Specifications

This section begins with a general description of the traits of the TDS 684A and 7XXA Digitizing Oscilloscopes. Three sections follow, one for each of three classes of traits: *nominal traits, warranted characteristics,* and *typical characteristics*.

Product Description

The TDS 684A and 7XXA Digitizing Oscilloscopes are portable, four-channel instruments suitable for use in a variety of test and measurement applications and systems. Table 2–1 lists key features.

Table 2–1: Key Features of the TDS 684A and 7XXA Oscilloscopes

Feature	TDS 684A	TDS 7XXA
Digitizing rate, maximum	5 GS/s on each channel simultaneously	TDS 744A: 2 GS/s TDS 784A: 4 GS/s
Analog bandwidth	1 GHz	TDS 744A: 500 MHz TDS 784A: 1 GHz
Channels	Four, each with 8-bit resolution	
Record lengths, maximum	15,000 samples	50,000 samples (500,000 with option 1M)
Acquisition modes	Sample, envelope, and average	Sample, envelope, average, high-resolution, and peak-detect
Trigger modes	Include: edge, logic, and pulse. Video trigger, with option 05, modes include: NTSC, SECAM, PAL, HDTV, and FlexFormat.	
Display	Color for distinguishing among waveforms, measurements, and associated text	
Storage	1.44 Mbyte, 3.5 inch, DOS 3.3-or-later floppy disk. NVRAM storage for saving waveforms, hardcopies, and setups	
I/O	Full GPIB programmability. Hardcopy output using GPIB, RS-232, or Centronics ports	

User Interface

Use a combination of front-panel buttons, knobs, and on-screen menus to control the many functions of the oscilloscope. The front-panel controls are grouped according to function: vertical, horizontal, trigger, and special. Set a function you adjust often, such as vertical positioning or the time base setting, directly by its own front-panel knob. Set a function you change less often, such as vertical coupling or horizontal mode, indirectly using a selected menu.

Menus

Pressing one (sometimes two) front-panel button(s), such as vertical menu, displays a *main* menu of related functions, such as coupling and bandwidth, at the bottom of the screen. Pressing a main-menu button, such as coupling, displays a *side* menu of settings for that function, such as AC, DC, or GND (ground) coupling, at the right side of the screen. Pressing a side-menu button selects a setting such as DC.

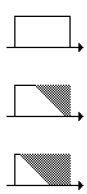
Indicators

On-screen readouts help you keep track of the settings for various functions, such as vertical and horizontal scale and trigger level. Some readouts use the cursors or the automatic parameter extraction feature (called measure) to display the results of measurements made or the status of the instrument.

General Purpose Knob

Assign the general purpose knob to adjust a selected parameter function. More quickly change parameters by toggling the **SHIFT** button. Use the same method as for *selecting* a function, except the final side-menu selection assigns the general purpose knob to *adjust* some function, such as the position of measurement cursors on screen, or the setting for a channel fine gain.

GUI



The user interface also makes use of a GUI, or Graphical User Interface, to make setting functions and interpreting the display more intuitive. Some menus and status are displayed using iconic representations of function settings, such as those shown here for full, 250 MHz and 20 MHz bandwidth. Such icons allow you to more readily determine status or the available settings.

Signal Acquisition System

The signal acquisition system provides four, full-featured vertical channels with calibrated vertical scale factors from 1 mV to 10 V per division. All channels can be acquired simultaneously.

Each of the full-featured channels can be displayed, vertically positioned, and offset, can have their bandwidth limited (250 MHz or 20 MHz) and their vertical coupling specified. Fine gain can also be adjusted.

Besides these channels, up to three math waveforms and four reference waveforms are available for display. (A math waveform results when you specify dual waveform operations, such as add, on any two channels. A reference waveform results when you save a waveform in a reference memory.)

Horizontal System

There are three horizontal display modes: main only, main intensified, and delayed only. You can select among various horizontal record length settings.

A feature called "Fit to Screen" allows you to view entire waveform records within the 10 division screen area. In other words, waveforms are compressed to fit on the screen. See Table 2–2.

Table 2–2: Record Length vs. Divisions per Record, Samples per Division and Sec/Div Sequence

	Divisions per Record	
	Sample/Division (Sec/Div Sequence)	
Record Length	Fit to Screen OFF 50 (1–2–5)	Fit to Screen ON (Sample/Div & Sec/Div Sequence varies)
500	10 divs	10 divs
1000	20 divs	10 divs
2500	50 divs	10 divs
5000	100 divs	10 divs
15000	300 divs	15 divs
50000 (TDS 7XXA only)	1,000 divs	10 divs
75000 (TDS 7XXA opt. 1M only)	1,500 divs	15 divs
100000 (TDS 7XXA opt. 1M only)	2,000 divs	10 divs
130000 (TDS 7XXA opt. 1M only)	2,600 divs	13 divs
250000 (TDS 7XXA opt. 1M only, 1 or 2 channels)	5,000 divs	10 divs
500000 (TDS 7XXA opt. 1M only, 1 channel)	10,000 divs	10 divs

Both the delayed only display and the intensified zone on the main intensified display may be delayed by time with respect to the main trigger. Both can be set to display immediately after the delay (delayed runs after main mode). The delayed display can also be set to display at the first valid trigger after the delay (delayed-triggerable modes).

