TEK
070-6603-00
Product Group 37

2440
OSCILLOSCOPE
SERVICE

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

Please Check for CHANGE INFORMATION at the Rear of This Manual

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Instrument Serial Numbers

Each instrument has a serial number on a panel insert, tag, or stamped on the chassis. The first number or letter designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B000000 Tektronix, Inc., Beaverton, Oregon, USA
100000 Tektronix Guernsey, Ltd., Channel Islands
200000 Tektronix United Kingdom, Ltd., London
300000 Sony/Tektronix, Japan
700000 Tektronix Holland, NV, Heerenveen,The Netherlands

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.

Terms in This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

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

Terms as Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property, including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols in This Manual

This symbol indicates where applicable cautionary or other information is to be found. For maximum input voltage see Table 1-1.

Symbols as Marked on Equipment

DANGER — High voltage.

Protective gound (earth) terminal.

ATTENTION — Refer to manual.

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before making any connections to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising from Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulated) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for the instrument.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the instrument parts list. A replacement fuse must meet the type, voltage rating, and current rating specifications for the fuse that it replaces.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this instrument in an atmosphere of explosive gasses.

Do Not Remove Covers or Panels

To avoid personal injury, the instrument covers or panels should only be removed by qualified service personnel. Do not operate the instrument without covers and panels properly installed.

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

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

Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections or components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

Power Source

This product is intended to operate from a power source that does not apply more than 250 volts rms bwetween the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding connector in the power cord is essential for safe operation.

SPECIFICATION

INTRODUCTION

The TEKTRONIX 2440 Digital Oscilloscope is a portable, dual-channel instrument with a maximum digitizing rate of 500 Megasamples per second. The scope is capable of simultaneous acquisition of Channel 1 and Channel 2 input signals. It has a real-time useful storage bandwidth of 200 MHz for single-event acquisitions, with an equivalent-time bandwidth of 300 MHz when repetitive acquisitions are acquired. Since both channels are acquired simultaneously, the XY display is available to full bandwidth. Options include a Word Recognition Probe, Video signal triggering, Probe Power, and Rackmounting.

The instrument is microprocessor controlled and menu driven, displaying at the top of the screen alphanumeric CRT readouts of the vertical and horizontal scale factors, trigger levels, trigger source, and cursor measurements. Menus, displayed at the bottom of the CRT display, are used by the operator to select the operating mode.

A user makes decisions as to what operation and mode setup the instrument must have to make the measurement wanted and then selects the proper functions using a combination of front-panel buttons and the displayed menu.

Five menu buttons mounted on the CRT bezel are used to make selections from the entry choices displayed. The top line of the menu display usually contains the menu title, and the bottom line labels the buttons with the control functions they select. The selection is made (indicated by an underscoring of the menu label in the display) when the bezel button below the selected function is pressed. The menus, system operating modes, and auxiliary functions are described in Section 5, "Controls, Connectors, and Indicators" of the Operators manual included with this instrument, and the "Getting Acquainted" procedure in Section 1 of that manual familiarizes the user with menu operation.

VERTICAL SYSTEM

The two vertical channels have calibrated deflection factors from 2 mV to 5 V per division in a 1-2-5 sequence of 14 steps. Use of coded probes having attenuation factors of 1X, 10X, 100X, and 1000X extends the minimum sensitivity to 5,000 V per division (with the 1000X probe) and the maximum sensitivity to 200 μV per division (using a 1X probe in SAVE or AVERAGE expanded mode).

VOLTS/DIV readouts are automatically switched to display a correct scale factor when properly coded probes are attached. Each channel can be separately inverted. ADD and MULT are display functions provided by the processor system.

In SAVE mode, the waveforms may be both horizontally and vertically repositioned, expanded horizontally and vertically, added to each other, or multiplied together for either XY or YT displays.

HORIZONTAL SYSTEM

Horizontal display modes of A, A INTEN, and B Delayed are available. The time base has 29 calibrated SEC/DIV settings in a 1-2-5 sequence from 2 ns per division to 5 s per division. An External Clock mode is provided that accepts clocking signals from 1 MHz to 100 MHz.

The B Trace and the intensified zone on the A INTEN Trace may be delayed by time with respect to the A trigger, and a DELAY by EVENTS function permits the A display to be delayed by a selected number of B Trigger events. In the case of DELAY by EVENTS, the B Trigger SOURCE, COUPLING, SLOPE, and LEVEL controls define the nature of the signal needed to produce events triggering. The number of events required to satisfy the

delay may be set from 1 to 65,536, with a resolution of one event. The DELTA DELAY feature produces two independently settable delayed B Traces in DELAY by TIME.

TRIGGER SYSTEM

The trigger system of the scope provides many features for selecting and processing a signal used in triggering the acquisition system. The conventional features of SOURCE selection, Trigger LEVEL control, Trigger SLOPE, Trigger MODE, and CPLG (coupling) include enhancements not normally found in a conventional oscilloscope.

The choices of VERT, CH1 or CH2, EXT1 or EXT2, LINE, and A*B or WORD (16-bit data word recognition) are available as SOURCE selections for triggering A Horizontal Mode acquisitions. These sources for trigger signals provide a wide range of applications involving specialized triggering requirements. Except for A*B (A AND B) and LINE (power-source frequency), the same Trigger SOURCE selections are available for triggering B acquisitions. The selected trigger signal is conditioned by the choice of input CPLG (coupling). These coupling selections are AC, DC, HF REF, LF REJ, and NOISE REJ. LEVEL control provides a settable amplitude (with CRT readout) at which triggering will occur, and SLOPE control determines on which slope of the triggering signal (plus or minus) the acquisition is triggered.

Trigger MODE choices are AUTO LEVEL, AUTO, NORM, and SINGLE SEQ (single sequence), for the A and A INTENSIFIED Modes, and Triggerable After Delay and Runs After Delay, for the B Mode. AUTO LEVEL provides for automatic leveling on the applied trigger signal. AUTO MODE produces an auto trigger in the event a trigger signal is either not received or not within the limits needed to produce a triggering event. When triggering conditions are met, a normal triggered display results. At SEC/DIV settings of 100 ms per division and longer, the AUTO MODE switches to ROLL. In ROLL MODE, the display is continually updated and trigger signals are disregarded.

NORM (normal) trigger MODE requires that all triggering requirements are met before an acquisition will take place. SINGLE SEQ (single sequence) MODE is a variation of the conventional single-shot displays found on many previous oscilloscopes. In SINGLE SEQ, a single complete acquisition is done on all called-up VERTICAL MODES. Since an acquisition depends on the acquisition mode in effect, many of the scope operating features are altered in SINGLE SEQ. A complete description of this mode is discussed in "Controls, Connectors, and Indicators" in Section 5 of the Operators manual.

The user has a choice of trigger points within the acquired waveform record by selecting the amount of pre-trigger data displayed. The trigger location in the record is selectable from a choice of five pretrigger lengths beginning at one-eighth of the record length and increasing to seven-eighths of the record length. A record trigger position is independently selectable for both A and B acquisitions. Additional trigger positions in the record are selectable via the GPIB interface commands.

CURSOR MEASUREMENTS

Time and Voltage cursors are provided for making parametric measurements on the displayed waveforms. Time may be measured either between the cursor positions (DELTA TIME) or between a selected cursor and the trigger point of an acquired waveform (ABSOLUTE). Time cursor readouts are scaled in seconds, degrees, or percentage values. The 1/TIME cursors may be scaled in hertz (Hz), degrees, or percentage.

Voltage cursor measurements on a waveform display can be selected to read either the voltage difference between the cursor positions or the absolute voltage position of a selected cursor with respect to ground. The volts measurement readouts may be scaled in units of volts, decibels (dB), or percent. The Voltage cursors and Time cursors may also be coupled to track together (V@T and SLOPE) and assigned to a particular waveform for ease in making peak-to-peak and slope waveform measurements. The units for V@T may be volts, percent, or dB; SLOPE may have units of slope (VOLTS/SEC), percent (VOLTS/VOLT), or dB.

