine, 11 ms duration, 3 shocks per surface (18 total).
Transportation	<b>REF:</b> Qualified under NTSC Test Procedure 1A, Category II (24-inch drop).
Humidity	<b>REF:</b> Will operate at 95% relative humidity for up to five days.

## Certification and Compliances

**Table 1- 10: Certifications and Compliances**

Category	Standards or description
EC Declaration of Conformity - EMC	<p>Meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility.</p> <p>Compliances were demonstrated using EN 61326:1997 EMC Product Family Standard for Electrical Equipment for Measurement, Control, and Laboratory use.</p> <p>Emissions<sup>1</sup>:            EN 61326 Class A Radiated and Conducted Emissions            EN 61000-3-2(A14) Conducted Power Line Harmonic Current</p> <p>Immunity<sup>1,2</sup>:            IEC 61000-4-2 Electrostatic Discharge Immunity, Performance Criterion "B"            IEC 61000-4-3 Radiated RF Electromagnetic Field Immunity<sup>3,4</sup> Performance Criterion "A"            IEC 61000-4-4 Electrical Fast Transient/Burst Immunity, Performance Criterion "B"</p> <p>IEC 61000-4-5 Power Line Surge Immunity, Performance Criterion "B"</p> <p>IEC 61000-4-6 Conducted RF Immunity<sup>3</sup>, Performance Criterion "A"</p> <p>IEC 61000-4-11 Voltage Dips and Short Interruptions Immunity, Performance Criterion "B"</p>
Australia Declaration of Conformity	Complies with EMC Framework and demonstrated per Emission standard: AS/NZS 2064 Industrial, Scientific, and Medical Equipment.
USA, FCC Compliance	Emissions comply with FCC Code of Federal Regulations 47, Part 15, Subpart B, Class A Limits.
EMC Compliance	Meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility when used with the product(s) stated in the specifications table. Refer to the EMC specification published for the stated products. May not meet the intent of the directive if used with other products.
Equipment Type	Test and measuring
Safety Class	Class 3 (as defined in IEC 61010-1, Annex H)

**Table 1-10: Certifications and Compliances (Cont.)**

<b>Category</b>	<b>Standards or description</b>								
Pollution Degree	Pollution Degree 2 (as defined in IEC 61010-1). Note: Rated for indoor use only.								
Pollution Degree Descriptions	A measure of the contaminants that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.								
	<table border="1"> <tr> <td>Pollution Degree 1</td> <td>No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.</td> </tr> <tr> <td>Pollution Degree 2</td> <td>Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.</td> </tr> <tr> <td>Pollution Degree 3</td> <td>Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.</td> </tr> <tr> <td>Pollution Degree 4</td> <td>Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.</td> </tr> </table>	Pollution Degree 1	No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.	Pollution Degree 2	Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.	Pollution Degree 3	Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.	Pollution Degree 4	Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.
Pollution Degree 1	No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.								
Pollution Degree 2	Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.								
Pollution Degree 3	Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.								
Pollution Degree 4	Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.								

<sup>1</sup> **Compliance demonstrated using high quality, shielded interface cables.**

<sup>2</sup> **Minimum immunity test requirement, except where noted.**

<sup>3</sup> **Performance Criterion: Product continues to operate properly and display remains readable.**

<sup>4</sup> **Controlled EM environment requirement (1V/M).**



# Operating Information



# Installation

This section contains the following information:

- Mechanical installation instructions
- Electrical installation instructions
- Operating instructions that relate to the service of this instrument

## Mechanical Installation

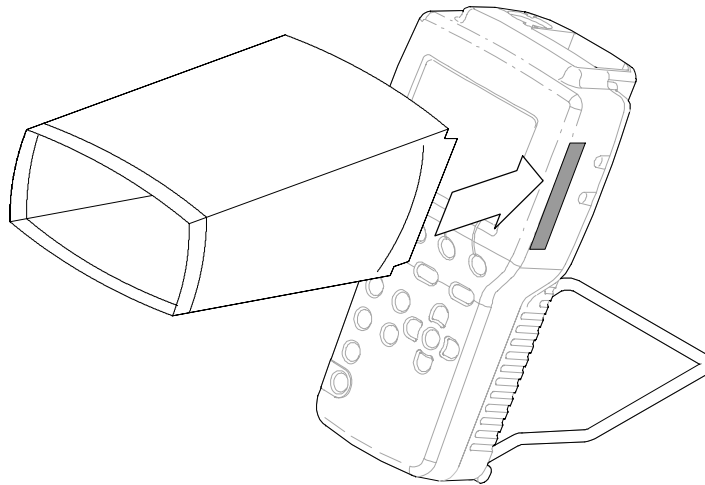
Before installing the WFM90D or WFM91D Handheld Waveform, Vector, Picture, and Audio Monitor, refer to the Environmental Characteristic requirements, located in Table 1-9 on page 1-8 of the *Specifications* section.

All qualification testing was performed with the factory shipped cabinet installed. To guarantee compliance with specifications, only operate the instrument in its cabinet.

**Unpacking** Save the shipping carton and packing materials (including antistatic bag) in case it becomes necessary to ship the instrument for repair. Refer to *Repackaging Instructions* on page 6-2 for instructions on packaging the instrument for shipment.

**Viewing Hood** You can purchase a viewing hood and desk stand to use with your WFM90D or WFM91D. The viewing hood makes it easier to view the instrument display in well-lighted situations.

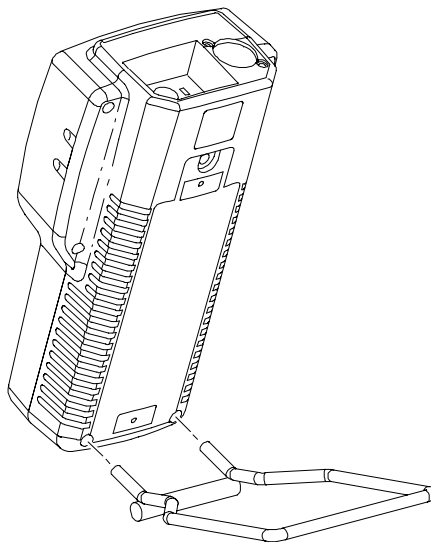
To attach the hood to the instrument, attach the supplied Velcro strips to the sides of the instrument, and then press the flaps of the viewing hood onto the strips as shown in Figure 2-1.



**Figure 2- 1: Installing the viewing hood**

**Desk Stand**

The desk stand holds the monitor upright on a flat surface. Insert the prongs of the stand into the holes in the back of the instrument as shown in Figure 2-2.

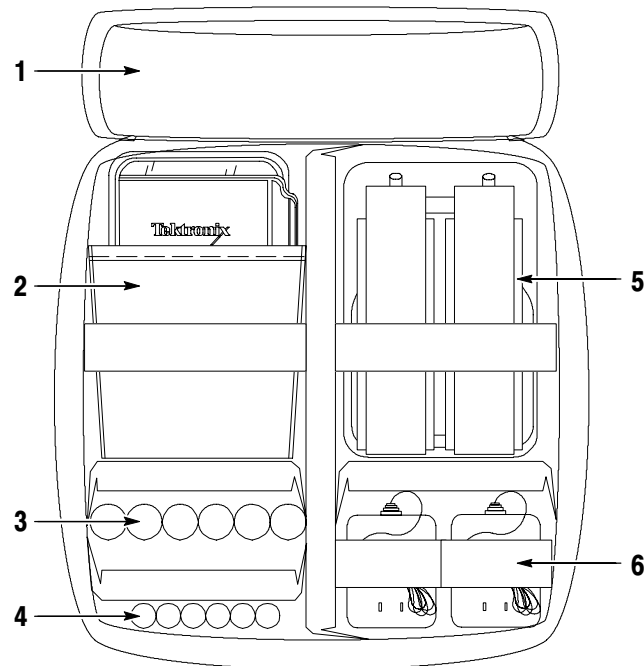


**Figure 2- 2: Installing the desk stand**



**Travel Case** The travel case (Option 33) can safely hold the handheld monitor and its accessories while traveling between locations. The case also holds a companion handheld TSG95 or TSG601 generator. The travel case compartments (see Figure 2-3) hold the following items:

1. Signal cables and user manuals for the monitor and generator.
2. Handheld monitor; viewing hood slipped around the monitor.
3. Spare batteries for the handheld monitor.
4. Spare batteries for the handheld generator.
5. Handheld generator, desk stand, and carrying straps.
6. AC adapter(s).



**Figure 2-3: Packing the Option 33 travel case**

## Electrical Installation

Follow these instructions for electrical installation.

### Instrument Configuration

There are no internal jumper settings for these monitors. Instrument configuration is through the CONFIG menu (refer to page 2-21).

### Power Source

The WFM90D and WFM91D handheld monitors are designed to operate from either six C-cell alkaline batteries, a rechargeable NiMH battery pack, or an AC adapter wall unit producing 12 VDC.



---

#### **CAUTION.** DC Power Source

*To avoid possible damage to the instrument circuitry when using a DC power source other than the supplied AC adapter, ensure that the DC source is a negative-ground 11 - 18 V system with a negative center lead. The DC source should be able to provide 12 W of power.*

---

### Recharging the NiMH Batteries

The NiMH batteries begin to charge automatically when you plug the 12 VDC adapter into the instrument, whether instrument power is on or off. The battery charge time is 6.5 hours when the instrument is off, and 20 hours while the instrument is on. When the batteries are fully charged, the monitor goes into a safe trickle-charge mode, which can run indefinitely.

The message LOW BAT is displayed onscreen when the remaining battery power cannot guarantee reliable instrument operation. After this message appears, the monitor will operate for some length of time, which is dependent on the operating mode.

For optimal battery life and capacity, use the NiMH battery pack in full charge/discharge cycles (fully discharge the battery pack before recharging, and then charge the battery pack until it is fully charged). A new battery pack will take a few charge/discharge cycles to reach full capacity.

### Replacing the NiMH Batteries

The battery compartment is located under the back panel of the monitor. To open the compartment, turn the screw head at the top of the panel 1/4 turn.

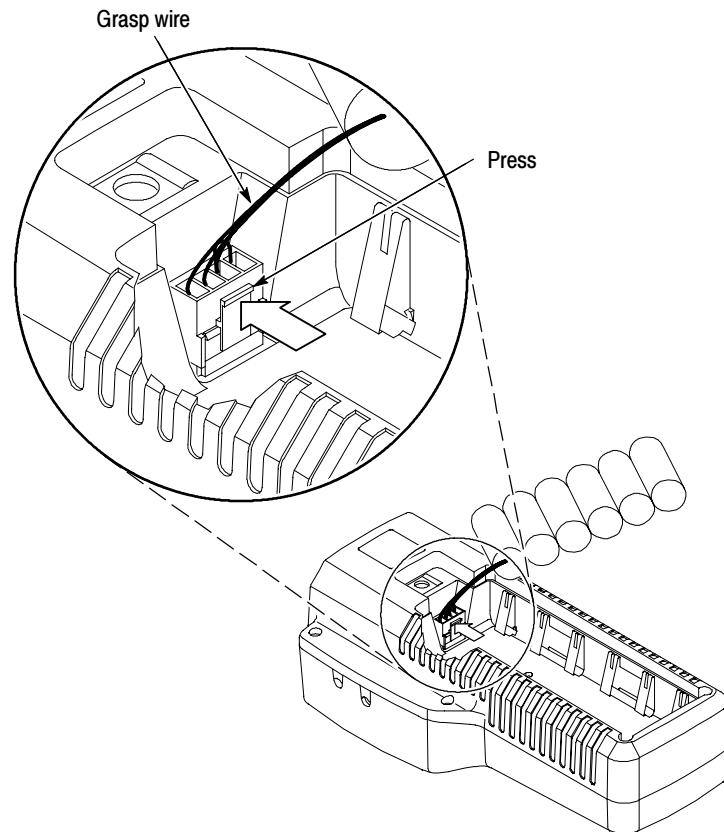
The optional NiMH battery pack has a connector that fits on the jumper in the battery compartment (see Figure 2-4). To remove the battery pack, grasp the batteries close to the wire leads. Press in on the top portion of the battery connector tab and then pull up gently.

To replace the NiMH battery pack, use only the Tektronix rechargeable NiMH battery pack, part number 146-0107-01. Do not use any other battery pack.

---

**NOTE.** To prevent a loss of battery power, be sure that the battery connector tab snaps on to the jumper housing.

---



**Figure 2-4: Removing the NiMH battery pack**

### Replacing the Alkaline Batteries

You can use six alkaline batteries to power the WFM90D and WFM91D, however, the battery life may be limited.

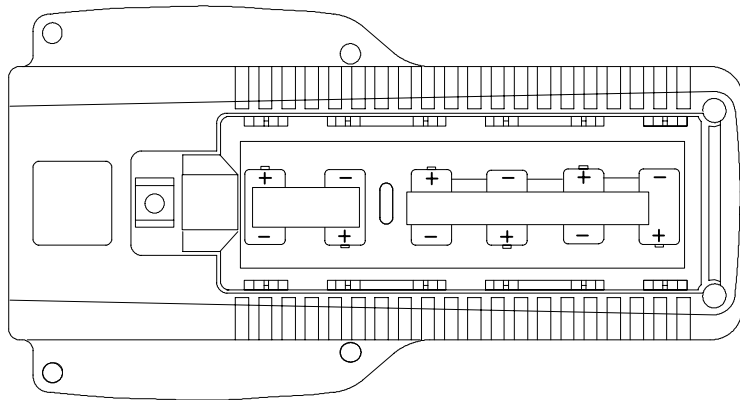
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**NOTE.** Always replace all of the alkaline batteries at the same time.

*The polarity of the alkaline batteries must be correct for the instrument to operate.*

---

The battery compartment is located under the back panel of the monitor. To open the compartment, turn the screw head at the top of the panel 1/4 turn. Replace all of the batteries, following the polarity indications on the bottom of the battery compartment, which are also shown in Figure 2-5.



**Figure 2-5: Inside of the battery compartment, showing polarity markings**

# Functional Overview

This section describes the WFM90D and WFM91D controls and connectors.

## Keypad Controls

The keypad (front panel) is illustrated in Figure 2-6.

### Power Switch

**ON.** The ON button toggles the instrument power on and off. The current instrument keypad and menu selections are saved when you turn off the instrument using this button. The instrument configuration is not saved if the power source is removed before you turn off the instrument with this button.

### Display Mode Selection

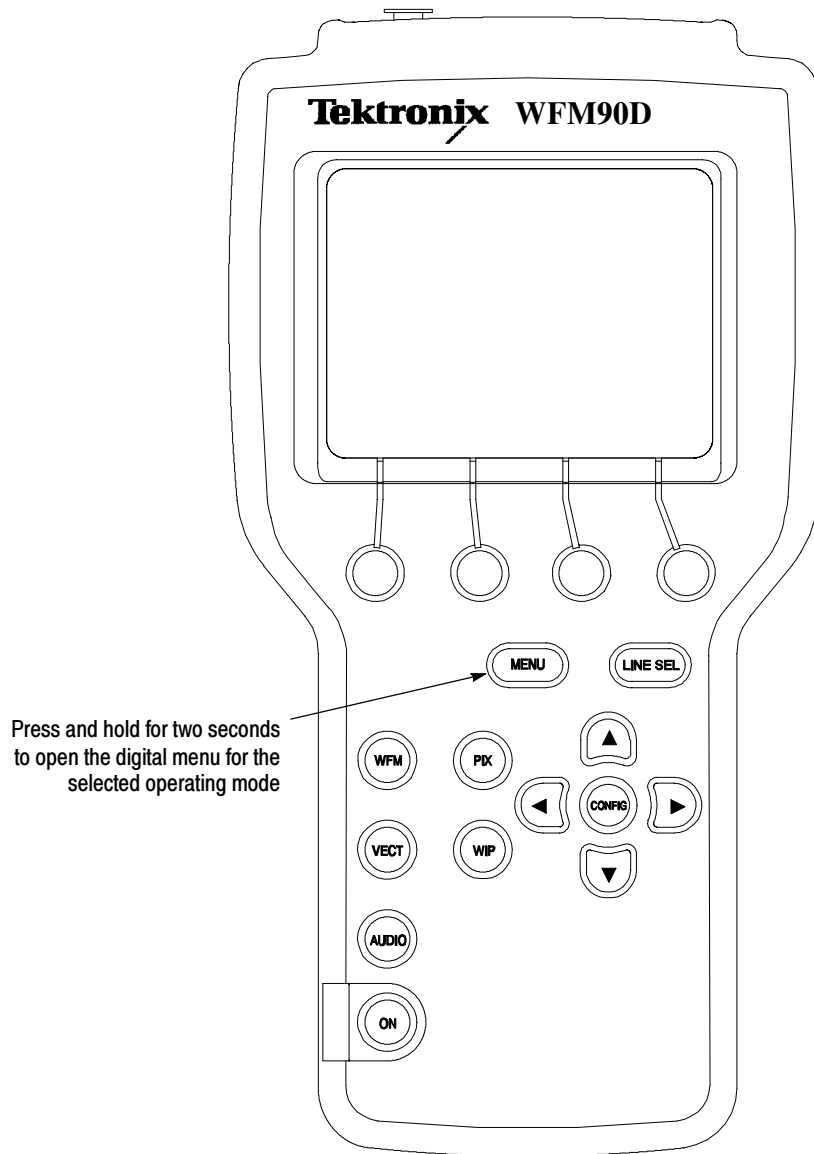
**WFM.** Pressing the WFM button enters the Waveform display mode.

**VECT.** Pressing the VECT button enters the Vector display mode.

**AUDIO.** Pressing the AUDIO button enters the Audio display mode.

**PIX.** Pressing the PIX button enters the Picture display mode.

**WIP.** Pressing the WIP button enters the Waveform-in-Picture display mode. The previously selected display mode, other than Picture, is shown in a 1/4-screen-sized window that overlays the Picture display.



**Figure 2- 6: WFM90D keypad**

## Menu Control

The menus use a combination of onscreen readout and multi-use buttons, in conjunction with the Arrow Buttons, to control most of the monitoring functions. Menus are entered by pressing one of the MENU, CONFIG, or LINE SEL buttons. Menus are exited by pressing the entry button for the open menu, or by entering another menu.

Menu operation and selections are detailed in *Using the Menus* starting on page 2-15.

**MENU.** Pressing the MENU button toggles an operating menu on and off. An operating menu contains monitoring selections that are specifically related to the currently selected display mode.

**Digital menus.** Pressing and holding the MENU button while in WFM, VECTOR, PICTURE, or WIP mode enters a digital operating menu. Operating menus are described in detail in *Operating Menus* starting on page 2-17.

**CONFIG.** Pressing the CONFIG button toggles the Configuration menu on and off. The Configuration menu contains selections which control overall instrument monitoring operation. Configuration menu selections are described in detail in *Configuration Menu* starting on page 2-21.

**LINE SEL.** Pressing the LINE SEL button toggles the Line Select mode on and off and displays the Line Select menu (shown in Table 2-9 on page 2-26).

**Bezel Buttons.** The four unlabeled buttons directly below the display are referred to as the bezel buttons. These buttons are used for making menu selections and are only enabled while menus are displayed on screen.

## Arrow Buttons

The function of the arrow buttons is dependent on the current state of the instrument. For the Waveform and Audio display modes, they control signal positioning. For the Vector display mode, they control vector phase, with the ▲ and ▼ buttons providing fine adjustment, and the ◀ and ▶ buttons providing coarse adjustment.

The arrow buttons retain their default function for the reduced display when the Waveform-in-Picture display mode is selected. When the Configuration menu is displayed, the ▲ and ▼ buttons operate the menu category selection, while the ◀ and ▶ buttons retain their default function for the current display mode.

### Instrument Reset

Extraordinary conditions may cause the WFM90D and WFM91D controls to become locked or to respond erratically. To reset the instrument, first press the ON button to turn off the power, then press the ON button again while holding down the WIP and CONFIG buttons. The instrument should return to normal operation with the keypad controls and menu selections assigned to the factory-set defaults.

If this reset does not return the instrument to normal operation, contact your Tektronix field office or call Tektronix at the phone number listed on page *xii* at the front of this manual.

## Side-Panel Connectors and Switches

The WFM90D and WFM91D side panels are illustrated in Figure 2-7.

**VIDEO IN.** Passive BNC input, unterminated, 75  $\Omega$  compensated for a video signal. A rear-panel switch provides an internal 75  $\Omega$  signal termination.

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**NOTE.** *A loop-through connector can be used by connecting a BNC "T" connector to the Video In BNC. Slide the rear panel switch to the HI-Z position.*

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**EXT REF.** Passive BNC input, unterminated, 75  $\Omega$  compensated for an external sync video signal. A rear-panel switch provides an internal 75  $\Omega$  signal termination.

**VIDEO OUT.** A BNC connector used to output the instrument display to a remote monitor or video switcher.

**AUDIO IN.** A standard three-pin XLR connector for a single channel of audio input.

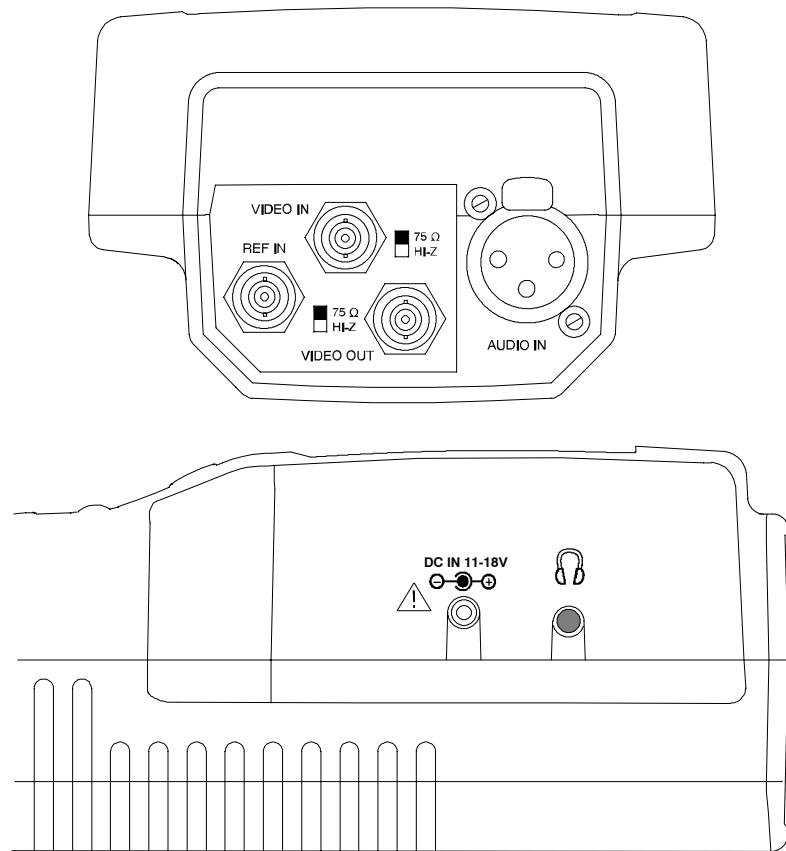
**Audio out.** A standard stereo mini-headphone jack for the output of the audio input signal. The mono input signal is heard on both stereo channels. The audio volume is fixed for each reference level. The larger the displayed signal, the louder the volume.

**DC IN 11-18V.** The DC input connector is a 2 mm plug that accepts a 12 VDC power input using a negative center lead.



**CAUTION.** *DC Power Source*

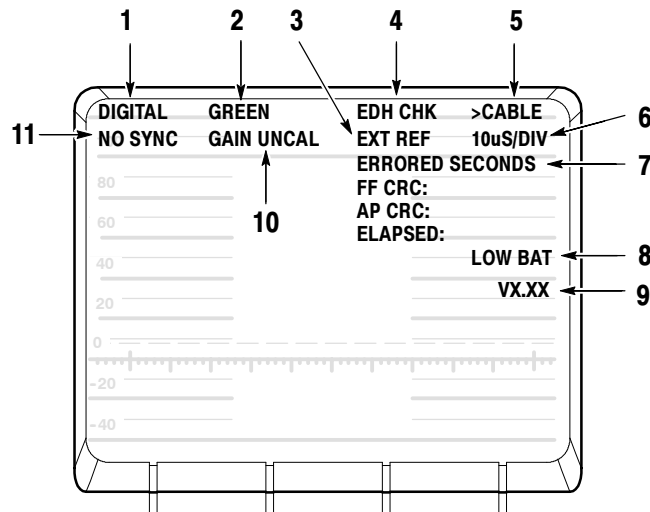
To avoid possible damage to the instrument circuitry when using a DC power source other than the supplied AC adapter, ensure that the DC source is a negative-ground 11 - 18 V system with a negative center lead. The DC source should be able to provide 12 W of power.



**Figure 2-7: WFM90D and WFM91D side panels**

## Onscreen Readouts

The WFM90D and WFM91D use onscreen messages to alert you to certain monitoring conditions. Figure 2-8 shows example readout messages and their locations.



**Figure 2-8: Onscreen readout messages**

### Readout Description

1. The video message reports the video type. Possible messages are shown in Table 2-1.
2. The component readout shows which component is selected for display through the digital Waveform menu: COMPOSITE, GREEN, BLUE, RED, Y, Pb, Pr, C. The readout only appears if digital video is locked or if INPUT CTL is set to DIGITAL.
3. The EXT REF message appears in the Waveform and Vector display modes when the video signal is locking to an external video reference signal.
4. The EDH report appears when EDH is turned on.
5. When the cable report is turned on (see *Configuration Menu*, page 2-21) the message displays >CABLE if the cable length is greater than approximately 200 meters. If the cable is shorter than 200 meters, there is no readout.

---

**NOTE.** The CABLE RPT readout is meaningful only when the instrument is operating in DIGITAL mode. In ANALOG mode, you can ignore the readout.

---

6. The sweep rate is only displayed in the Waveform display mode. There is no sweep rate readout when 2 Field sweep is selected.
7. When the CRC Watch is turned on, the ERRORED SECONDS message block appears.
8. The LOW BAT message is displayed when the instrument is battery operated and the remaining battery power has reached a critically low level. The remaining length of time that the instrument can be operated reliably is dependent on the current operating mode.
9. The instrument software version number is displayed when the Configuration menu is open with the DISPLAY category selected.
10. The GAIN UNCAL message appears in the Waveform, Vector, and Waveform-in-Picture display modes when the Variable Gain is on.
11. The MISSING SYNC message appears in all analog video display modes when the signal reference has been lost. NO SYNC appears in digital modes when analog sync is missing.

**Table 2-1: Video readout messages**

Message	Conditions	INPUT CTRL setting
DIGITAL	Digital video locked to 525 on a WFM90D; 625 on a WFM91D	DIGITAL or AUTO
<name of video standard>	Digital video lock to an unsupported standard	DIGITAL or AUTO
ANALOG	No digital video lock	AUTO
UNLOCK	No digital video lock	DIGITAL

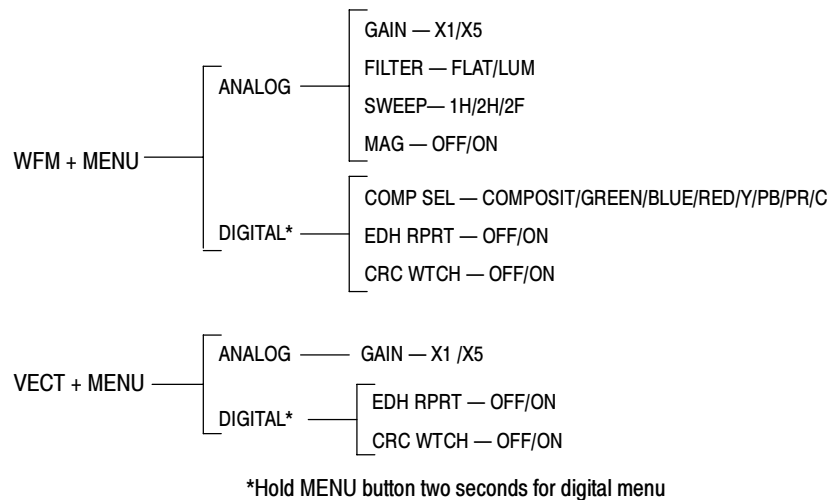


# Using the Menus

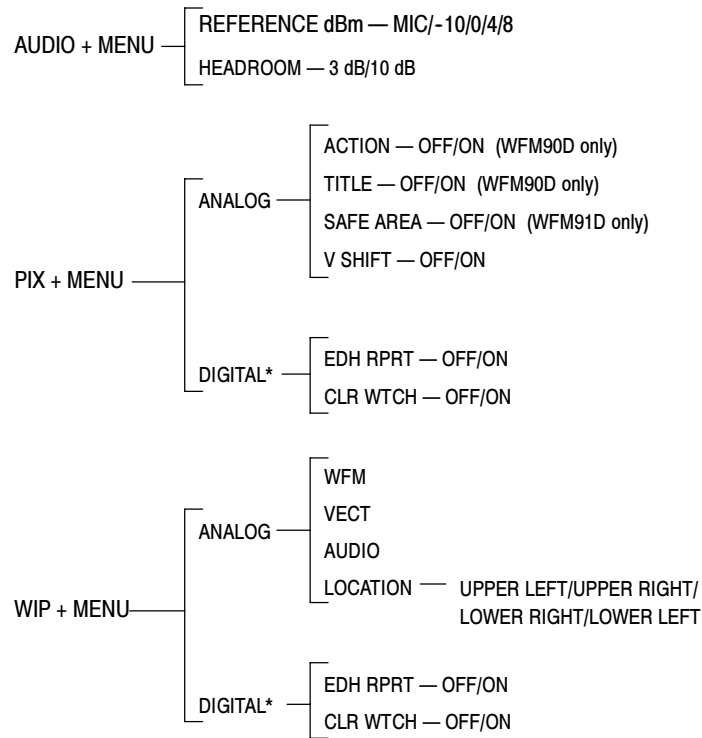
This section describes the operating and configuration menus for the WFM90D and WFM91D.

Figure 2-9 and Figure 2-10 show the complete menu structure for all of the operating menus. Figure 2-12 (on page 2-22) shows the menu structure for the Configuration menu.

Some menu selections appear only in one or the other model, or only in digital mode. These special considerations are noted in the following illustrations and tables.

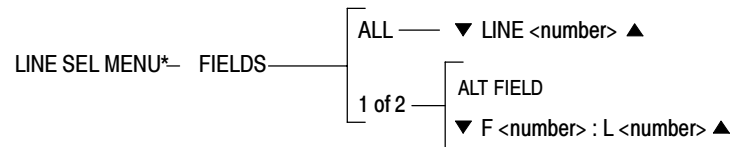


**Figure 2-9: Waveform and Vector menus**



\*Hold MENU button two seconds for digital menu

**Figure 2- 10: Audio, Picture, and Waveform-in-Picture menus**



\*Line Select menu appears only in WFM + VECT modes

**Figure 2- 11: Line Select menu**

## Operating Menus

The following pages describe the operating menus, shown in Figure 2-9 and Figure 2-10.

Each operating mode has an associated menu. In addition, the Waveform, Vector, Picture, and WIP operating modes have an associated digital menu.

Operating menu selections affect only the display mode in which they appear (unless otherwise noted). If you switch to a different operating mode, the menu for the new mode will display.

### Accessing Menus

To enter an operating menu, select the desired operating mode (such as Waveform or Audio), and then press the MENU button.

To exit, press the MENU button again.

### Accessing Digital Menus

To enter a digital operating menu, first ensure that the input control is configured for AUTO or DIGITAL (see *Configuration Menu* on page 2-21). Then select the desired operating mode (Waveform, Vector, Picture, or WIP) and hold the MENU button for 2 seconds.

To exit, press the MENU button again.

### Using the Menus

Press the bezel button that corresponds to the desired selection on the display. When you make a selection, changes are displayed immediately.

To adjust values, press the two right bezel buttons while displaying a menu selection such as ▼ TRACE ADJUST ▲.

### Waveform Menu

Press the WFM button and the MENU button to open the Waveform operating menu. Hold the MENU button in for two seconds to open the digital menu. For more details on menu access, see page 2-17.

Waveform menu choices are shown in Table 2-2. The Waveform menu tree is shown in Figure 2-9.