The delayed display (or the intensified zone) may also be delayed by a selected number of events. In this case, the events source is the delayed-trigger source. The delayed trigger can also be set to occur after a number of events plus an amount of time.

Trigger System

The triggering system supports a varied set of features for triggering the signal-acquisition system. Trigger signals recognized include:

- Edge (main- and delayed-trigger systems): This familiar type of triggering is fully configurable for source, slope, coupling, mode (auto or normal), and holdoff.
- Logic (main-trigger system): This type of triggering can be based on pattern (asynchronous) or state (synchronous). In either case, logic triggering is configurable for sources, for boolean operators to apply to those sources, for logic pattern or state on which to trigger, for mode (auto or normal), and for holdoff. Time qualification may be selected in pattern mode. Another class of logic trigger, setup/hold, triggers when data in one trigger source changes state within the setup and hold times that you specify relative to a clock in another trigger source.
- Pulse (main-trigger system): Pulse triggering is configurable for triggering on runt or glitch pulses, or on pulse widths or periods inside or outside limits that you specify. It can also trigger on a pulse edge that has a slew rate faster or slower than the rate you specify. The pulse trigger is also configurable for source, polarity, mode, and holdoff.
- Video (with option 05: Video Trigger): Video triggering is compatible with standard NTSC, PAL, SECAM, and HDTV formats. An additional feature called FlexFormat™ (flexible format) allows the user to define the video format on which to trigger.

You can choose where the trigger point is located within the acquired waveform record by selecting the amount of pretrigger data displayed. Presets of 10%, 50%, and 90% of pretrigger data can be selected in the horizontal menu, or the general purpose knob can be assigned to set pretrigger data to any value within the 0% to 100% limits.

Acquisition Control

You can specify a mode and manner to acquire and process signals that matches your measurement requirements.

- Select the mode for interpolation (linear or sin (x)/x). This can increase the apparent sample rate on the waveform when the maximum real-time rate is exceeded.
- Use sample, envelope, and average modes to acquire signals. With the TDS 7XXA, also use high-resolution and peak-detect modes.
- Set the acquisition to stop after a single acquisition (or sequence of acquisitions if acquiring in average or envelope modes) or after a limit condition has been met.
- Select channel sources for compliance with limit tests. You can direct the TDS to signal you or generate hard copy output either to a printer or to a floppy-disk file based on the results. Also, you can create templates for use in limit tests.

On-Board User Assistance

Help and autoset can assist you in setting up the Digitizing Oscilloscope to make your measurements.

Help

Help displays operational information about any front-panel control. When help mode is in effect, manipulating any front-panel control causes the Digitizing Oscilloscope to display information about that control. When help is first invoked, an introduction to help is displayed on screen.

Autoset

Autoset automatically sets up the Digitizing Oscilloscope for a viewable display based on the input signal.

Measurement Assistance

Once you have set up to make your measurements, the cursor and measure features can help you quickly make those measurements.

Cursor

Three types of cursors are provided for making parametric measurements on the displayed waveforms. Horizontal bar cursors (H Bar) measure vertical parameters (typically volts). Vertical bar cursors (V Bar) measure horizontal parameters (typically time or frequency). Paired cursors measure both amplitude and time simultaneously. These are delta measurements; that is, measurements based on the difference between two cursors.

Both H Bar and V Bar cursors can also be used to make absolute measurements. For the H Bars, either cursor can be selected to read out its voltage with respect to any channel’s ground reference level. For the V Bars, the cursors measure time with respect to the trigger point (event) of the acquisition. The cursors can also control the portion of the waveform on which automatic measurements are made.

For time measurements, units can be either seconds or hertz (for 1/time).

With the video trigger option installed (Option 05), you can measure the video line number using the vertical cursors. You can measure IRE amplitude (NTSC) using the horizontal cursors with or without the video trigger option installed.

Measure

Measure can automatically extract parameters from the signal input to the Digitizing Oscilloscope. Any four out of the 25 parameters available can be displayed to the screen. The waveform parameters are measured continuously with the results updated on-screen as the Digitizing Oscilloscope continues to acquire waveforms.

Digital Signal Processing (DSP)

An important component of the multiprocessor architecture of this Digitizing Oscilloscope is Tektronix's proprietary digital signal processor, the DSP. This dedicated processor supports advanced analysis of your waveforms when doing such compute-intensive tasks as interpolation, waveform math, and signal averaging. It also teams with a custom display system to deliver specialized display modes (See *Display*, later in this description.)

Storage

Acquired waveforms may be saved in any of four nonvolatile REF (reference) memories or on a 3.5 inch, DOS 3.3-or-later compatible disk. Any or all of the saved waveforms may be displayed for comparison with the waveforms being currently acquired.

The source and destination of waveforms to be saved may be chosen. You can save any of the four channels to any REF memory or 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.

I/O

The oscilloscope is fully controllable and capable of sending and receiving waveforms over the GPIB interface (IEEE Std 488.1–1987/IEEE Std 488.2–1987 standard). 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-compensation and self-diagnostic features built into the Digitizing Oscilloscope to aid in fault detection and servicing are also accessible using commands sent from a GPIB controller.