WAVEFORM ACQUISITION

Waveforms may be acquired in NORMAL, ENVELOPE, or AVG (Average) acquisition modes; the mode chosen depends on the measurement requirements. NORMAL mode continuously acquires and displays successive acquisitions producing a "live" waveform display similar to that seen with an analog oscilloscope. AVG (averaging) mode averages successive acquisitions of a waveform resulting in an improved signal-to-noise ratio of the displayed waveform. Low-amplitude signals masked by noise become easily visible for making measurements and analysis by averaging from 2 to 256 acquisitions for removing uncorrelated noise. ENVELOPE mode saves the

maximum and minimum data-point values over a selected number of acquisitions from 1 to 256 plus CONT (continuous). The display presents a visual image of the amount of change (envelope) that occurs to a waveshape during the accumulated acquisitions. Frequency, phase, amplitude, and position changes are easily identified when acquiring in ENVELOPE mode. The glitch-catching capability of ENVELOPE mode can capture single-event pulses as narrow as 2 ns at the slowest SEC/DIV setting of 5 seconds per division.

For all three acquisition modes, equivalent-time sampling extends the Useful Storage Bandwidth to 300 MHz if the signal is repetitive and REPET mode is turned on. At 50 ns/DIV and faster, randomly-acquired data points (or samples) taken from successive acquisitions of a periodic signal are used to fill the complete record (1024 data points) of the signal waveform display. Depending on the SEC/DIV setting, as few as 10 data points (at 2 ns/DIV) or as many as 512 data points (at 50 ns/DIV) may be obtained on each triggered acquisition. Sampling of successive acquisitions continues until a predetermined number of data points are acquired and any remaining points in the record are determined by interpolating between the acquired points. (The predetermined number includes at least enough data point to meet the Useful Storage Bandwidth of 300 MHz specified for REPET mode.) These interpolated points are replaced by randomly-acquired data points as they become available from successive acquisitions.

Horizontally, the record length of acquired waveforms is 1024 data points (512 max/min pairs in ENVELOPE mode), of which 500 make up a one-screen display (50 data points per division for 10 divisions). The entire record may be viewed by using the Horizontal POSITION control to position any portion of the record within the viewing area.

STORAGE AND I/O

Acquired waveforms may be saved in any of four REF waveform nonvolatile memories. Any or all of the saved reference waveforms may be displayed for comparison with the waveforms being currently acquired. The source and destination of waveforms to be saved may be user designated. Assignment can be made to save either channel 1 or channel 2 (or the results of an addition or multiplication of the two channels) to any REF memory or to move a stored reference from one REF memory to another. Reference waveforms may also be written into a REF memory location via the GPIB interface.

The scope is fully controllable and capable of sending and receiving waveforms via the standard equipped GPIB interface. This feature makes the instrument ideal for making automated measurements in a production or research and development environment that calls for repetitive data taking. Self- calibration and self-diagnostic features built into the scope to aid in fault detection and servicing are also accessible via commands sent from the GPIB controller.

Another standard feature is the "DEVICES" setting for GPIB Interface control. This feature allows the user to output waveforms (and other on-screen information) from the front panel to many printers and plotters that use HP® Graphics Language. In this way, hard copies of acquired waveforms can be obtained without putting the scope into a system controller environment

EXTENDED FEATURES

There are several other features incorporated into this instrument designed to make it more usable, namely, the HELP, Auto Setup, MEASURE, and AutoStep Sequencer features.

HELP: The HELP function can be used to display operational information about any front-panel control. When HELP mode is in effect, manipulating almost any front-panel control causes the scope to display information about that control. When HELP is first invoked, an introduction to HELP is displayed on screen.

Auto Setup: The Auto Setup function is used to automatically setup the scope for a viewable display based on the input signal. The user can specify the waveform characteristic the display is optimized for (front-edge, period, etc.) from a menu displayed upon executing Auto Setup.

MEASURE: MEASURE automatically extracts parameters from signal input to the scope. In the "SNAPSHOT" mode, 20 different waveform parameters are extracted and displayed for a single acquisition. In the continuous extraction mode, up to four parameters are extracted continuously as the instrument continues to acquire.

AutoStep Sequencer (PRGM): With AutoStep, the user can save single front-panel setups or sequences of setups and associated flow control and Input/Output actions for later recall. If MEASURE and/or OUTPUT are saved as part of these setups they can be used for automatic parameter extraction and data printout. 100 to 800 front-panel setups (depending on complexity) can be stored in one or more sequences.

The complete descriptions of these four features are found in Section 5 of the Operators manual included with this instrument.

The following items are standard accessories shipped with the scope instrument:

2	Probe packages
1	Snap-lock accessories pouch
1	Zip-lock accessories pouch
1	Operators manual
1	Programmer's Reference Guide
2	Users Reference Guide
1	Fuse
1	Power cord (installed)
1	Blue plastic CRT filter (installed)
1	Clear plastic CRT filter
1	Front-panel cover

For part numbers and further information about standard accessories and a list of the optional accessories, refer to "Options and Accessories" (Section 7) in this manual. For additional information on accessories and ordering assistance, contact your Tektronix representative or local Tektronix Field Office.

PERFORMANCE CONDITIONS

The following electrical characteristics (Table 1-1) apply when the scope has been calibrated at an ambient temperature between +20°C and +30°C, has had a warmup period of at least 20 minutes and is operating at an ambient temperature between −15°C and +55°C (unless otherwise noted).

Items listed in the "Performance Requirements" column are verifiable qualitative or quantitative limits that define the measurement capabilities of the instrument.

Environmental characteristics are given in Table 1-2. The scope meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style D equipment, with the humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4. The rackmounted scope meets the vibration and shock requirements of MIL-T-28800C for Type III, Class 5, Style D equipment when mounted using the rackmount rear-support kit supplied with both the 1R Option and the Rackmount Conversion kit.

Mechanical characteristics of the scope are listed in Table 1-3.

Video Option characteristics are given in Table 1-4.

RECOMMENDED ADJUSTMENTS SCHEDULE

For optimum performance to specification, the internal SELF CAL should be done:

1. If the operating temperature is changed by more that 5°C since the last SELF CAL was performed.

2. Immediately before making measurements requiring the highest degree of accuracy.

Table 1-1
Electrical Characteristics

Characteristics	Performance Requirements
ACQUISITION SYSTEM—CHANNEL 1 AND CHANNEL 2	
Resolution	8 bits.[a] Displayed vertically with 25 digitization levels (DL)[b] per division.
Dynamic Range[a]	
SEC/DIV	
100 or slower	−128 to +127 DL's.
50 to 500 ns	−124 to +123 DL's.
200 ns	−121 to +120 DL's.
100 ns	−113 to +112 DL's.
50 ns to 2 ns	
Repet OFF	−113 to +112 DL's.
Repet ON	121 to 120 DL's.
Record Length	1024 samples.[a] Displayed horizontally with 50 samples per division, 20.48-division trace length.[a]
Sample Rate	10 samples per second to 500 megasamples per second (5 s per division to 100 ns per division).
Sensitivity	
Range	80 μV per DL to 0.2 V per DL in a 1-2-5 sequence of 11 steps (2 mV per division to 5 V per division).
Accuracy	
Normal and Average Modes	Within ±(2% + 1 DL) at any VOLTS/DIV setting for a signal 1 kHz or less contained within ±75 DL (±3 divisions) of center when a SELF CAL has been performed within ±15°C of the operating temperature. Measured on a four- or five-division signal with VOLTS or V@T cursors; UNITS set to delta volts.
Envelope Mode	Add 1% to Normal Mode specifications.
Variable Range	Continuously variable between VOLTS/DIV settings. Extends sensitivity to 0.5 V per DL or greater, 12.5 V per division or greater.

[a]Performance Requirement not checked in the manual.

[b]"DL" is the abbreviation for "digitization level." A DL is the smallest voltage level change that can be resolved by the internal 8-bit A-D converter, with the input scaled to the VOLTS/DIV setting of the channel used. Expressed as a voltage, a DL is equal to 1/25 of a division times the VOLTS/DIV setting.