**Table 2-2: Waveform menu choices, analog and digital**

Submenu	Digital only	Function
GAIN		Sets the Waveform display mode vertical gain and the Vector display mode gain to X1 or X5.
FILTER		Selects FLAT (unfiltered display) or LUM (low-pass filtered for luminance display).
SWEEP		Selects sweep rate: 1H (5 $\mu$ s/division), 2H (10 $\mu$ s/division), or 2F (two field).
MAG		Turns horizontal gain on or off. When set to on, additional sweep rates are available: 1H + MAG (0.5 ms/division), 2H + MAG (1 ms/division), and 2F + MAG (magnified by approximately X20).
COMP SEL	✓	Selects a component of the signal for display. You can also display a composite signal (the digital input signal is converted to analog).
EDH RPRT	✓	Enables or disables the EDH reporting readout at the top center of the display in Waveform and Vector modes.
CRC WTCH	✓	Enables or disables the CRC reporting readout on the right side of the display in Waveform and Vector modes.

**Vector Menu**

Press the VECT button and the MENU button to open the Vector operating menu. Hold the MENU button in for two seconds to open the digital menu. For more details on menu access, see page 2-17.

Vector menu choices are shown in Table 2-3. The Vector menu tree is shown in Figure 2-9.

**Table 2-3: Vector menu choices, analog and digital**

Submenu	Digital only	Function
GAIN		Sets the Vector display mode gain and the Waveform display mode vertical gain to X1 or X5.
EDH RPRT	✓	Enable or disable the EDH reporting readout at the top center of the display in Waveform and Vector modes.
CRC WTCH	✓	CRC Watch. Enable or disable the CRC reporting readout on the right side of the display in Waveform and Vector modes.



**Audio Menu** Press the AUDIO button and the MENU button to open the Audio operating menu. There is no digital menu for audio. For more details on menu access, see page 2-17.

Audio menu choices are shown in Table 2-3. The Audio menu tree is shown in Figure 2-10.

**Table 2-4: Audio menu choices**

Submenu	Function
REFERENCE dBu	Sets the Audio reference level to MIC, -10, 0, 4, or 8. The reference levels are measured in dBu, and the MIC level is for testing microphones.
HEADROOM	Sets the headroom reference level to -3 dB or +10 dB. Use the +10 dB setting for viewing signal levels greater than 3 dB over the reference level.

**Picture Menu** Press the PIX button and the MENU button to open the Picture operating menu. Hold the MENU button in for two seconds to open the digital menu. For more details on menu access, see page 2-17.

Picture menu choices are shown in Table 2-5. The Picture menu tree is shown in Figure 2-10.

**Table 2-5: Picture menu choices, analog and digital**

Submenu	Digital only	Function
ACTION		WFM90D only. Turns the Safe Action area markers on and off.
TITLE		WFM90D only. Turns the Safe Title area markers on and off.
SAFE AREA		WFM91D only. Turns the Safe Area markers on and off.
V SHIFT		Turns the vertical shift on and off. The vertical shift allows you to view the vertical interval on the Picture display. The vertical interval display does not appear on the VIDEO OUT signal.
EDH RPRT	✓	Enable or disable the EDH reporting readout at the top center of the display in Waveform and Vector modes.
CRC WTCH	✓	CRC Watch. Enable or disable the CRC reporting readout on the right side of the display in Waveform and Vector modes.

### **WIP Menu (Waveform-in-Picture)**

Press the WIP button and the MENU button to open the Waveform-in-Picture operating menu. Hold the MENU button in for two seconds to open the digital menu. For more details on menu access, see page 2-17.

WIP menu choices are shown in Table 2-5. The WIP menu tree is shown in Figure 2-10.

**Table 2-6: WIP menu choices, analog and digital**

<b>Submenu</b>	<b>Digital only</b>	<b>Function</b>
WFM		Selects the Waveform mode for display in the WIP window.
VECT		Selects the Vector mode for display in the WIP window.
AUDIO		Selects the Audio mode for display in the WIP window.
LOCATION		Selects the position of the WIP window in the Picture display (selects from the four corners of the screen).
EDH RPRT	✓	Enable or disable the EDH reporting readout at the top center of the display in Waveform and Vector modes.
CRC WTCH	✓	CRC Watch. Enable or disable the CRC reporting readout on the right side of the display in Waveform and Vector modes.

## Configuration Menu

The following pages describe the instrument configuration menu, shown in Figure 2-12 on page 2-22. Menu categories and functions are described in Table 2-7.

### Configuration Menu Access

To enter the Configuration menu, press the CONFIG button.

To exit the configuration menu, press the CONFIG button again.

### Using the Configuration Menu

Press the bezel button that corresponds to the desired selection on the display. When you make a selection, changes are displayed immediately.

Configuration menu categories are displayed above the left bezel button. The selected category is highlighted. To scroll through the menu categories, press the left bezel button or press the ▲ and ▼ buttons.

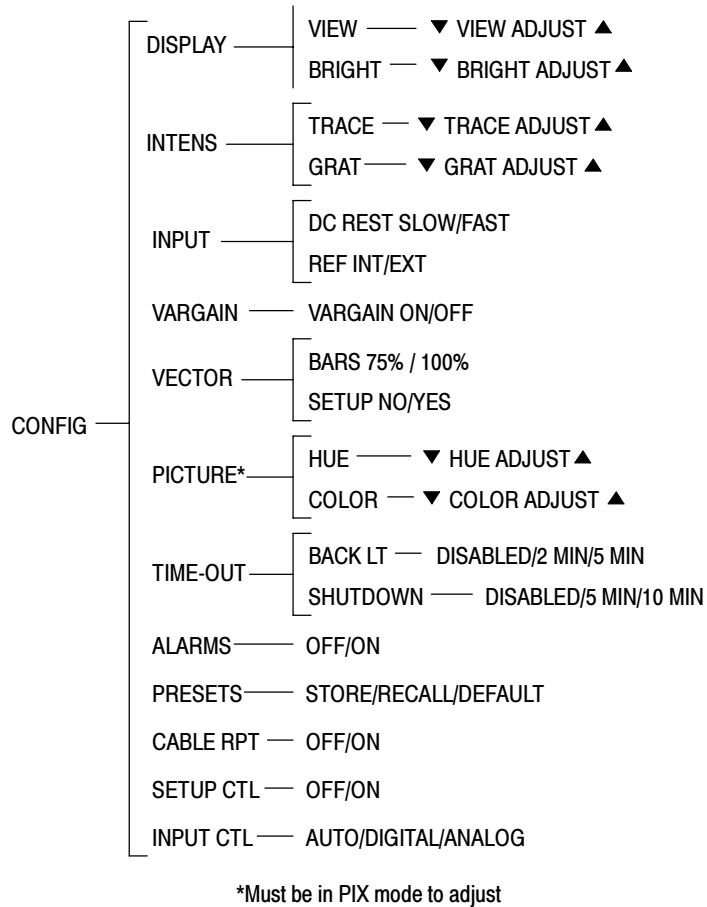
Menu selections within the selected category appear over the right three Bezel Buttons.

To adjust values, press the two right bezel buttons while displaying a menu selection such as ▼ TRACE ADJUST ▲.

---

**NOTE.** *If you adjust picture hue and/or color, the only way to ensure that the hue and color have been correctly reset is to recall the factory default settings through Configuration PRESETS.*

---



**Figure 2- 12: Configuration menu**

**Table 2-7: Configure menu choices**

Category	Submenu	Function
DISPLAY	VIEW	The right two bezel buttons adjust the viewing angle of the LCD display up or down to allow optional viewing of the display from different positions.
	BRIGHT	The right two bezel buttons adjust the brightness of the LCD display.
INTENS	TRACE	The right two bezel buttons adjust the intensity of the signal trace.
	GRAT	The right two bezel buttons adjust the intensity of the measurement graticule.
INPUT	DC REST	Sets the DC restorer speed to SLOW or FAST.
	REF	Sets the video signal reference to INT (internal reference) or EXT (external reference input signal). When external reference is selected, EXT REF appears in the onscreen readout of the Waveform and Vector displays. If the monitor loses its signal reference, MISSING SYNC is displayed in the onscreen readout.
VAR GAIN	VAR GAIN	Turns the variable gain on and off. When the variable gain is on, the right two bezel buttons adjust the signal gain (the instrument must be in Waveform or Vector display mode). The first time you press one of the right two bezel buttons, the category list disappears from the left side of the display to provide maximum signal viewing. The right two bezel buttons will now adjust the signal gain. To see the category list, press the left bezel button.  When the variable gain is on, GAIN UNCAL displays onscreen in Waveform, Vector, and Waveform-in-Picture display modes.
VECTOR	BARS	Sets the calibration of the vector chrominance gain to correctly process 75% or 100% amplitude color bar signals.
	SETUP	<i>(WFM90D only.)</i>  Sets the vector gain to correctly process NTSC input signals with or without setup.
	ALT PH	<i>(WFM91D only.)</i>  Alternate Phase. Turns the PAL +V mode on and off. When the mode is on, the phase reference of the -V lines is inverted and then shown as an overlay on the +V lines to provide a comparison display.
PICTURE	HUE	<i>(WFM90D only.)</i>  When HUE is selected, the right two Bezel Buttons adjust the hue of the Picture display (instrument must be in Picture display mode).
	COLOR	The right two Bezel Buttons adjust the color of the Picture display (instrument must be in Picture display mode).

**Table 2-7: Configure menu choices (Cont.)**

Category	Submenu	Function
TIME-OUT	BACK LT	You can set the instrument to shut down power to the backlight after 2 minutes or 5 minutes of inactivity.
	SHUTDOWN	You can set the instrument to power down after 5 minutes or 10 minutes of inactivity. Only functional when the instrument is battery powered.
ALARMS		Turns the alarm on and off for the Waveform and Vector display modes.
PRESETS	STORE	Stores the current keypad and menu settings in memory for future recall.
	RECALL	Resets the keypad and menu settings to the last settings that were stored in memory.
PRESETS	DEFAULT	Resets the front panel and menu settings to their factory-set defaults. Monitoring adjustments such as signal position, vector phase, and picture hue are also reset. The default settings of the keypad and menus are listed in Table 2-8.
CABLE RPT		Turns the cable report off and on. When cable report is turned on, the readout displays <b>&gt;Cable</b> if the cable length is greater than 200M. If the cable is equal to or less than 200 meters, there is no readout.
SETUP CTL		<i>(WFM90D only; has no effect on the WFM91D).</i> Turns the setup on or off for digital signals. When setup is on, 7.5 IRE of setup is applied to the input signal.
INPUT CTL		Specifies the type of input signal the instrument will receive. With ANALOG selected, the monitor operates like an analog-only monitor. With AUTO selected, the instrument automatically switches between analog and digital modes based on the input signal. With DIGITAL selected, the instrument is always in digital mode. You might want to use this setting if you will frequently connect and disconnect the input signal, so that the instrument doesn't switch into analog mode when no signal is detected.

**Table 2-8: Default instrument settings**

<b>Display mode</b>	<b>Waveform</b>
Signal reference	Internal
Filter	Flat
DC restorer speed	Slow
Gain	X1
Variable gain	Off
Sweep	2H (2 Line)
Mag	Off
Bars	75%
Setup ( <i>WFM90D only</i> )	Yes
Alt Phase ( <i>WFM91D only</i> )	Off
Reference dBu	0 dBu
Headroom	3 dB
WIP location	Bottom right
Alarms	Off
Safe action	Off
Safe title	Off
Vertical shift	Off
Backlight time-out	Disabled
Instrument time-out	Disabled
Cable report	On
Setup control ( <i>WFM90D function only</i> )	On
Input control	Auto
EDH report	On
CRC watch	Off

## Line Select Menu

Enter the Waveform, Vector, or WIP operating mode.

Press the LINE SEL button to turn on Line Select mode and open the Line Select menu. The number of the selected line and/or field displays in the menu bar over the right two Bezel Buttons.

The Line Select menu is shown in Figure 2-11 on page 2-16 and the Line Select menu choices are shown in Table 2-9.

**Table 2-9: Line Select menu choices**

<b>Selection</b>	<b>Function</b>
FIELDS ALL	Selects all video fields for display. The two right bezel buttons select which line number is displayed. The menu bar over these two buttons displays the selected line number.
FIELDS 1 OF 2	When 1OF 2 is selected, the menu selection ALT FIELD appears. This allows you to select the video field in which the selected line is displayed.





# Theory of Operation



# Theory of Operation

This section contains a module-level description of the instrument circuitry. The description is based on the block diagram in Figure 3-1. (For serial numbers below B020100, see Figure 3-2).

## Input Board

The signal input and output connectors are located on the Input board. There are receivers for the Audio, Video, and External Reference inputs. This board also provides an automatic equalizer for serial digital video inputs, a switch for the video signal reference, and a variable gain circuit for the audio input.

The output of the serial digital video automatic equalizer is routed to the SDI Interface board for further processing and a video signal is returned from the SDI Interface board. A signal line, DIG, from the SDI Interface board can disable the video input amplifier to select the video signal from the SDI Interface board or it can disable the video from the SDI Interface board and enable the video from the video input amplifier.

The video input signal has a DC voltage feedback clamp from the Bottom board. The video output signal from the Bottom board is routed through the Input board. The audio variable gain is controlled by the microprocessor serial bus, which is routed to the Input board from the Top board through the Bottom board.

## SDI Interface Board

The equalized SDI signal from the Input board is received on the SDI and N\_SDI lines. A clock extraction and reclocking function provides clock and data on the SDOP, SDON, SCOP, SCON lines. It also provides the “LOCK” output, which determines whether an SDI signal is present. This board also provides a serial-to-parallel function, as well as system detection and EDH functionality.

The parallel data and clock are then fed to a digital-to-analog converter with composite encoding functions. The output of the converter is filtered and amplified before being sent to the Input Board.

The video output amplifier can be disabled by a low on the DIG line to allow for an analog input to the Input board. An A/D converter measures the voltage on the CARRIER\_DET line to estimate the degradation that the SDI signal has experienced due to long cables and so forth.

The entire board is controlled by a I2C bus with the I2C clock on SCLK and the I2C data on MOSI.

## Top Board

The Top board contains the microprocessor circuitry, the rasterizer and graphics generator, the subcarrier oscillator, and the timing generator.

**Microprocessor.** The microprocessor takes input from the front-panel keypad to control the operation of the instrument through the serial bus, parallel bus, and dedicated control lines.

**Rasterizer and Graphics.** The rasterizer and graphics block produces all internally generated video including waveforms, graticules, and menus. The rasterizer uses the horizontal and vertical deflection signals to produce the waveforms. The rasterizer uses the horizontal and vertical sync signals from the Bottom board to lock to the incoming video signal.

The rasterizer needs a good analog timing voltage to run correctly. This timing voltage is generated by a circuit loop between the Top and Bottom boards. Problems with this circuit can be on either circuit board.

## Bottom Board

The Bottom board contains the power supply circuitry, the horizontal and vertical deflection circuits, the NTSC or PAL decoder, the vectorscope and burst-lock circuitry, the sync separator, and the audio amplifier for the headphone output.

## LCD Display and Backlight (Serial Numbers B020100 and Above)

The LCD Display module generates the display graphics using input signals generated on the Top and Bottom boards. The power for the LCD Display module comes from the Bottom board. The display backlight is incorporated into the LCD Display module. See Figure 3-1.

## LCD Display and Backlight (Serial Numbers Below B020100)

The LCD Display module generates the display graphics using input signals generated on the Top and Bottom boards. The power for the LCD Display module comes from the Bottom board, while the power for the backlight comes from the Backlight Power Supply board. The display backlight mounts into the side of the LCD Display module. See Figure 3-2.

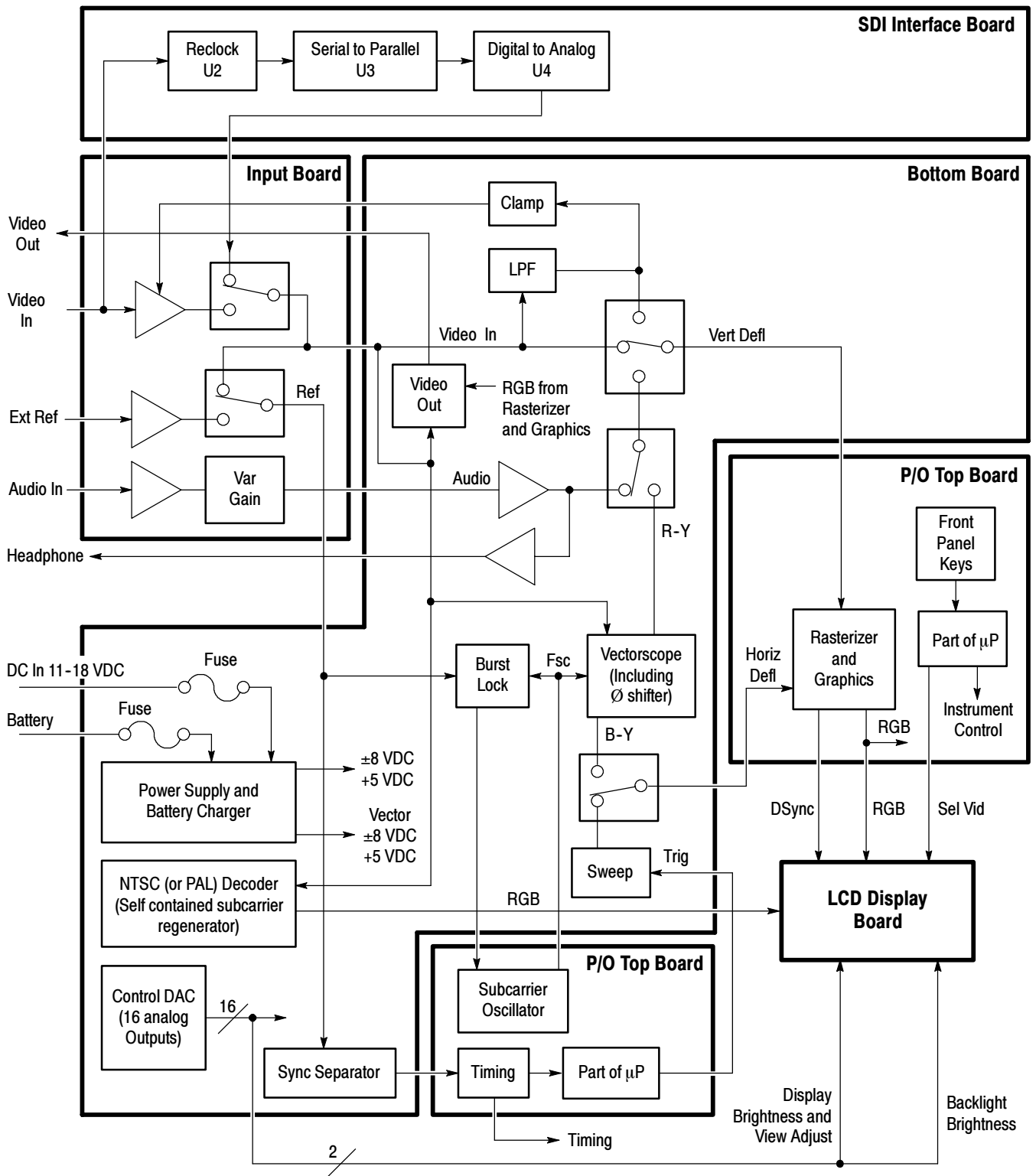


Figure 3-1: Simplified block diagram (serial numbers B020100 and above)

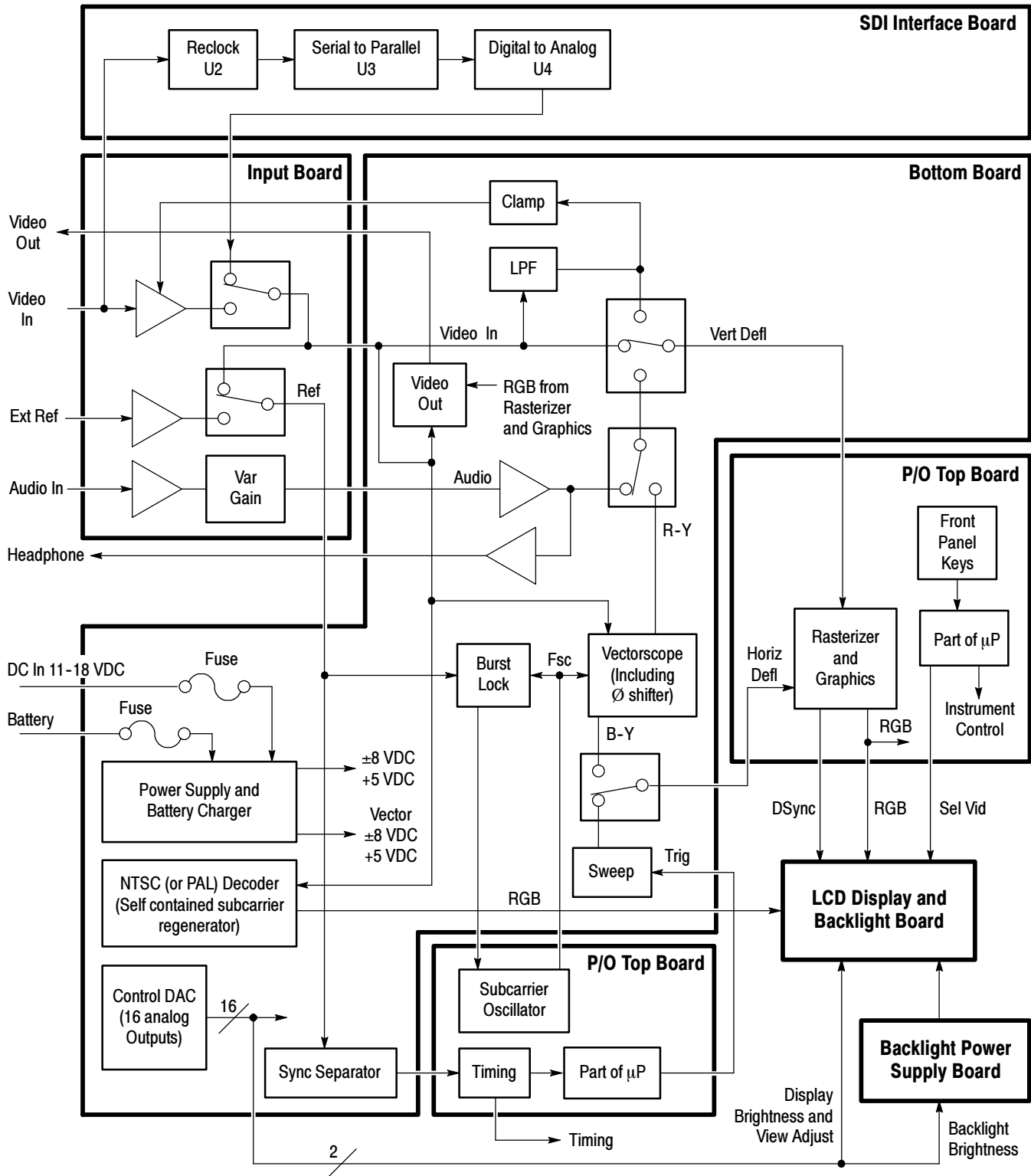


Figure 3-2: Simplified block diagram (serial numbers below B020100)



# Performance Verification





# Performance Verification

This section contains the following information:

- Summary verification procedure
- List of equipment required to perform the procedures
- Performance Verification Procedures: Analog Section
- Performance Verification Procedures: Digital Section

Perform the procedures in this section to ensure that the instrument is operating properly and is meeting the performance requirements listed in the *Specifications* section.

The procedures are divided into two sections: an analog section and a digital section. Perform the procedures in the analog section for all instruments. In addition, perform the procedures in the digital section if you are using digital input signals.

## Conventions

The following conventions apply throughout these procedures:

- Each verification procedure uses the following format:

Title of verification procedure

Specification requirement(s) the procedure is verifying

Verification procedure

- When you are instructed to use a front-panel control or to select a specific menu item on the waveform monitor, the name of the control or menu item appears in boldface type.

---

**NOTE.** Do not change the front-panel settings or controls unless this is called out in the procedures. Each procedure requires you to set the instrument to certain default settings before verifying the procedure requirement. If you change these settings, except as called out in the procedure, you may obtain invalid results.

The verification procedures are written in a sequential format. If you are unsure about equipment hookups or instrument settings for a specific procedure step, you will need to review the previous steps to verify the hookups and settings required for the current step.

---

**Prerequisites**

The tests in this section comprise a valid confirmation of instrument performance when the following requirements are met:

- Test equipment used to verify performance requirements must be calibrated and working within the limits specified in Table 4-2 on page 4-3.
- The WFM90D or WFM91D Handheld Waveform, Vector, Picture, and Audio Monitor must have last been adjusted at an ambient temperature range of +20° C to +30° C, and must have been operating for a warm-up period of at least 20 minutes.

**Summary Verification**

The summary verification is listed in Table 4-1 and is intended for those who are familiar with the complete performance verification procedures. Procedure titles and page numbers provide a cross-reference to the performance verification procedures on the following pages.

**Table 4-1: Summary verification procedure**

Procedure	Procedure requirement	Page #
Preliminary setup	Initial equipment connections and control settings.	4-5
Sync separation	Signal synchronization will occur with input signals of composite video or black burst, with sync amplitudes of 40 IRE (300 mV PAL) $\pm$ 6 dB for internal reference, and sync amplitudes of between 143 mV and 4 V for external reference.	4-5
Sweep timing and integral linearity	Sweep Timing Accuracy: 5 $\mu$ s/Div. (1 Line), 10 $\mu$ s/Div. (2 Line), and 1.0 $\mu$ s/Div. (2 Line + MAG), $\pm$ 2%. 0.2 $\mu$ s/Div. (1 Line + MAG) $\pm$ 3%. Integral Linearity: $\pm$ 1%.	4-6
Vertical gain and vertical magnifier registration	1 Volt Full Scale: 1 V input displayed within 1% of 140 IRE (1.00 V PAL). X5 Gain: Gain accuracy within 5% with 1 V input signal. X5 Gain Registration: $\leq$ 1 major division of vertical shift from baseline between unmagnified and magnified signal.	4-7
Variable gain range and vertical position range	Variable Gain Range: Input signals between 0.8 V and 2 V can be adjusted to 140 IRE (1.0 V) display. 160 mV and 400 mV for X5 Gain. Vertical Position Range: 1 V signal can be positioned so that peak white and sync tip can be placed at blanking level, with the DC Restorer Clamp on, regardless of gain setting.	4-7
Overscan	$\leq$ 2% variation in baseline of 100 IRE (700 mV PAL) 12.5T (20T PAL) modulated pulse as it is positioned over the middle 80% of the screen.	4-8
Input and DC restorer frequency response	X1 Gain Response (Flat filter selected): 50 kHz to 6 MHz within 2% of response at 50 kHz. X5 Gain Response (Flat filter selected): 50 kHz to 6 MHz within 5% of response at 50 kHz. Attenuation of 60 Hz (50 Hz PAL) on Input Signal: SLOW mode: $\leq$ 20%. FAST mode: $\geq$ 90%.	4-9

**Table 4-1: Summary verification procedure (Cont.)**

Procedure	Procedure requirement	Page #
Vector phase stability	Phase Shift with Subcarrier Frequency Change from $F_{SC}$ to $F_{SC} \pm 50$ Hz ( $F_{SC} \pm 10$ Hz PAL): $\pm 2^\circ$ . Phase Shift with Burst Amplitude Change from Nominal to $\pm 6$ dB: $\pm 2^\circ$ . Phase Shift with Variable Gain Control Varied from +3 dB to -6 dB: $\pm 1^\circ$ .	4-11
Chrominance bandwidth	Chrominance Bandwidth: Upper -3 dB Point: $F_{SC} + 500$ kHz, $\pm 100$ kHz. Lower -3 dB Point: $F_{SC} - 500$ kHz, $\pm 100$ kHz.	4-12
Audio gain and frequency response	Measurement Accuracy: 0.5 dB at 1 kHz. Frequency Response: 0.5 dB from 50 Hz to 20 kHz.	4-13
Digital input gain accuracy	$\pm 2\%$ for 1 V encoded video	
Digital input frequency response	$\pm 4\%$ from 50 KHz to 4.5 MHz	
Digital input frequency response X5	$\pm 5\%$ from 50 KHz to 4.5 MHz	

## Equipment Required

Table 4-2 lists the required equipment and accessory items to perform the performance verification procedures. Minimum equipment specifications are followed by an example of equipment that meet these specifications.

An accuracy ratio of 4:1 or better for the warranted specifications will be obtained using the equipment recommended in Table 4-2 with the following exceptions:

- Audio Amplitude: 2.5:1
- Audio Flatness: 2.5:1

**Table 4-2: Equipment required for performance verification**

Equipment description	Minimum requirements	Equipment example
Analog television test signal generator	Color test signals for the television standard of the monitor to be tested: color bar signal, pulse and bar; with 2T pulse, 2T bar, and modulated pulse, field square wave signal, and black burst signal	NTSC: Tektronix 1410 <sup>2</sup> TV Test Signal Generator with Option AA and Option AB (modified SPG2 and TSG7), TSG3, and TSG5 PAL: Tektronix 1411 <sup>2</sup> TV Test Signal Generator with Option AA and Option AB (modified SPG12 and TSG17), TSG13, and TSG15
Serial digital television test signal generator	Color test signals for the television standard of the monitor to be tested: color bar signal, pulse and bar; with 2T pulse, 2T bar, modulated pulse, and line sweep.	TSG601 Handheld Serial Component Signal Generator
Leveled sine wave generator	Output Level Range: -11.55 dBm (200 mV) to 0.43 dBm (800 mV); Frequency: 50 kHz to 10 MHz	Tektronix SG 503 <sup>3</sup> Leveled Sine Wave Generator

**Table 4-2: Equipment required for performance verification (Cont.)**

Equipment description	Minimum requirements	Equipment example
Function generator	Range: 0.1 to 5 Vpp when loaded by 75 $\Omega$ , 10 Vpp when unloaded; Frequency: 50 kHz to 10 MHz.	Tektronix FG 503 <sup>3</sup> Function Generator
Audio generator	Amplitude Range: -10 dBu to 8 dBu; Frequency: 1 kHz to 50 kHz	Tektronix ASG 100 Audio Signal Generator
Voltmeter	Range: 0 VDC to > 100 VDC; Accuracy: $\pm 0.1\%$	Tektronix DM 504A <sup>3</sup> Digital Multimeter
Frequency counter	Range: 10 Hz to 10 MHz; Accuracy: $\pm 0.001\%$	Tektronix DC 503A <sup>3</sup> Universal Counter
Video amplitude calibrator (VAC)	Signal: Adjustable square wave 0.0 mVpp to 999.9 mVpp; Resolution: 0.1 mV; Accuracy: 0.05%; Frequency: Approximately 270 Hz	Tektronix part number 067-0916-00 <sup>3</sup>
Peak-to-peak detector	Input Signal Range: 0.25 Vpp to 1.0 Vpp; Flatness: $\pm 0.2\%$ 50 kHz to 10 MHz; Input Impedance: 75 $\Omega$	Tektronix part number 015-0408-00 (includes peak-to-peak detector head, Tektronix part number 015-0413-00) <sup>3</sup>
75 $\Omega$ termination	Two required; feed-through type	Tektronix part number 011-0103-02
75 $\Omega$ coaxial cable	Two cables required, male to male BNC connectors	Tektronix part number 012-0159-00 (42-inch)
50 $\Omega$ coaxial cable	1% precision, male to male BNC connectors	Tektronix part number 012-0482-00 (36-inch)
Audio cable	XLR female to XLR male	Switchcraft part number SC3XXJ
50 $\Omega$ -to-75 $\Omega$ minimum loss attenuator	Impedance: 50 $\Omega$ -to-75 $\Omega$ ; Tolerance: $\pm 0.5$ dB; Frequency: 100 MHz	Tektronix part number 011-0057-00
X10 attenuator	75 $\Omega$	Tektronix part number 011-0061-00
Dual input coupler	Matched BNC cable-T for making phase comparisons between two inputs; Matched length of the two arms within $\pm 0.1$ inch	Tektronix part number 067-0525-02
BNC female to BNC female connector		Tektronix part number 103-0028-00

<sup>2</sup> The 1410-Series generators with standard SPG and TSG modules can be used, but not all checks and adjustments can be made. The standard SPG2 and SPG12 modules will not check lock to changes in sync amplitude, cw lock to changes in burst amplitude, and frequency lock to burst offset frequency changes. The signal generator can be ordered with one or both options (AA and AB). The TSG3 and TSG13 are Modulated Staircase Generators with variable APL. The TSG5 and TSG15 are Pulse and Bar Generators with modulated pulse and field square wave signals.