The oscilloscope can also output copies of its display using the hardcopy feature. This feature allows you to output waveforms and other on-screen information to a variety of graphic printers and plotters from the TDS front panel, providing hard copies without requiring you to put the TDS into a system-controller environment. You can make hardcopies in a variety of popular output formats, such as PCX, TIFF, BMP, RLE, EPS, Interleaf, and EPS mono or color. You can also save hardcopies in a disk file in any of the formats above. The hardcopies obtained are based on what is displayed on-screen at the time hardcopy is invoked. The hardcopies can be stamped with date and time and spooled to a queue for printing at a later time. You can output screen information via GPIB, RS-232C, or Centronics interfaces.

Display

The TDS 684A and 7XXA Digitizing Oscilloscopes offer flexible display options. You can customize the following attributes of your display:

- Color: Waveforms, readouts, graticule, and variable persistence with color coding
- Intensity: waveforms, readouts, and graticule
- Style of waveform display(s): vectors or dots, intensified or nonintensified samples, infinite persistence, and variable persistence with color coding
- Interpolation method: Sin(x)/x or Linear
- Display format: xy or yt with various graticule selections including NTSC and PAL to be used with video trigger (option 05)

Zoom

This oscilloscope also provides an easy way to focus in on those waveform features you want to examine up close. By invoking zoom, you can magnify the waveform using the vertical and horizontal controls to expand (or contract) and position it for viewing.

Nominal Traits

This section contains a collection of tables that list the various *nominal traits* that describe the TDS 684A and 7XXA oscilloscopes. Electrical and mechanical traits are included.

Nominal traits are described using simple statements of fact such as “Four, all identical” for the trait “Input Channels, Number of,” rather than in terms of limits that are performance requirements.

Table 2–3: Nominal Traits — Signal Acquisition System

Name	Description	
Bandwidth Selections	20 MHz, 250 MHz, and FULL	
Samplers, Number of	Four, simultaneous	
Digitized Bits, Number of	8 bits[1]	
Input Channels, Number of	Four	
Input Coupling	DC, AC, or GND	
Input Impedance Selections	1 MΩ or 50 Ω	
Ranges, Offset	**Volts/Div Setting**	**Offset Range**
	1 mV/div – 100 mV/div	±1 V
	101 mV/div – 1 V/div	±10 V
	1.01 V/div – 10 V/div	±100 V
Range, Position	±5 divisions	
Range, 1 MΩ Sensitivity	1 mV/div to 10 V/div[2]	
Range, 50 Ω Sensitivity	1 mV/div to 1 V/div[2]	

1 **Displayed vertically with 25 digitization levels (DLs) per division and 10.24 divisions dynamic range with zoom off. A DL is the smallest voltage level change of the oscilloscope input that can be resolved by the 8-bit A-D Converter. Expressed as a voltage, a DL is equal to 1/25 of a division times the volts/division setting.**

2 **The sensitivity ranges from 1 mV/div to 10 V/div (for 1 MΩ) or to 1 V/div (for 50 Ω) in a 1–2–5 sequence of coarse settings with Fit-to-Screen off. Between coarse settings, the sensitivity can be finely adjusted with a resolution equal to 1% of the more sensitive coarse setting. For example, between 50 mV/div and 100 mV/div, the volts/division can be set with 0.5 mV resolution.**

Table 2–4: Nominal Traits — Time Base System

Name	Description
Range, Sample-Rate[1,3]	TDS 684A; 5 Samples/sec to 5 GSamples/sec on four channels simultaneously TDS 744A: 5 Samples/sec to 2 GSamples/sec when acquiring 1 channel to 1 G Sample/sec when acquiring 2 channels, or to 500 MSamples/sec when acquiring 3 or 4 channels TDS 784A: 5 Samples/sec to 4 GSamples/sec when acquiring 1 channel to 2 G Sample/sec when acquiring 2 channels, or to 1 GSamples/sec when acquiring 3 or 4 channels
Range, Interpolated Waveform Rate[2,3]	TDS 684A: 10 GSamples/sec to 250 GSamples/sec TDS 744A: 1 GSamples/sec to 100 GSamples/sec TDS 784A: 2 GSamples/sec to 250 GSamples/sec
Range, Seconds/Division	TDS 684A: 0.2 ns/div to 10 s/div TDS 744A: 0.5 ns/div to 10 s/div TDS 784A: 0.2 ns/div to 10 s/div
Record Length Selection	500 samples, 1000 samples, 2500 samples 5000 samples, 15000 samples The TDS 7XXA also offers: 50000 samples and, with its option 1M, 75000, 100000, 130000, 250000 (1 or 2 channels), or 500000 (1 channel) samples

1 The range of real-time rates, expressed in samples/second, at which a digitizer samples signals at its inputs and stores the samples in memory to produce a record of time-sequential samples.

2 The range of waveform rates for interpolated (or equivalent-time on the TDS 7XXA) waveform records.

3 The Waveform Rate (WR) is the equivalent sample rate of a waveform record. For a waveform record acquired by real-time sampling of a single acquisition, the waveform rate is the same as the real-time sample rate; for a waveform created by interpolation of real-time samples from a single acquisition or, on applicable products, the equivalent-time sampling of multiple acquisitions, the waveform rate created is faster than the real time sample rate. For all these cases, the waveform rate is 1/(Waveform Interval) for the waveform record, where the waveform interval (WI) is the time between the samples in the waveform record.