Table 1-1 (cont)

Characteristics	Performance Requirements
ACQUISITION SYSTEM—CHANNEL 1 AND CHANNEL 2 (cont)	
Bandwidth	Bandwidth is measured with a leveled, low distortion, 50-Ω source, sine-wave generator, terminated in 50 Ω. The reference signal is set to 6 divisions or to the maximum leveled amplitude obtainable if the Volt/Div setting is too high to yield 6 div's on screen. Bandwidth with probe is checked using a probe-tip-to-GR termination adaptor (017-0520-00). Bandwidth with external termination is checked using a BNC 50-Ω feed-through terminator (011-0049-01).
−3 dB Bandwidth	
Normal or Average Modes. Envelope Mode at SEC/DIV settings of 0.2 μs or faster.	Using standard accessory probe or internal termination (not checked with probe in manual).
−15°C to +30°C	Dc to 300 MHz.
+30°C to +55°C	Upper Bandwidth Limit reduced by 2.5 MHz for each °C above 30°C.[a]
Envelope Mode at SEC/DIV settings of 0.5 μs or slower.	Dc to 150 MHz using standard accessory probe, internal 50-Ω termination, or external 50-Ω termination on 1-MΩ input.[a]
−4.7 dB Bandwidth	
Normal or Average Mode. Envelope Mode at SEC/DIV settings of 0.2 μs or faster.	Using 50-Ω external termination on 1-MΩ input.
+30°C to +55°C	Upper Bandwidth Limit reduced by 2.5 MHz for each °C above 30°C.[a]
Single Event Useful Storage Bandwidth	
Normal or Average Mode, SEC/DIV at 0.1 μs or Faster; Repet OFF	DC to 200 MHz (calculated). $USB = \frac{F_{(\text{sample freq max})^c}}{2.5}$
AC Coupled Lower −3 dB Point	
1X Probe	10 Hz or less.[a]
10X Probe	1 Hz or less.[a]
Step Response, Repet and Average On; Average Set to 16	
Rise Time	1.17 ns or less (calculated).[a] $T_r \text{ (in ns)} = \frac{350}{\text{BW (in MHz)}}$

[a]Performance Requirement not checked in the manual.

[c]Sample freq. max. is 500 MHz.

Table 1-1 (cont)

Characteristics	Performance Requirements
ACQUISITION SYSTEM—CHANNEL 1 AND CHANNEL 2 (cont)	
Envelope Mode Pulse Response	
Minimum Single Pulse Width for 50% or Greater Amplitude Capture at 85% or Greater Confidence	2 ns.[a]
Minimum Single Pulse Width for Guaranteed 50% or Greater Amplitude Capture	8 ns.[a]
Channel Isolation	Measured with a 10-division, sine-wave input and equal VOLT/DIV settings on both channels. 100:1 or greater at 100 MHz for VOLT/DIV settings from 2 mV/DIV and 500 mV/DIV; 50:1 or greater at 300 MHz for VOLT/DIV settings from 20 mV/DIV to 500 mV/DIV. 25:1 or greater at 300 MHz for VOLT/DIV settings of 5 mV/DIV and 10 mV/DIV.
Acquired Channel 2 Signal Delay with Respect to Channel 1 Signal at Full Bandwidth	±250 ps.[a]
Input R and C (1 MΩ)	
Resistance	1 MΩ ±0.5%.[a] In each attenuator, the input resistance of all VOLTS/DIV positions is matched to within 0.5%.[a]
Capacitance	15 pF ±2 pF.[a] In each attenuator, the input capacitance of all VOLTS/DIV positions is matched to within 0.5 pF.[a]
Input R (50 Ω)	
Resistance	50 Ω ±1%.[a]
VSWR (DC to 300 MHz)	1.3:1 or better.[a]
Maximum Input Voltage ⚠	5 V rms; 0.5 W·sec for any one-second interval for instantaneous voltages from 5 V to 50 V.

[a]Performance Requirement not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements
ACQUISITION SYSTEM—CHANNEL 1 AND CHANNEL 2 (cont)	
Maximum Input Voltages ⚠	
Input Coupling Set to DC, AC, or GND	400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.[a]
Common-Mode Rejection Ratio (CMRR); ADD Mode with Either Channel Inverted	At least 10:1 at 50 MHz for common-mode signals of 10 divisions or less with VARIABLE VOLTS/DIV adjusted for best CMRR at 50 kHz.
POSITION	
Range	± (9.3 to 10.4) div., at 50 mV per division with INVERT off, when Self Cal has been done within ±5°C of the operating temperature.
Gain Match between NORMAL and SAVE	±3 DLs for positions within ±5 divisions from center.
Low-Frequency Linearity	
Normal or Average Mode	3 DLs or less compression or expansion of a two-division, center-screen signal when positioned anywhere within the acquisition window.
20-MHz Bandwidth Limiter	
—3 dB Bandwidth	13 MHz to 24 MHz.
100-MHz Bandwidth Limiter	
—3 dB Bandwidth	80 MHz to 120 MHz.
Rise Time	2.9 ns to 4.4 ns.[a]
	With a five-division, fast-rise step (rise time of 300 ps or less) using 50-Ω dc input coupling and VOLTS/DIV setting of 10 mV.[a]

[a]Performance Requirement not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements
TRIGGERING—A and B	
Minimum P-P Signal Amplitude for Stable[a] Triggering from Channel 1, Channel 2, or ADD Source	
A Trigger	
DC Coupled	0.35 division from DC to 50 MHz, increasing to 1.0 division at 300 MHz; 1.5 divisions at 300 MHz in ADD mode.
NOISE REJ Coupled	1.2 divisions or less from DC to 50 MHz; increasing to 3 divisions at 300 MHz; 4.5 divisions at 300 MHz in ADD mode.
AC Coupled	0.35 division from 60 Hz to 50 MHz; increasing to 1.0 division at 300 MHz; 1.5 divisions at 300 MHz in ADD mode. Attenuates signals below 60 Hz.
HF REJ Coupled	0.50 division from DC to 30 kHz. Attenuates signals above 30 kHz.
LF REJ Coupled	0.50 division from 80 kHz to 50 MHz; increasing to 1.0 division at 300 MHz; 1.5 divisions at 300 MHz in ADD mode. Attenuates signal below 80 kHz.
B Trigger	Multiply all A Trigger specifications by two.
A.B Selected	Multiply all A Trigger specifications by two.
Minimum P-P Signal Amplitude for Stable Triggering[a] from EXT TRIG 1 or EXT TRIG 2 Source	
A Trigger	
EXT Gain = 1	
DC Coupled	17.5 mV from DC to 50 MHz, increasing to 50 mV at 300 MHz.
NOISE REJ Coupled	60 mV or less from DC to 50 MHz; increasing to 150 mV at 300 MHz.
AC Coupled	17.5 mV from 60 Hz to 50 MHz; increasing to 50 mV at 300 MHz. Attenuates signals below 60 Hz.
HF REJ Coupled	25 mV from DC to 30 kHz.
LF REJ Coupled	25 mV from 80 kHz to 50 MHz; increasing to 50 mV at 300 MHz.
EXT Gain = ÷5	Amplitudes are five times those specified for Ext Gain = 1.
B Trigger	Multiply all A Trigger amplitude specifications by two.
A.B Selected	Multiply all A Trigger amplitude specifications by two.

[a]A stable trigger is one that results in a uniform, regular display triggered on the selected slope (±). A stably-triggered display should NOT have the trigger point switch between opposite slopes on the waveform, nor should it "roll" across the screen, as successive acquisitions occur. At TIME/DIV settings of 2 ms/DIV and faster, the TRIG'D LED is constantly lit if the display is stably triggered (the LED can flash for SEC/DIV settings of 10 ms/DIV and slower).