<sup>3</sup> Requires a Tektronix TM 500-Series or TM 5000-Series Power Module Mainframe.

# Performance Verification: Analog Section

Perform the following steps before beginning the verification procedures:

1. Plug the AC power adapter into the instrument and then plug the adapter into the AC power source.
2. Connect the multiburst signal from the analog television signal generator through a 75  $\Omega$  in-line termination and dual-input coupler to the **VIDEO IN** and **REF IN** connectors on the WFM90D or WFM91D monitor.
3. Set the input termination switches to the **HIZ** position.
4. Turn on the WFM90D or WFM91D monitor.
5. Enter the Configure menu. Select **PRESETS** and then select **DEFAULT**.

---

**NOTE.** Be sure you have warmed up the instrument for at least 20 minutes before you perform any of the verification procedures.

---

## Sync Separation

This procedure verifies the following requirement:

Signal synchronization will occur with input signals of composite video or black burst, with sync amplitudes of 40 IRE (300 mV PAL)  $\pm$  6 dB for internal reference, and sync amplitudes of between 143 mV and 4 V for external reference.

1. Enter the Configuration menu and select the **INPUT** category.
2. Check for a stable display while switching between **INT** and **EXT REF**.
3. Remove the termination from the dual-input coupler.
4. Check for a stable display while switching between **INT** and **EXT REF**.
5. Add three 75  $\Omega$  terminations to the dual-input coupler.
6. Check for a stable display while switching between **INT** and **EXT REF**.
7. Select **INT REF** from the Configuration menu **INPUT** category.
8. Remove the dual-input coupler from the instrument.

## Sweep Timing and Integral Linearity

This procedure verifies the following requirement:

Sweep Timing Accuracy: 5  $\mu\text{s}/\text{Div.}$  (1 Line), 10  $\mu\text{s}/\text{Div.}$  (2 Line), and 1.0  $\mu\text{s}/\text{Div.}$  (2 Line + MAG),  $\pm 2\%$ . 0.2  $\mu\text{s}/\text{Div.}$  (1 Line + MAG)  $\pm 3\%$ . Integral Linearity:  $\pm 1\%$ .

1. Connect the multiburst signal from the analog television signal generator to the **VIDEO IN** connector on the WFM90D or WFM91D monitor, and to the input on the frequency counter, using a T-connector, 75  $\Omega$  cable, and 75  $\Omega$  in-line termination.
2. Set the multiburst generator controls to Low, Continuous, and Manual. Set the output frequency to 100 kHz (as read on the frequency counter).
3. Check for one cycle per division,  $\pm 1$  minor division, over the center ten graticule divisions.
4. Select **1H SWEEP** from the Operating menu.
5. Set the multiburst generator frequency to 200 kHz.
6. Check for one cycle per division,  $\pm 1$  minor division, over the center ten graticule divisions.
7. Adjust the multiburst generator frequency so that the cycles land exactly on the first and tenth graticule marks.
8. Check that each cycle is within  $\pm 0.5$  minor division of a major graticule mark.
9. Select **MAG ON** from the Operating menu.
10. Set the multiburst generator frequency to 2 MHz.
11. Check for one cycle per division,  $\pm 1$  minor division, over the center ten graticule divisions, and also at both ends of the magnified sweep (using the horizontal position control), ignoring the first and last cycle.
12. Set the multiburst generator frequency to 1 MHz.
13. Select **2H SWEEP** from the Operating menu.
14. Check for one cycle per division,  $\pm 1$  minor division, over the center ten graticule divisions, and also at both ends of the magnified sweep (using the horizontal position control), ignoring the first and last cycle.
15. Select **MAG OFF** from the Operating menu.

## Vertical Gain and Vertical Magnifier Registration

This procedure verifies the following requirement:

1 Volt Full Scale: 1 V input displayed within 1% of 140 IRE (1.00 V PAL).  
 X5 Gain: Gain accuracy within 5% with 1 V input signal. X5 Gain Registration:  
 $\leq 1$  major division of vertical shift from baseline between unmagnified and magnified signal.

1. Set the multiburst generator controls to Composite and Multiburst.
2. Position the signal baseline to the graticule baseline, and then select **X5 GAIN** from the Operating menu.
3. Check that the signal baseline is within  $\pm 1$  major division of the graticule baseline.
4. Select **X1 GAIN** from the Operating menu.
5. Remove the signal and termination from the **VIDEO IN** connector.
6. Connect the output of the VAC to the **VIDEO IN** connector. Do not terminate the input.
7. Set the VAC for a 999.9 mV output, with all of the buttons out except for +LUM and NTSC (PAL button for the WFM 91).
8. Check for a display amplitude of 140 IRE  $\pm 1.4$  IRE (1000 mV  $\pm 10$  mV PAL).
9. Set the VAC for a 199.9 mV output.
10. Select **X5 GAIN** from the Operating menu.
11. Check for a display amplitude of 140 IRE  $\pm 5$  IRE (1000 mV  $\pm 50$  mV PAL).
12. Select **X1 GAIN** from the Operating menu.

## Variable Gain Range and Vertical Position Range

This procedure verifies the following requirement:

Variable Gain Range: Input signals between 0.8 V and 2 V can be adjusted to 140 IRE (1.0 V) display. 160 mV and 400 mV for X5 Gain. Vertical Position Range: 1 V signal can be positioned so that peak white and sync tip can be placed at blanking level, with the DC Restorer Clamp on, regardless of gain setting.

1. Set the VAC for a 999.9 mV output.

2. Select **VAR GAIN ON** from the Configuration menu.
3. Check by adjusting the **Variable Gain** controls that the signal amplitude can be displayed less than 70 IRE (500 mV PAL).
4. Set the VAC for a 799.9 mV output.
5. Check by adjusting the **Variable Gain** controls that the signal amplitude can be displayed greater than 140 IRE (1000 mV PAL).
6. Select **X5 GAIN** from the Operating menu.
7. Set the VAC for a 399.9 mV output.
8. Enter the Configuration menu and select the **VAR GAIN** category.
9. Check by adjusting the **Variable Gain** controls that the signal amplitude can be displayed less than 140 IRE (1000 mV PAL).
10. Set the VAC for a 159.9 mV output.
11. Check by adjusting the **Variable Gain** controls that the signal amplitude can be displayed greater than 140 IRE (1000 mV PAL).
12. Replace the VAC signal on the **VIDEO IN** connector with a pulse and bar signal using a 75  $\Omega$  in-line termination.
13. Check by adjusting the **Vertical Position** controls, that the white bar and sync tip portions of the signal can be adjusted to the graticule baseline.
14. Select **VAR GAIN OFF** from the Configuration menu.
15. Select **X1 GAIN** from the Operating menu.

## Overscan

This procedure verifies the following requirement:

$\leq 2\%$  variation in baseline of 100 IRE (700 mV PAL) 12.5T (20T PAL) modulated pulse as it is positioned over the middle 80% of the screen.

1. Check that the amplitude of the sine wave at the bottom of the mod pulse varies less than 2% while using the **Vertical Position** controls to position the signal over the middle 80% of the graticule.
2. Remove the pulse and bar signal from the **VIDEO IN** connector.



## Input and DC Restorer Frequency Response

This procedure verifies the following requirement:

X1 Gain Response (Flat filter selected): 50 kHz to 6 MHz within 2% of response at 50 kHz. X5 Gain Response (Flat filter selected): 50 kHz to 6 MHz within 5% of response at 50 kHz. Attenuation of 60 Hz (50 Hz PAL) on Input Signal: SLOW mode:  $\leq 20\%$ . FAST mode:  $\geq 90\%$ .

1. Select **EXT REF** from the Configuration menu.
2. Connect the 50  $\Omega$  precision cable from the output of the leveled sine wave generator to the dual-input coupler using a 50  $\Omega$ -to-75  $\Omega$  minimum loss attenuator.
3. Connect one side of the dual-input coupler to the **VIDEO IN** connector.
4. Connect the Tektronix part number 015-0413-00 Peak-to-Peak Detector Head to the other end of the dual-input coupler, using the female-to-female BNC connector. Connect the other end of the Peak-to-Peak Detector Head to the Tektronix part number 015-0408-00 Peak-to-Peak Detector + Input.
5. Connect the peak-to-peak detector Output to the digital multimeter or oscilloscope.
6. Set the leveled sine wave generator frequency to 50 kHz and adjust the generator amplitude for exactly 100 IRE (700 mV PAL) of display.
7. Adjust the peak-to-peak detector Plus amplifier and input control until the green LED is on.
8. Note the digital multimeter readout level or the oscilloscope DC level.
9. Set the sine wave generator frequency to 3.58 MHz (4.43 MHz PAL).
10. Adjust the sine wave generator amplitude for exactly 100 IRE (700 mV PAL) of display.
11. Check that the digital multimeter readout level, or the oscilloscope DC level is within  $\pm 14$  mV of the reading noted in step 8.
12. Set the sine wave generator frequency to 6 MHz.
13. Adjust the sine wave generator amplitude for exactly 100 IRE (700 mV PAL) of display.
14. Check that the digital multimeter readout level or the oscilloscope DC level, is within  $\pm 14$  mV of the reading noted in step 8.
15. Set the sine wave generator frequency to 50 kHz.
16. Select **X5 GAIN** from the Operating menu.

17. Adjust the peak-to-peak detector Plus amplifier and input control fully counterclockwise.
18. Adjust the sine wave generator for a display amplitude of 100 IRE (700 mV PAL).
19. Note the digital multimeter readout level or the oscilloscope DC level.
20. Set the sine wave generator frequency to 3.58 MHz (4.43 MHz PAL).
21. Adjust the sine wave generator amplitude for exactly 100 IRE (700 mV PAL) of display.
22. Check that the digital multimeter readout level, or the oscilloscope DC level, is within  $\pm 7$  mV of the reading noted in step 19.
23. Set the sine wave generator frequency to 6 MHz.
24. Adjust the sine wave generator amplitude for exactly 100 IRE (700 mV PAL) of display.
25. Check that the digital multimeter readout level, or the oscilloscope DC level, is within  $\pm 7$  mV of the reading noted in step 19.
26. Select **X1 GAIN** from the Operating menu.
27. Remove the dual-input coupler from the instrument.
28. Connect the function generator output to the **VIDEO IN** connector using a X10 (75  $\Omega$ ) attenuator.
29. Select **1H SWEEP** from the Operating menu.
30. Enter the Configuration menu and select the **INPUT** category. Select **EXT REF** and **SLOW DC REST**.
31. Set the function generator to output a 60 Hz (50 Hz PAL) sine wave with a display amplitude of 100 IRE (700 mV PAL) on the WFM90D or WFM91D monitor.
32. Connect a black burst signal to the **REF IN** connector. Do not terminate the input.
33. Check that the display amplitude is  $\geq 80$  IRE (560 mV PAL).
34. Select **FAST DC REST**.
35. Check that the display amplitude is  $\leq 10$  IRE (70 mV PAL).
36. Select **INT REF** and **SLOW DC REST** from the Configuration menu.
37. Remove all input signals from the WFM90D or WFM91D monitor.

## Vector Phase Stability

This procedure verifies the following requirement:

Phase Shift with Subcarrier Frequency Change from  $F_{SC}$  to  $F_{SC} \pm 50$  Hz ( $F_{SC} \pm 10$  Hz PAL):  $\pm 2^\circ$ . Phase Shift with Burst Amplitude Change from Nominal to  $\pm 6$  dB:  $\pm 2^\circ$ . Phase Shift with Variable Gain Control Varied from +3 dB to -6 dB:  $\pm 1^\circ$ .

1. Connect a 75% color bar signal to the **VIDEO IN** connector. Set the input switch to the **75  $\Omega$**  position.
2. Select **VECTOR** display mode on the WFM90D or WFM91D monitor.
3. Use the **Phase** controls to position the burst vector on the 180° graticule line.
4. Check that when the television generator subcarrier frequency is changed  $\pm 50$  Hz ( $\pm 10$  Hz PAL) from nominal, that the display locks, and that the burst phase has changed  $\pm 2^\circ$  or less.
5. Return the subcarrier frequency to nominal on the television signal generator.
6. Replace the color bar signal on the **VIDEO IN** connector with a black burst signal.
7. Check that the vector phase changes less than  $\pm 2^\circ$  while varying the burst amplitude from nominal to  $\pm 6$  dB (1/2 to 2X amplitude), using the television signal generator burst amplitude control.
8. Return the burst amplitude to nominal on the television signal generator.
9. Select **VAR GAIN ON** from the Configuration menu.
10. Check that the vector phase changes less than  $\pm 1^\circ$  while varying the vector burst amplitude from 1/2 to 1.5 times nominal amplitude using the variable gain control.
11. Select **VAR GAIN OFF** from the Configuration menu.
12. Remove the signal input from the **VIDEO IN** connector.

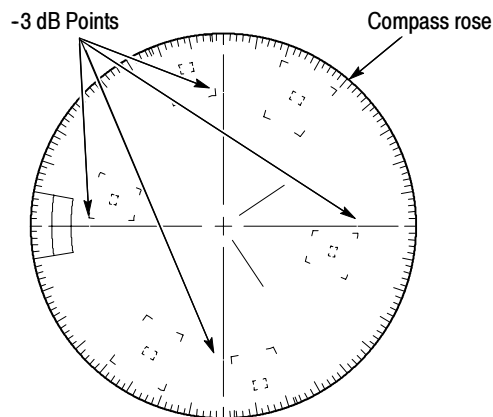
## Chrominance Bandwidth

This procedure verifies the following requirement:

Chrominance Bandwidth: Upper -3 dB Point:  $F_{SC} + 500 \text{ kHz}$ ,  $\pm 100 \text{ kHz}$ .

Lower -3 dB Point:  $F_{SC} - 500 \text{ kHz}$ ,  $\pm 100 \text{ kHz}$ .

1. Connect the precision  $50 \Omega$  cable to the output of the leveled sine wave generator. Connect the other end of the cable to the  $50 \Omega$  to  $75 \Omega$  minimum-loss attenuator, and then connect the attenuator to the **VIDEO IN** connector.
2. Select **EXT REF** from the Configuration menu.
3. Set the leveled sine wave generator frequency to 3.58 MHz (4.43 MHz PAL) and adjust the amplitude control so that the circle overlays the graticule compass rose.
4. Decrease the frequency on the leveled sine wave generator until the edge of the circle display reaches the -3 dB (70%) gaps on the vertical graticule axis. See Figure 4-1.



**Figure 4-1: -3 dB marks on the vector graticule**

5. Check that the frequency readout on the leveled sine wave generator is between 2.98 and 3.18 MHz (3.83 and 4.03 MHz PAL).
6. Adjust the frequency on the leveled sine wave generator until the edge of the circle display reaches the -3 dB (70%) point gaps on the horizontal graticule axis.
7. Check that the frequency readout on the leveled sine wave generator is between 2.98 and 3.18 MHz (3.83 and 4.03 MHz PAL).

8. Increase the frequency on the leveled sine wave generator until the edge of the circle display expands out to the compass rose and again reduces to the -3 dB (70%) point gaps on the vertical graticule axis. See Figure 4-1.
9. Check that the frequency readout on the leveled sine wave generator is between 3.98 and 4.18 MHz (4.83 and 5.03 MHz PAL).
10. Adjust the frequency on the leveled sine wave generator until the edge of the circle display reaches the -3 dB (70%) point gaps on the horizontal graticule axis.
11. Check that the frequency readout on the leveled sine wave generator is between 3.98 and 4.18 MHz (4.83 and 5.03 MHz PAL).
12. Remove all signals from the WFM90D or WFM91D monitor.

## Audio Gain and Frequency Response

This procedure verifies the following requirement:

Measurement Accuracy: 0.5 dB at 1 kHz. Frequency Response: 0.5 dB from 50 Hz to 20 kHz.

1. Connect the output from the audio generator to the **AUDIO IN** connector on the WFM90D or WFM91D monitor.
2. Set the audio generator for a 1 kHz tone output, with an amplitude of +8.0 dBu. Select Signal On.
3. Select **AUDIO** display mode on the WFM90D or WFM91D monitor.
4. Enter the Operating menu and select **8 dBu**.
5. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.
6. Set the audio generator for a +4.0 dBu output amplitude.
7. Select **4 dBu** from the Operating menu.
8. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.
9. Set the audio generator for a 0.0 dBu output amplitude.
10. Select **0 dBu** from the Operating menu.
11. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.
12. Set the audio generator for a -10.0 dBu output amplitude.

13. Select **-10 dBu** from the Operating menu.
14. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.
15. Set the audio generator for a 50 Hz tone output, with an amplitude of +8.0 dBu.
16. Select **8 dBu** from the Operating menu.
17. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.
18. Set the audio generator frequency to 5 kHz.
19. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.
20. Set the audio generator frequency to 10 kHz.
21. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.
22. Set the audio generator frequency to 15 kHz.
23. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.
24. Set the audio generator frequency to 20 kHz.
25. Check that the display amplitude is within 0.5 dB of the reference level graticule lines.

## Performance Verification: Digital Section

Perform the following steps before beginning the verification procedures:

1. Plug the AC power adapter into the WFM90D or WFM91D monitor and then plug the adapter into the AC power source.
2. Connect the 75% color bar signal from the digital television signal generator to the VIDEO IN connector on the WFM90D or WFM91D monitor. Set the digital television signal generator to output a 525 signal for the WFM90D monitor or a 625 signal for the WFM91D monitor.
3. Turn on the WFM90D or WFM91D monitor.
4. Set the input termination switches to the 75  $\Omega$  position.
5. Check that the readout in the upper left corner of the display changes to show: DIGITAL CMPST. This indicates that the instrument is receiving the serial digital signal.
6. Enter the Configure menu. Select **PRESETS** and then select **DEFAULT**.

---

**NOTE.** While checking values in the following procedure steps, you may want to clear the menu from the screen. To do so, press the **MENU** button twice. Then press and hold the **MENU** button for two seconds when you need to enter the digital menu again.

---

### Check Sync Separation

This procedure verifies the following requirement:

1 V input displayed within 2%

1. Select Waveform mode on the WFM90D or WFM91D monitor.
2. Press and hold **MENU** for two seconds to display the digital waveform menu.
3. Set the **COMP SEL** to **COMPOSITE**.
4. Check that the displayed video is 1 V,  $\pm 2\%$  (approximately 1/4 major division) from sync tip to white bar (-40 IRE to +100 IRE for 525 or -300 mV to +700 mV for 625).
5. Set the **COMP SEL** to **GREEN**.

6. Check that the displayed video is 714 mV,  $\pm 2\%$  (approximately 1/4 major division) from graticule baseline to white bar (0 IRE to +100 IRE for 525 or 0 V to +700 mV for 625).
7. Set the **COMP SEL** to **BLUE**.
8. Check that the displayed video is 714 mV,  $\pm 2\%$  (approximately 1/4 major division) from graticule baseline to white bar (0 IRE to +100 IRE for 525 or 0 V to +700 mV for 625).
9. Set the **COMP SEL** to **RED**.
10. Check that the displayed video is 714 mV,  $\pm 2\%$  (approximately 1/4 major division) from graticule baseline to white bar (0 IRE to +100 IRE for 525 or 0 V to +700 mV for 625).
11. Set the **COMP SEL** to **Y**.
12. Check that the displayed video is 1 V,  $\pm 2\%$  (approximately 1/4 major division) from sync tip to white bar (-40 IRE to +100 IRE for 525 or -300 mV to +700 mV for 625).
13. Exit the digital waveform menu.

## Check Frequency Response

This procedure verifies the following requirement:

Flat Filter, 1 V Full Scale, 50 kHz to 4.5 MHz, within 4%

1. Enter the Configure menu. Select **PRESETS** and then select **DEFAULT**.
2. Select the **WFM** display mode on the WFM90D or WFM91D monitor.
3. Press **MENU** to display the waveform menu.
4. Change the **SWEEP** to **1H**.
5. Press and hold **MENU** for two seconds to display the digital waveform menu.
6. Set the **COMP SEL** to **Y** and exit the menu.
7. Set the digital signal generator to output a 100% sweep signal.
8. Check that the variation in the peak-to-peak amplitude of the signal is less than 4% from the beginning of the sweep to half-way between the last two markers (0.25 major divisions on a 60% sweep or 0.4 major divisions on a 100% sweep to 4.5 MHz).



## Check Frequency Response at X5 Gain

This procedure verifies the following requirement:

Flat Filter, X5 Gain, 50 kHz to 4.5 MHz, within 5%.

1. Select the **WFM** mode on the WFM90D or WFM91D monitor.
2. Press **MENU** to display the waveform menu.
3. Set the **GAIN** to **X5** and exit the menu.
4. Set the digital signal generator to output a 100% sweep signal.
5. Adjust the position control to view the bottom of the 100% sweep signal.
6. Check that the variation in the peak-to-peak amplitude of the signal is less than 5% from the beginning of the sweep to half-way between the last two markers (0.75 major divisions on a 60% sweep or 1.25 major divisions on a 100% sweep to 4.5 MHz).

This completes the performance verification procedure. Press **CONFIG** to enter the configuration menu and return the **PRESETS** to **DEFAULT**.





# Adjustment Procedures



# Adjustments

This section contains the following information:

- Summary adjustment procedure
- List of equipment required to perform the procedures
- Adjustment procedures

## Summary Adjustment

Table 5-1 is a cross-reference to the adjustment procedure steps.

**Table 5-1: Summary adjustment**

<b>Adjustment</b>	<b>Page number</b>
ANALOG SECTION: Preliminary setup	5-5
Raster VCO	5-5
Sweep timing and horizontal mag registration	5-5
Vertical gain and X5 gain registration	5-7
Frequency response	5-7
Vector quadrature phase	5-9
Vector gain and X5 gain phase	5-9
Audio gain	5-10
DIGITAL SECTION: Preliminary setup	5-11
Vertical gain	5-11
Frequency response	5-12
Vector gain and X5 gain phase	5-12
Cable margin	5-13

## Equipment Required

Table 5-2 lists the equipment required to adjust the instrument settings.

**Table 5-2: Equipment required for adjustments**

Equipment description	Minimum requirements	Equipment example
Analog television test signal generator	75% color bar test signal for the television standard of the monitor to be tested	NTSC: Tektronix TSG100; PAL: Tektronix TSG111
Serial digital television test signal generator	Color test signals for the television standard of the monitor to be tested: color bar signal, pulse and bar; with 2T pulse, 2T bar, modulated pulse, and line sweep.	TSG601 Handheld Serial Component Signal Generator
Leveled sine wave generator	Output Level Range: -11.55 dBm (200 mV) to 0.43 dBm (800 mV); Frequency: 50 kHz to 10 MHz	Tektronix SG503 <sup>1</sup> Leveled Sine Wave Generator
Function generator	Range: 0.1 to 5 Vpp when loaded by 75 $\Omega$ , 10 Vpp when unloaded; Frequency: 50 kHz to 10 MHz.	Tektronix FG503 <sup>1</sup> Function Generator
Audio generator	Amplitude Range: -10 dBu to 8 dBu; Frequency: 1 kHz to 50 kHz	Tektronix ASG100 Audio Signal Generator
Voltmeter	Range: 0 VDC to > 100 VDC; Accuracy: $\pm 0.1\%$	Tektronix DM504A <sup>1</sup> Digital Multimeter
Frequency counter	Range: 10 Hz to 10 MHz; Accuracy: $\pm 0.001\%$	Tektronix DC503A <sup>1</sup> Universal Counter
Video amplitude calibrator (VAC)	Signal: Adjustable square wave 0.0 mVpp to 999.9 mVpp; Resolution: 0.1 mV; Accuracy: 0.05%; Frequency: Approximately 270 Hz	Tektronix part number 067-0916-00 <sup>1</sup>
Peak-to-peak detector	Input Signal Range: 0.25 Vpp to 1.0 Vpp; Flatness: $\pm 0.2\%$ 50 kHz to 10 MHz; Input Impedance: 75 $\Omega$	Tektronix part number 015-0408-00 (includes p-p detector head, 015-0413-00) <sup>1</sup>
75 $\Omega$ termination	One required; feed-through type	Tektronix part number 011-0103-02
75 $\Omega$ coaxial cable	Three cables required, male-to-male BNC connectors	Tektronix part number 012-0159-00 (42-inch) Tektronix part number 012-1339-00 (24-inch)
50 $\Omega$ coaxial cable	1% precision, male-to-male BNC connectors	Tektronix part number 012-0482-00 (36-inch)
Dual input coupler	Matched BNC cable-T for comparing phase between 2 inputs; Length of the 2 arms matches within $\pm 0.1$ inch	Tektronix part number 067-0525-02
75 $\Omega$ coaxial cable clone	200 meter	Faraday Technology SC75A375B-A
Audio cable	XLR female to XLR male	Switchcraft part number SC3XXJ
50 $\Omega$ -to-75 $\Omega$ minimum loss attenuator	Impedance: 50 $\Omega$ -to-75 $\Omega$ ; Tolerance: $\pm 0.5$ dB; Frequency: 100 MHz	Tektronix part number 011-0057-00
BNC female to BNC female connector		Tektronix part number 103-0028-00
BNC female to dual banana adapter		Tektronix part number 103-0090-00

<sup>1</sup> Requires a Tektronix TM 500-Series or TM 5000-Series Power Module Mainframe.

## Adjustment Procedures

The monitor does not have any internal adjustments. All adjustments are made through the Calibration menu using the front panel buttons.

The adjustment procedure steps are sequential. If you are unsure of equipment connections or front-panel settings for a specific step, review the settings and connections for the previous step.

**Conventions** Throughout these procedures, boldface type indicates that you will use a front-panel control or select a specific menu item on the WFM90D or WFM91D.

**Prerequisites** The adjustments in this section provide a valid adjustment of instrument performance when the following requirements are met:

- Test equipment used to verify performance requirements must be calibrated and working within the limits specified in Table 5-2 on page 5-2.
- The WFM90D or WFM91D must have been adjusted at an ambient temperature range of +20° C to +30° C, and must have been operating for a warm-up period of at least 20 minutes.

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**NOTE.** Use only the front-panel settings described in the procedure steps. If you deviate from these settings, you may incorrectly adjust your instrument.

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### How to Adjust Instrument Settings

1. Press and hold the CONFIG button for three seconds to enter the Calibration menu. The menu allows either analog or serial digital adjustments, depending on which input signal is connected. The menu lists the adjustments you can make (CAL MENU list), and displays the CAL and SAVE selections.
2. Use the arrow buttons to highlight the desired adjustment in the list and then select CAL to begin this adjustment.
3. Use the arrow buttons to adjust the setting. Most adjustments provide a POS (position) or PHASE menu selection, which allows you to toggle the arrow buttons between the selected adjustment and signal positioning.

---

**NOTE.** Select SAVE from the Calibration menu after completing an adjustment. If you do not save an adjustment, the instrument will revert to the previous setting at next instrument power-up.

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4. Select SAVE to save the adjustment in memory.
5. Select CAL MENU to return the display to the main Calibration menu.





# Adjustment Procedures: Analog Section

Perform these steps to prepare the instrument to be adjusted:

1. Plug the AC power adapter into the WFM90D or WFM91D, and then plug the adapter into the AC power source.
2. Set the input termination switches to the **HIZ** position.
3. Connect a 75% color bar signal from the analog television signal generator to the **VIDEO IN** connector, using a 75  $\Omega$  in-line termination.
4. Turn on the instrument.
5. Press the **CONFIG** button. Select **PRESETS**, and then select **DEFAULT**.
6. Read *How to Adjust Instrument Settings* on page 5-3.

## Raster VCO

Perform these steps to adjust the raster VCO:

1. Select **RAST VCO** from the Calibration menu.
2. Select **CAL**, and then select **AUTO**.
3. Wait until the **CANCEL** message disappears from the screen.
4. Select **CAL MENU**, and then select **SAVE** from the menu.

## Sweep Timing and Horizontal Mag Registration

Perform these steps to adjust the sweep timing and horizontal mag registration:

1. Replace the signal on the **VIDEO IN** connector with the output from the function generator. Be sure to use a 50  $\Omega$ -to-75  $\Omega$  minimum-loss attenuator and a precision (1%) 50  $\Omega$  cable if the generator specifies a 50  $\Omega$  output.
2. Set the function generator for a 200 kHz sine wave output.

---

**NOTE.** Verify the generator frequencies used in these steps by checking them on the frequency counter.

---

3. Select **1H SWEEP** from the Operating menu.
4. Select **1H SWEEP** from the Calibration menu, and then select **CAL**.
5. Adjust the **arrow buttons** for one cycle per major division.

6. Select **CAL MENU**, and then select **SAVE**.
7. Set the function generator frequency to 100 kHz.
8. Select **2H SWEEP** from the Operating menu.
9. Select **2H SWEEP** from the Calibration menu, and then select **CAL**.
10. Adjust the **arrow buttons** for one cycle per major division.
11. Select **CAL MENU**, and then select **SAVE**.
12. Replace the signal on the **VIDEO IN** connector with the output from the leveled sine wave generator. Use the 50  $\Omega$ -to-75  $\Omega$  minimum-loss attenuator and precision (1%) 50  $\Omega$  cable if the generator specifies a 50  $\Omega$  output.
13. Set the sine wave generator for a 1 MHz output.
14. Select **MAG ON** from the Operating menu.
15. Select **MAG GAIN** from the Calibration menu, and then select **CAL**.
16. Adjust the **arrow buttons** for one cycle per major division.
17. Select **CAL MENU**, and then select **SAVE**.
18. Select **MAG OFF** from the Operating menu.
19. Replace the signal on the **VIDEO IN** connector with a 75% color bar signal from the television signal generator, using a 75  $\Omega$  in-line termination.
20. Select **2F SWEEP** from the Operating menu.
21. Select **2F SWEEP** from the Calibration menu, and then select **CAL**.
22. Adjust the **arrow buttons** for a sweep length of 12 major divisions.
23. Select **CAL MENU**, and then select **SAVE**.
24. Select **2H SWEEP** from the Operating menu.
25. Select **MAG REG** from the Calibration menu, and then select **CAL**.
26. Select **POS**, and then use the **arrow buttons** to position the falling edge of sync to the center graticule mark.
27. Select **MAG ON**, and then select **MAG REG**.
28. Use the **arrow buttons** to return the falling edge of sync to the center graticule mark.
29. Select **MAG OFF**.
30. Select **CAL MENU**, and then select **SAVE**.

## Vertical Gain and X5 Gain Registration

Perform these steps to adjust the vertical gain and X5 gain registration:

1. Replace the signal on the **VIDEO IN** connector with the output from the VAC. Do not terminate the input.
2. Set the VAC for a 999.9 mV output with all of the buttons out except +LUM and NTSC (PAL button for the WFM91D).
3. Select **X1 GAIN** from the Calibration menu, and then select **CAL**.
4. Adjust the **arrow buttons** for a display amplitude of exactly 140 IRE (1000 mV PAL).
5. Select **CAL MENU**, and then select **SAVE**.
6. Set the VAC for a 199.9 mV output.
7. Select **X5 GAIN** from the Operating menu.
8. Select **X5 GAIN** from the Calibration menu, and then select **CAL**.
9. Adjust the **arrow buttons** for a display amplitude of exactly 140 IRE (1000 mV PAL).
10. Select **CAL MENU**, and then select **SAVE**.
11. Replace the signal on the **VIDEO IN** connector with a 75% color bar signal from the television signal generator, using a 75  $\Omega$  in-line termination.
12. Select **X5 POS** from the Calibration menu, and then select **CAL**.
13. Select **X1 GAIN**, and then position the signal baseline to the graticule baseline.
14. Select **X5 GAIN** from the Calibration menu, and then select **X5 POS**.
15. Use the **arrow buttons** to return the signal baseline to the graticule baseline.
16. Select **X1 GAIN** from the Calibration menu.
17. Select **CAL MENU**, and then select **SAVE**.
18. Remove the signal and termination from the **VIDEO IN** connector.