Table 2–5: Nominal Traits — Triggering System

Name	Description
Range, Delayed Trigger Time Delay	16 ns to 250 s
Range, Events Delay	TDS 684A; 2 to 10,000,000 TDS 7XXA: 1 to 10,000,000
Range (Time) for Pulse-Glitch, Pulse-Width, Time-Qualified Runt Triggering, or Slew Rate Trigger, Delta Time	1 ns to 1 s

Table 2–5: Nominal Traits — Triggering System (Cont.)

Name	Description	
Ranges, Setup and Hold for TimeSetup/Hold Violation Trigger	**Feature**	**Min to max**
	Setup Time	–100 ns to 100 ns
	Hold Time	–1 ns to 100 ns
	Setup + Hold Time	2 ns
	For Setup Time, positive numbers mean a data transition before the clock edge and negative means a transition after the clock edge. For Hold Time, positive numbers mean a data transition after the clock edge and negative means a transition before the clock edge. Setup + Hold Time is the algebraic sum of the Setup Time and the Hold Time programmed by the user.	
Ranges, Trigger Level or Threshold	**Source**	**Range**
	Any Channel	±12 divisions from center of screen
	Auxiliary	±8 V
	Line	±400 V
Video Trigger Modes of Operation (Option 05 Video Trigger)	Supports the following video standards: ■ NTSC (525/60) – 2 field mono or 4 field ■ PAL (625/50) – 2 field mono or SECAM, 8 field ■ HDTV – (787.5/60) (1050/60) (1125/60) (1250/60) ■ FlexFormat™ (user definable standards) User can specify: field rate, number of lines, sync pulse width and polarity, line rate, and vertical interval timing.	

Table 2–6: Nominal Traits — Display System

Name	Description
Video Display	Color display, 7 inch diagonal, with a display area of 5.04 inches horizontally by 3.78 inches vertically
Video Display Resolution	640 pixels horizontally by 480 pixels vertically
Waveform Display Graticule	Single Graticule: 401 × 501 pixels, 8 ×10 divisions, where divisions are 1 cm by 1 cm
Waveform Display Colors	Sixteen colors in infinite-persistence or variable persistence display with color coding

Table 2–7: Nominal Traits — GPIB Interface, Output Ports, and Power Fuse

Name	Description
Interface, GPIB	GPIB interface complies with IEEE Std 488-1987
Interface, RS-232	RS-232 interface complies with EIA/TIA 574 (talk only)
Interface, Centronics	Centronics interface complies with Centronics interface standard C332-44 Feb 1977, REV A
Interface, Video	VGA video output with levels that comply with EIA RS 343A standard. DB-15 connector
Logic Polarity for Main- and Delayed-Trigger Outputs	Negative TRUE. High to low transition indicates the trigger occurred.
Fuse Rating	Either of two fuses[1] may be used: a 0.25″ × 1.25″ (UL 198.6, 3AG): 6 A FAST, 250 V or a 5 mm × 20 mm (IEC 127): 5 A (T), 250 V.

1 **Each fuse type requires its own fuse cap.**

Table 2–8: Nominal Traits — Data Handling and Reliability

Name	Description
Time, Data-Retention, Nonvolatile Memory[1, 2]	Battery life ≥ 5 years
Floppy disk	3.5 inch, 720 K or 1.44 Mbyte, DOS 3.3-or-later compatible

1 **The times that reference waveforms, stored setups, and calibration constants are retained.**

2 **Data is maintained by small lithium-thionyl-chloride batteries internal to the memory ICs. The amount of lithium is so small in these ICs that they can typically be safely disposed of with ordinary garbage in a sanitary landfill.**

Table 2–9: Nominal Traits — Mechanical

Name	Description
Cooling Method	Forced-air circulation with no air filter. Clearance is required.
Construction Material	Chassis parts constructed of aluminum alloy; front panel constructed of plastic laminate; circuit boards constructed of glass laminate. Cabinet is aluminum and is clad in Tektronix Blue vinyl material.
Finish Type	Tektronix Blue vinyl-clad aluminum cabinet
Weight	Standard Digitizing Oscilloscope 14.1 kg (31 lbs), with front cover. 24.0 kg (53 lbs), when packaged for domestic shipment Rackmount Digitizing Oscilloscopes 14.1 kg (31 lbs) plus weight of rackmount parts, for the rackmounted Digitizing Oscilloscopes (Option 1R). Rackmount conversion kit 2.3 kg (5 lbs), parts only; 3.6 kg (8 lbs), parts plus package for domestic shipping
Overall Dimensions	Standard Digitizing Oscilloscope Height: 193 mm (7.6 in), with the feet installed Width: 445 mm (17.5 in), with the handle Depth: 434 mm (17.1 in), with the front cover installed Rackmount Digitizing Oscilloscope Height: 178 mm (7.0 in) Width: 483 mm (19.0 in) Depth: 558.8 mm (22.0 in)

Warranted Characteristics

This section lists the various *warranted characteristics* that describe the TDS 684A and 7XXA Digitizing Oscilloscopes. Electrical and environmental characteristics are included.

Warranted characteristics are described in terms of quantifiable performance limits which are warranted.

***NOTE**. In these tables, those warranted characteristics that are checked in the procedure* Performance Verification *appear in **boldface type** under the column* **Name**.

As stated above, this section lists only warranted characteristics. A list of *typical characteristics* starts on page 2–21.