Table 1-1 (cont)

Characteristics	Performance Requirements
TRIGGERING—A and B (cont)	
Maximum P-P Signal Rejected by NOISE REJ Coupling Signals within the Vertical Bandwidth	
Channel 1 or Channel 2 Source	0.4 division or greater for VOLTS/DIV settings of 10 mV and higher. Maximum noise rejected is reduced at 2 mV per division and 5 mV per division.
EXT TRIG 1 or EXT TRIG 2 Source	20 mV or greater when Ext Trig Gain = 1. 100 mV or greater when Ext Trig Gain = ÷5.
EXT TRIG 1 and EXT TRIG 2 Inputs	
Resistance	1 MΩ ±1%.[a]
Capacitance	15 pF ±3 pF.[a]
Maximum Input Voltage ⚠	400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.[a]
LEVEL Control Range	
Channel 1 or Channel 2 Source	±18 divisions × VOLTS/DIV setting.[a]
EXT TRIG 1 or EXT TRIG 2 Source	
EXT GAIN = 1	±0.9 volt.[a]
EXT GAIN = ÷5	±4.5 volts.[a]
LEVEL Readout Accuracy (for triggering signals with transition times greater than 20 ns)	
Channel 1 or Channel 2 Source	
DC Coupled	
+15°C to +35°C	Within ± [3% of setting + 3% of p-p signal + (0.2 division × VOLTS/DIV setting) + 0.5 mV + (0.5 mV × probe attenuation factor)].
−15°C to +55°C (excluding +15°C to +35°C)	Add (1.5 mV × probe attenuation) to +15°C to +35°C specification.[a]
NOISE REJ Coupled	Add ± (0.6 division × VOLTS/DIV setting) to DC Coupled specifications. Checked at 50 mV per division.

[a]Performance Requirement not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements		
TRIGGERING—A and B (cont)			
LEVEL Readout Accuracy (for triggering signals with transition times greater than 20 ns)			
(continued)			
EXT TRIG 1 or EXT TRIG 2 Source			
EXT GAIN = 1			
DC Coupled	Within ± [3% of setting + 4% of p-p signal + 10 mV + (0.5 mV × probe attenuation factor)].		
NOISE REJ Coupled	Add ±30 mV to DC Coupled specifications.		
EXT GAIN = ÷5			
DC Coupled	Within ± [3% of setting + 4% of p-p signal + 50 mv + (0.5 mV × probe attenuation factor)].		
NOISE REJ Coupled	Add ±150 mV to DC Coupled specifications.		
Variable A Trigger Holdoff	**A SEC/DIV[a]**	**MIN HO[a]**	**MAX HO[a]**
	2 ns 5 ns 10 ns 20 ns 50 ns 100 ns 200 ns	2-4 μs	9-15 μs

[a]Performance Requirement not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements		
TRIGGERING—A and B (cont)			
Variable A Trigger Holdoff	**A SEC/DIV[a]**	**MIN HO[a]**	**MAX HO[a]**
	500 ns	5-10 μs	
	1 μs 2 μs 5 μs	10-20 μs 20-40 μs 50-100 μs	100-150 μs
	10 μs 20 μs 50 μs	0.1-0.2 ms 0.2-0.4 ms 0.5-1.0 ms	1-1.5 ms
	100 μs 200 μs 500 μs	1-2 ms 2-4 ms 5-10 ms	10-15 ms
	1 ms 2 ms 5 ms	10-20 ms 20-40 ms 50-100 ms	90-150 ms
	10 ms 20 ms 50 ms	0.1-0.2 s 0.2-0.4 s 0.5-1.0 s	0.9-1.5 s
	100 ms 200 ms	1-2 s 2-4 s	9-15 s
	500 ms 1 s 2 s 5 s	5-10 s	
SLOPE Selection	Conforms to trigger-source and ac-power-source waveforms.		
Trigger Position Jitter (P-P)	Checked in NORMAL ACQUIRE mode with a 5-division step having less than or equal to 1 ns rise time.		
A Mode, B Mode (TRIG AFTER)			
SEC/DIV 100 ns and slower	0.04 x SEC/DIV setting[a,b]		
SEC/DIV 50 ns and faster	(0.04 x SEC/DIV setting) + 200 ps[a,b]		
B Mode (RUNS AFTER)			
SEC/DIV 50 ns and faster	(0.04 x B SEC/DIV + 200 ps[a]		
SEC/DIV 50 μs to 100 ns	0.04 x B SEC/DIV[a]		
SEC/DIV 100 μs and slower	0.08 x B SEC/DIV[a]		

[a]Performance Requirements not checked in the manual.

[b]Use B SEC/DIV setting if mode is B; otherwise, use A SEC/DIV setting.

Table 1-1 (cont)

Characteristics	Performance Requirements
TIME BASE	
Sample Rate Accuracy Average Over 100 or More Samples	±0.0015%.[a]
External Clock Repetition Rate Minimum	1 MHz.[a]
Maximum	100 MHz.[a]
Events Count	1 to 65,536[a]
Events Maximum Repetition Rate	100 MHz.[a]
Signal Levels Required for EXT Clock or EVENTS Channel 1 or Channel 2 SOURCE DC Coupled	0.7 division from DC to 50 MHz; increasing to 2.0 divisions at 100 MHz; 3.0 divisions at 100 MHz in ADD mode.[a]
NOISE REJ Coupled	2.4 divisions or less from DC to 50 MHz; increasing to 6.0 divisions at 100 MHz; 9.0 divisions at 100 MHz in ADD mode.[a]
AC Coupled	0.7 division from 60 Hz to 50 MHz; increasing to 2.0 divisions at 100 MHz; 3.0 divisions at 100 MHz in ADD mode. Attenuates signals below 60 Hz.[a]
HF REJ Coupled	1.0 division from DC to 30 kHz. Attenuates signals above 30 kHz.[a]
LF REJ Coupled	1.0 division from 80 kHz to 50 MHz; increasing to 2.0 divisions at 100 MHz; 3.0 divisions at 100 MHz in ADD mode. Attenuates signals below 80 kHz.[a]
EXT TRIG 1 or EXT TRIG 2 Source Ext Gain = 1 DC Coupled	35 mV from DC to 50 MHz; increasing to 100 mV at 100 MHz.[a]
NOISE REJ Coupled	120 mV or less from DC to 50 MHz; increasing to 300 mV at 100 MHz.[a]
AC Coupled	35 mV from 60 Hz to 50 MHz; increasing to 100 mV at 100 MHz. Attenuates signals below 60 Hz.[a]
HF REJ Coupled	50 mV from DC to 30 kHz.[a]
LF REJ Coupled	50 mV from 80 kHz to 50 MHz; increasing to 100 mV at 100 MHz.[a]
Ext Gain = ÷ 5	Amplitudes are five times those specified for Ext Gain = 1.[a]

[a]Performance Requirement not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements
TIME BASE (cont)	
Delay Time Range	
B RUNS AFTER DELAY	
SEC/DIV 50 ns and faster	
REPET ON	(0.08 x B SEC/DIV) to 1.05 ms.[a]
REPET OFF	(0.08 x B SEC/DIV) to 524 μs.[a]
SEC/DIV 50 μs to 100 ns	(0.08 x B SEC/DIV) to (65,536 x 0.08 x B SEC/DIV).[a]
SEC/DIV 100 μs and slower	(0.04 x B SEC/DIV) to (65,536 x 0.04 x B SEC/DIV).[a]
B TRIGGERABLE AFTER DELAY	
SEC/DIV 50 ns and faster	
REPET ON	16 ns to 1.05 ms.[a]
REPET OFF	8 ns to 524 μs.[a]
SEC/DIV 50 μs to 100 ns	(0.08 x B SEC/DIV) to (65,536 x 0.08 x B SEC/DIV).[a]
SEC/DIV 100 μs and slower	(0.04 x B SEC/dIV) to (65,536 x 0.04 x B SEC/DIV).[a]
Delay Time Resolution	
B RUNS AFTER DELAY	
SEC/DIV 50 μs and faster	(0.08 x B SEC/DIV).[a]
SEC/DIV 100 μs and slower	(0.04 x B SEC/DIV).[a]
B TRIGGERABLE AFTER DELAY	
SEC/DIV 50 ns and faster	
REPET ON	16 ns.[a]
REPET OFF	8 ns.[a]
SEC/DIV 50 μs to 100 ns	(0.08 x B SEC/DIV).[a]
SEC/DIV 100 μs and slower	(0.04 x B SEC/DIV).[a]
Delay Time Accuracy	±0.0015[a].