## Frequency Response

Perform these steps to adjust the frequency response:

1. Connect a 50  $\Omega$  precision cable from the leveled sine wave generator output to the dual-input coupler using a 50  $\Omega$ -to-75  $\Omega$  minimum loss attenuator.

2. Connect one side of the dual-input coupler to the **VIDEO IN** connector.
3. Connect the Tektronix part number 015-0413-00 Peak-to-Peak Detector Head to the other end of the dual-input coupler, using the female-to-female BNC connector.
4. Connect the other end of the Peak-to-Peak Detector Head to the Tektronix part number 015-0408-00 Peak-to-Peak Detector + Input.
5. Connect the peak-to-peak detector Output to the digital multimeter, or an oscilloscope.
6. Select **EXT REF** from the Configuration menu.
7. Set the leveled sine wave generator frequency to 50 kHz and adjust the generator amplitude for exactly 100 IRE (700 mV PAL) of display.
8. Adjust the peak-to-peak detector Plus amplifier and input control until the green LED is on.
9. Note the digital multimeter readout level or the oscilloscope DC level.
10. Set the sine wave generator frequency to 3.58 MHz (4.43 MHz PAL).
11. Adjust the amplitude of the sine wave generator so that the digital multimeter readout, or oscilloscope level, matches that noted in step 9.
12. Select **X1 FREQ** from the Calibration menu, and then select **CAL**.
13. Adjust the **arrow buttons** for a display amplitude of exactly 100 IRE (700 mV PAL).
14. Select **CAL MENU**, and then select **SAVE**.
15. Select **X5 GAIN** from the Operating menu.
16. Set the leveled sine wave generator frequency to 50 kHz, and adjust the generator amplitude for exactly 100 IRE (700 mV PAL) of display.
17. Adjust the peak-to-peak detector Plus amplifier and input control fully counterclockwise.
18. Note the digital multimeter readout level or the oscilloscope DC level.
19. Set the sine wave generator frequency to 3.58 MHz (4.43 MHz PAL).
20. Adjust the amplitude of the sine wave generator so that the digital multimeter readout, or oscilloscope level, matches that noted in step 18.
21. Select **X5 FREQ** from the Calibration menu, and then select **CAL**.
22. Adjust the **arrow buttons** for a display amplitude of exactly 100 IRE (700 mV PAL).

23. Select **CAL MENU**, and then select **SAVE**.
24. Select **X1 GAIN** from the Operating menu, and **INT REF** from the Configuration menu.

## Vector Quadrature Phase

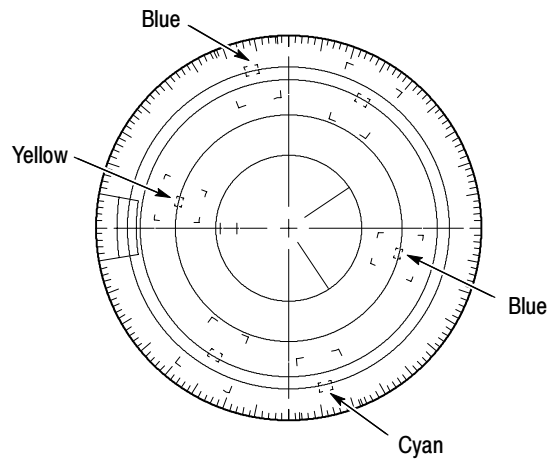
Perform these steps to adjust the vector quadrature phase:

1. Replace the signal on the **VIDEO IN** connector with a 75% color bar signal from the television signal generator using a 75  $\Omega$  in-line termination.
2. Select **VECTOR** display mode.
3. WFM91D ONLY — Select **ALT ON** from the Configuration menu.
4. Select **QUAD PH** from the Calibration menu, select **CAL**, and then select **RY OFFSET**.
5. Adjust the **arrow buttons** for the best center dot overlay.
6. Select **QUAD PH**.
7. Adjust the **arrow buttons** for the best circle overlay.
8. Select **CAL MENU**, and then select **SAVE**.
9. WFM91D ONLY — Select **ALT OFF** from the Configuration menu.

## Vector Gain and X5 Gain Phase

Perform these steps to adjust the vector gain and X5 gain phase:

1. WFM90D ONLY — Verify that the television signal generator has setup turned on.
2. Select **VEC GAIN** from the Calibration menu, select **CAL**, and then select **TEST ON**.
3. Adjust the **▲** and **▼** **buttons** so that the vector dots land in the center of the red and cyan graticule target boxes. See Figure 5-1.
4. Adjust the **◀** and **▶** **buttons** so that the vector dots land in the center of the yellow and blue graticule target boxes. See Figure 5-1.
5. Select **CAL MENU**, and then select **SAVE**.
6. Select **X5 PHASE** from the Calibration menu, and then select **CAL**.



**Figure 5-1: NTSC graticule showing the vector gain adjustment**

7. Select **PHASE** and use the **arrow buttons** to position the burst vector exactly on the 180° graticule line.
8. Select **X5 GAIN**, and then select **X5 PHASE**.
9. Use the **arrow buttons** to position the burst vector exactly on the 180° graticule line.
10. Select **CAL MENU**, and then select **SAVE**.

## Audio Gain

Perform these steps to adjust the audio gain:

1. Connect the output from the audio generator to the **AUDIO IN** connector.
2. Set the audio generator for a 1 kHz tone output with an amplitude of +8.0 dBu. Select Signal On from the audio generator.
3. Select the **AUDIO** display mode on the WFM90D or WFM91D.
4. Select **8 dBu** from the Operating menu.
5. Select **AUD GAIN** from the Calibration menu, and then select **CAL**.
6. Use the **arrow buttons** to position the signal display exactly on the 8 dBu graticule lines.
7. Select **CAL MENU**, and then select **SAVE**.

# Adjustment Procedures: Digital Section

Perform the following steps to prepare the instrument to be adjusted:

1. Plug the AC power adapter into the WFM90D or WFM91D, and then plug the adapter into the AC power source.
2. Set the input termination switches to the **75  $\Omega$**  position on the WFM90D or WFM91D.
3. Connect a 75% color bar signal from the digital television signal generator to the **VIDEO IN** connector.
4. Turn on the instrument.
5. Press the **CONFIG** button. Select **PRESETS**, and then select **DEFAULT**.
6. Read *How to Adjust Instrument Settings* on page 5-3.

## Vertical Gain

Perform the following steps to adjust the vertical gain:

1. Select **DG1 X1 GAIN** from the Calibration menu, and then select **CAL**.
2. Moving between position control (POS) and gain adjust (DG1 X1 Gain), adjust the arrow buttons for a display amplitude of exactly 140 IRE (1000 mV PAL).
3. Select **DG CAL MENU**, and then select **SAVE**.
1. Select **DG2 X1 GAIN** from the Calibration menu, and then select **CAL**.
2. Moving between position control (POS) and gain adjust (DG2 X1 Gain), adjust the arrow buttons for a display amplitude of exactly 140 IRE (1000 mV PAL).
3. Select **DG CAL MENU**, and then select **SAVE**.
1. Select **DG3 X1 GAIN** from the Calibration menu, and then select **CAL**.
2. Moving between position control (POS) and gain adjust (DG3 X1 Gain), adjust the arrow buttons for a display amplitude of exactly 140 IRE (1000 mV PAL).
3. Select **DG CAL MENU**, and then select **SAVE**.

## Frequency Response

Perform the following steps to adjust the frequency response:

1. Set the digital signal generator for a Pulse and Bar signal.
2. Select **DG X1 FREQ** from the Calibration menu, and then select **CAL**.
3. Moving between position control (POS) and gain adjust (DG X1 FREQ), adjust the arrow buttons for the flattest bottom on the modulated pulse.
4. Select **DG CAL MENU**, and then select **SAVE**.
5. Select **DG X5 FREQ** from the Calibration menu, and then select **CAL**.
6. Moving between position control (POS) and gain adjust (DG X5 FREQ), adjust the arrow buttons for the flattest bottom on the modulated pulse.
7. Select **DG CAL MENU**, and then select **SAVE**.

## Vector Gain and X5 Gain Phase

Perform the following steps to adjust the vector gain and X5 gain phase:

1. Set the digital signal generator for a 75% color bar signal.
2. Select **DG VEC GAIN** from the Calibration menu, select **CAL**, and then select **TEST ON**.
3. Adjust the up and down arrow buttons so that the vector dots land in the center of the graticule target boxes.
4. Moving between PHASE and DG VEC GAIN, Adjust the left and right arrow buttons so that the vector dots land in the center of the graticule target boxes. See Figure 5-1.
5. Select **DG CAL MENU**, and then select **SAVE**.



## Cable Margin

Perform the following steps to adjust the cable margin indicator (you are adjusting the value at which the cable flag comes on to 200 meters):

1. Connect the output from the digital signal generator to the WFM90D or WFM91D through the cable clone. Set the cable clone to simulate 200 meters of Belden 8281 cable.
2. Select **CABLE LEN** from the Calibration menu, and then select **CAL**. Two values are displayed in the upper right corner of the screen: cable length calibration (**CABLE LEN CAL**) and cable reading.

---

**NOTE.** *These displayed values are representative of cable length, but do not equate directly to meters. A higher reading indicates a shorter cable.*

---

3. Adjust the arrow buttons until the **CABLE LEN CAL** value matches the **CABLE READING** value. The up and down arrow buttons adjust the value by +1 and -1; the left and right arrow buttons adjust the value by +5 and -5.
4. Select **DG CAL MENU**, and then select **SAVE**.





# Maintenance



# Maintenance

The maintenance or service of this instrument must be performed only by qualified service personnel who have read the *Service Safety Summary* and the *Operating Information* sections of this manual.



---

**CAUTION.** *If the instrument does not function properly, perform troubleshooting and take corrective action immediately to prevent additional problems.*

---

## Cleaning

This section provides information about how to clean the instrument and how to perform preventive maintenance.

### General Care

Protect the instrument from adverse weather conditions. The instrument is not waterproof.



---

**CAUTION.** *To avoid damage to the instrument, do not expose it to sprays, liquids, or solvents.*

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*Do not use chemical cleaning agents; they may damage the instrument. Avoid chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.*

---

### Cleaning the Exterior

Clean the exterior surfaces of the instrument with a dry, lint-free cloth or a soft-bristle brush. If dirt remains, use a cloth or swab dampened with a 75% isopropyl alcohol solution. A swab is useful for cleaning in narrow spaces around the controls and connectors. Do not use abrasive compounds on any part of the instrument.

### Interior

The monitor does not normally require interior cleaning.

### Visual Inspection

After cleaning, carefully check the instrument for defective connections, damaged parts, and improperly seated transistors or integrated circuits. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, determine the cause of overheating before replacing the damaged part.

### **Performance Verification and Adjustments**

Instrument performance should be checked after each 2000 hours of operation or every 12 months. This will help to ensure maximum performance and assist in locating defects that may not be apparent during regular operation. Performance Verification and Adjustment Procedures are included in this manual.

## **After Repair Adjustments**

You should perform the *Adjustment Procedures* starting on page 5-1 whenever you have removed the Top or Bottom cover during the service of this instrument.

## **Repackaging Instructions**

Use the following instructions to prepare your instrument for shipment to a Tektronix, Inc., Service Center:

1. Attach a tag to the instrument showing: the owner, complete address and phone number of someone at your firm who can be contacted, the instrument serial number, and a description of the required service.
2. Package the instrument in the original packaging materials. If the original packaging materials are not available, follow these directions:
  - a. Obtain a carton of corrugated cardboard having inside dimensions six or more inches greater than the dimensions of the instrument. Use a shipping carton that has a test strength of at least 250 pounds (113.5 kg).
  - b. Place the instrument in its carrying pouch or surround the instrument with a protective bag.
  - c. Pack dunnage or urethane foam between the instrument and the carton. If using Styrofoam kernels, overfill the box and compress the kernels by closing the lid. There should be three inches of tightly packed cushioning on all sides of the instrument.
3. Seal the carton with shipping tape, industrial stapler, or both.

# Remove and Replace

This section tells you how to remove and replace the customer replaceable modules and parts of the WFM90D or WFM91D Handheld Waveform, Vector, Picture, and Audio Monitor.



**CAUTION.** To prevent damage to the instrument, disconnect the power adapter and remove installed batteries from the monitor before starting disassembly. See Batteries on page 6-28.

## Tools Required

Use the tools in Table 6-1 to disassemble the instrument to its individual modules. Some of these tools are required only for removal of specific instrument components.

**Table 6-1: Tools required for module removal**

Name	Description
Torx screwdriver handle	Accepts Torx-driver bits
T-10 Torx tip	Torx-driver bit for T-10 size screw heads
#1 point Phillips tip	
9/16" hexagonal driver	Deep socket
1/4" hexagonal driver	
Flat blade screwdriver	
Tweezers or needle-nose pliers	
Cleaners	See <i>Cleaning</i> on page 6-1
Soldering iron	40 W
Solder	2% RMA flux content solder

## Procedures

Table 6-2 lists the remove and replace procedures in this section and their starting page numbers.

**Table 6-2: Remove and replace procedure list**

<b>Replaceable part</b>	<b>Page number</b>
Top cover	6-5
LCD display lens	6-5
LCD Display Assembly B020100 and above	6-8
LCD Display Assembly below B020100	6-11
Backlight	6-14
Top board	6-15
Keypad	6-16
Top board shield	6-17
Bottom board	6-19
SDI Interface board	6-21
Backlight board	6-22
Input board assembly	6-24
Battery cover	6-25
Carrying strap	6-25
Turnlock stud and bushing	6-26
Battery cushion pad	6-28
Battery pack	6-28
Alkaline batteries	6-29
Bottom cover	6-31
Battery power connector	6-31
Battery contacts	6-32
Turnlock stud receptacle	6-34
Bottom cover electrical shield	6-34
Battery orientation marker and battery cushion pad	6-35
AC adapter EMI suppressor	6-37



## Top Cover Assembly

The top cover assembly contains replaceable subparts. Procedures for removing the subparts are included below.

### Top Cover

**Remove.** To remove the top cover assembly:

1. Remove the six retaining screws using the Torx-tip screwdriver. See Figure 6-1.
2. Gently lift the top cover off of the bottom cover.

---

**NOTE.** Do not allow dust to accumulate on the inside surface of the top cover; set the top cover face up on your work surface or cover it with a lint-free cloth.

---

**Replace.** To replace the top cover assembly:

1. Align the top cover over the bottom cover so that the keypad buttons will slide through the top cover keypad holes.
2. Make sure that no wires will be pinched between the top and bottom covers.
3. Gently lower the top cover onto the bottom cover. Shake the top cover slightly if needed to insert the keypad buttons into the top cover holes.
4. Install the six retaining screws using the Torx-tip screwdriver.

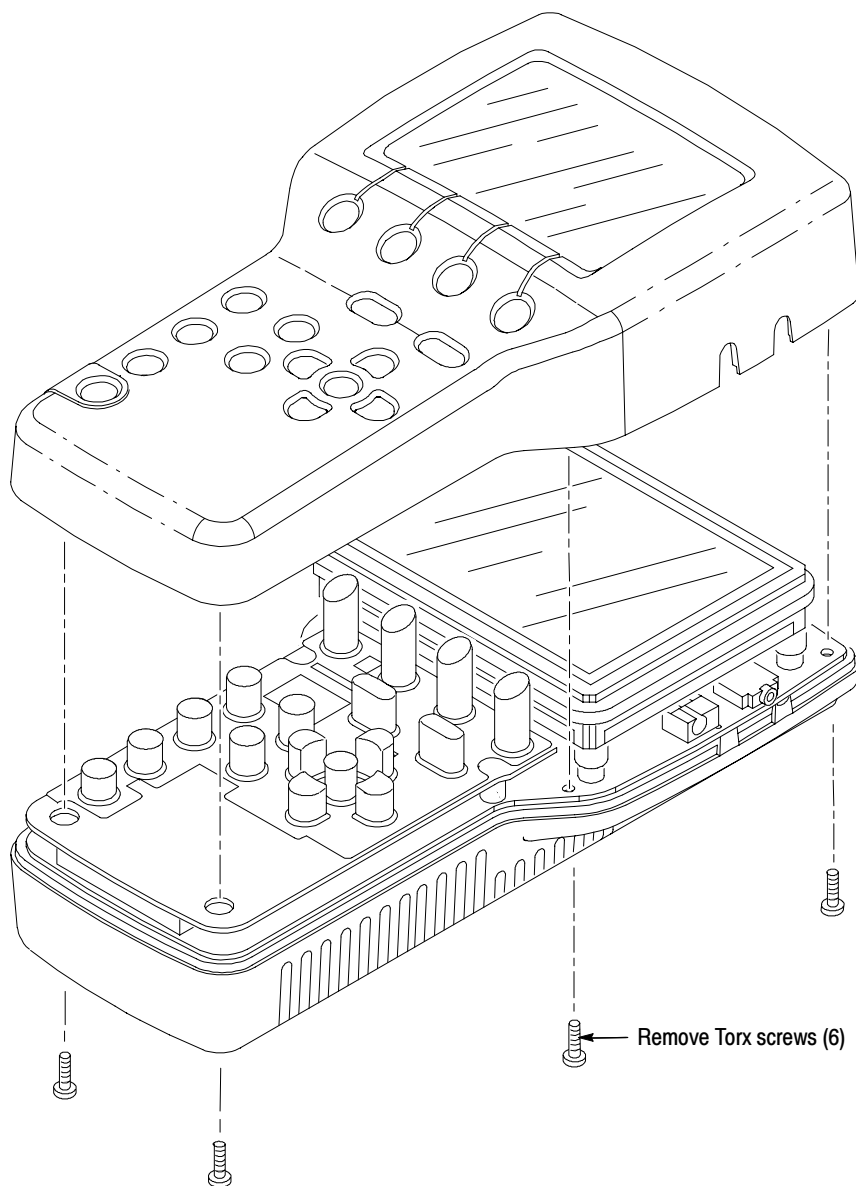
### LCD Display Lens

**Remove.** To remove the LCD display lens:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Press firmly on the LCD display lens from the front of the top cover until it comes loose from the top cover.
3. Clean any remaining glue residue from the top cover. Refer to *Cleaning* on page 6-1.

**Replace.** To replace the LCD display lens:

1. Align the LCD display lens with the depression in the back side of the top cover and press the lens into place.
2. Install the top cover. Refer to *Top Cover* on page 6-5.



**Figure 6- 1: Removing the top cover**

## LCD Display Assembly

The LCD display assembly does not contain any replaceable subparts. If you need to replace any part of the display assembly, you must replace the entire assembly.



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**CAUTION.** *To avoid damaging the LCD display, do not touch the face of the display because it is hard to clean and is easily scratched.*

---

**LCD Display.** The LCD display assembly was updated at serial number B020100.

- To replace an LCD Display assembly for serial numbers below B020100, order the *Front Panel Display Replacement* kit from Tektronix and follow the instructions provided in the kit.
- To replace an LCD Display assembly for serial numbers B020100 and above, follow the instructions labeled *LCD - Newer Instruments on page 6-8*.
- To remove an LCD Display assembly for serial numbers below B020100 and then reinstall that same assembly (for example, to access another assembly), follow the instructions labeled *LCD - Older Instruments on page 6-11*.

## LCD - Newer Instruments

For instruments with serial numbers B020100 and above.

**Remove.** To remove the LCD Display assembly:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Grasp the sides of the Display assembly and lift the assembly as shown in Figure 6-2 so that you can access the cables underneath the assembly.
3. Disconnect the 20-pin ribbon cable as follows: (Refer to Figure 6-2 on page 6-9 and Figure 6-3 on page 6-10 for cable locations.)
  - a. Locate the connector latch on the back side of the LCD Display assembly and pull the latch out as shown in Figure 6-2 on page 6-9.
  - b. Pull the ribbon cable out of the connector.
4. Disconnect the 10-pin ribbon cable from the bottom of the Display assembly.
5. Remove the LCD Display assembly from the instrument.

---

**NOTE.** *The 20-pin cable connecting the LCD Display assembly to the Bottom board is a zero insertion-force ribbon cable.*

---

**Replace.** To replace an LCD Display assembly:

1. Connect the 10-pin ribbon cable from the Bottom board into the back of the display assembly.
2. Connect the 20-pin ribbon cable from the Bottom board into the back of the display assembly.
3. If you are installing a new ribbon cable, set the display just above its resting position on the locating feet. Use your finger to crease the ribbon cable so that when the display is set down on the locating feet, the ribbon cable does not raise the display up off of the locating feet.
4. Set the display assembly onto the four locating feet. The locating feet fit into small holes in each of the four corners on the back of the display. See Figure 6-3.

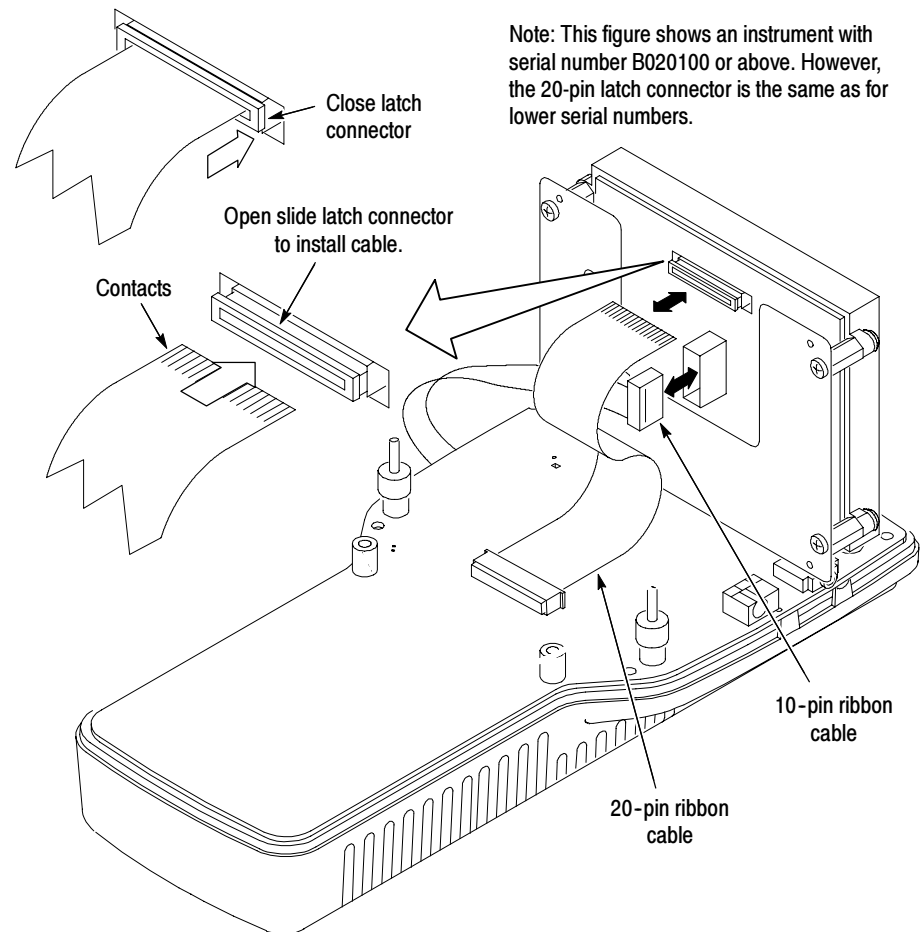


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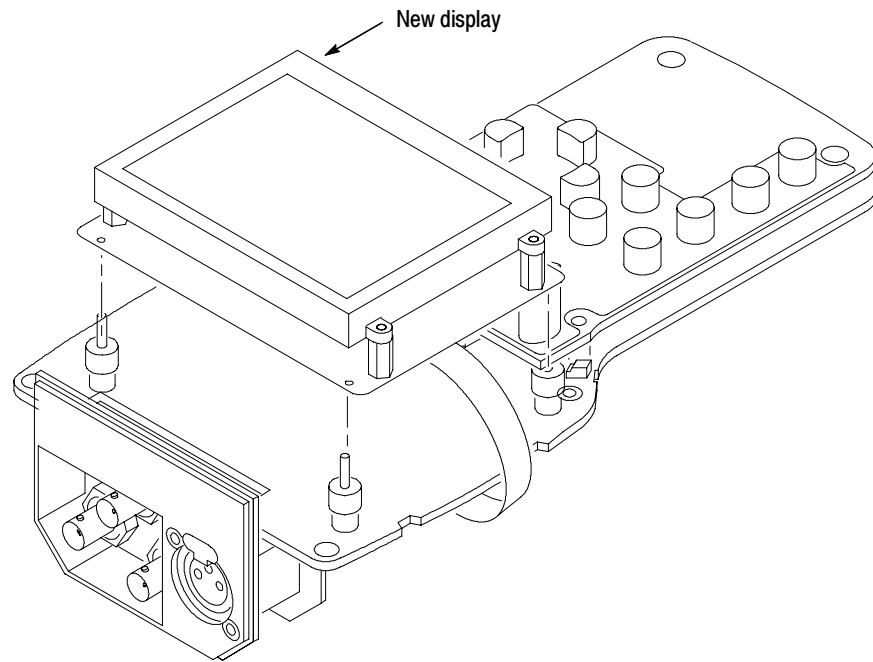
**CAUTION.** *To avoid damaging the LCD display, do not touch the face of the display because it is hard to clean and is easily scratched.*

---

5. If you replaced the LCD display, carefully remove the protective plastic cover from the face of the LCD display by prying up the corner of the cover and pulling it off the display.
6. If it is necessary to clean the front of the LCD display, wipe gently across the surface using a soft, lint-free cloth dampened in a solution of 75% isopropyl alcohol and 25% water.



**Figure 6-2: Removing the cables from the LCD Display assembly**



**Figure 6- 3: LCD Display assembly feet**

**LCD - Older Instruments**

Instructions for serial numbers below B020100. This procedure tells how to remove and replace an LCD Display assembly (for example, to gain access to another module). However, if you need to replace the LCD Display assembly with a new one, please order the LCD Display Assembly Replacement kit from Tektronix and follow the enclosed instructions.

**Remove.** To remove the LCD display assembly:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Disconnect the wires from the two backlight connectors.
3. Grasp the sides of the LCD display to lift it up off of the locating feet and disconnect the ribbon cable from the back of the display module.

---

**NOTE.** *The cable connecting the display module to the Bottom board is a zero insertion-force ribbon cable. To remove the cable from the connector housing, pull out the connector latch, and then pull the ribbon cable out of the connector. See Figure 6-4.*

---

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**NOTE.** *Some early instruments used cushion pads instead of locating feet to hold the display module in position. If your instrument has cushion pads, replace the pads at this time with locating feet. Contact your local Tektronix representative to order the necessary parts.*

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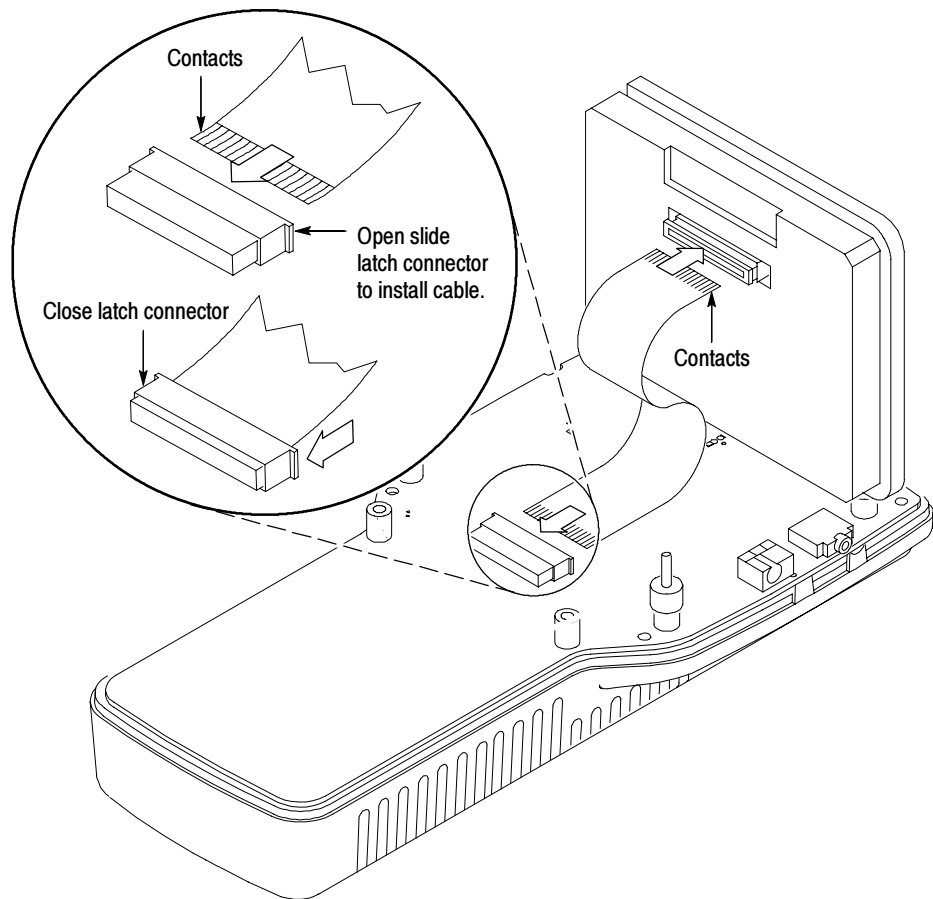
**Replace.** To replace the existing LCD Display Assembly:

1. Connect the ribbon cable from the Bottom board into the back of the display module.

---

**NOTE.** *The cable connecting the display module to the Bottom board is a zero insertion-force ribbon cable. To install the cable into the connector, pull out the connector latch and then push the ribbon cable into the connector housing. When the cable rests against the back of the connector, press in the connector latch to lock the cable in place. See Figure 6-4.*

---



**Figure 6-4: Installing the LCD display cable**

2. If you are replacing the ribbon cable, set the LCD display just above its resting position on the locating feet. Use your finger to create the ribbon cable so that when the LCD display is set down on the locating feet, the ribbon cable does not raise the LCD display up off of the locating feet.
3. Set the LCD display module onto the four locating feet. The locating feet fit into small holes in each of the four corners on the back of the LCD display. See Figure 6-5.





**Backlight** To replace a faulty backlight for instruments with serial numbers B020100 and above, you must install a new LCD display assembly.

However, the backlight is separately replaceable in instruments with serial numbers below B020100.

**Remove.** To remove the backlight (below B020100 only):

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Remove the LCD display module. Refer to *LCD - Older Instruments* on page 6-11.
3. Remove the display padding from the side of the LCD display module where the backlight is installed.
4. Remove the two outside retaining screws on the backlight assembly with the Philips screwdriver. Do not remove the center screw.
5. Gently pull the backlight out of the LCD display module.



---

**CAUTION.** To avoid breaking the backlight while replacing it, do not force it into the LCD display module.

---

**Replace.** To replace the backlight:

1. Install the backlight assembly into the side of the LCD display module.
2. Install the two retaining screws into the backlight assembly.
3. A new display pad is supplied with the replacement backlight assembly. Install the display padding onto the side of the LCD display module as follows:
  - a. Peel the protective cover from the LCD display padding.
  - b. Align the padding with the top surface of the LCD display module and press the padding onto the side of the display. See Figure 6-5 on page 6-5.
4. Install the LCD display module. Refer to *LCD - Older Instruments* on page 6-11.
5. Install the top cover. Refer to *Top Cover* on page 6-5.

## Top Board Assembly

The Top board assembly contains replaceable subparts.

### Top Board

**Remove.** To remove the Top board:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Remove the two retaining screws from the top of the Top board.
3. Gently pull on the bottom of Top board to separate it from the Bottom board.
4. If you are replacing the Top board, remove the keypad from the Top board. Refer to *Keypad* on page 6-16.

**Replace.** To replace the Top board:

1. Install the keypad if you have replaced the Top board. Refer to *Keypad* on page 6-16.
2. Gently press on the bottom of the Top board to insert the Top board connector into the Bottom board connector.
3. Be sure that the circuit board shield is properly aligned. Refer to *Top Board Shield* on page 6-17.
4. Install the two retaining screws into the top of the Top board.
5. Install the top cover. Refer to *Top Cover* on page 6-5.