Performance Conditions

The performance limits in this specification are valid with these conditions:

- The oscilloscope must have been calibrated/adjusted at an ambient temperature between +20° C and +30° C.
- The oscilloscope must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.
- The oscilloscope must have had a warm-up period of at least 20 minutes.
- The oscilloscope must have had its signal-path-compensation routine last executed after at least a 20 minute warm-up period at an ambient temperature within ±5° C of the current ambient temperature.

Table 2–10: Warranted Characteristics — Signal Acquisition System

Name	Description			
Accuracy, DC Gain	TDS 684A: ±1.5% for all sensitivities from 2 mV/div to 10 V/div ± 2.0% at 1 mV/div sensitivity TDS 7XXA: ±1% for all sensitivities from 1 mV/div to 10 V/div with offset from 0 V to ±100V			
Accuracy, Offset	**Volts/Div Setting**	**TDS 684A Offset Accuracy**	**TDS 744A Offset Accuracy**	**TDS 784A Offset Accuracy**
	1 mV/div – 100 mV/div	±((0.2% × | Net Offset[1] |) + 1.5 mV + (0.6 div x V/div))	±((0.2% × | Net Offset[1] |) + 1.5 mV + (0.1 div x V/div setting))	±((0.2% × | Net Offset[1] |) + 1.5 mV + (0.1 div x V/div setting))
	101 mV/div – 1 V/div	±((0.25% × | Net Offset[1] |) + 15 mV + (0.6 div x V/div))	±((0.25% × | Net Offset[1] |) + 15 mV + (0.1 div x V/div setting))	±((0.25% × | Net Offset[1] |) + 15 mV + (0.1 div x V/div setting))
	1.01 V/div – 10 V/div	±((0.25% × | Net Offset[1] |) + 150 mV + (0.6 div x V/div))	±((0.25% × | Net Offset[1] |) + 150 mV + (0.1 div x V/div setting))	±((0.25% × | Net Offset[1] |) + 150 mV + (0.1 div x V/div setting))
Analog Bandwidth, DC-50 Ω Coupled and Bandwidth selection is FULL	**Volts/Div**	**684A Bandwidth[2]**	**744A Bandwidth[2]**	**784A Bandwidth[2]**
	10 mV/div – 1 V/div	DC – 1 GHz	DC – 500 MHz	DC – 1 GHz
	5 mV/div – 9.95 mV/div	DC – 750 MHz	DC – 500 MHz	DC – 750 MHz
	2 mV/div – 4.98 mV/div	DC – 600 MHz	DC – 500 MHz	DC – 600 MHz
	1 mV/div – 1.99 mV/div	DC – 500 MHz	DC – 450 MHz	DC – 500 MHz
Analog Bandwidth, DC-50 Ω Coupled with P6245 Probe and Bandwidth selection is FULL	**Volts/Div as Read Out on Screen**	**684A Bandwidth[2]**	**744A Bandwidth[2]**	**784A Bandwidth[2]**
	10 mV/div – 100 V/div	(Not Applicable)	(Not Applicable)	(Not Applicable)
	100 mV/div – 10 V/div	DC – 1 GHz	DC – 500 MHz	DC – 1 GHz
	50 mV/div – 99.5 mV/div	DC – 750 MHz	DC – 500 MHz	DC – 750 MHz
	20 mV/div – 49.8 mV/div	DC – 600 MHz	DC – 500 MHz	DC – 600 MHz
	10 mV/div – 19.9 mV/div	DC – 500 MHz	DC – 450 MHz	DC – 500 MHz

Table 2–10: Warranted Characteristics — Signal Acquisition System (Cont.)

Name	Description			
Analog Bandwidth, DC-1M Ω Coupled with P6139A Probe and Bandwidth selection is FULL	**Volts/Div as Read Out on Screen**	**684A Bandwidth[2]**	**744A Bandwidth[2]**	**784A Bandwidth[2]**
	10 mV/div – 100 V/div	500 MHz	500 MHz	500 MHz
	100 mV/div – 10 V/div	500 MHz	500 MHz	500 MHz
	50 mV/div – 99.5 mV/div	500 MHz	500 MHz	500 MHz
	20 mV/div – 49.8 mV/div	500 MHz	500 MHz	500 MHz
	10 mV/div – 19.9 mV/div	400 MHz	450 MHz	500 MHz
Crosstalk (Channel Isolation)	≥100:1 at 100 MHz and ≥30:1 at the rated bandwidth for any two channels having equal Volts/Div settings			
Delay Between Channels, Full Bandwidth	TDS 684A: ≤100 ps for any two channels with equal Volts/Div and Coupling settings TDS 744A/784A: ≤50 ps for any two channels with equal Volts/Div and Coupling settings			
Input Impedance, DC–1 MΩ Coupled	1 MΩ ±0.5% in parallel with 10 pF ±3 pF			
Input Impedance, DC–50 Ω Coupled	50 Ω ±1% with VSWR ≤1.3:1 from DC – 500 MHz, ≤1.5:1 from 500 MHz – 1 GHz			
Input Voltage, Maximum, DC–1 MΩ, AC–1 MΩ, or GND Coupled	±400 V (DC + peak AC); derate at 20 dB/decade above 1 MHz			
Input Voltage, Maximum, DC-50 Ω or AC–50 Ω Coupled	5 V_{RMS}, with peaks ≤ ±30 V			
Lower Frequency Limit, AC Coupled	TDS 684A: ≤10 Hz when AC–1 MΩ Coupled; ≤200 kHz when AC–50 Ω Coupled[3]			