[a]Performance Requirement not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements
NONVOLATILE MEMORY	
Front-Panel Setting, Waveform Data, Sequencer, and Calibration Data Retention Time	Greater than 3 years.
Battery	3.6-volt, 1.6-Amp Hour, Lithium Thionyl Chloride; Manufacturer EAGLE PICHER, Type LTC16P/P, TEK Part Number 146-0062-00; UL Listed. (See Warning below.) **WARNING** *To avoid personal injury, observe proper procedures for handling and disposal of lithium batteries. Improper handling may cause fire, explosion, or severe burns. Don't recharge, crush, disassemble, heat the battery above 212°F (100°C), incinerate, or expose contents of the battery to water. Dispose of battery in accordance with local, state, and national regulations.* *Typically, small quantities (less than 20) can be safely disposed of with ordinary garbage in a sanitary landfill.* *Larger quantities must be sent by surface transport to a hazardous waste disposal facility. The batteries should be individually packaged to prevent shorting and packed in a sturdy container that is clearly labeled "Lithium Batteries—DO NOT OPEN".*

Table 1-1 (cont)

Characteristics	Performance Requirements
SIGNAL OUTPUTS	
CALIBRATOR	CALIBRATOR output amplitudes at 5 MHz are at least 50% of output amplitudes at 1 ms SEC/DIV setting.[a]
Voltage (with A SEC/DIV switch set to 1 ms)	
1 MΩ Load	0.4 V ±1%.[a]
50 Ω Load	0.2 V ±1.5%.[a]
Current (short circuit load with A SEC/DIV switch set to 1 ms)	8 mA ±1.5%.[a]
Repetition Period	

A SEC/DIV Setting[a]	Calibrator Frequency[a]	Calibrator Period[a]	Div/ Cycle[a]
2 ns	5 MHz	200 ns	100
5 ns			40
10 ns			20
20 ns			10
50 ns			4
100 ns			2
200 ns			1
500 ns	1 MHz	1 μs	2
1 μs			1
2 μs			0.5
5 μs	50 kHz	20 μs	4
10 μs			2
20 μs			1
50 μs	5 kHz	200 μs	4
100 μs			2
200 μs			1
500 μs	500 Hz	2 ms	4
1 ms			2
2 ms			1
5 ms	50 Hz	20 ms	4
10 ms			2
20 ms			1
50 ms			0.4
100 ms			0.2
200 ms			0.1
500 ms			0.04
1 s			0.02
2 s			0.01
5 s			0.004

[a]Performance Requirement not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements
SIGNAL OUTPUTS (cont)	
CH 2 SIGNAL OUTPUT	
Output Voltage	20 mV per division ±10% into 1 MΩ. 10 mV per divison ±10% into 50 Ω.
Offset	±10 mV into 50 Ω, when dc balance has been performed within ±5°C of the operating temperature.
−3 dB Bandwidth	DC to greater than 50 MHz.
A TRIGGER, RECORD TRIGGER, and WORD RECOGNIZER Output	
Logic Polarity	Negative true. Trigger occurrence indicated by a HI to LO transition.[a]
Output Voltage HI	
Load of 400 μA or Less	2.5 V to 3.5 V.[a]
50 Ω Load to Ground	0.45 V or greater.[a]
Output Voltage LO	
Load of 4 mA or Less	0.5 V or less.[a]
50 Ω Load to Ground	0.15 V or less.[a]
SEQUENCE OUT, STEP COMPLETE Outputs	
Logic Polarity	Negative true. HI to LO transition indicates the event occurred.
Output Voltage HI	
Load of 400 μA or less	2.5 V to 3.5 V.[a]
50-Ω Load to Ground	0.45 V or greater.[a]
Output Voltage LO	
Load of 4 mA or less	0.5 V or less.[a]
50-Ω Load to Ground	0.15 V or less.[a]
SEQUENCE IN Input	
Logic Polarity	Negative true. HI to LO transition restarts a paused sequence.[a]
High-Level Input Current	20 μA maximum at Vin = 2.7 V.[a]
Low-Level Input Current	−0.4 mA maximum at Vin = 0.4 V.[a]
High-Level Input Voltage	2.0 V minimum.[a]
Low-level Input Voltage	0.8 V maximum.[a]
Absolute Maximum Ratings	
Vin max	+7.0 V.[a]
Vin min	−0.5 V.[a]

[a]Performance Requirements not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements
DISPLAY	
Graticule	80 mm × 100 mm (8 × 10 divisions).[a]
Phosphor	P31.[a]
Nominal Accelerating Potential	16 kV.[a]
Waveform and Cursor Display, Vertical	
Resolution, Electrical	One part in 1024 (10 bit). Calibrated for 100 points per division.[a]
Gain Accuracy	Graticule indication of voltage cursor difference is within 1% of CRT cursor readout value, measured over center 6 divisions.
Centering; Vectors OFF	Within ±0.1 division.
Offset with Vectors ON	Less than 0.05 division.
Linearity	Less than 0.1 division difference between graticule indication and crt cursor readout when active volts cursor is positioned anywhere on screen and inactive cursor is at center screen.[a]
Vector Response	
NORMAL Mode	
Step Aberration	+4%, −4%, 4% p-p.
Fill	Edges of filled regions match reference lines within ±0.1 division.
ENVELOPE Mode	
Fill	Less than 1% change in p-p amplitude of a 6-division, filled ENVELOPE waveform when switching vectors ON and OFF.
Waveform and Cursor Display, Horizontal	
Resolution, Electrical	One part in 1024 (10 bit). Calibrated for 100 points per division.[a]
Gain Accuracy	Graticule indication at time cursor difference is within 1% of crt cursor readout value, measured over center 6 divisions.
Centering; Vectors OFF	Within ±0.1 division.
Offset with Vectors ON	Less than 0.05 division.
Linearity	Less than 0.1 division difference between graticule indication and crt cursor readout when active time cursor is positioned anywhere along center horizontal graticule line and inactive cursor is at center screen.[a]

[a]Performance Requirement not checked in the manual.

Table 1-1 (cont)

Characteristics	Performance Requirements
AC POWER SOURCE	
Source Voltage	
Nominal Ranges	
115 V	90 V to 132 V.[a]
230 V	180 V to 250 V.[a]
Source Frequency	48 Hz to 440 Hz.[a]
Fuse Rating	5 A, 250 V, AGC/3AG, Fast Blow; or 4 A, 250 V, 5 × 20 mm Time-Lag (T).[a] Each fuse type requires a different fuse cap.[a]
Power Consumption	
Typical (standard instrument)	160 watts (250 VA).[a]
Maximum (fully optioned instrument)	200 watts (300 VA).[a]
Primary Grounding[c]	Type test 0.1 Ω maximum. Routine test to check grounding continuity between chassis ground and protective earth ground.[a]

[a]Performance Requirement not checked in the manual.

[c]Routine test is with ROD-L/EPA Electronic Model 100AV Hi-Pot Tester. This tests both the Primary Circuit Dielectric Withstand and Primary Grounding in one operation. Contact Tektronix Product Safety prior to using any other piece of equipment to perform these tests.

Table 1-2

Environmental Characteristics

Characteristics	Performance Requirements
STANDARD INSTRUMENT	
Environmental Requirements	This Oscilloscope meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style D equipment, with the humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4.
Temperature	
Operating	−15°C to +55°C.
Nonoperating (storage)	−62°C to +85°C.
Altitude	
Operating	To 15,000 feet (4500 meters). Maximum operating temperature decreased 1°C for each 1000 feet (300 meters) above 5000 feet (1500 meters).
Nonoperating (storage)	To 50,000 feet (15,000 meters).
Humidity	
Operating and Storage	Stored at 95% relative humidity for five cycles (120 hours) from 30°C to 60°C, with operation performance checks at 30°C and 55°C.
Vibration	
Operating	15 minutes along each of three axes at a total displacement of 0.025 inch (0.64 mm) p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one-minute sweeps. Hold 10 minutes at each major resonance, or if none exist, hold 10 minutes at 55 Hz (75 minutes total test time).
Shock	
Operating and Nonoperating	50-g, half-sine, 11-ms duration, three shocks on each face, for a total of 18 shocks.
Transit Drop (not in shipping package)	12-inch (300-mm) drop on each corner and each face (exceeds MIL-T-28800C, paragraphs 3.9.5.2 and 4.5.5.4.2).
Bench Handling	
Cabinet On and Cabinet Off	MIL-STD-810C, Method 516.2, Procedure V (MIL-T-28800C, Paragraph 4.5.5.4.3).
Topple (cabinet installed)	
Operating	Set on rear feet and allow to topple over onto each of four adjacent faces (Tektronix Standard 062-2858-00).
Packaged Transportation	
Drop	Meets the limits of the National Safe Transit Assn., test procedure 1A-B-2; 10 drops of 36 inches (914 mm) (Tektronix Standard 062-2858-00).
Vibration	Meets the limits of the National Safe Transit Assn., test procedure 1A-B-1; excursion of 1 inch (25.4 mm) p-p at 4.63 Hz (1.1 g) for 30 minutes (Tektronix Standard 062-2858-00).