## Keypad

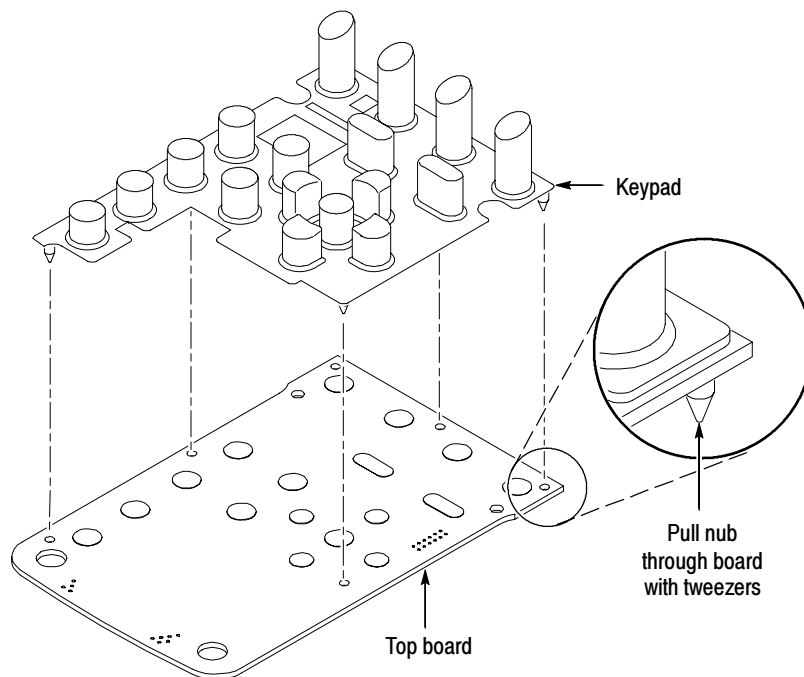
**Remove.** To remove the keypad:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Remove the Top board. Refer to *Top Board* on page 6-15.
3. Gently pull the keypad from the Top board.

**Replace.**

To replace the keypad:

1. Press the nubs on the keypad through the holes in the Top board.
2. Use tweezers or needle-nose pliers from the backside of the Top board to pull the nubs of the keypad through the Top board. See Figure 6-6.



**Figure 6-6: Installing the keypad**

3. Install the Top board. Refer to *Top Board* on page 6-15.
4. Install the top cover. Refer to *Top Cover* on page 6-5.

## Top Board Shield

**Remove.** To remove the Top board shield:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Remove the two retaining screws from the top of the Top board.
3. Slide the Top board shield out from under the Top board.

**Replace.** To replace the Top board shield:

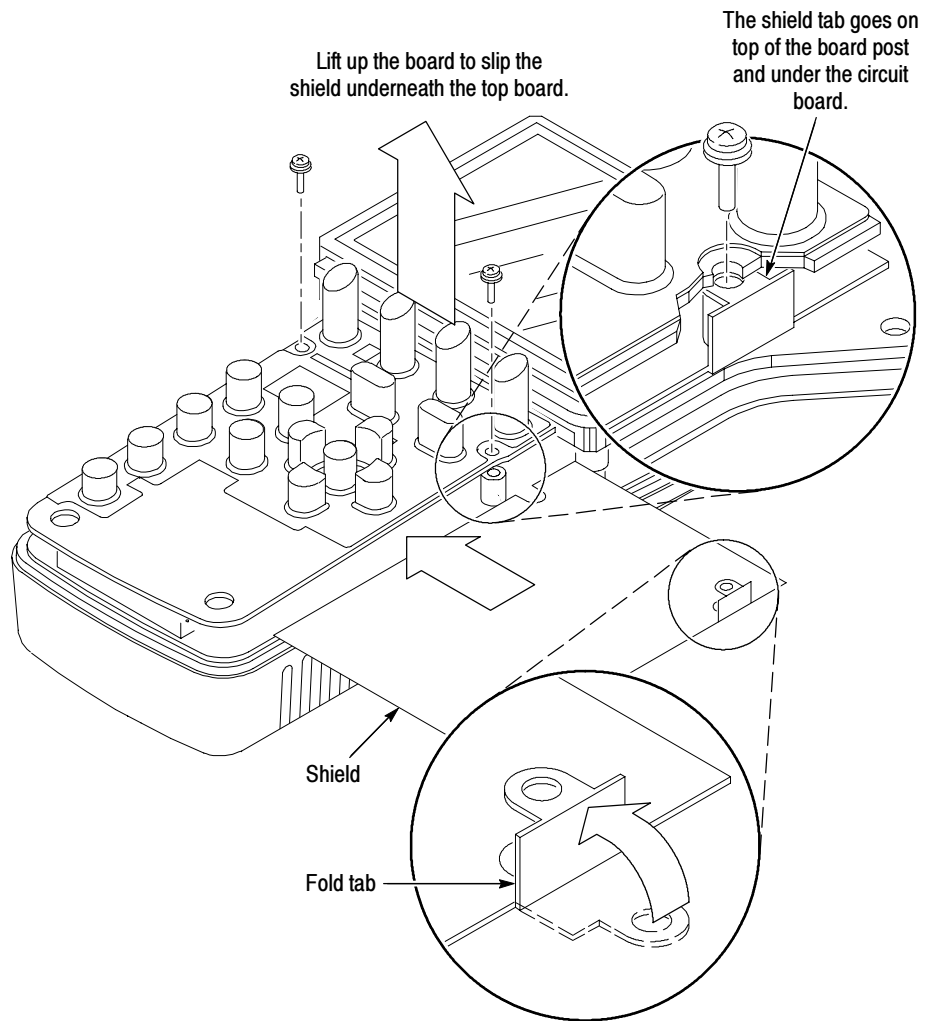
1. If you are replacing the Top board shield, bend the tab on the shield as shown in Figure 6-7.
2. Slide the shield under the Top board and align the cutouts in the shield with the mounting posts of the Top board.

---

**NOTE.** *Be sure to properly align the tab of the Top board shield so that the tab is under the Top board and that the Top board retaining screw goes through the tab. Failure to do this will result in noisy display graphics. See Figure 6-7.*

---

3. Install the two retaining screws into the top of the Top board.
4. Install the top cover. Refer to *Top Cover* on page 6-5.



**Figure 6-7: Installing the Top board shield**

## Bottom Board

**Remove.** To remove the Bottom board:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Remove the LCD display assembly. Refer to *LCD Display* on page 6-7.
3. Remove the Top board. Refer to *Top Board* on page 6-15.
4. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
5. Lift on the Bottom board while you press on the battery connector in the battery compartment.

---

**NOTE.** *The Backlight board is present only in instruments with serial numbers below B020100, that have not been upgraded with a new display assembly.*

---

6. Gently pull the Backlight board (if present) from the back of the Bottom board.
7. Gently pull the Input board assembly from the back of the Bottom board.

**Replace.** To replace the Bottom board:

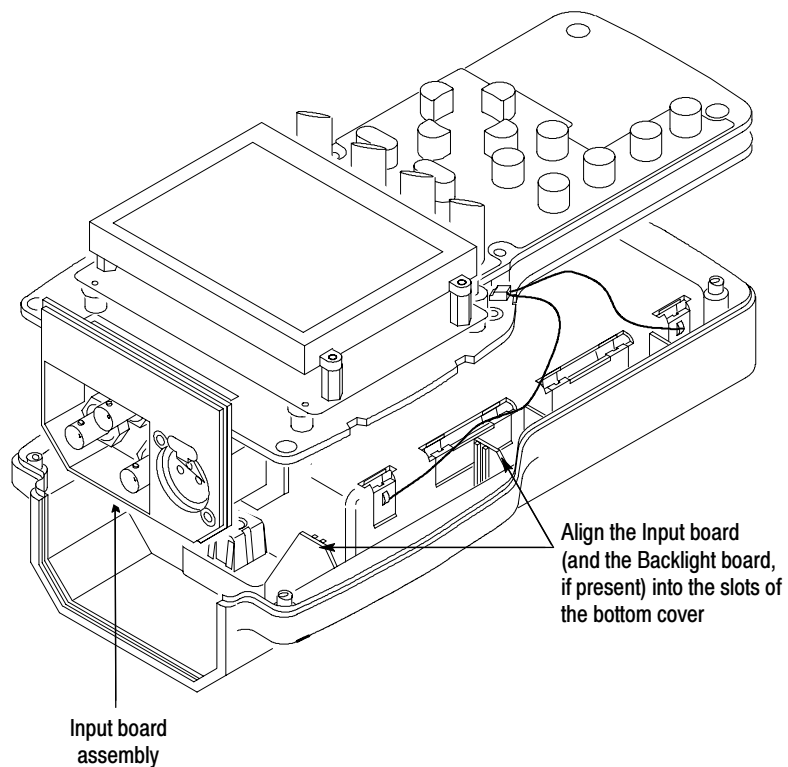
1. Install the Input board into the back of the Bottom board.

---

**NOTE.** *The Backlight board is present only in instruments with serial numbers below B020100, that have not been upgraded with a new display assembly.*

---

2. Align the Input board (and the Backlight board, if present) with the slots in the bottom cover and gently slide the boards into the bottom cover. See Figure 6-8 on page 6-20.
3. Install the Top board. Refer to *Top Board* on page 6-15.
4. Install the LCD display assembly. Refer to *LCD Display* on page 6-7.
5. Install the top cover. Refer to *Top Cover* on page 6-5.
6. Install the battery cover. Refer to *Battery Cover* on page 6-25.



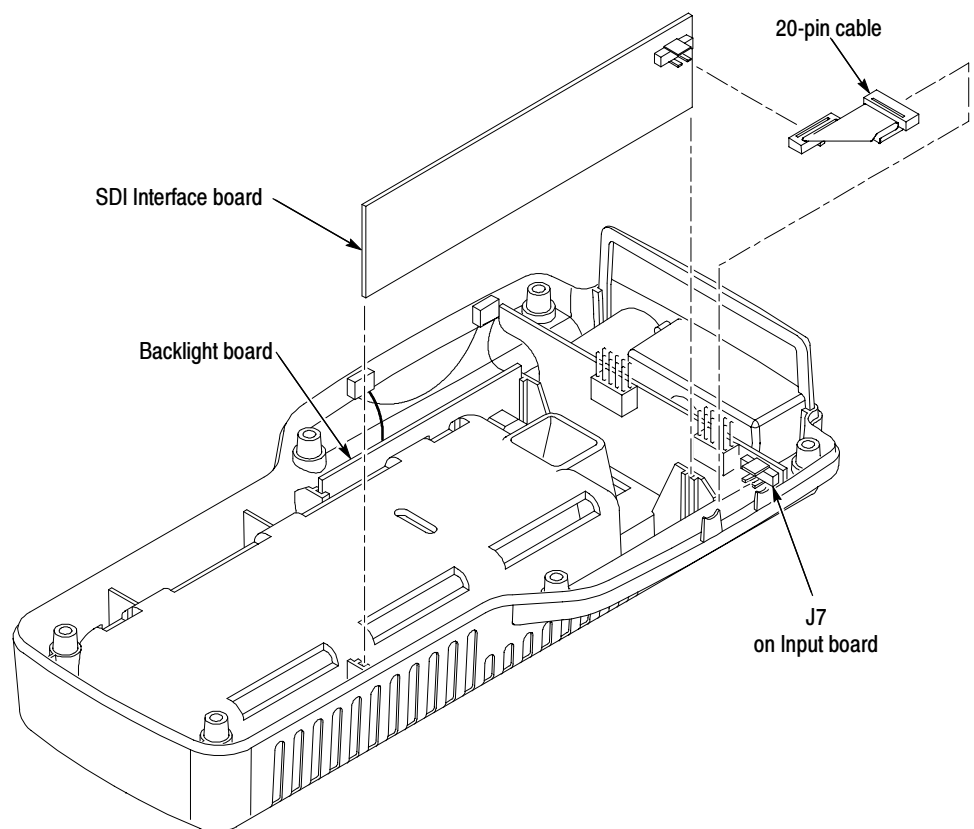
**Figure 6- 8: Installing the Bottom board**



**SDI Interface Board**

To remove the SDI Interface board:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
3. Lift on the Bottom board while pressing on the battery connector in the battery compartment.
4. Disconnect the 20-pin cable from J7 on the Input board. See Figure 6-9.
5. Remove the SDI Interface board from the slot in the bottom cover.



**Figure 6-9: Installing the SDI Interface board**

To replace the SDI Interface board, reverse the removal procedure.

## **Backlight Board**

The following procedure tells you how to remove the Backlight board and reinstall the same board (for example, to gain access to another assembly). To replace the Backlight board, you must replace the LCD Display assembly; contact your Tektronix representative to order the replacement kit, which includes installation instructions.

---

**NOTE.** *The Backlight board is present only in instruments with serial numbers below B020100 that have not been upgraded. At serial number B020100, the Backlight board was incorporated into the new LCD Display assembly.*

*If your instrument has an SDI board installed, be careful not to disconnect the cables from the SDI board.*

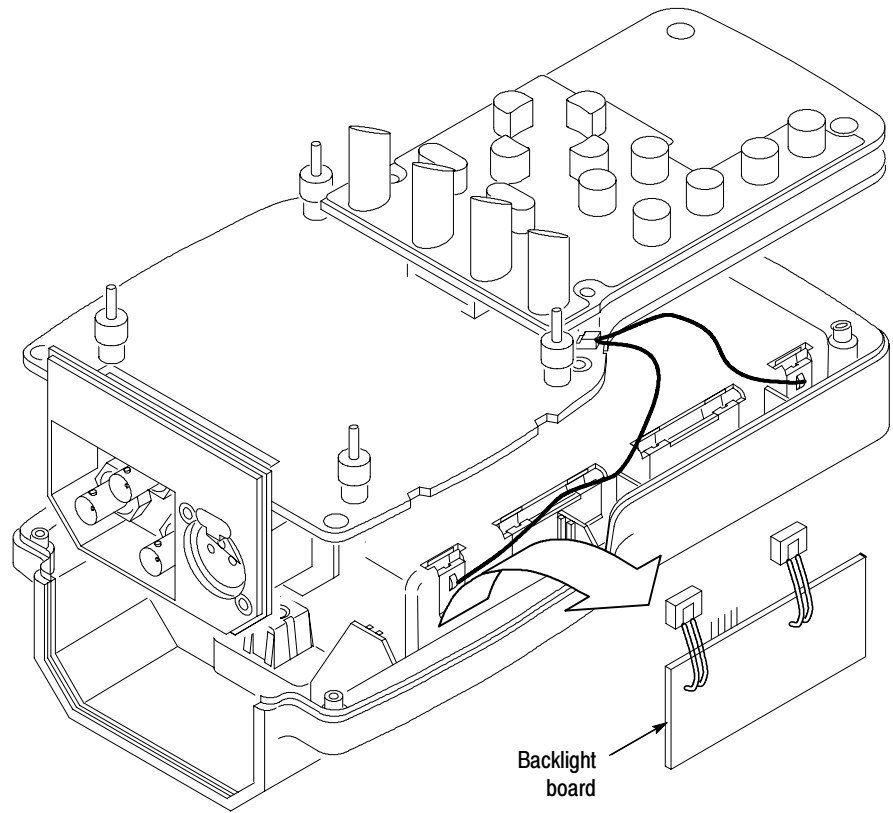
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**Remove.** To remove the Backlight board:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Disconnect the two backlight wires from the LCD display assembly. See Figure 6-10.
3. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
4. Lift on the Bottom board while pressing on the battery connector in the battery compartment.
5. Gently pull the Backlight board from the back of the Bottom board and remove the board from the instrument.

**Replace.** To replace the Backlight board:

1. Be sure that the Backlight board shield is in place.
2. Install the Backlight board into the back of the Bottom board.
3. Align the Backlight and Input boards with the slots in the bottom cover and gently slide the boards into the bottom cover.
4. Connect the two backlight wires to the LCD display assembly.
5. Install the top cover. Refer to *Top Cover* on page 6-5.
6. Install the battery cover. Refer to *Battery Cover* on page 6-25.



**Figure 6-10: Removing the Backlight board**

## Input Board Assembly

**Remove.** To remove the Input board:

1. Remove the top cover. Refer to *Top Cover* on page 6-5.
2. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
3. Lift on the Bottom board while you press on the battery connector in the battery compartment.
4. Gently pull the Input board assembly from the back of the Bottom board.
5. Unscrew the retaining nuts from the three BNC connectors on the rear panel.
6. Pull the rear panel cover off of the BNC connectors.

**Replace.** To replace the Input board:

1. Install the rear panel cover over the BNC connectors on the Input board.
2. Install the retaining nuts onto the three BNC connectors on the rear panel.
3. Install the Input board assembly onto the back of the Bottom board.
4. Align the Input board (and Backlight board, if present) with the slots in the bottom cover and gently slide the boards into the bottom cover.
5. Install the top cover. Refer to *Top Cover* on page 6-5.
6. Install the battery cover. Refer to *Battery Cover* on page 6-25.

## Battery Cover Assembly

The battery cover assembly contains replaceable subparts. Procedures for removing the subparts are included.

### Battery Cover

**Remove.** To remove the battery cover assembly:

1. Turn the turnlock stud 1/4-turn counterclockwise.
2. Pull outwards on the upper portion of the battery cover.

**Replace.** To replace the battery cover assembly:

1. Place the lower lip of the battery cover into the instrument housing and press the top portion of the cover into the instrument. See Figure 6-11 on page 6-26.
2. Secure the battery cover by turning the turnlock stud 1/4-turn clockwise.

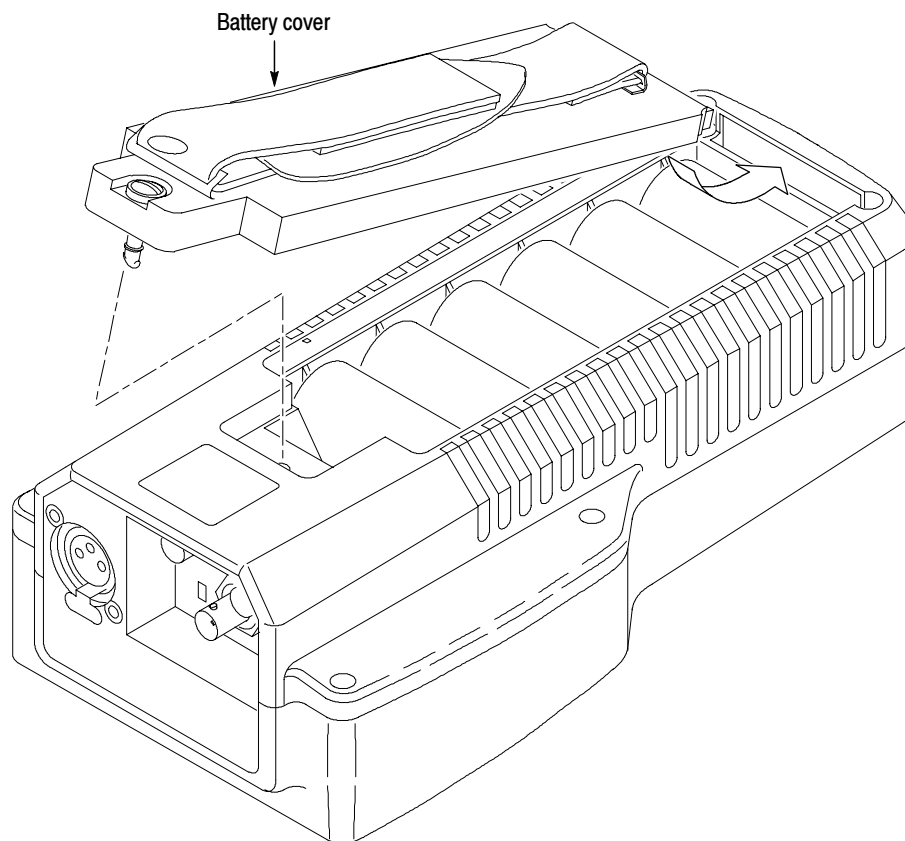
### Carrying Strap

**Remove.** To remove the carrying strap:

1. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
2. To remove the carrying strap, remove the two retaining nuts on the inside of the battery cover and pull the carrying strap off of the cover.

**Replace.** To replace the carrying strap:

1. Insert the two standoff studs of the carrying strap through the battery cover and install the two retaining nuts.
2. Install the battery cover. Refer to *Battery Cover* on page 6-25.

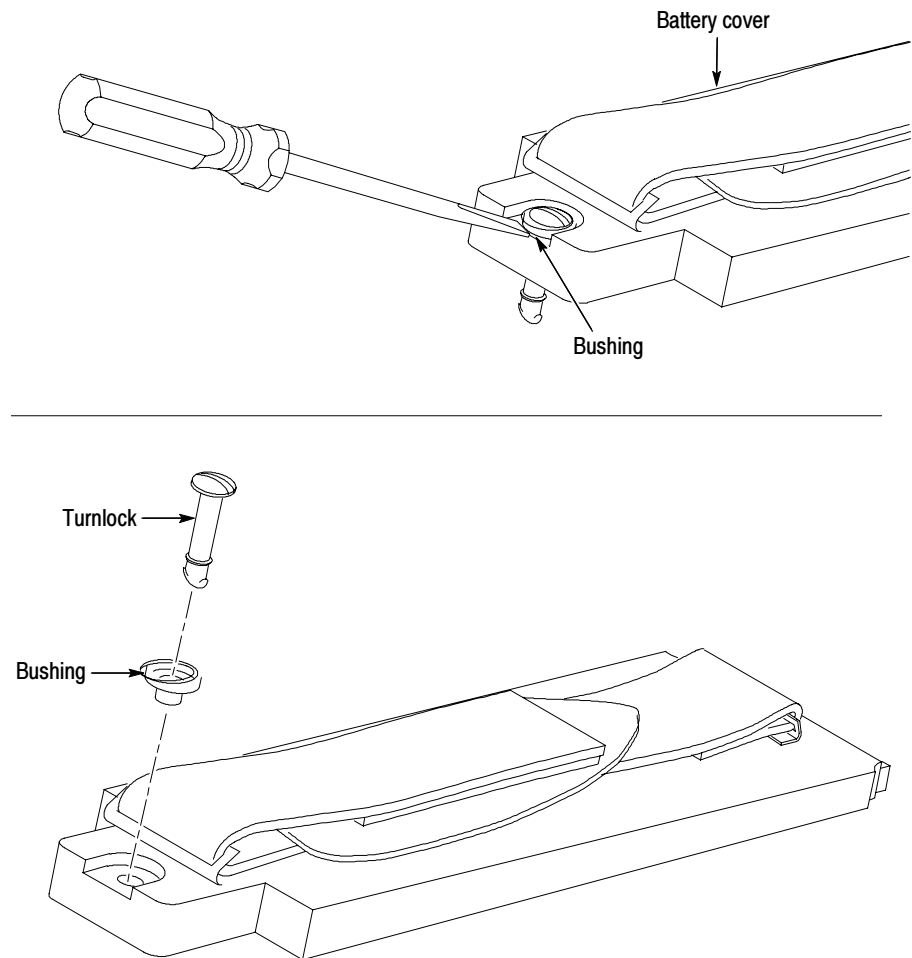


**Figure 6- 11: Installing the battery cover**

### **Turnlock Stud and Bushing**

**Remove.** To remove the turnlock stud and bushing:

1. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
2. Gently pry up on the outside portion of the bushing as shown in Figure 6-12.
3. Gently pull and rock the turnlock stud while holding the bushing.



**Figure 6-12: Removal and replacement of the turnlock stud**

**Replace.** To replace the turnlock stud and bushing:

1. Press the turnlock stud into the bushing.
2. To install the turnlock stud and bushing into the battery cover, press firmly on the turnlock stud head. Be sure to keep the bushing head level with the battery cover while you press on the turnlock stud. The bushing will snap into place when it is correctly installed.
3. Install the battery cover. Refer to *Battery Cover* on page 6-25.

## Battery Cushion Pad

**Remove.** To remove the battery cushion pad:

1. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
2. To remove the cushion pad, pry it up around the edges and pull it off of the battery cover.
3. If necessary, clean the surface of the cushion pad to remove any remaining glue residue. See *Cleaning* on page 6-1.

**Replace.** To replace the battery cushion pad:

1. Peel off the protective covering of the adhesive surface of the cushion pad.
2. Position the cushion pad in place above the battery cover before you press it onto the battery cover. Rub your fingers over the pad once it is positioned on the battery cover to make sure the pad is securely in place.
3. Install the battery cover. Refer to *Battery Cover* on page 6-25.

## Batteries

There are two procedures for replacing the batteries. The first is for the optional NiMH battery pack and second is for alkaline batteries.

### NiMH Battery Pack

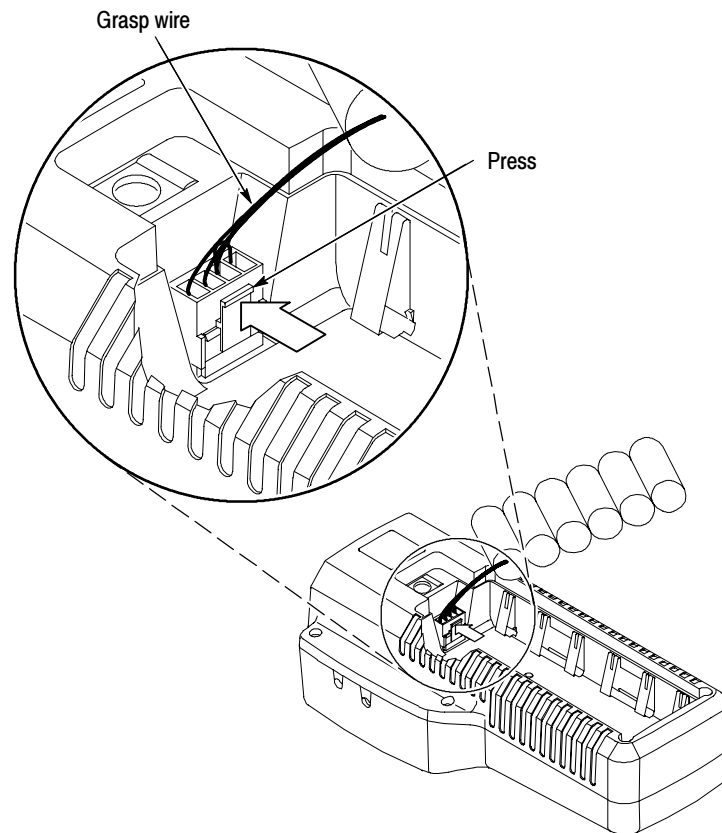
**Remove.** To remove the NiMH battery pack:

1. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
2. Grasp the batteries close to the wire leads. Use your thumb to press in on the top portion of the battery connector tab, and then pull gently upwards. See Figure 6-13.

**Replace.**

1. Press the battery connector onto the jumper in the battery compartment. Be sure the battery connector tab snaps onto the jumper housing to prevent a loss of battery power.
2. Install the battery cover. Refer to *Battery Cover* on page 6-25.





**Figure 6-13: Removing the NiMH battery pack**

## Alkaline Batteries

**Remove.** To remove the C-size alkaline batteries:

1. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
2. Carefully pull the batteries out of the battery compartment.

**Replace.** To replace the C-size alkaline batteries:

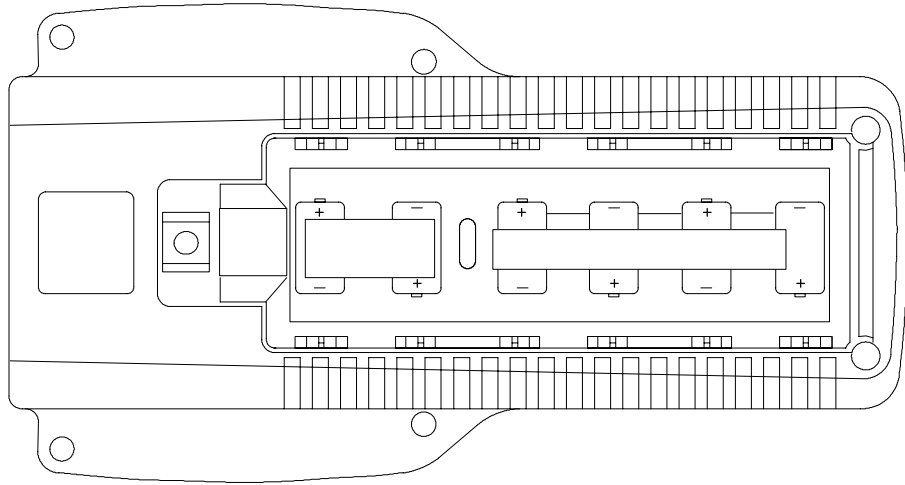
1. Press the batteries into place according to the polarity label on the bottom of the battery compartment. See Figure 6-14.

---

**NOTE.** The polarity of the alkaline batteries must be correct for the instrument to operate. Always replace all of the alkaline batteries at the same time when replacing discharged batteries.

---

2. Install the battery cover. Refer to *Battery Cover* on page 6-25.



**Figure 6- 14: Installed polarity of alkaline batteries**

## Bottom Cover Assembly

The bottom cover assembly contains replaceable subparts. Procedures for removing and installing the subparts are included below.

### Bottom Cover

**Remove.** To remove the bottom cover:

1. Remove any installed batteries. Refer to *Batteries* on page 6-28.
2. Remove the six Torx screws from the bottom cover.
3. Carefully remove the bottom cover and place it beside the top cover.



---

**CAUTION.** To prevent damage to the battery-power wires soldered to the bottom cover, carefully remove the bottom cover

---

4. Lift the Bottom board slightly out of the top cover so that you can pull the battery-power wires from jumper J21 of the Bottom board. See Figure 6-16.

**Replace.** To replace the bottom cover:

1. Lift the Bottom board slightly out of the top cover so that you can connect the battery-power wires onto jumper J21 of the Bottom board.
2. Carefully place the bottom cover onto the top cover.



---

**CAUTION.** To prevent damage to the battery-power or backlight wires, carefully replace the bottom cover. The bottom cover has slots in the molded plastic to hold both the Backlight board and Input board in place.

---

3. Install the six Torx screws into the bottom cover.
4. Install your removed batteries. Refer to *Batteries* on page 6-28.

### Battery Power Connector

**Remove.** To remove the battery power connector:

1. Remove the bottom cover. Refer to *Bottom Cover* on page 6-31.
2. Unsolder the battery connector wires from the battery contacts.

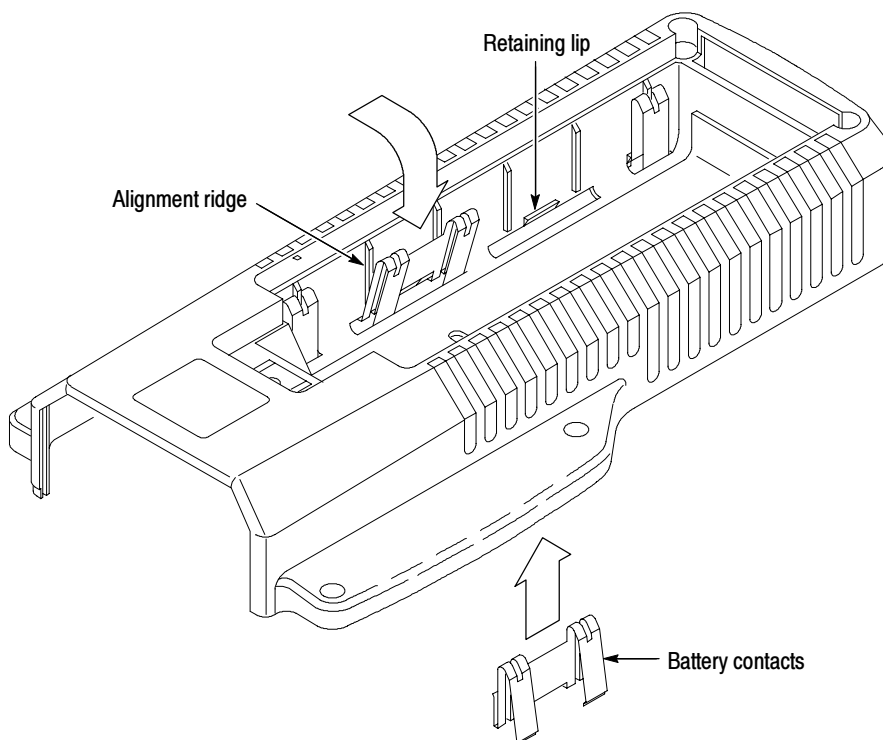
**Replace.** To replace the battery power connector:

1. Solder the battery power connector wires to the battery contacts. See Figure 6-16.
2. Install the bottom cover. Refer to *Bottom Cover* on page 6-31.