1 **Net Offset = Offset – (Position × Volts/Div). Net Offset is the nominal voltage level at the oscilloscope input that corresponds to the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this voltage level.**

2 **The limits given are for the ambient temperature range of 0°C to +30°C. Reduce the upper bandwidth frequencies by 5 MHz for the TDS 684A or by 2.5 MHz for the TDS 7XXA for each °C above +30°C.**

3 **The AC Coupled Lower Frequency Limits are reduced by a factor of 10 when 10X passive probes are used.**

Table 2–11: Warranted Characteristics — Time Base System

Name	Description
Accuracy, Long Term Sample Rate and Delay Time	TDS 684A: ±100 ppm over any ≥1 ms interval TDS 7XXA: ±25 ppm over any ≥1 ms interval

Table 2–12: Warranted Characteristics — Triggering System

Name	Description	
Sensitivity, Edge-Type Trigger, Coupling set to "DC"[1]	**Trigger Source**	**Sensitivity**
	Any Channel	TDS 684A: 0.35 division from DC to 50 MHz, increasing to 1 division at 1 GHz TDS 7XXA: 0.35 division from DC to 50 MHz, increasing to 1 division at 500 MHz for the TDS 744A or to 1 division at 1 GHz for the TDS 784A
	Auxiliary	TDS 684A or 784A: 250 mV from DC to 50 MHz, increasing to 500 mV at 100 Mhz TDS 744A: 400 mV from DC to 50 MHz, increasing to 750 mV at 100 Mhz
Accuracy (Time) for Pulse-Glitch or Pulse-Width Triggering	**Time Range**	**Accuracy**
	1 ns to 1 μs	±(20% of setting + 0.5 ns)
	1.02 μs to 1 s	±(100 ns + 0.01% of Setting)
Input Signal Sync Amplitude for Stable Triggering, NTSC and PAL modes (Option 05 Video Trigger)	Field selection "Odd", "Even", or "All": 0.6 division to 4 divisions Field selection "Numeric": 1 division to 4 divisions (NTSC mode)	
Jitter (Option 05 Video Trigger)	60 ns_{p-p} on NTSC or PAL signal	

1 **The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. The TRIG'D LED stays constantly lighted when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.**

Table 2–13: Warranted Characteristics — Output Ports, Probe Compensator, and Power Requirements

Name	Description	
Logic Levels, Main- and Delayed-Trigger Outputs	**Characteristic**	**Limits**
	Vout (HI)	≥2.5 V open circuit; ≥1.0 V into a 50 Ω load to ground
	Vout (LO)	≤0.7 V into a load of ≤4 mA; ≤0.25 V into a 50 Ω load to ground
Output Voltage and Frequency, Probe Compensator	**Characteristic**	**Limits**
	Output Voltage	0.5 V (base-top) ±1% into a ≥50 Ω load
	Frequency	1 kHz ±5%
Output Voltage, Signal Out (CH 3[1])	For TDS 684A: 20 mV/division ±20% into a 1 MΩ load; 10 mV/division ±20% into a 50 Ω load For TDS 7XXA: 22 mV/division ±20% into a 1 MΩ load; 11 mV/division ±20% into a 50 Ω load	
Source Voltage	90 to 250 VAC_{RMS}, continuous range	
Source Frequency	45 Hz to 440 Hz	

Table 2–13: Warranted Characteristics — Output Ports, Probe Compensator, and Power Requirements (Cont.)

Name	Description
Power Consumption	≤300 W (450 VA)

1 **CH 3 signal out is present at the rear panel if CH 3 is selected as the trigger source for the main and/or delayed trigger systems. It is not available when a channel other than CH3 is the source for the Video Trigger when Option 05 is installed.**

Table 2–14: Warranted Characteristics — Environmental

Name	Description
Atmospherics	Temperature (no diskette in floppy drive): TDS 684A: Operating: +4° C to +45° C TDS 7XXA: Operating: +4° C to +50° C Nonoperating: –22° C to +60° C Relative humidity (no diskette in floppy drive): Operating: 20% to 80%, at or below +32° C, upper limit derates to 30% relative humidity at +45° C Nonoperating: 5% to 90%, at or below +41° C, upper limit derates to 30% relative humidity at 60° C Altitude: To 4570 m (15,000 ft.), operating To 12190 m (40,000 ft.), nonoperating
Dynamics	Random vibration (floppy diskette not installed): 0.31 g rms, from 5 to 500 Hz, 10 minutes each axis, operating 3.07 g rms, from 5 to 500 Hz, 10 minutes each axis, nonoperating
Emissions[1, 2]	Meets or exceeds the requirements of the following standards: Vfg. 243/1991 Amended per Vfg. 46/1992 FCC Code of Federal Regulations, 47 CFR, Part 15, Subpart B, Class A European Community Requirements EN 55011 Class A Radiated Emissions EN 55011 Class A Conducted Emissions EN 50081–1 EN60555–2 Power Line Harmonic Emissions

Table 2–14: Warranted Characteristics — Environmental (Cont.)