Table 1-2 (cont)

Characteristics	Performance Requirements
STANDARD INSTRUMENT (cont)	
Environmental Requirements (cont)	
EMI (electromagnetic interference)	Meets MIL-T-28800C; MIL-STD-461B, part 4 (CE-03 and CS-02), part 5 (CS-06 and RS-02), and part 7 (CS-01, RE-02, and RS-03—limited to 1 GHz); VDE 0871, Category B; Part 15 of FCC Rules and Regulations, Subpart J, Class A; and Tektronix Standard 062-2866-00.
Electrostatic Discharge Susceptibility	Meets Tektronix Standard 062-2862-00. The instrument will not change control states with discharges of less than 10 kV.
X-Ray Radiation	Meets requirements of Tektronix Standard 062-1860-00.
RACKMOUNTED INSTRUMENT	
Environmental Requirements	Listed characteristics for vibration and shock indicate those environments in which the rackmounted instrument meets or exceeds the requirements of MIL-T-28800C with respect to Type III, Class 5, Style D equipment with the rackmounting rear-support kit installed. Refer to the Standard Instrument Environmental Specification for the remaining performance requirements. Instruments will be capable of meeting or exceeding the requirements of Tektronix Standard 062-2853-00, class 5.
Temperature (operating)	−15°C to +55°C, ambient temperature measured at the instrument's air inlet. Fan exhaust temperature should not exceed +65°C.
Vibration	15 minutes along each of three major axes at a total displacement of 0.015 inch (0.38 mm) p-p (2.3 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz to 10 Hz in one-minute sweeps. Hold 10 minutes at each major resonance, or if no major resonance is present, hold 10 minutes at 55 Hz (75 minutes total test time).
Shock (operating and nonoperating)	30-g, half-sine, 11-ms duration, three shocks per axis in each direction, for a total of 18 shocks.

Table 1-3

Mechanical Characteristics

Characteristics	Description
STANDARD INSTRUMENT	
Weight	
With Front Cover, Accessories, and Accessories Pouch	≃12.8 kg (28.1 lbs).
Without Front Cover, Accessories, and Accessories Pouch	≃10.9 kg (23.9 lbs).
Domestic Shipping Weight	≃16.4 kg (36 lbs).
Overall Dimensions	See Figure 1-1 for a dimensional drawing.
Height	
With Feet and Accessories Pouch	190 mm (7.48 in).
Without Accessories Pouch	160 mm (6.3 in).
Width (with handle)	330 mm (13.0 in).
Depth	
With Front Cover	479 mm (18.86 in).
With Handle Extended	550 mm (21.65 in).
Cooling	Forced air circulation; no air filter.
Finish	Tektronix Blue vinyl-clad material on aluminum cabinet.
Construction	Aluminum-alloy/plastic-composite chassis (spot-molded). Plastic-laminate front panel. Glass-laminate circuit boards.
RACKMOUNTING	
Rackmounting Conversion Kit	
Weight	4.0 kg (8.8 lbs).
Domestic Shipping Weight	6.3 kg (13.8 lbs).
Height	178 mm (7 in).
Width	483 mm (19 in).
Depth	419 mm (16.5 in).
Rear Support Kit	
Weight	0.68 kg (1.5 lbs).
OPTION 1R	
Rackmounted Instrument (Option 1R)	
Weight	≃15.8 kg (34.9 lbs).
Domestic Shipping Weight	≃18.1 kg (39.9 lbs).
Height	178 mm (7 in).
Width	483 mm (19 in).
Depth	419 mm (16.5 in).

Table 1-4

Option 05 (TV Trigger) Electrical Characteristics

Characteristics	Performance Requirements
VERTICAL—CHANNEL 1 AND CHANNEL 2	
Frequency Response	
Full Bandwidth	
50 kHz to 5 MHz	Within ±1%.
Greater than 5 MHz to 10 MHz	Within +1%, −2%.
Greater than 10 MHz to 30 MHz	Within +2%, −3%. For VOLTS/DIV switch settings between 5 mV and 0.2 V per division with VARIABLE VOLTS/DIV set to CAL. Five-division, 50 kHz reference signals from a 50 Ω system. With external 50 Ω termination on a 1 MΩ input.
20 MHz Bandwidth Limit	
50 kHz to 5 MHz	Within +1%, −4%.
Square Wave Flatness	
Field Rate	
5 mV/div to 20 mV/div	±1%, 1% p-p at 60 Hz with input signal of 0.1 V.
50 mV/div	±1%, 1% p-p at 60 Hz with input signal of 1.0 V. With fast-rise step (rise time 1 ns or less), 1 MΩ dc input coupling, an external 50 Ω termination, and VARIABLE VOLTS/DIV set to CAL. Exclude the first 20 ns following the step transition and exclude the first 30 ns when 20 MHz BW LIMIT is set.
Line Rate	
5 mV/div to 20 mV/div	±1%, 1% p-p at 15 kHz with input signal of 0.1 V.
50 mV/div	±1%, 1% p-p at 15 kHz with input signal of 1.0 V.
TV (Back-Porch) Clamp (CH 2 Only)	
60 Hz Attenuation	18 dB or greater. For VOLTS/DIV switch settings between 5 mV and 0.2 V with VARIABLE VOLTS/DIV set to CAL. Six-division reference signal.
Back-Porch Reference	Within ±1.0 division of ground reference.

Table 1-4 (cont)

Characteristics	Performance Requirements
TRIGGERING	
Sync Separation	Stable video rejection and sync separation from sync-positive or sync-negative composite video, 525 to 1280 lines, 50 Hz or 60 Hz, interlaced or noninterlaced systems.
Trigger Modes	
A Horizontal Mode	All lines: Field 1, selected line (1 to n), Field 2, selected line (1 to n), Alt fields, selected line (1 to n). n is equal to or less than the number of lines in the frame and less than or equal to 1280.
B Horizontal Mode	Delayed by time.
Minimum Input Signal Amplitude for Stable Triggering[a,b]	
Channel 1 and Channel 2	
Composite Video	2 divisions.
Composite Sync	0.6 divisions. Peak signal amplitude within 18 divisions of input ground reference.
EXT TRIG 1 or EXT TRIG 2	
EXT GAIN = 1	
Composite Video	60 mV.
Composite Sync	30 mV. Peak signal amplitude within ±0.9 V from input ground reference.
EXT GAIN = ÷5	
Composite Video	300 mV.
Composite Sync	150 mV Peak signal amplitude within ±4.9 V from input ground reference.