## Battery Contacts

**Remove.** To remove the battery contacts:

1. Remove the bottom cover. Refer to *Bottom Cover* on page 6-31.
2. To remove one of the battery contacts that has the battery power connector soldered to it, unsolder the battery connector wire before you remove the battery contact.
3. Pry the battery contact past the retaining lip on the bottom cover. See Figure 6-15.

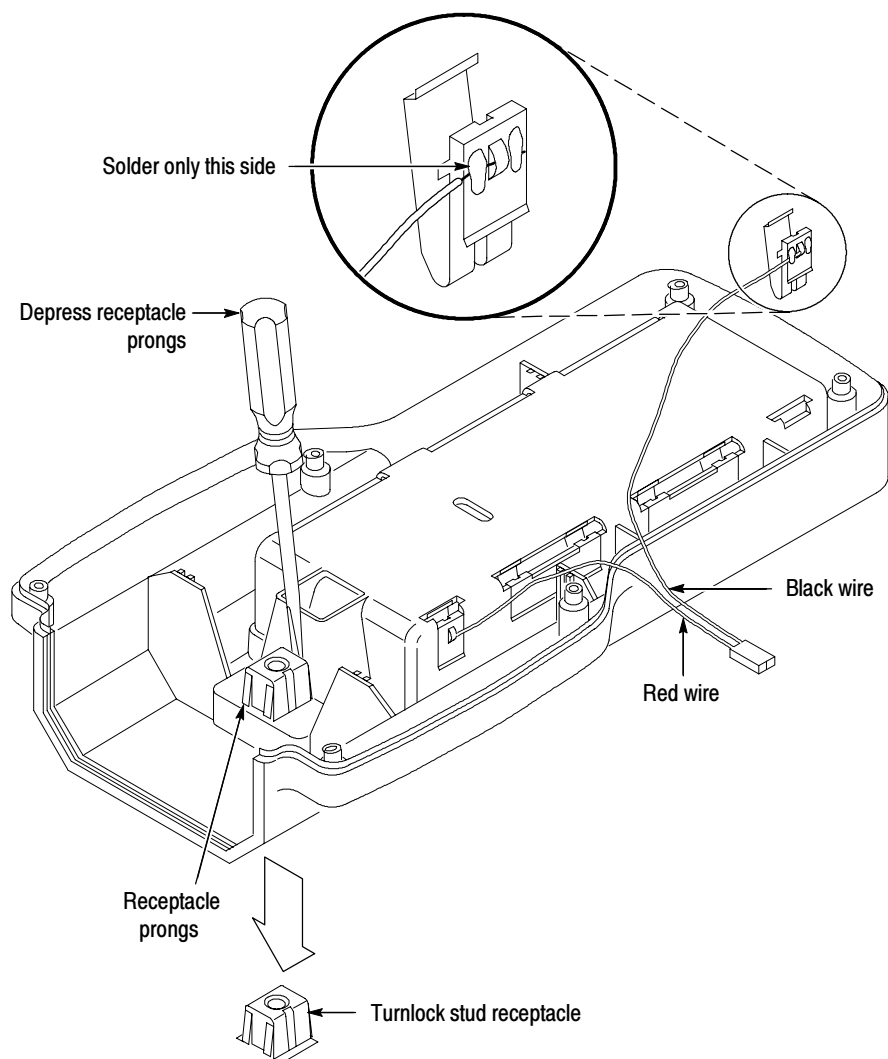


**Figure 6- 15: Battery contact installation alignment**

4. Push the battery contact through the slot on the bottom cover.

**Replace.** To replace the battery contacts:

1. Align the slot in the battery contact with the battery contact alignment ridge on the bottom cover. See Figure 6-15.
2. Push the battery contact through the slot in the bottom cover until the battery contact snaps past the retaining lip of the bottom cover.
3. If you replaced one of the battery contacts that had the battery-power wires soldered to it, resolder the battery connector wire to the battery contact. See Figure 6-16.



**Figure 6-16: Battery power-wire and turnlock stud receptacle installation**

4. Install the bottom cover. Refer to *Bottom Cover* on page 6-31.

## Turnlock Stud Receptacle

**Remove.** To remove the turnlock stud receptacle:

1. Remove the bottom cover. Refer to *Bottom Cover* on page 6-31.
2. Depress the retaining fingers on the turnlock stud receptacle and push the receptacle through the bottom cover. See Figure 6-16.

**Remove.** To replace the turnlock stud receptacle:

1. Push the turnlock stud receptacle through the bottom cover. Be sure the retaining fingers snap into position. See Figure 6-16.
2. Install the bottom cover. Refer to *Bottom Cover* on page 6-31.

## Bottom Cover Electrical Shield

**Remove.** To remove the electrical shield:

1. Remove the bottom cover. Refer to *Bottom Cover* on page 6-31.
2. Pry up the electrical shield on the inside of the bottom cover around the edges and peel it off of the bottom cover.
3. If necessary, clean the surface of the bottom cover to remove any remaining glue residue.

**Replace.** To replace the electrical shield:

1. Peel the protective covering off the adhesive surface of the electrical shield.
2. Position the electrical shield above the inside of the bottom cover and align the hole in the shield with the hole in the bottom cover.
3. Press the shield onto the bottom cover and rub the shield to make sure it is securely in place.
4. Install the bottom cover. Refer to *Bottom Cover* on page 6-31.

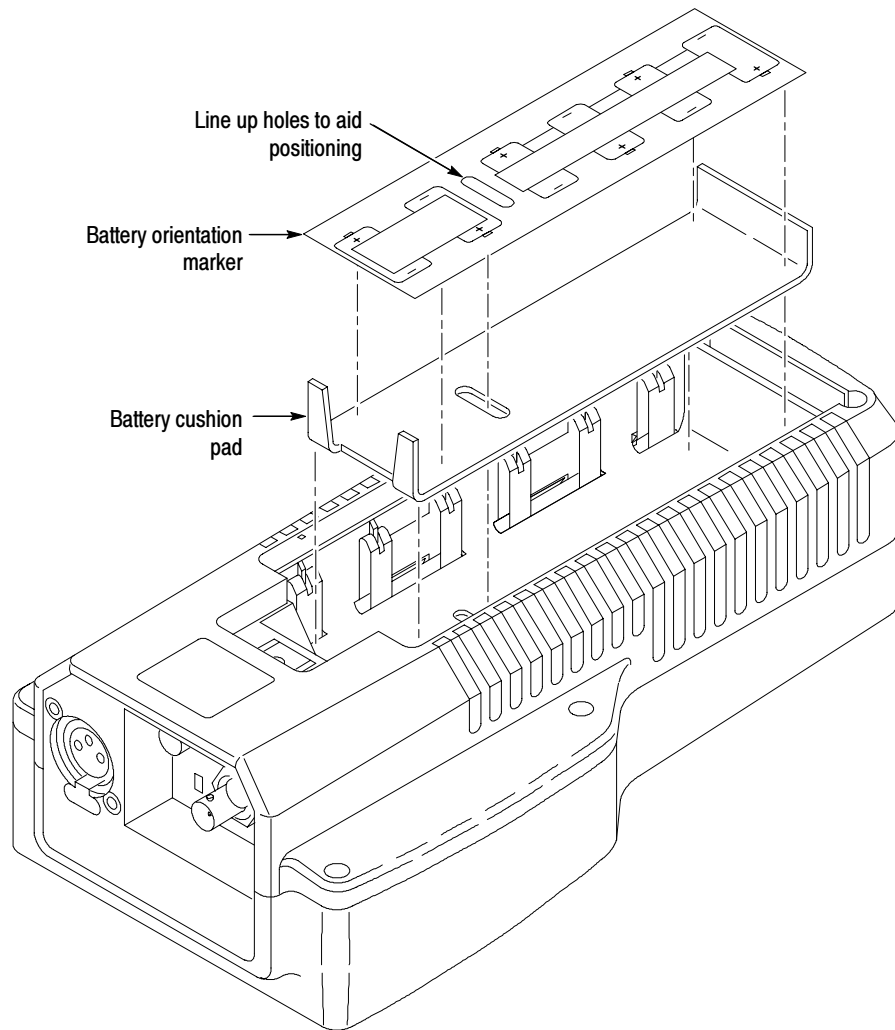
### Battery Orientation Marker and Battery Cushion Pad

**Remove.** To remove the battery orientation marker and/or the battery cushion pad:

1. Remove the battery cover. Refer to *Battery Cover* on page 6-25.
2. To only remove the battery orientation marker, pry it up around the edges and peel it off of the battery cushion pad on the bottom cover.
3. To remove both the battery orientation marker and the battery cushion pad, pry the battery cushion pad up around the edges, and peel it off of the bottom cover.
4. If necessary, clean the surface of the battery cushion pad or the bottom cover to remove any remaining glue residue. Refer to *Cleaning* on page 6-1.

**Replace.** To replace the battery orientation marker and/or the battery cushion pad:

1. To replace the battery cushion pad and the battery orientation marker, peel off the protective covering of the adhesive surface of the battery cushion pad.
2. Position the battery cushion pad above the bottom cover. See Figure 6-17.
3. Press the pad onto the bottom cover and rub the pad to make sure the it is securely in place.
4. Peel off the protective covering of the adhesive surface of the battery orientation marker.
5. Position the battery orientation marker above the battery cushion pad. See Figure 6-17.
6. Press the marker onto the battery cushion pad and rub the marker to make sure it is securely in place.
7. Install the battery cover. Refer to *Battery Cover* on page 6-25.



**Figure 6- 17: Battery orientation marker position**



## AC Adapter EMI Suppressor

**Remove.** To remove the AC adapter EMI suppressor:

1. Release the retaining latches on the side of the EMI suppressor.
2. Pull the AC adapter cord from the EMI suppressor.

**Replace.** To replace the AC adapter EMI suppressor:

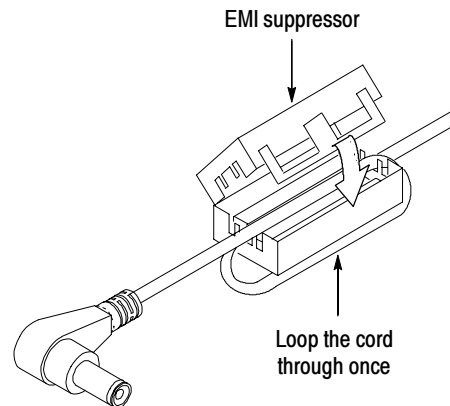
1. Place the EMI suppressor within 12 inches of the end of the adapter cord.

---

**NOTE.** *The EMI suppressor is most effective when placed close to the end of the AC adapter cord.*

---

2. Loop the AC adapter cord through the middle of the EMI suppressor. Close the EMI suppressor until the sides of the suppressor latch together. See Figure 6-18.



**Figure 6-18: Installing the EMI suppressor**



# Troubleshooting Procedures

This section contains the following information to help you locate problems within the WFM90D or WFM91D:

- List of equipment required to perform the procedures
- Battery-fault analysis
- Low-voltage power supply
- Fault symptom table
- Troubleshooting flowcharts
- Connector pin locator diagram

## Equipment Required

The following equipment and accessory items are required to perform the Troubleshooting Procedures. Minimum requirement specifications are followed by an example of equipment that meet these specifications.

**Table 6-3: Equipment required for troubleshooting**

Equipment description	Minimum requirements	Equipment example
Television test signal generator	75% color bar and 100% flat field test signals for the television standard of the monitor to be tested	NTSC: Tektronix TSG100; PAL: Tektronix TSG111
Audio generator	Amplitude Range: -10 dBu to 8 dBu; Frequency: 1 kHz to 50 kHz	Tektronix ASG100 Audio Signal Generator
Oscilloscope	100 MHz	Tektronix 1465B
Picture monitor	Composite video for the television standard of the monitor to be tested	
75 $\Omega$ coaxial cable	Two cables required, male-to-male BNC connectors	Tektronix part number 012-0159-00 (42-inch)
Circuit board vise		
Test resistor	Two 30 $\Omega$ , 3 W	Tektronix part number 308-0142-00
Test resistor	10 k $\Omega$ , 2 W	Tektronix part number 305-0103-00
Jumper wires	Three, 8 inch	20 AWG
12 V power supply		Tektronix PS282

## Battery-Fault Analysis

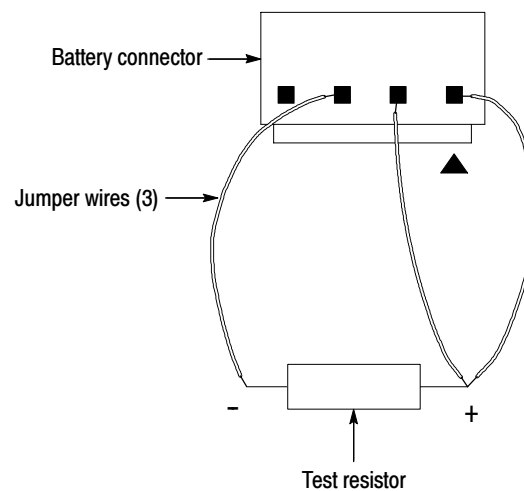
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**NOTE.** If the instrument functions properly when powered by the AC adapter, but there are battery or battery charging problems, use the following procedure. If there are no battery problems or if the instrument does not function properly with the AC adapter, proceed to Low-Voltage Power Supply on page 6-42.

---

Use the following procedure to determine if the battery charger circuit is operating properly:

1. Remove the AC adapter from the WFM90D or WFM91D.
2. Remove the battery cover and any installed batteries from the instrument. See *Batteries* on page 6-28.
3. Use three jumper wires to connect a 30  $\Omega$ , 3 W resistor to the battery connector pins, as shown in Figure 6-19.



**Figure 6-19: Testing the battery charging circuit**

---

**NOTE.** If the jumper wires will not stay securely attached to the battery connector pins, remove the instrument bottom case to obtain access to the battery connector pins on the Bottom board. Refer to Bottom Cover on page 6-31.

---

4. Attach the voltmeter across the test resistor shown in Figure 6-19.
5. Connect the AC adapter to the WFM90D or WFM91D.

6. Check for a voltage reading of +2 VDC on the voltmeter with the WFM90D or WFM91D turned on, and a reading of +8 to +9 VDC with the instrument turned off. The voltage will slowly rise when the instrument is turned off.
7. If the voltage reading in the previous step was correct, replace the batteries. If the voltage reading was incorrect, replace the Bottom board.



---

**WARNING.** *To prevent electric shock and high-voltage arcing, do not operate the Backlight power supply with the LCD module removed. High voltages in excess of 1 kV can be present on the Backlight power supply leads when operated open circuit.*

*If the LCD module is removed, always remove the Backlight board before powering up the instrument for test.*

---

## Low-Voltage Power Supply

Use the following procedure to check that the low-voltage power supplies are operating properly before proceeding to *Fault Symptom Table*.

1. Disconnect the AC adapter from the WFM90D or WFM91D.
2. Remove any installed batteries. See *Batteries* on page 6-28.
3. Remove the top cover. See *Top Cover* on page 6-5.
4. Connect the AC adapter and turn on the instrument.
5. Check that the low-voltage power supplies are operating properly, as indicated by the supply voltages listed in Table 6-4:

**Table 6-4: Low-voltage power supplies**

Supply	Test Point	Output	Ripple
+8 V	J9, pin 13	± 40 mV	30 mV
-8 V	J9, pin 14	± 40 mV	30 mV
+5 V	J9, pin 15	± 25 mV	60 mV

6. If the low-voltage power supplies are operating properly, proceed to *Fault Symptom Table*.
7. If any of the voltages are out of specification, check the two fuses on the Bottom board.




---

**CAUTION.** Do not use a soldering iron larger than 18 W. To do so may damage the circuit board and the surrounding circuitry.

---

8. If a fuse is bad, remove the AC adapter and replace the fuse before you retest the low-voltage power supplies.
9. If both of the fuses are good, replace the Bottom board.

---

**NOTE.** Be sure to remove all modules one at a time, to isolate the Bottom board in a supply is excessively loaded.

---

## Fault Symptom Table

**NOTE.** Check the low-voltage power supplies (see Low-Voltage Power Supply on page 6-42) before proceeding with the following procedure:

1. Disconnect the AC adapter from the instrument.
2. Remove any installed batteries. See *Batteries* on page 6-28.
3. Remove the top cover. See *Top Cover* on page 6-5.
4. Remove the bottom cover. See *Bottom Cover* on page 6-31.



**CAUTION.** To avoid breaking the circuit boards, do not tighten the circuit board vise too tightly.

5. Secure the instrument circuit boards in the circuit board vise.
6. Connect a 75% color bar test signal to the VIDEO IN connector and connect the VIDEO OUT connector to the picture monitor.
7. Locate your fault symptom in Table 6-5 and use the indicated flowchart to isolate the faulty module.

**Table 6-5: Fault symptom table**

Symptom	Flowchart
No display after pressing the front panel ON button	page 6-45
Graticule is good, but the Waveform display is distorted or not visible	page 6-46
Graticule is good, but there is no Vector display	page 6-47
Graticule is good, but the Audio display is distorted or not visible	page 6-49
No display in the Picture display mode	page 6-50
Bad graticule and menu, but Picture display mode is good	page 6-51
Display all white	page 6-52
Waveform display mode sweep not triggered	page 6-53
Vector display unlocked	page 6-54
Vector display jitter	page 6-55
Distorted vectors in Vector display	page 6-55
Control problem	page 6-56
Menus horizontally unlocked in Picture display mode	page 6-57

**Table 6-5: Fault symptom table (Cont.)**

<b>Symptom</b>	<b>Flowchart</b>
Dim or blotchy display	page 6-58
All display modes are bad except Picture, when no menus are displayed	page 6-58

## **Troubleshooting Flowcharts**

The troubleshooting flowcharts help you isolate the faulty module. Each flowchart is directly related to a fault symptom listed in Table 6-5.

Figure 6-36 on page 6-59 illustrates the connector and pin locations for the circuit board connectors listed in the troubleshooting flowcharts.