Name	Description
Susceptibility[1, 2]	Meets or exceeds the EMC requirements of the following standards: EN 50082–1 European Community Requirements IEC 801-2 Electrostatic Discharge IEC 801-3 Radiated Susceptibility IEC 801-4 Fast Transients IEC 801-5 AC Surge
Third Party Certification	Conforms to and is certified where appropriate to: UL 1244 CSA–C22.2 No. 231

1 **VGA output cable needs to be terminated, if connected at all, for the Instrument to meet these standards. The test will pass with LCOM part # CTL3VGAMM–5.**

2 **The GPIB cable connected to the instrument for certain of the emissions tests must be "low EMI" having a high-quality outer shield connected through a low impedance to both connector housings. Acceptable cables are Tektronix part numbers 012-0991-00, -01, -02, and -03. In order to maintain the EMI performance conforming to the above regulations, the following cables, or their equivalent, should be used: a shielded Centronics cable, 3 meters in length, part number 012-1214-00, and a shielded RS-232 cable, 2.7 meters in length, CA part number 0294-9.**

Typical Characteristics

This subsection contains tables that list the various *typical characteristics* which describe the TDS 684A and 7XXA Digitizing Oscilloscopes.

Typical characteristics are described in terms of typical or average performance. Typical characteristics are not warranted.

Table 2–15: Typical Characteristics — Signal Acquisition System

Name	Description			
Accuracy, Delta Time Measurement	The limits are given in the following table for signals having amplitude greater than 5 divisions, reference level = 50%, filter set to (sinX/X), acquired at 5 mV/div or greater. For the TDS 7XXA, pulse duration < 10 div. Channel skew not included.			
	For the Single Shot condition, $1.4 \leq T_r/S_i \leq 4$, where S_i is the sample interval and T_r is the displayed rise time.			
	TDS 684A: For the averaged condition, $1.4 \leq T_r/W_i \leq 40$, where W_i is the Waveform Interval, as described elsewhere in these specifications.			
	TDS 684A: Extra error in the measurement will occur for two-channel measurements due to channel-to-channel skew. This is described elsewhere in these specifications.			
	Conditions	**Time Measurement Accuracy**		
	Single Shot or Sample mode (or HiRes mode on the TDS 7XXA), Full Bandwidth selected	TDS 684A: $\pm$((0.20 $\times$ sample interval) + (100 ppm $\times$ | Reading |) + (0.05 $\times$ W_i)) TDS 684A example: at 5 GS/s, 5 ns/div, measuring a 40 ns wide pulse, accuracy = $\pm$(40 ps + 4 ps + 5 ps) = $\pm$49 ps. TDS 7XXA: $\pm\geq$ 0.15 sample interval + 25 ppm $\times$ | Reading | + t/div/1000 TDS 7XXA example: at 4 Gs/s, accuracy = 37.5 ps		
	$\geq$ 100 Averages, Full Bandwidth selected. TDS 7XXA: repetitive	TDS 684A: $\pm$(10 ps + (100 ppm $\times$ | Reading |) + (0.25 $\times$ W_i)) TDS 7XXA: 20 ps + (25 ppm $\times$ | Reading |) + t/div/1000		
Calculated Rise Time[1]	**Volts/Div Setting**	**684A Rise Time**	**744A Rise Time**	**784A Rise Time**
	10 mV/div – 1 V/div	450 ps	800 ps	400 ps
	5 mV/div – 9.95 mV/div	600 ps	800 ps	530 ps
	2 mV/div – 4.98 mV/div	750 ps	800 ps	600 ns
	1 mV/div – 1.99 mV/div	900 ps	890 ns	800 ns

Table 2–15: Typical Characteristics — Signal Acquisition System (Cont.)

Name	Description				
Effective Bits — TDS 684A	**Input Frequency**	**Effective Bits**			
The chart on the right gives the typical effective bits for a 9-division p-p sine-wave input, 50 mV/div, 10 ns/div (5 GS/s), with a record length of 1000 points:	98 MHz	6.3 bits			
	245 MHz	6.0 bits			
	490 MHz	5.5 bits			
	990 MHz	5.2 bits			
Effective Bits — TDS 744A		**Sample Rate**			
The chart on the right gives the typical effective bits for a sine wave adjusted to 9.2 divisions at 1 MHz, 50 mV/div @ 25° C	**Input Frequency**	**2 GS/s**	**10 MS/s & HiRes**		
	1 MHz – 9.2 divs	6.8 bits	9.7 bits		
	500 MHz	6.8 bits	N/A		
Effective Bits — TDS 784A		**Sample Rate**			
The chart on the right gives the typical effective bits for a sine wave adjusted to 9.2 divisions at 1 MHz, 50 mV/div @ 25° C	**Input Frequency**	**4 GS/s**	**10 MS/s & HiRes**		
	1 MHz – 9.2 divs	6.6 bits	9.7 bits		
	500 MHz – 8.5 divs	6.6 bits	N/A		
	1 GHz – 6.5 divs	5.5 bits	N/A		
Frequency Limit, Upper, 250 MHz Bandwidth Limited	250 MHz				
Frequency Limit, Upper, 20 MHz Bandwidth Limited	20 MHz				
Step Response Settling Errors			**Settling Error (%)[2] at**		
	Volts/Div Setting	**± Step Amplitude**	**20 ns**	**100 ns**	**20 ms**
	1 mV/div – 100 mV/div	≤2 V	0.5%	0.2%	0.1%
	101 mV/div – 1 V/div	≤20 V	1.0%	0.5%	0.2%
	1.01 V/div – 10 V/div	≤200 V	1.0%	0.5%	0.2%