[a]**Performance Requirement not checked in manual.**

[b]**A stable trigger is one that results in a uniform, regular display triggered on the selected slope (±). A stably-triggered display should NOT have the trigger point switch between opposite slopes on the waveform, nor should it "roll" across the screen, as successive acquisitions occur. At TIME/DIV settings of 2 ms/DIV and faster, the TRIG'D LED is constantly lit if the display is stably triggered (the LED can flash for SEC/DIV settings of 10 ms/DIV and slower).**

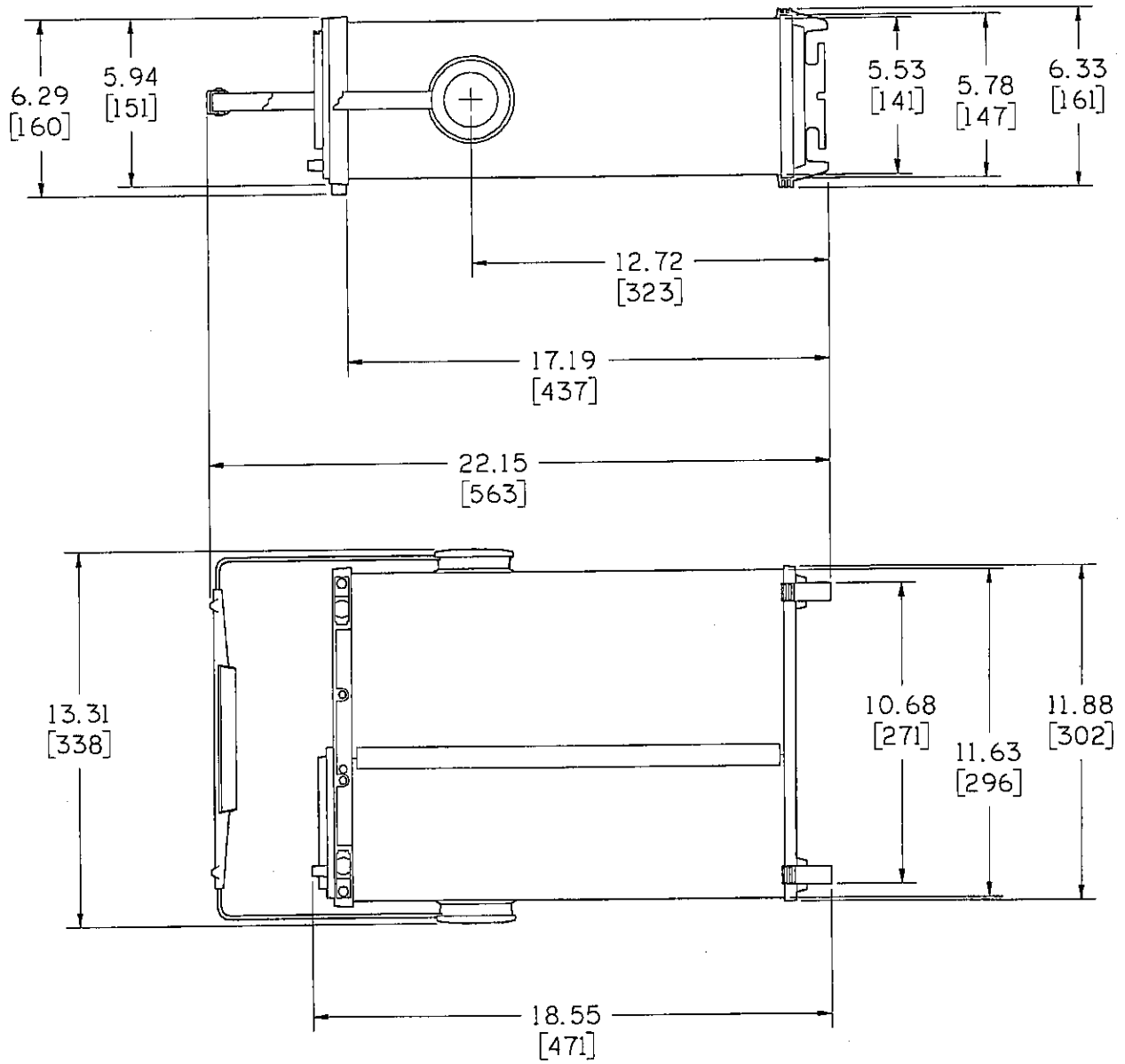


Figure 1-1. Dimensional drawing.

PREPARATION FOR USE

SAFETY

This section tells how to prepare for and to proceed with the initial start-up of the TEKTRONIX 2440 Digital Oscilloscope.

Refer to the Operators and Servicing Safety Summaries at the front of this manual for power source, grounding, and other safety considerations pertaining to the use of the instrument. Before connecting the oscilloscope to a power source, read both this section and the Safety Summaries.

CAUTION

This instrument may be damaged if operated with the LINE VOLTAGE SELECTOR switch set for the wrong applied ac input-source voltage or if the wrong line fuse is installed.

LINE VOLTAGE SELECTION

The scope operates from either a 115 V or 230 V nominal ac power-input source having a line frequency ranging from 48 Hz to 440 Hz. Before connecting the power cord to a power-input source, verify that the LINE VOLTAGE SELECTOR switch, located on the rear panel (see Figure 2-1), is set for the correct nominal ac input-source voltage. To convert the instrument for operation from one line-voltage range to the other, move the LINE VOLTAGE SELECTOR switch to the correct nominal ac source-voltage setting (see Table 2-1). The detachable power cord may have to be changed to match the particular power-source outlet.

LINE FUSE

To verify the proper value of the instrument's power-input fuse, perform the following procedure:

1. Press in the fuse-holder cap and release it with a slight counterclockwise rotation.

2. Pull the cap (with the attached fuse inside) out of the fuse holder.

3. Verify proper fuse value (see Table 2-1).

4. Install the proper fuse and reinstall the fuse-holder cap.

NOTE

A 4 A, 250 V, 5 × 20 mm Time-lag (T) fuse may be substituted for the factory-installed fuse. However, the two types of fuses are NOT directly interchangeable; each requires a different type of fuse cap.

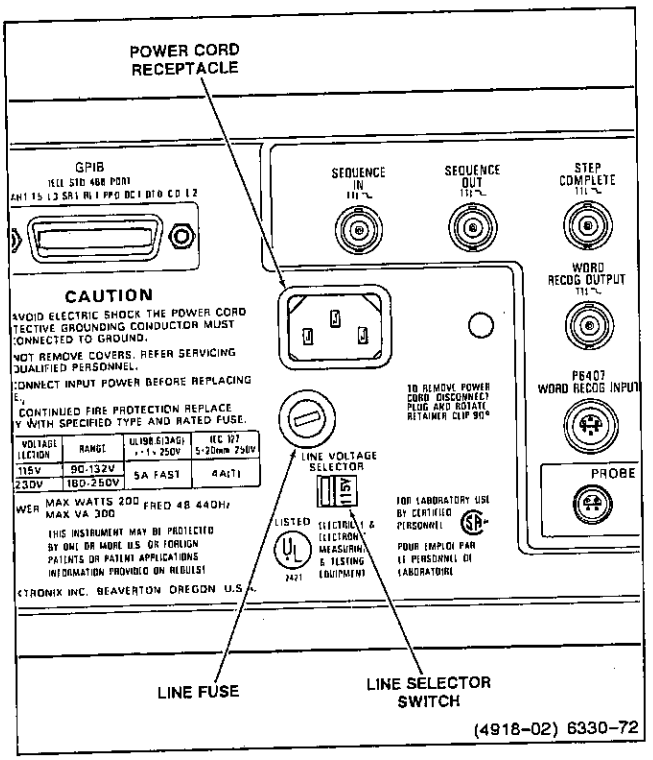
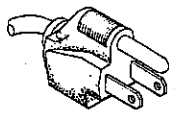
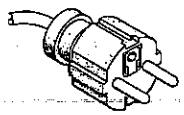
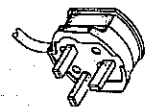
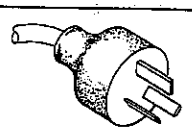
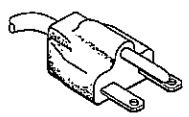
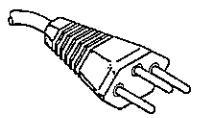


Figure 2-1. LINE VOLTAGE SELECTOR, line fuse, and power cord receptacle.