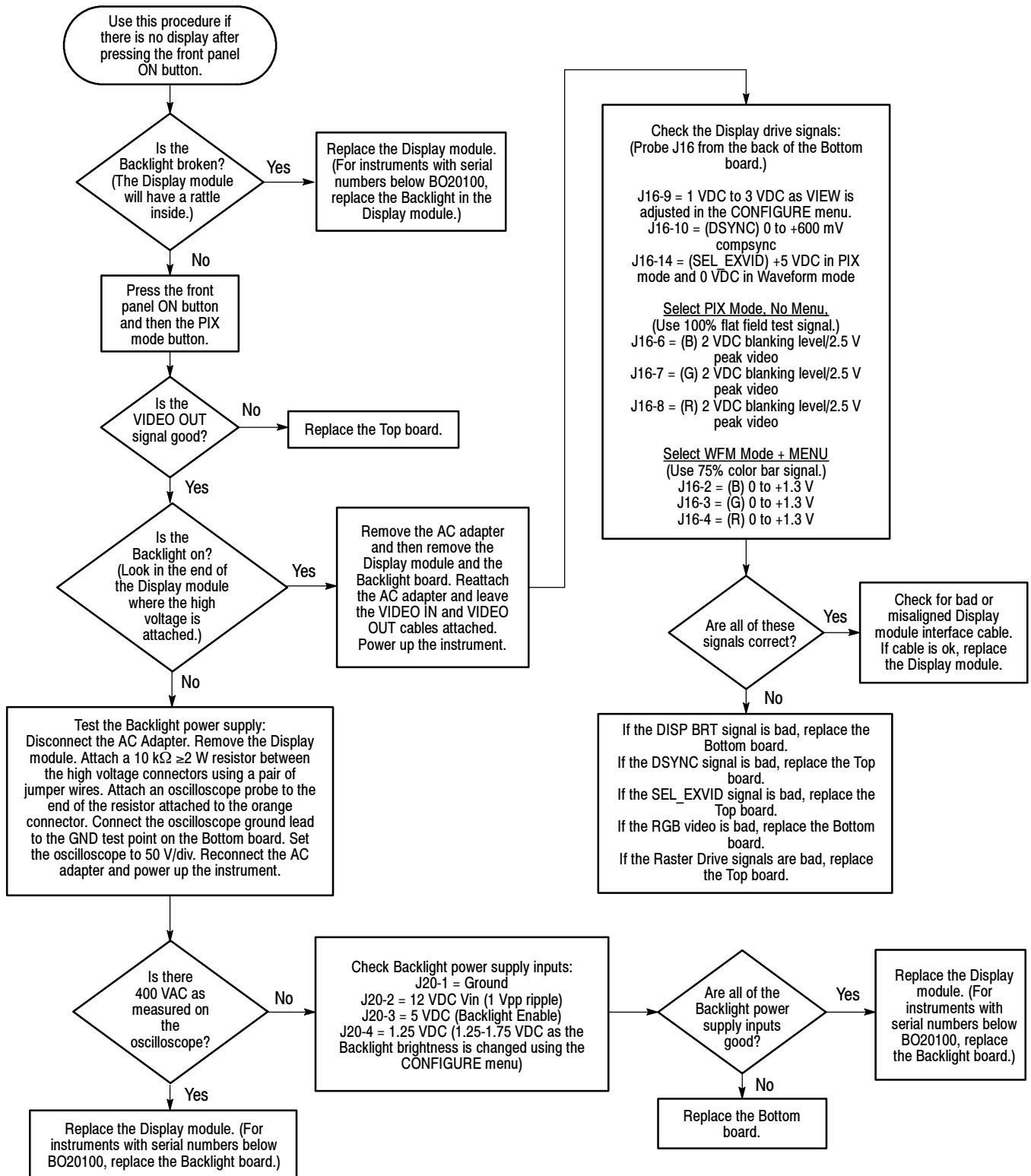


Figure 6-20: Flowchart for no display

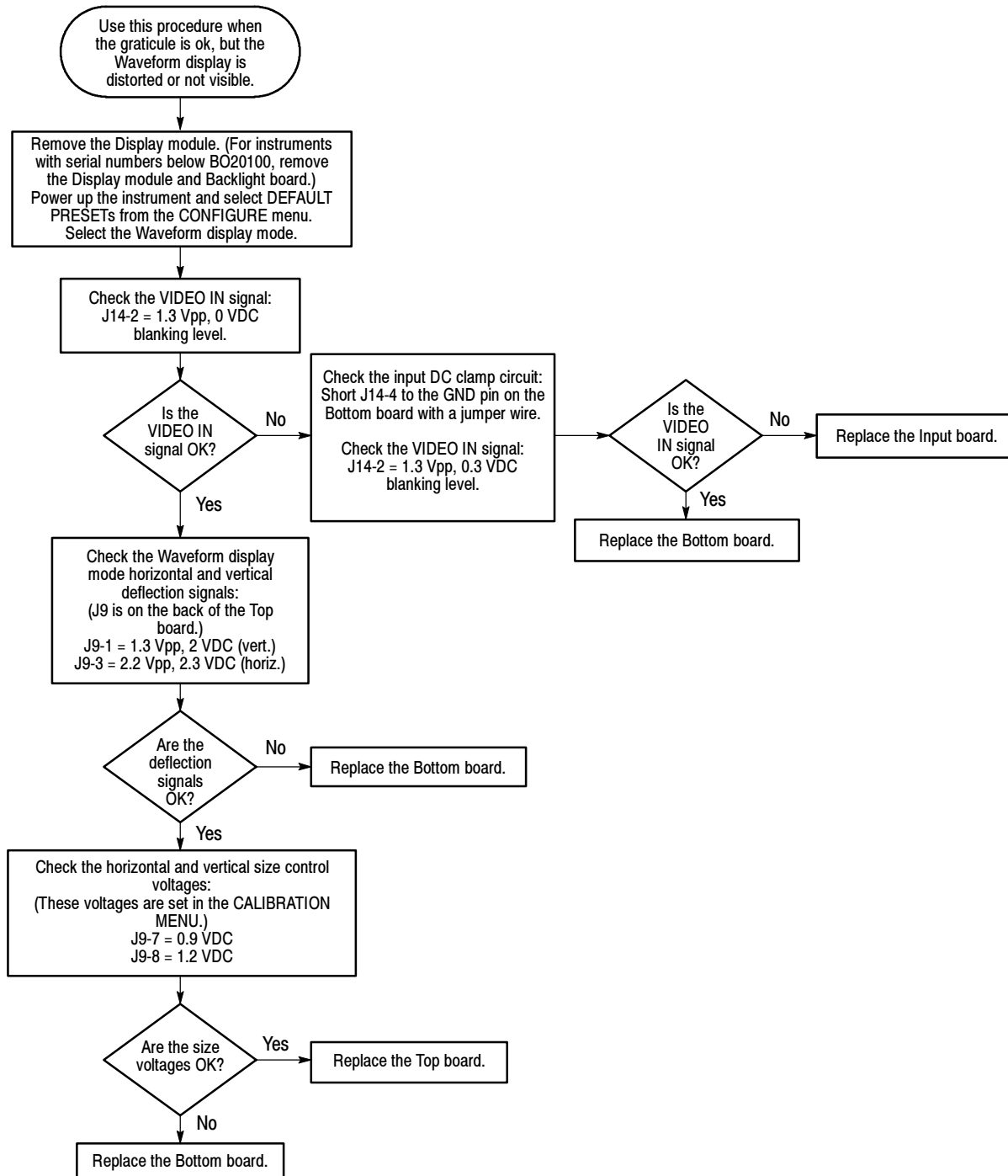


Figure 6-21: Flowchart for distorted waveform display

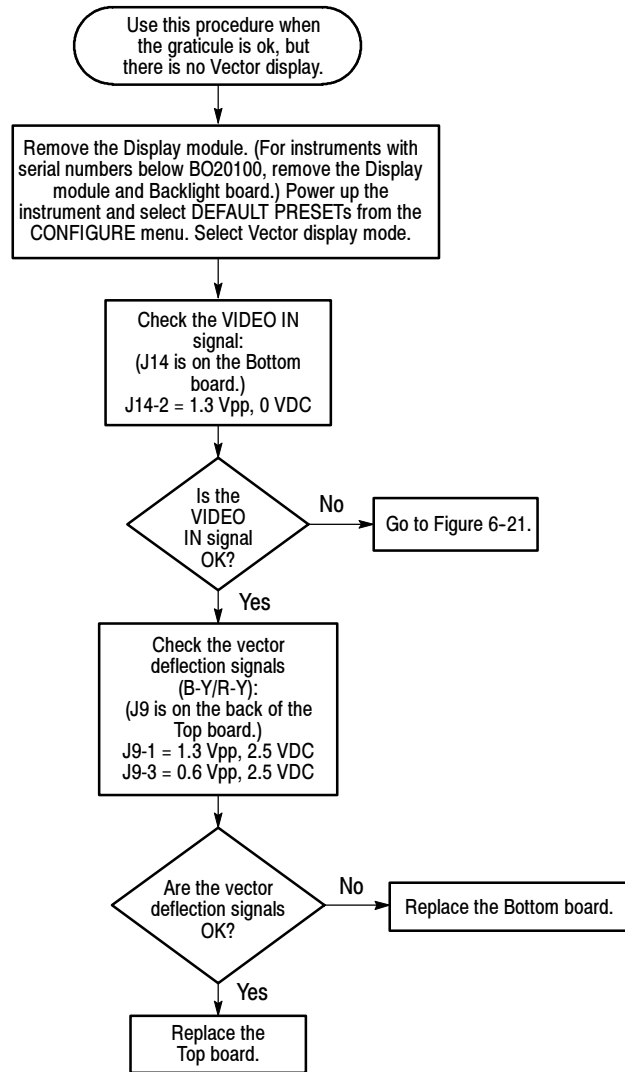


Figure 6-22: Flowchart for no vector display

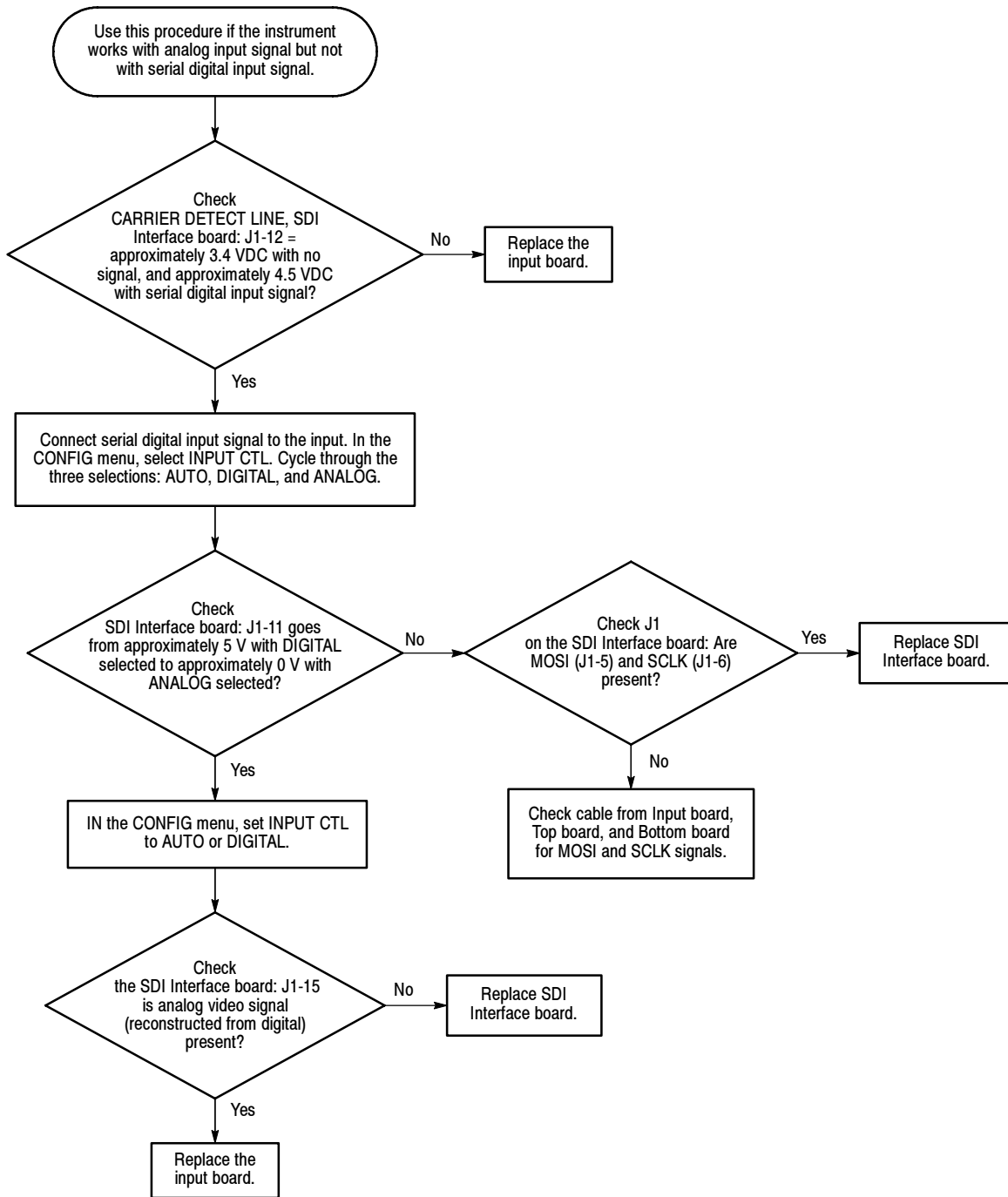


Figure 6- 23: Flowchart for problems processing serial digital input signals

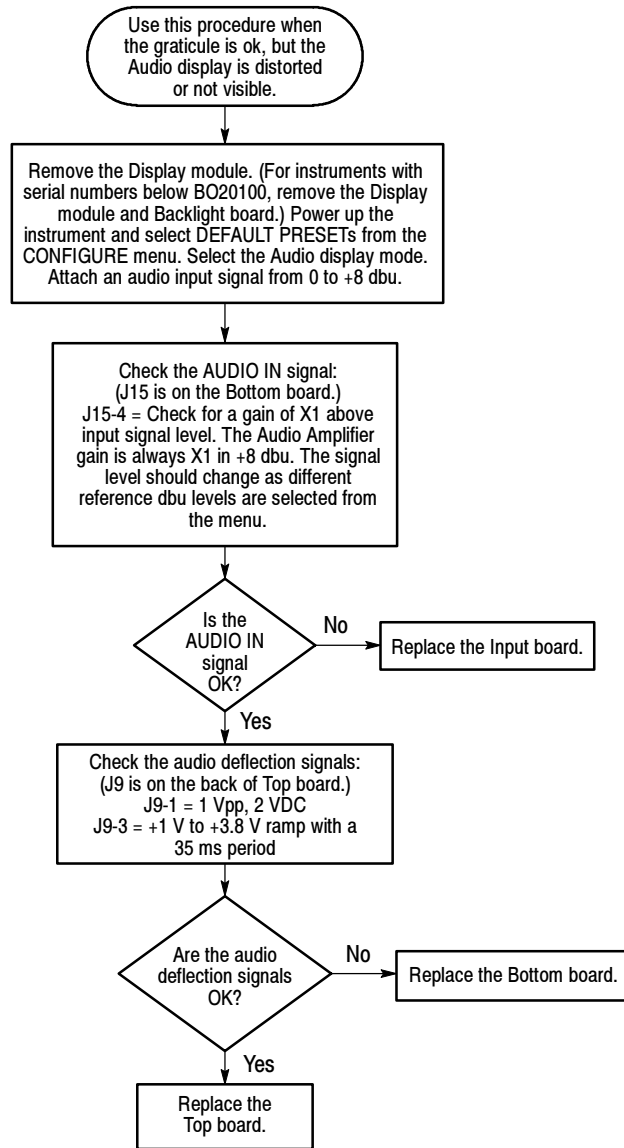


Figure 6-24: Flowchart for bad audio display

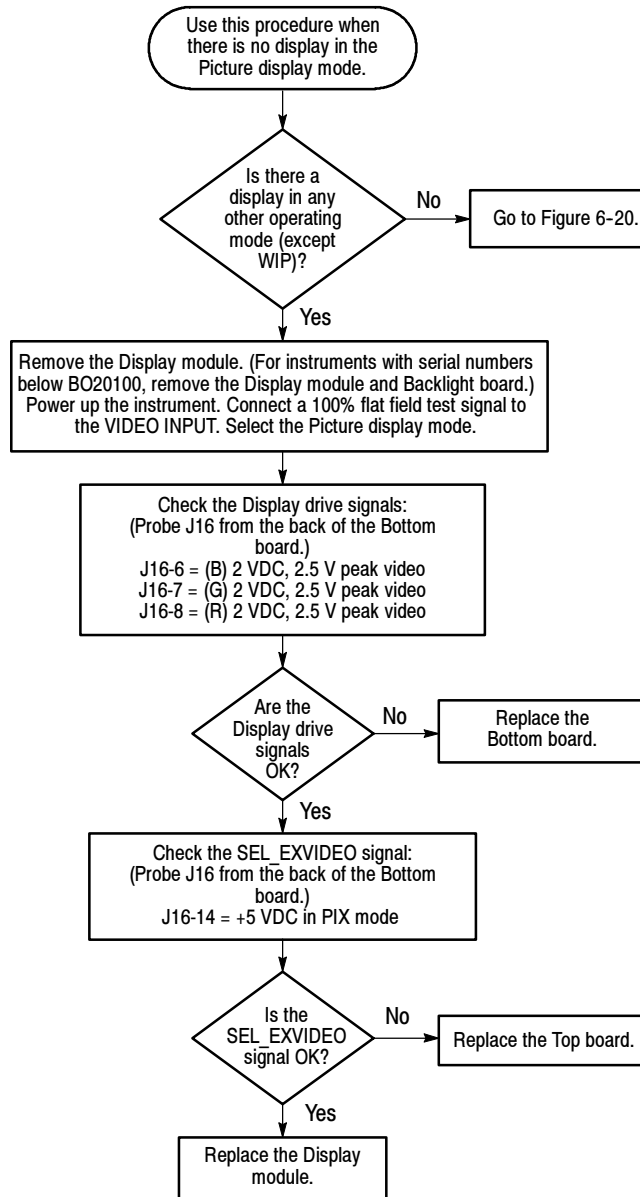
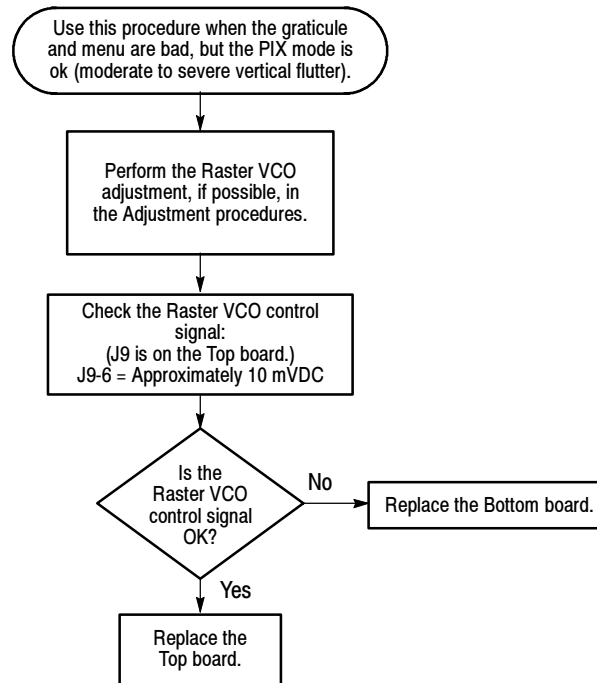


Figure 6- 25: Flowchart for no picture display



**Figure 6-26: Flowchart for bad graticules and menus**

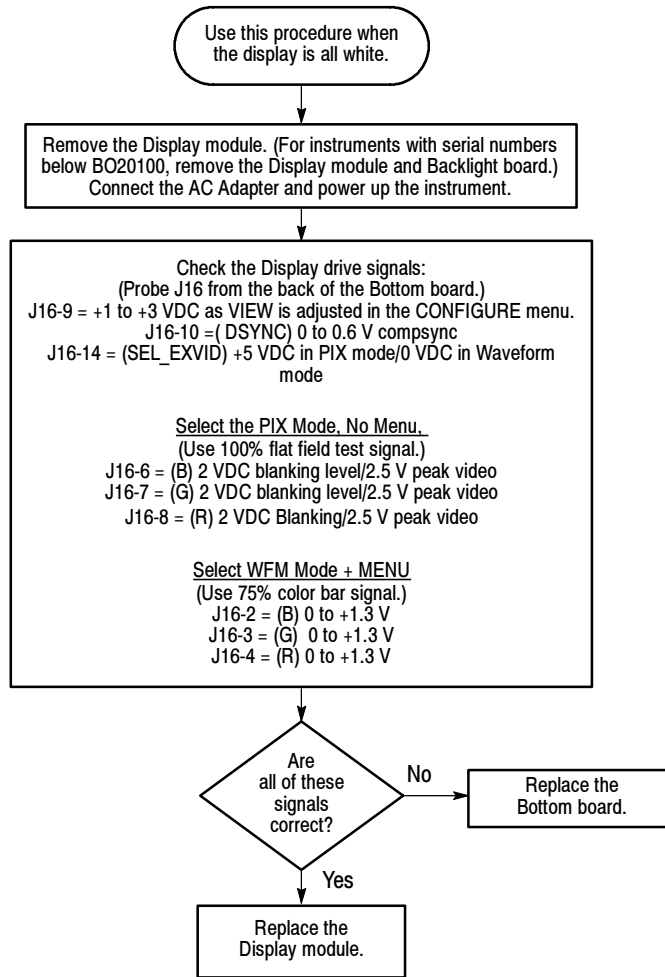


Figure 6-27: Flowchart for all white display



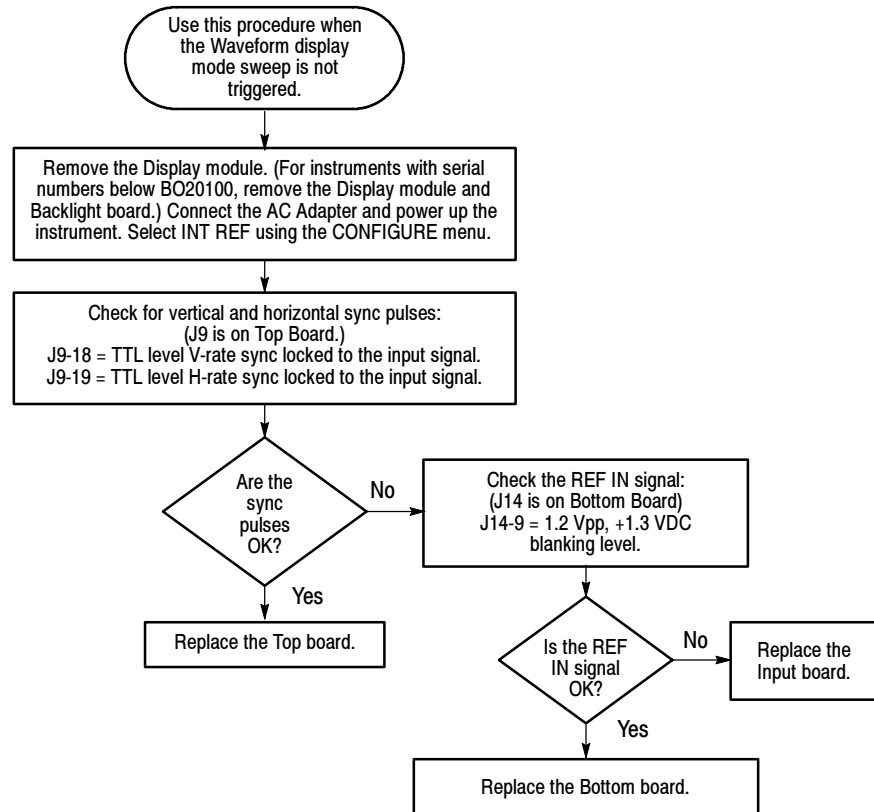


Figure 6-28: Flowchart for untriggered waveform display

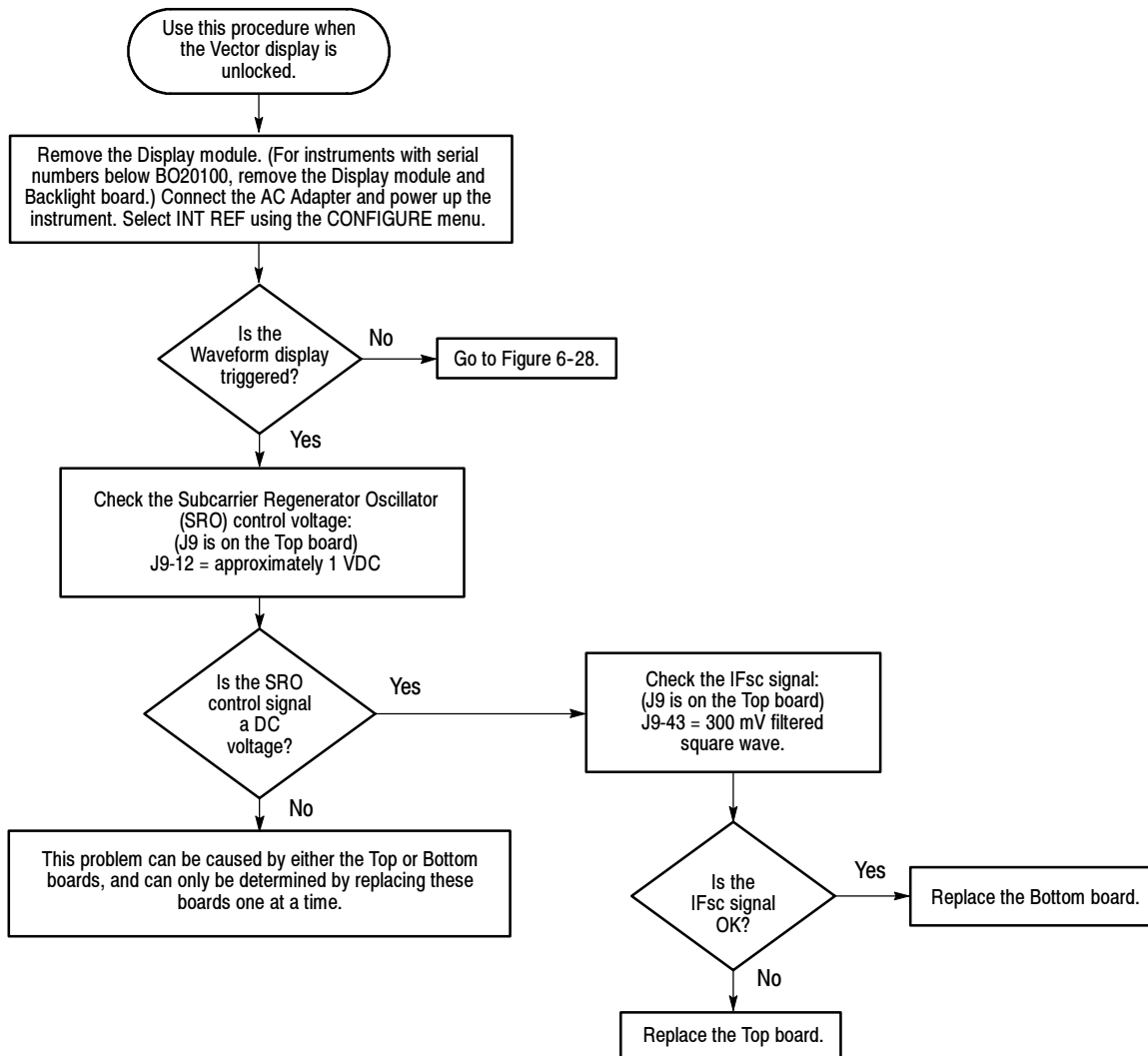
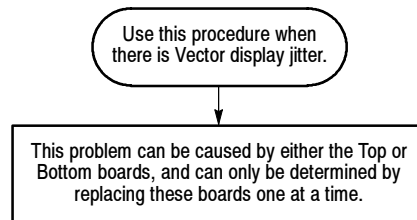
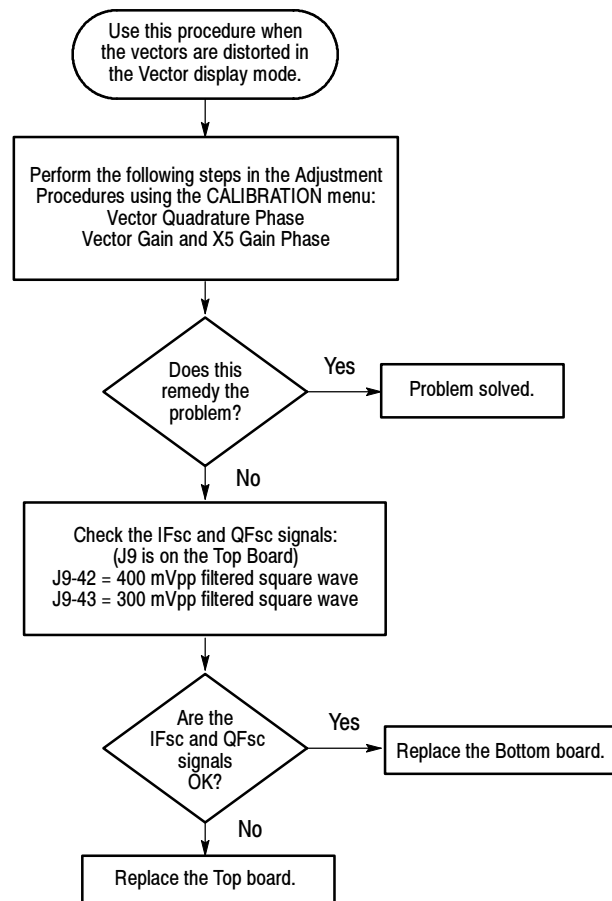


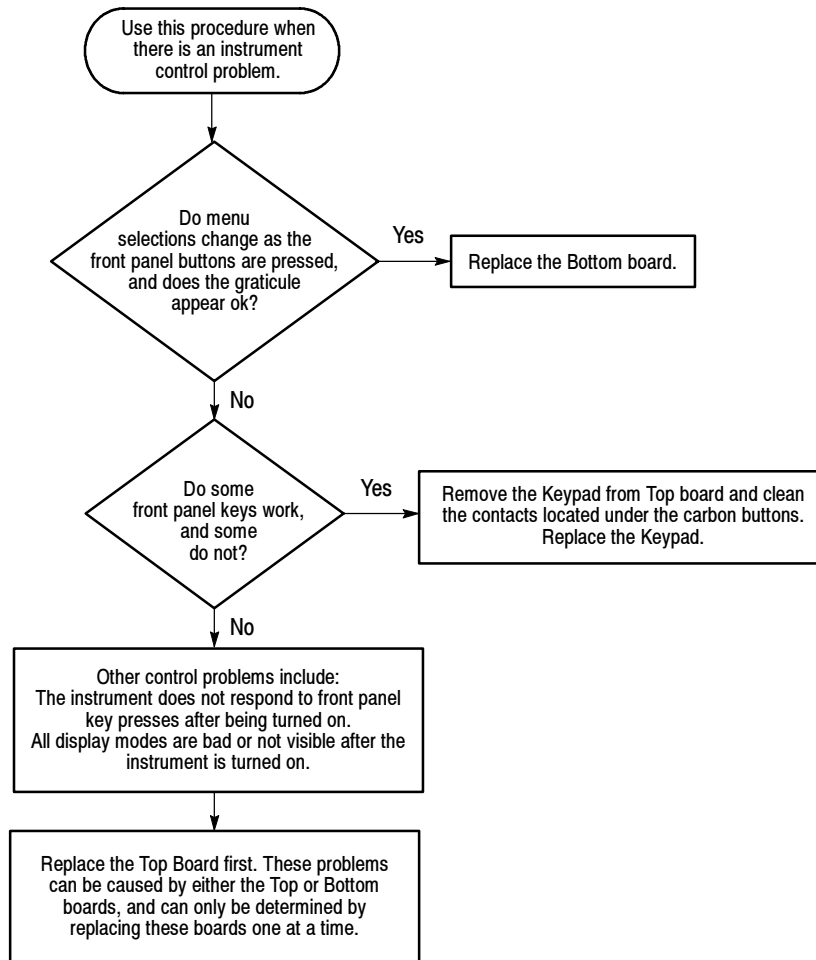
Figure 6-29: Flowchart for unlocked vector display



**Figure 6-30: Flowchart for vector display jitter**



**Figure 6-31: Flowchart for distorted vectors**



**Figure 6- 32: Flowchart for problems with the instrument controls**

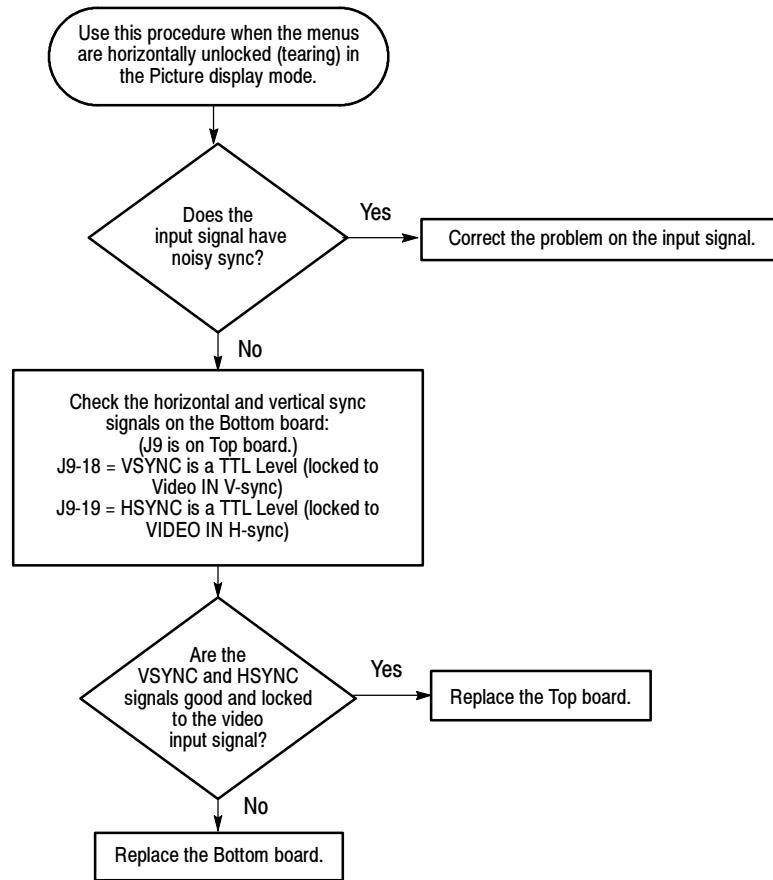
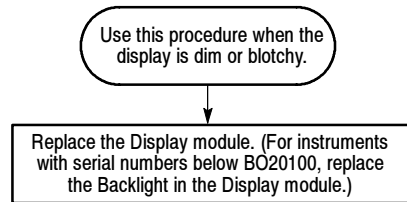
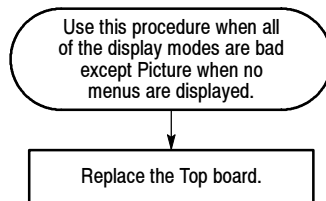


Figure 6-33: Flowchart for bad menus in the picture display



**Figure 6- 34: Flowchart for dim or blotchy display**



**Figure 6- 35: Flowchart for bad displays except Picture mode**

## Connector Diagram

Figure 6-36 illustrates the connector and pin locations of the circuit board connectors listed in the troubleshooting flowcharts.

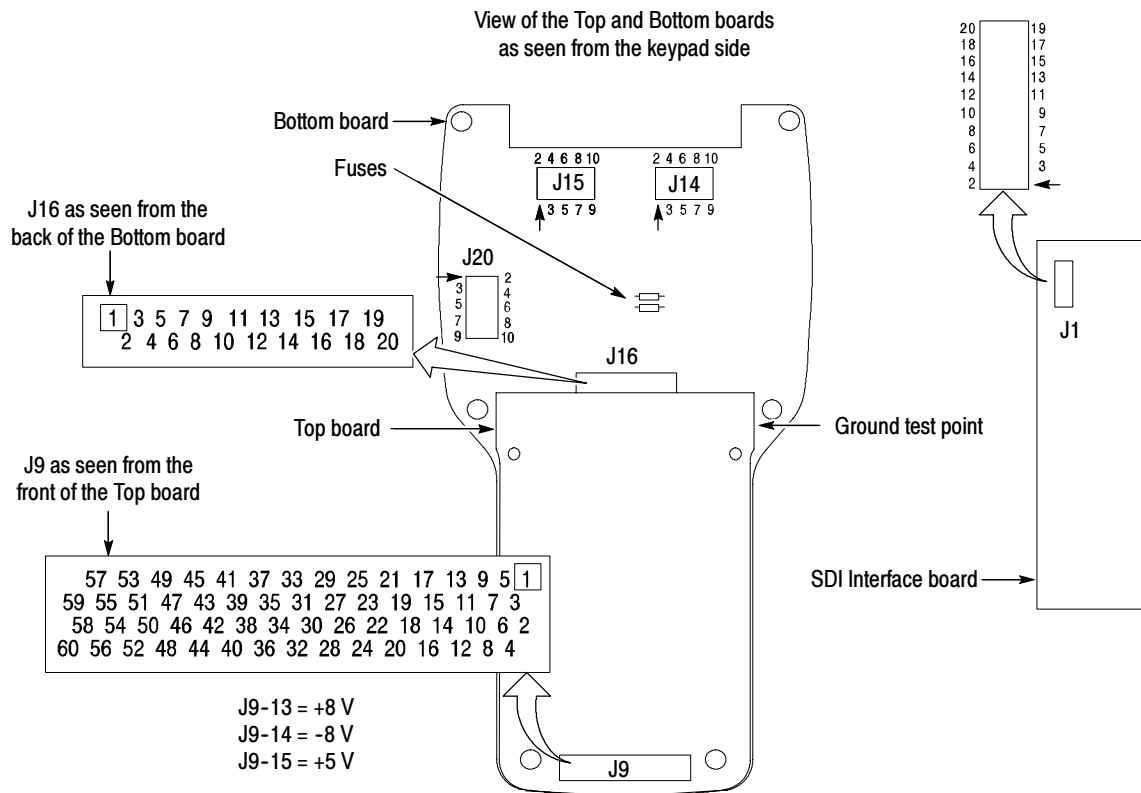


Figure 6-36: Circuit board connector and pin locations







# Options



# Options

This section lists the options and accessories for the WFM90D and WFM91D. You can order options and accessories with the monitor or purchase them separately through a Tektronix field office or distributor. When ordering, include the option or part number and the description.

## Options

You can order the following options with the WFM90D and WFM91D. When ordering replacement power adapters, use the Tektronix part numbers listed in Table 7-1.

**Table 7-1: Options**

Option	Description	Tektronix part number
Option 01	NiMH battery pack	146-0107-01
Option A1	220 V wall unit power adapter, European TUV	119-4540-02
Option A2	240 V wall unit power adapter, UK	119-4541-02
Option A3	240 V wall unit power adapter, Australia	119-4542-02
Option A6	100 V wall unit power adapter, Japan	119-4539-02
Option A10	220 V wall unit power adapter, China	119-6904-00
Option A99	No power cord (WFM91D)	
Option M2	5 years warranty/remedial service	
Option M8	4 calibration/performance tests	
Option 33	Travel-line package, including: <ul style="list-style-type: none"><li>■ NiMH battery pack</li><li>■ Viewing hood</li><li>■ Desk stand</li><li>■ Travel case for a WFM90D or WFM91D monitor and a TSG95 or TSG601 signal generator</li></ul>	

## Accessories

Standard accessories are shipped with every instrument. The standard accessories for the WFM90D and WFM91D and the Tektronix part numbers to use when ordering are listed in Table 7-2.

**Table 7-2: Standard accessories**

Description	Quantity	Tektronix part number
<i>WFM90D &amp; WFM91D Handheld Waveform, Vector, Picture, &amp; Audio Monitor User Manual</i>	1 ea	071-1142-00
120 V wall unit power adapter, US	1 ea	119-4538-01
Carrying pouch	1 ea	116-1330-01

**Table 7-3: Optional accessories**

Description	Tektronix part number
<i>WFM90D &amp; WFM91D Handheld Waveform, Vector, Picture, &amp; Audio Monitor Service Manual</i>	071-1143-01
NiMH battery pack	146-0107-01
Instrument desk stand	386-6787-01
Viewing hood	011-0167-01
Travel case for a WFM90D or WFM91D monitor and a TSG95 or TSG601 signal generator	016-1344-00



# Replaceable Mechanical Parts



# Replaceable Parts List

This section lists the replaceable modules for this instrument. Use this list to identify and order replacement parts.

## Parts Ordering Information

Replacement parts are available through your local Tektronix, Inc., Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If you order a part that has been replaced with a different or improved part, your local Tektronix, Inc., Field Office or representative will contact you concerning any change in part number.

## Module Servicing

Modules can be serviced by selecting one of the following three options. Contact your local Tektronix service center or representative for repair assistance.

**Module Exchange.** In some cases you may exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-833-9200. Outside North America, contact a Tektronix sales office or distributor; see the Tektronix web site for a list of offices: [www.tektronix.com](http://www.tektronix.com).

**Module Repair and Return.** You may ship your module to us for repair, after which we will return it to you.

**New Modules.** You may purchase replacement modules in the same way as other replacement parts.

## Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the WFM90D and WFM91D. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

### Parts list column descriptions

Column	Column name	Description
1	Figure & index number	Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow.
2	Tektronix part number	Use this part number when ordering replacement parts from Tektronix.
3 and 4	Serial number	Column three indicates the serial number at which the part was first effective. Column four indicates the serial number at which the part was discontinued. No entry indicates the part is good for all serial numbers.
5	Qty	This indicates the quantity of parts used.
6	Name & description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.
7	Mfr. code	This indicates the code of the actual manufacturer of the part.
8	Mfr. part number	This indicates the actual manufacturer's or vendor's part number.

**Abbreviations**      Abbreviations conform to American National Standard ANSI Y1.1-1972.

**Mfr. Code to Manufacturer Cross Index**      The table titled Manufacturers Cross Index shows codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

**Instrument Accessories**      The part numbers for the standard and optional accessories available with this instrument are located at the end of the replaceable parts list.