Table 2-1

Voltage, Fuse, and Power-Cord Data

Plug Configuration	Category	Power Cord And Plug Type	Line Voltage Selector Setting	Voltage Range (AC)	Factory Installed Instrument Fuse	Fuse Holder Cap	Reference Standards[b]
	U.S. Domestic Standard	U.S. 120V 15A	115V	90V to 132V	5A, 250V AGC/3AG Fast-blow (UL 198.6)	AGC/3AG	ANSI C73.11 NEMA 5-15-P UL 198.6
	Option A1	EURO 240V 10-16A	230V	180V to 250V	5A, 250V AGC/3AG Fast-blow (UL 198.6)	AGC/3AG	CEE(7), II, IV, VII IEC 83 IEC 127
	Option A2	UK[a] 240V 6A	230V	180V to 250V	5A, 250V AGC/3AG Fast-blow (UL 198.6)	AGC/3AG	BS 1363 IEC 83 IEC 127
	Option A3	Australian 240V 10A	230V	180V to 250V	5A, 250V AGC/3AG Fast-blow (UL 198.6)	AGC/3AG	AS C112 IEC 127
	Option A4	North American 240V 15A	230V	180V to 250V	5A, 250V AGC/3AG Fast-blow (UL 198.6)	AGC/3AG	ANSI C73.20 NEMA 6-15-P IEC 83 UL 198.6
	Option A5	Switzerland 220V 6A	230V	180V to 250V	5A, 250V AGC/3AG Fast-blow (UL 198.6)	AGC/3AG	SEV IEC 127

[a] A 6A, Type C fuse is also installed inside the plug of the Option A2 power cord.

[b] Reference Standards Abbreviations:

ANSI—American National Standards Institute
AS—Standards Association of Australia
BS—British Standards Institution
CEE—International Commission on Rules for the Approval of Electrical Equipment
IEC—International Electrotechnical Commission
NEMA—National Electrical Manufacturer's Association
SEV—Schweizevischer Elektrotechischer Verein
UL—Underwriters Laboratories Inc.

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POWER CORD

This instrument has a detachable three-wire power cord with a three-contact plug for connection to both the power source and protective ground. The power cord is secured to the rear panel by a cord-set securing clamp. The protective ground contact on the plug connects (through the power cord protective grounding conductor) to the accessible metal parts of the instrument. For protection against electrical shock, insert this plug into a power-source outlet that has a properly grounded protective-ground contact.

Instruments are shipped with the required power cord as ordered by the customer. Information on the available power cords is presented in Table 2-1, and part numbers are listed in "Options and Accessories" (Section 7). Contact your Tektronix representative or local Tektronix Field Office for additional power-cord information.

INSTRUMENT COOLING

To prevent instrument damage from overheated components, adequate internal airflow must be maintained. Before turning on the power, first verify that air-intake holes on the bottom and side of the cabinet and the fan exhaust holes are free of any obstruction to airflow. The scope has a thermal cutout that will activate if overheating occurs. The scope shuts down immediately with no attempt to save waveforms or front-panel conditions if a cutout happens. Power will be disabled to the scope until the thermal cutout cools down, at which time the power-on sequence is redone. The resulting loss of the last front-panel and waveform data will cause the power-on self test to fail and is indicated to the user by a failed CKSUM-NVRAM test (number 6000 in the main EXTENDED DIAGNOSTICS menu). The cause of the overheating must be corrected before attempting prolonged operation of the scope. Pressing the MENU OFF/EXTENDED FUNCTIONS button restores the scope to the normal operating mode.

START-UP

This instrument automatically performs power-up tests each time the instrument is turned on. These tests provide the highest possible confidence level that the instrument is fully functional. If no faults are encountered, the instrument will enter the Scope mode in the either ACQUIRE or SAVE Storage mode, depending on the mode in effect when it was powered off.

If tests are failed, the scope displays the Extended Diagnostics menu. If the failure is in the range of 1000-5300 and the message "HARDWARE PROBLEM—SEE SERVICE MANUAL" is displayed with the menu, see "Diagnostics" in Section 6 for more information. If the failure is in 1000-5300 range, but "RUN SELF CAL WHEN WARMED UP" is displayed, the SELF CAL procedure should be executed from the EXTENDED FUNCTIONS menu (wait for the NOT WARMED UP message to disappear from the SELF CAL menu). If failures persist after the SELF CAL is run (the "HARDWARE PROBLEM—SEE SERVICE MANUAL" message will be displayed), see "Diagnostics" in Section 6 for more information.

Failure of a test in the range of 7000 to 9300 may not indicate a fatal scope fault. Several conditions can occur that will cause a non-fatal failure of the tests. The scope will display "RUN SELF CAL WHEN WARMED UP" to indicate a SELF CAL should be performed. If SELF CAL does not clear the failure ("HARDWARE PROBLEM—SEE SERVICE MANUAL" is displayed), the scope may still be usable for your immediate measurement purposes. For example, if the problem area is in CH 2, CH 1 may still be used with full confidence of making accurate measurements. Press the MENU OFF/EXTENDED FUNCTIONS button to exit EXTENDED DIAGNOSTICS and enter Scope mode.

NOTE

The SELF CAL procedure is detailed in Section 5 of this manual. Refer to Section 6 of this manual for information on the power-up tests and the procedures to follow in the event of a failed power-up test.

A fatal fault in the operating system will cause the scope to abort. No displays are possible, and the user is notified of an abort situation only by the flashing of the Trigger LED indicators (if that is possible). Cycling the power off then back on may clear the problem, but a failure of this magnitude usually requires the scope to be referred to a qualified service person for checkout and repairs. Persistent or reoccurring failures of the power-on or self-diagnostic tests should be brought to the attention of a qualified service person at the first opportunity. Consult your service department, your local Tektronix Service Center, or nearest Tektronix representative if further assistance is needed.

POWER-DOWN

NOTE

POWER INTERRUPTION TO THE INSTRUMENT WHEN THE SELF-CALIBRATION ROUTINE IS EXECUTING INVALIDATES THE INSTRUMENT CALIBRATION CONSTANTS. Upon such an interruption, the instrument sets an internal flag denoting that SELF CAL was running at shutdown. When power is reestablished, the scope will display "RUN SELF CAL WHEN WARMED UP". When the "NOT WARMED UP" message disappears from the SELF CAL menu, the user MUST perform a SELF CAL to escape the EXT DIAG menu (the ↑ menu button MUST be used to access the SELF CAL menu—see Section 6 for more information). If failures persist after the SELF CAL is performed, refer the instrument to qualified service personnel.

For a normal power-off from the scope mode, an orderly power-down sequence retains the SAVE and SAVEREF waveforms, the current front-panel control settings, and any stored front-panel settings. If a power-off or transient power fluctuation occurs during SELF CAL, or EXTENDED CALIBRATION, or the instrument shuts-down at any time due to overheating, the normal power-down sequence is not executed. The result is loss of stored calibration constants or last front-panel control settings (or both) and a failure of the next power-on self-test (6000-6400 range). If front panel, sequencer, or stored waveform information was lost, the error will clear itself on the next power-down/power-up cycle. If calibration constants were lost the instrument will display information indicating if calibration is needed.

If power is momentarily interrupted, starting the power-off sequence, but is reestablished before the sequence completes, the scope will redo the power-on procedure. If the scope is in the middle of a waveform acquisition when power interruption occurs, the waveform data will not be saved, and the invalid waveform data display will be seen when power-on has completed. Press ACQUIRE to restart the acquisition and obtain valid waveform data.

REPACKAGING FOR SHIPMENT

It is recommended that the original carton and packing material be saved in the event it is necessary for the instrument to be reshipped using a commercial transport carrier. If the original materials are unfit or not available, then repackage the instrument using the following procedure.

1. Use a corrugated cardboard shipping carton having a test strength of at least 275 pounds and with an inside dimension at least six inches greater than the instrument dimensions.

2. If the instrument is being shipped to a Tektronix Service Center, enclose the following information: the owner's address, name and phone number of a contact person, type and serial number of the instrument, reason for returning, and a complete description of the service required.

3. Completely wrap the instrument with polyethylene sheeting or equivalent to protect the outside finish and prevent entry of harmful substances into the instrument.

4. Cushion instrument on all sides using three inches of padding material or urethane foam, tightly packed between the carton and the instrument.

5. Seal the shipping carton with an industrial stapler or strapping tape.

6. Mark the address of the Tektronix Service Center and also your own return address on the shipping carton in two prominent locations.