## Manufacturers Cross Index

<b>Mfr. Code</b>	<b>Manufacturer</b>	<b>Address</b>	<b>City, State, Zip Code</b>
0DWW6	MICRO POWER ELECTRONICS	7973 SW CIRRUS DRIVE, BLDG 22	BEAVERTON, OR 97008
0GV90	GLOBTEK INC	186 VETERANS DRIVE	NORTHVALE, NJ 07647-2303
0KB01	STAUFFER SUPPLY CO	810 SE SHERMAN	PORTLAND, OR 97214-4657
0LXM2	LZR ELECTRONICS INC	8051 CESSNA AVENUE	GAITHERSBURG, MD 20879
10764	TENSOLITE CO	3000 COLUMBIA HOUSE BLVD, SUITE 120	VANCOUVER, WA 98661
14310	AULT INC	7300 BOONE AVE NORTH BROOKLINE PARK	MINNEAPOLIS, MN 55428
2K262	BOYD CORPORATION	6136 NE 87TH AVENUE	PORTLAND, OR 97220
39951	AROW COMPONENTS & FASTENERS INC	AROW COMPONENTS & FASTENERS, INC. 31012 HUNTWOOD AVE.	HAYWARD, CA 94544
55322	SAMTEC INC	810 PROGRESS BLVD, PO BOX 1147	NEW ALBANY, IN 47150-1147
73743	FISCHER SPECIAL MFG CO	111 INDUSTRIAL RD PO BOX 76500	COLD SPRINGS, KY 41076
75915	LITTELFUSE TRACOR INC SUB OF TRACOR INC	800 E NORTHWEST HWY	DES PLAINES IL 60016-3049
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077-0001
83285	STEWART MFG CO	1200 E 36TH ST PO BOX 510	CHATTANOOGA, TN 37401-0510
93907	CAMCAR DIV OF TEXTRON INC	ATTN: ALICIA SANFORD 516 18TH AVE	ROCKFORD, IL 611045181
94222	SOUTHCO, INC.	210 N BRINTON LAKE RD	CONCORDVILLE, PA 19331
99981	SINO AMERICAN ELECTRONIC CO LTD	3333 BOWERS AVE, SUITE 251	SANTA CLARA, CA 95054
TK1415	CABOT SAFETY CORP	7911 ZIONSVILLE RD	INDIANAPOLIS, IN 46268
TK1416	SHARP CORP	22-22 NAGAIKE-CHO ABENO-KU	OSAKA, JAPAN
TK2427	A/D ELECTRONICS INC	10421 BURNHAM DRIVE NW, BLDG #4	GIG HARBOR, WA 98332

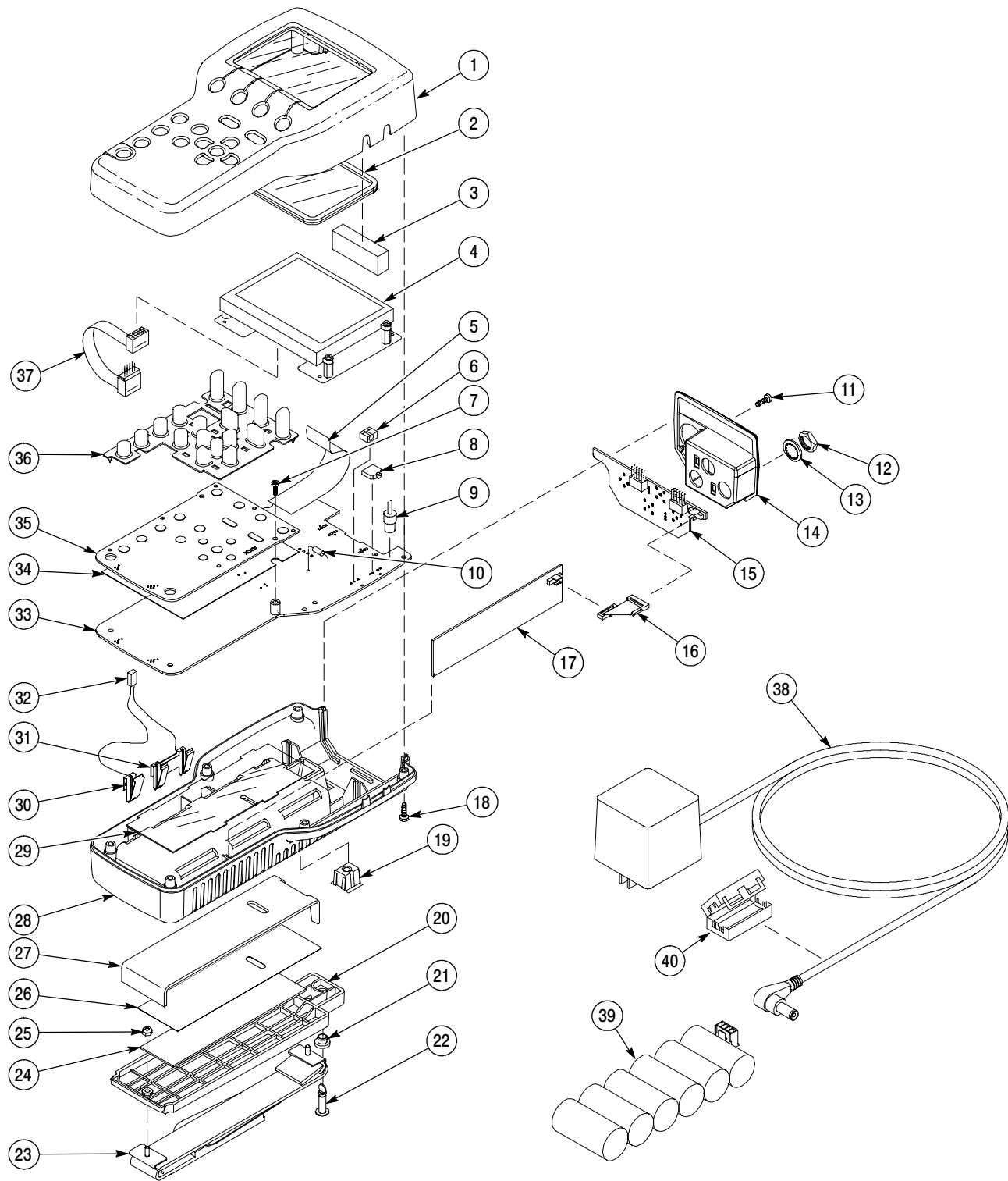


Figure 8- 1: Exploded view (serial numbers B020100 and above)

**Replaceable Parts List for serial numbers B020100 and above**

Fig. & Index Number	Tektronix Part Number	Serial No. Effective	Serial No. Discont'd	Qty	Name & Description	Mfr. Code	Mfr. Part Number
8-1-1	202-0394-00			1	CASE, TOP:POLYCARBONATE,WFM90D	80009	202-0394-00
	202-0395-00			1	CASE, TOP:POLYCARBONATE,WFM91D	80009	202-0395-00
8-1-2	378-0418-00			1	LENS, DISPLAY:POLYCARBONATE,CLEAR	80009	378-0418-00
8-1-3	348-0090-00	B020100		1	PAD,CUSHION	80009	348-0090-00
8-1-4	065-0721-00	B020100		1	DISPLAY MODULE:LCD,4 INCH, COLOR,PROMATE	80009	065-0721-00
8-1-5	174-3287-00			1	CA ASSY,SP:FLAT FLEX,FLX,20,26 AWG,0.050 CTR, 4.0 L, X RTANG,PCB,STAGGERED	80009	174-3287-00
8-1-6	131-5148-00			1	JACK,POWER DC:PCB,MALE,RTANG,2.0 MM DIA PIN,7 MM H X 3.3 MM TAIL,3 COND,W/SWITCH	TK2427	ADC-016
8-1-7	211-0294-00			2	SCREW,MACH:M3 X 0.5 X 10MM,PNH,T-10 TORX	0KB01	211-0294-00
8-1-8	131-5798-00			1	CONN,JACK PHONE:PCB,FEMALE,RTANG,3 POS, W/SHUNT,3.5MM ID,0.354 H X 0.137 TAIL,5 TERM	0LXM2	SJ100
8-1-9	348-1722-00			4	FOOT ASSY:LCD 0.400L,0.280 OD	2K262	348-1722-00
8-1-10	159-0378-00			2	FUSE,WIRE LEAD:2.0A,125V,1 SEC MIN - 60 SEC	75915	R473 002-T1R
8-1-11	213-0774-00			2	SCREW,TPG,TF:M3-0.5 X 10MM L,TORX DRIVE	93907	ORDER BY DESC
8-1-12	220-0497-00			3	NUT,PLAIN,HEX:0.5-28 X 0.562 HEX,BRS CD PL	73743	ORDER BY DESC
8-1-13	210-1039-00			3	WASHER,LOCK:0.521 ID,INT,0.025 THK,SST	0KB01	1224-02-00-0541C
8-1-14	333-4144-00			1	PANEL,REAR:POLYCARBONATE	80009	333-4144-00
8-1-15	671-5567-00			1	CIRCUIT BD ASSY:INPUT BOARD	80009	671-5567-00
8-1-16	174-4740-00			1	CABLE ASSY,RIBBON:DUAL ENDED,ICD,FEMALE, 2 X 10, 0.050 CTR,PLZ,2.00"L	55322	FFSD-10-D-02.00-01-N
8-1-17	671-5566-00			1	CIRCUIT BD ASSY:SDI INTERFACE	80009	671-5566-00
8-1-18	211-0878-00			6	SCREW:4-40 X 0.5 LONG,PAN HD SCREW,TORX DRIVE,BLACK ZINC PLATED,W/LOCKING PATCH	0KB01	211-0878-00
8-1-19	214-4636-00			1	RCPT,TURNLOCK F:USED W/ SNAP-IN STUD	94222	82-35-309-56
8-1-20	200-4201-00			1	BATTERY,DOOR:MTC,POLYCARONATE	80009	200-4201-00
8-1-21	358-0792-00			1	BUSHING,RETAINR:STUD RETAINER,SOUTHCO	94222	82-32-401-41
8-1-22	355-0286-00			1	STUD,TURNLOCK:OVAL HEAD,STL, SOUTHCO	94222	82-11-520-16
8-1-23	346-0279-00			1	STRAP,CARRYING:1.00 X 11.00	80009	346-0279-00
8-1-24	348-1428-00			1	PAD,CUSHIONING:MTL,0.062 THICK PORON	80009	348-1428-00
8-1-25	210-0589-00			2	NUT,SLFLKG,HEX:4-40 X 0.246,STL CD PL	39951	ORDER BY DESC
8-1-26	334-8830-00			1	MARKER,IDENT:BATTERY,0.002 MATTE SILVER	80009	334-8830-00
8-1-27	348-1427-00			1	PAD,CUSHIONING:PAD,CUSHIONING,BATTERY	80009	348-1427-00
8-1-28	202-0339-00			1	CASE,BOTTOM:POLYCARBONATE	80009	202-0339-00
8-1-29	337-4036-00			1	SHIELD,ELEC:0.005 VALOX W/0.005 254 PRESSURE SENSITIVE ADHESIVE ON BACKSIDE,2.050 X 4.650	80009	337-4036-00
8-1-30	214-4627-01			2	SPRING,CONTACT:BATTERY CONTACT,SINGLE	80009	214-4627-01

**Replaceable Parts List for serial numbers B020100 and above (Cont.)**

Fig. & Index Number	Tektronix Part Number	Serial No. Effective	Serial No. Discont'd	Qty	Name & Description	Mfr. Code	Mfr. Part Number
8-1-31	214-4628-01			5	SPRING,CONTACT:BATTERY CONTACT, DUAL	80009	214-4628-01
8-1-32	174-3289-00			1	CA ASSY:DISCRETE,CPD,2,24 AWG,4.3 L, 1X2,0.079 CTR(2MM),PLZ BOTH ENDS,JST TYPE	80009	174-3289-00
8-1-33	671-3043-05			1	CIRCUIT BD ASSY:BOTTOM BOARD,WFM90D	80009	671-3043-05
	671-3263-05			1	CIRCUIT BD ASSY:BOTTOM BOARD,WFM91D	80009	671-3263-05
8-1-34	337-4035-00			1	SHIELD,ECB:ECB SHIELD,ALUM	80009	337-4035-00
8-1-35	671-5588-00		B010199	1	CIRCUIT BD ASSY:TOP BOARD,WFM90D	80009	671-5588-00
	671-5588-01	B020100		1	CIRCUIT BD ASSY:TOP BOARD,WFM90D	80009	671-5588-01
	671-5590-00		B010199	1	CIRCUIT BD ASSY:TOP BOARD,WFM91D	80009	671-5590-00
	671-5590-01	B020100		1	CIRCUIT BD ASSY:TOP BOARD,WFM91D	80009	671-5590-01
8-1-36	119-4788-00			1	KEYPAD:ELASTOMERIC,FRONT PANEL,17 KEY	80009	119-4788-00
8-1-37	174-5067-00	B020100		1	CA ASSY; RIBBON, 10 CONDUCT 4 IN, SPECIAL PINS	10764	174-5067-00
STANDARD ACCESSORIES							
	071-1142-00			1	MANUAL,TECH:USERS,WFM90D AND WFM91D	80009	071-1142-00
8-1-38	119-4538-01			1	POWER SUPPLY:12W,12V 1.0A,UNREGULATED, 120VAC 60HZ	14310	
	016-1330-01			1	CASE,CARRYING:CLEAR VINYL FRONT	80009	016-1330-01
OPTIONAL ACCESSORIES							
	071-1143-00		B010199		MANUAL,TECH:SERVICE,WFM90D AND WFM91D	80009	071-1143-00
	071-1143-01	B020100			MANUAL,TECH:SERVICE,WFM90D AND WFM91D	80009	071-1143-01
8-1-39	146-0107-01			1	BATTERY PACK:NIMH,6 C CELLS IN PLASTIC CASE	ODWW6	146-0107-01
8-1-40	276-0838-00			1	CORE:EMI SUPPRESS,IMPED 298 OHM AT 100MHZ,2-HALVES W/CLAMP, 0.705 X 0.725, 1.28 L	83285	28A2025-010
	386-6787-00			1	FLIP STAND:METAL	80009	386-6787-00
	011-0167-01			1	HOOD:PLASTIC	80009	011-0167-01
	016-1344-00			1	CARRYING CASE:WFM90D OR WFM91D & TSG95	80009	016-1344-00
	119-4540-02			1	POWER SUPPLY; WALL MOUNT;12W,220 VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM CABLE: EURO	14310	D48121000A220CM
	119-4541-02			1	POWER SUPPLY; WALL MOUNT;12W,240VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM,CABLE: UK	14310	F48121000A220CM
	119-4542-02			1	POWER SUPPLY; WALL MOUNT;12W 240VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM CABLE:AUSTR	0GV90	WD377E1000CRA12CN
	119-4539-02			1	POWER SUPPLY; WALL MOUNT;12W, 100VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM CABLE: JAPAN	14310	G48121000A220DM
	119-6904-00			1	POWER SUPPLY; WALL MOUNT;12W,220VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM CABLE: CHINA	99981	A41210H-A1034503-0

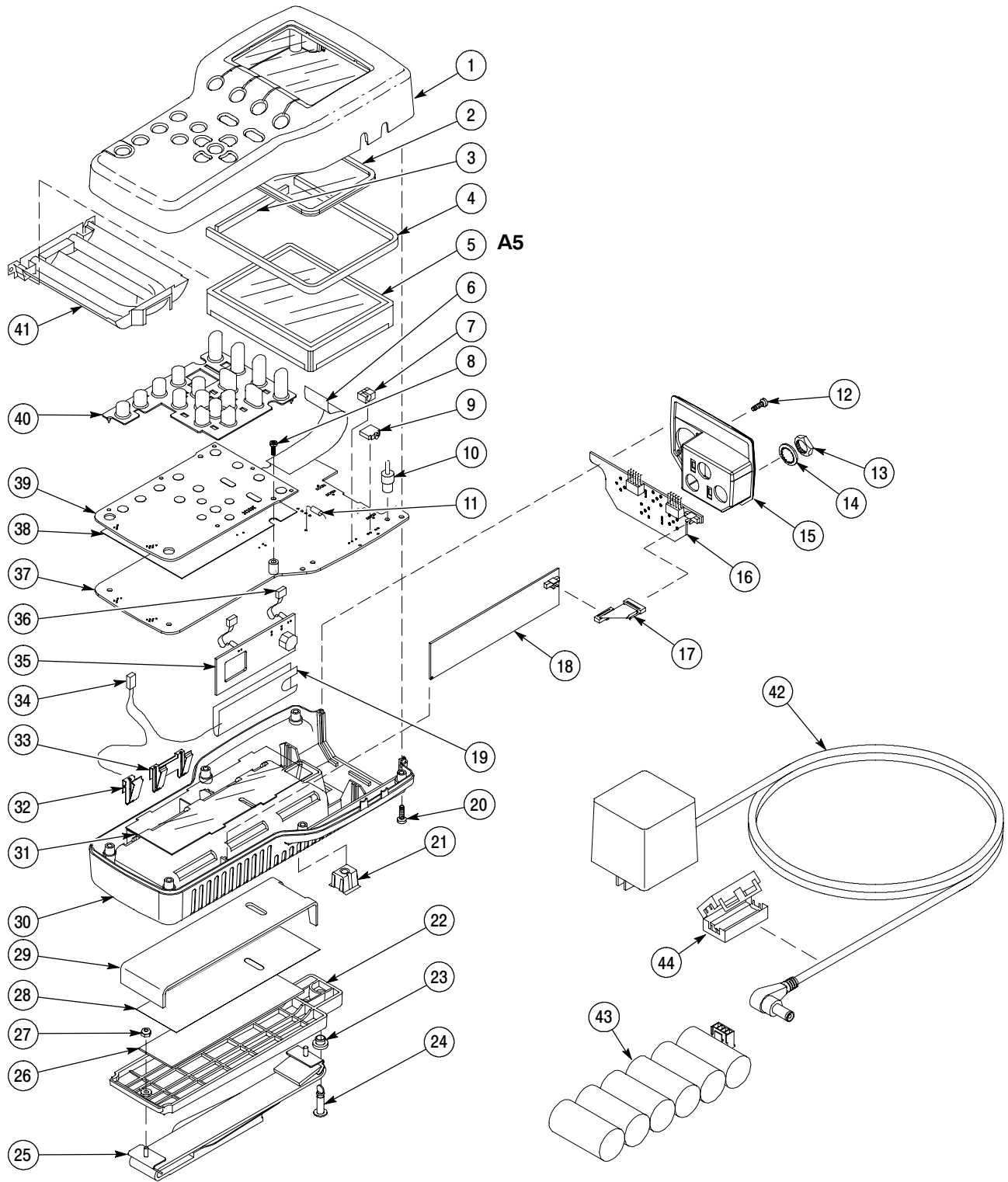


Figure 8-2: Exploded view (serial numbers below B020100)

**Replaceable Parts List for serial numbers below B020100**

Fig. & Index Number	Tektronix Part Number	Serial No. Effective	Serial No. Discont'd	Qty	Name & Description	Mfr. Code	Mfr. Part Number
8-2-1	202-0394-00			1	CASE,TOP:POLYCARBONATE,WFM90D	80009	202-0394-00
	202-0395-00			1	CASE,TOP:POLYCARBONATE,WFM91D	80009	202-0395-00
8-2-2	378-0418-00			1	LENS,DISPLAY:POLYCARBONATE,CLEAR	80009	378-0418-00
8-2-3	348-1436-00			1	PAD,CUSHION:BACKLIGHT	80009	348-1436-00
8-2-4	348-1437-00			1	PAD,CUSHION:LCD	80009	348-1437-00
8-2-5	119-6668-00			1	DISPLAY MODULE:LCD,4 INCH,COLOR,SAFETY CONTROLLED	TK1416	LQ4RA01
8-2-6	174-3287-00			1	CA ASSY,SP:FLAT FLEX,FLX,20,26 AWG,0.050 CTR, 4.0 L,CUT&STRIP X RTANG,PCB,STAGGERED	80009	174-3287-00
8-2-7	131-5148-00			1	JACK,POWER DC:PCB,MALE,RTANG,2.0 MM DIA PIN,7 MM H X 3.3 MM TAIL,3 COND,W/SWITCH	TK2427	ADC-016
8-2-8	211-0294-00			2	SCREW,MACHINE:M3 X 0.5 X 10MM, PNH,STL,CDPL,T-10 TORX DR	0KB01	211-0294-00
8-2-9	131-5798-00			1	CONN,JACK PHONE:PCB,FEMALE,RTANG,3 POS, W/SHUNT,3.5MM ID,0.354 H X 0.137 TAIL,5 TERM	0LXM2	SJ100
8-2-10	348-1722-00			4	FOOT ASSY:LCD 0.400L,0.280 OD	2K262	348-1722-00
8-2-11	159-0378-00			2	FUSE,WIRE LEAD:2.0A,125V,1 SEC MIN - 60 SECTROLLED	75915	R473 002-T1R
8-2-12	213-0774-00			2	SCREW,TPG,TF:M3-0.5 X 10MM L,TORX DRIVE	93907	ORDER BY DESCRIPTION
8-2-13	220-0497-00			3	NUT,PLAIN,HEX:0.5-28 X 0.562 HEX,BRS CD PL	73743	ORDER BY DESCRIPTION
8-2-14	210-1039-00			3	WASHER,LOCK:0.521 ID,INT,0.025 THK,SST	0KB01	1224-02-00-0541C
8-2-15	333-4144-00			1	PANEL,REAR:POLYCARBONATE	80009	333-4144-00
8-2-16	671-5567-00			1	CIRCUIT BD ASSY:INPUT BOARD	80009	671-5567-00
8-2-17	174-4740-00			1	CABLE ASSY,RIBBON:DUEL ENDED,ICD,FEMALE,2 X 10, 0.050 CTR,PLZ,2.00"L	55322	FFSD-10-D-02.00-01-N
8-2-18	671-5566-00			1	CIRCUIT BD ASSY:SDI INTERFACE	80009	671-5566-00
8-2-19	337-4286-00			1	SHEILD:BACKLIGHT ECB	80009	337-4286-00
8-2-20	211-0878-00			6	SCREW:4-40 X 0.5 LONG,PAN HD SCREW,TORX DRIVE,BLACK ZINC PLATED,W/LOCKING PATCH	0KB01	211-0878-00
8-2-21	214-4636-00			1	RCPT,TURNLOCK F:RECEPTACLE USED WITH SOUTHCO SNAP IN STUD	94222	82-35-309-56
8-2-22	200-4201-00			1	BATTERY,DOOR:MTC,POLYCARONATE	80009	200-4201-00
8-2-23	358-0792-00			1	BUSHING,RETAINR:STUD RETAINER,SOUTHCO	94222	82-32-401-41
8-2-24	355-0286-00			1	STUD,TURNLOCK:OVAL HEAD,STL, SOUTHCO	94222	82-11-520-16
8-2-25	346-0279-00			1	STRAP,CARRYING:1.00 X 11.00 CARRY HANDLE	80009	346-0279-00
8-2-26	348-1428-00			1	PAD,CUSHIONING:MTL,0.062 THICK PORON	80009	348-1428-00
8-2-27	210-0589-00			2	NUT,SLFLKG,HEX:4-40 X 0.246,STL CD PL	39951	ORDER BY DESCRIPTION

## Replaceable Parts List for serial numbers below B020100 (Cont.)

Fig. & Index Number	Tektronix Part Number	Serial No. Effective	Serial No. Discont'd	Qty	Name & Description	Mfr. Code	Mfr. Part Number
8-2-28	334-8830-00			1	MARKER,IDENT:BATTERY,0.002 MATTE SILVER	80009	334-8830-00
8-2-29	348-1427-00			1	PAD,CUSHIONING:PAD,CUSHIONING,BATTERY	80009	348-1427-00
8-2-30	202-0339-00			1	CASE,BOTTOM:POLYCARBONATE	80009	202-0339-00
8-2-31	337-4036-00			1	SHIELD,ELEC:0.005 VALOX W/0.005 254 PRESSURE SENSITIVE ADHESIVE ON BACKSIDE,2.050 X 4.650	80009	337-4036-00
8-2-32	214-4627-01			2	SPRING,CONTACT:BATTERY CONTACT,SINGLE	80009	214-4627-01
8-2-33	214-4628-01			5	SPRING,CONTACT:BATTERY CONTACT, DUAL	80009	214-4628-01
8-2-34	174-3289-00			1	CA ASSY,SP:DISCRETE,CPD,2,24 AWG,4.3 L, 1X2,0.079(2MM),PLZ BOTH ENDS,JST TYPE	80009	174-3289-00
8-2-35	671-3045-03			1	CIRCUIT BD ASSY:BACKLIGHT	80009	671-3045-03
8-2-36	174-3288-02			2	CA ASSY,SP:DISCRETE,CPD,2,24 AWG,300V,2.3 L, 1X2,0.079(2MM),RCPT X 1X4,0.079(2MM),RC	80009	174-3288-02
8-2-37	671-3043-05			1	CIRCUIT BD ASSY:BOTTOM BOARD,WFM90D	80009	671-3043-052-
	671-3263-05			1	CIRCUIT BD ASSY:BOTTOM BOARD,WFM91D	80009	671-3263-05
8-2-38	337-4035-00			1	SHIELD,ECB:ECB SHIELD,ALUM	80009	337-4035-00
8-2-39	671-5588-00			1	CIRCUIT BD ASSY:TOP BOARD,WFM90D	80009	671-5588-00
	671-5590-00			1	CIRCUIT BD ASSY:TOP BOARD,WFM91D	80009	671-5590-00
8-2-40	119-4788-00			1	KEYPAD:ELASTOMERIC,FRONT PANEL,17 KEY	80009	119-4788-00
8-2-41	150-0215-00			1	LAMP:BACKLIGHT,FLUORESCENT	TK1416	LQ0B01
					STANDARD ACCESSORIES		
	071-1142-00			1	MANUAL,TECH:USERS,WFM90D AND WFM91D	80009	071-1142-00
8-2-42	119-4538-01			1	POWER SUPPLY; WALL MOUNT;12W,120VAC 60HZ IN,12VDC 1.0A OUT,UNREG,183CM CABLE: USA	14310	
	016-1330-01			1	CASE,CARRYING:CLEAR VINYL FRONT	80009	016-1330-01
					OPTIONAL ACCESSORIES		
	071-1143-00				MANUAL,TECH:SERVICE,WFM90D AND WFM91D	80009	071-1143-00
8-2-43	146-0107-01			1	BATTERY PACK:NIMH,6 C CELLS IN PLASTIC CASE	ODWW6	146-0107-01
8-2-44	276-0838-00			1	CORE:EMI SUPPRESS,IMPED 298 OHM AT 100MHZ,2-HALVES W/CLAMP, 0.705 X 0.725, 1.28 L	83285	28A2025-010
	386-6787-00			1	FLIP STAND:METAL	80009	386-6787-00
	011-0167-01			1	HOOD:PLASTIC	80009	011-0167-01
	016-1344-00			1	CARRYING CASE:WFM90D OR WFM91D & TSG95	80009	016-1344-00
	119-4540-02			1	POWER SUPPLY; WALL MOUNT;12W,220 VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM CABLE: EURO	14310	D48121000A220CM

**Replaceable Parts List for serial numbers below B020100 (Cont.)**

<b>Fig. &amp; Index Number</b>	<b>Tektronix Part Number</b>	<b>Serial No. Effective</b>	<b>Serial No. Discont'd</b>	<b>Qty</b>	<b>Name &amp; Description</b>	<b>Mfr. Code</b>	<b>Mfr. Part Number</b>
	119-4541-02			1	POWER SUPPLY; WALL MOUNT;12W,240VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM,CABLE: UK	14310	F48121000A220CM
	119-4542-02			1	POWER SUPPLY; WALL MOUNT;12W 240VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM CABLE:AUSTR	0GV90	WD377E1000CRA12CN
	119-4539-02			1	POWER SUPPLY; WALL MOUNT;12W, 100VAC 50HZ IN,12VDC 1.0A OUT,UNREG,183CM CABLE: JAPAN	14310	G48121000A220DM



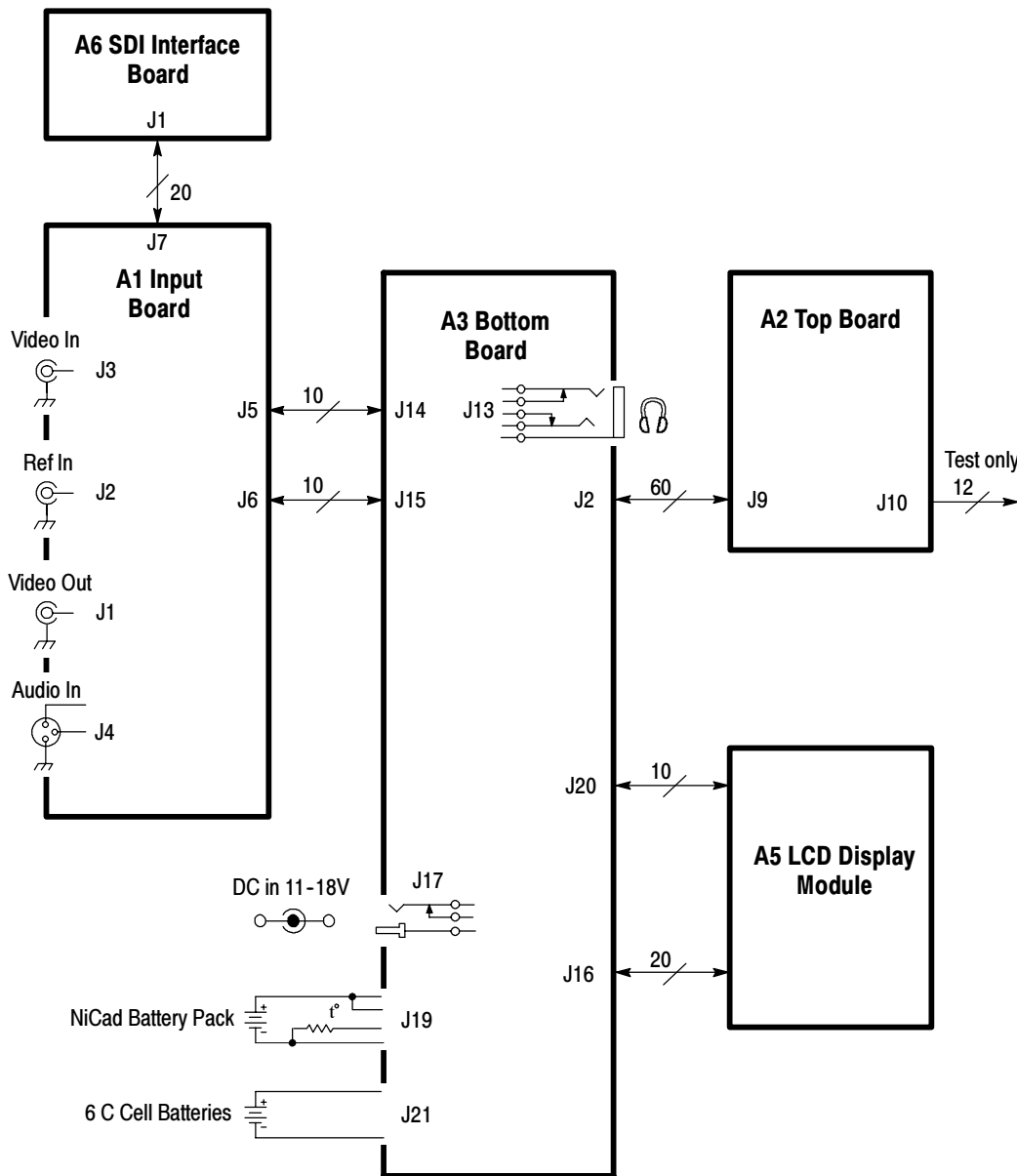


# Diagrams



# Diagrams

The interconnect diagram, Figure 9-1, shows the jumpers and connectors for the WFM90D and WFM91D Handheld Waveform, Vector, Picture, and Audio Monitor. (Figure 9-2 shows the interconnect diagram for instruments with serial numbers below B020100.)



**Figure 9-1: Interconnect diagram for instruments with serial numbers B020100 and above**

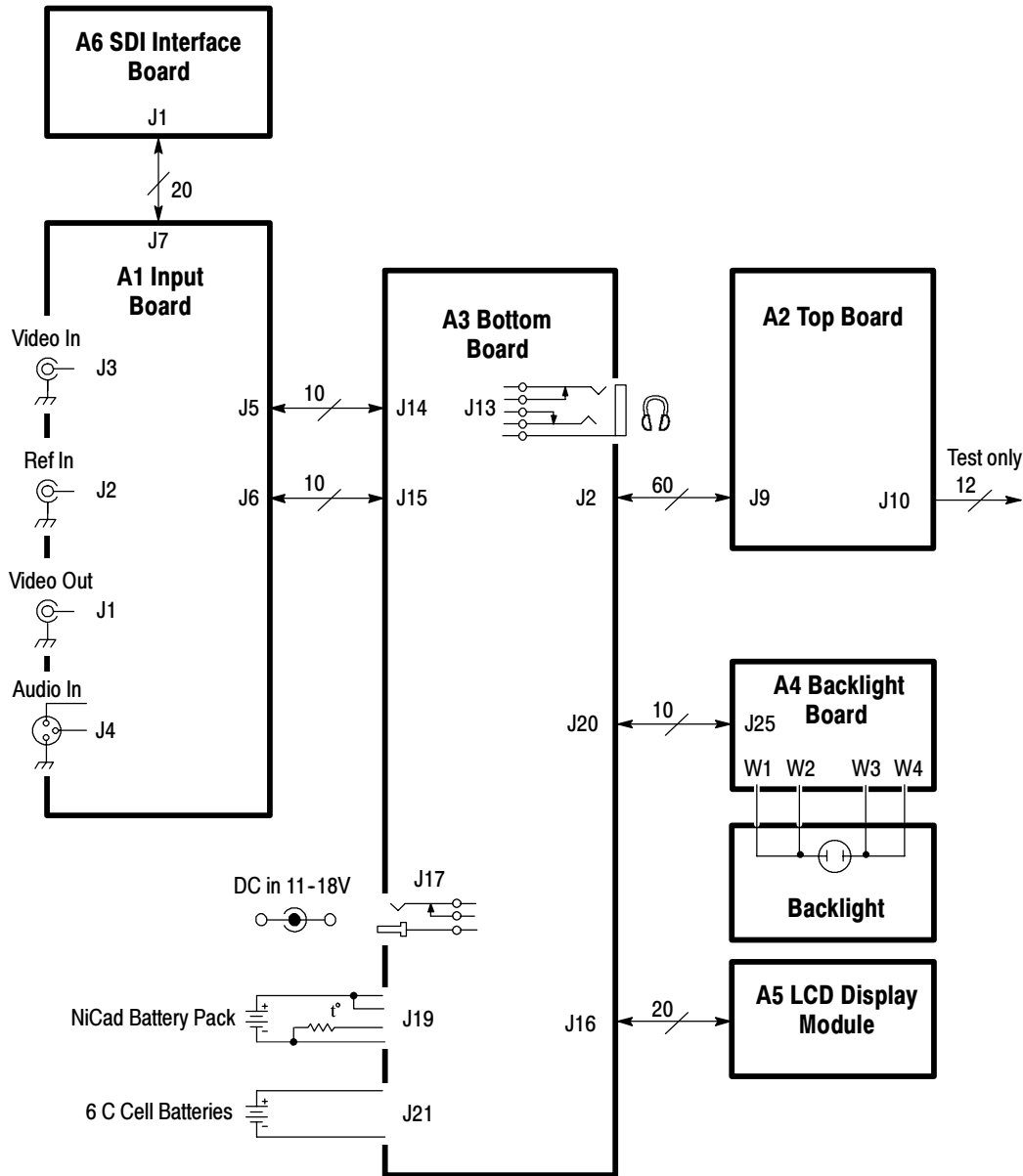


Figure 9-2: Interconnect diagram for instruments with serial numbers below B020100

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