1 **The numbers given are valid 0°C to +30°C and will increase as the temperature increases due to the degradation in bandwidth. Rise time is calculated from the bandwidth. It is defined by the following formula:**

$$TDS\ 684A\ Rise\ Time\ (ns) = \frac{450}{BW\ (MHz)} \qquad TDS\ 7XXA\ Rise\ Time\ (ns) = \frac{400}{BW\ (MHz)}$$

Note that if you measure rise time, you must take into account the rise time of the test equipment (signal source, etc.) that you use to provide the test signal. That is, the measured rise time (RT_m) is determined by the instrument rise time (RT_i) and the rise time of the test signal source (RTgen) according to the following formula:

$$RT_m{}^2 = RT_i{}^2 + RT_{gen}{}^2$$

2 **The values given are the maximum absolute difference between the value at the end of a specified time interval after the midlevel crossing of the step and the value one second after the midlevel crossing of the step, expressed as a percentage of the step amplitude.**

Table 2–16: Typical Characteristics — Triggering System

Name	Description	
Accuracy, Trigger Level or Threshold, DC Coupled (for signals having rise and fall times ≥ 20 ns)	**Trigger Source**	**Accuracy**
	Any Channel	±((2% × | Setting – Net Offset |) + (0.3 div × Volts/div Setting) + Offset Accuracy)
	Auxiliary	Not calibrated or specified
Input, Auxiliary Trigger	The input resistance is ≥1.5 kΩ; the maximum safe input voltage is ±20 V (DC + peak AC).	
Trigger Position Error, Edge Triggering	**Acquisition Mode**	**Trigger-Position Error[1,2]**
	Sample, Average	±(1 Waveform Interval + 1 ns)
	Envelope	±(2 Waveform Intervals + 1 ns)
Holdoff, Variable, Main Trigger	For all Time/Division ranges, the minimum holdoff is 250 ns and the maximum holdoff is 12 seconds. The minimum resolution is 8 ns for settings ≤ 1.2 µs.	
Lowest Frequency for Successful Operation of "Set Level to 50%" Function	30 Hz	
Sensitivity, Edge Trigger, Not DC Coupled[3]	**Trigger Source**	**Typical Signal Level for Stable Triggering**
	AC	Same as the DC-coupled limits for frequencies above 60 Hz. Attenuates signals below 60 Hz.
	Noise Reject	Three times the DC-coupled limits.
	High Frequency Reject	One and one-half times the DC-coupled limits from DC to 30 kHz. Attenuates signals above 30 kHz.
	Low Frequency Reject	One and one-half times the DC-coupled limits for frequencies above 80 kHz. Attenuates signals below 80 kHz.
Sensitivities, Logic Trigger and Events Delay, DC Coupled[4]	1.0 division, from DC to 500 MHz, at vertical settings > 10 mV/div and ≤ 1 V/div at the BNC input	
Sensitivities, Pulse-Type Runt Trigger[5]	1.0 division, from DC to 500 MHz, at vertical settings > 10 mV/div and ≤ 1 V/div at the BNC input	
Sensitivities, Pulse-Type Trigger Width and Glitch[6]	1.0 division, at vertical settings > 10 mV/div and ≤ 1 V/div at the BNC input	

Table 2–16: Typical Characteristics — Triggering System (Cont.)

Name	Description			
Width, Minimum Pulse and Rearm, for Logic Triggering or Events Delay	For vertical settings > 10 mV/div and ≤ 1 V/div at the BNC input			
	Triggering Type	**Minimum Pulse Width**	**Minimum Re-Arm Width**	**Minimum Time Between Channels[7]**
	Logic	Not Applicable	1 ns	1 ns
	Events Delay	1 ns (for either + or – pulse widths)	Not Applicable	2 ns
Width, Minimum Pulse and Rearm, for Pulse Triggering The minimum pulse widths and rearm widths and transition times[8] required for Pulse-Type triggering.	For vertical settings > 10 mV/div. and 3 1 V/div at the BNC input			
	Pulse Class	**Minimum Pulse Width**	**Minimum Re-Arm Width**	
	Glitch	1 ns	2 ns + 5% of Glitch Width Setting	
	Runt	2 ns	2 ns	
	Time-Qualified Runt	2 ns	8.5 ns + 5% of Width Setting	
	Width	1 ns	2 ns + 5% of Width Upper Limit Setting	
	Slew Rate	600 ps[8]	8.5 ns + 5% of Delta Time Setting	
Input Signal Sync Amplitude for Stable Triggering, HDTV and FLEXFMT modes (Option 05 Video Trigger)	All field selections: 0.6 division to 4 divisions			
Jitter for HDTV mode (Option 05 Video Trigger)	17 ns_{p-p}			
Sync Width Flex Format and HDTV modes (Option 05 Video Trigger)	min. 400 ns			
Sync Duty Cycle, Flex Format and HDTV modes (Option 05 Video Trigger)	min. 50 to 1			
Hum Rejection (Option 05 Video Trigger)	NTSC and PAL: –20 dB without any trigger spec deterioration. Triggering will continue down to 0 dB with some performance deterioration.			

1 The trigger position errors are typically less than the values given here. These values are for triggering signals having a slew rate at the trigger point of ≥ 0.5 division/ns.

2 The waveform interval (WI) is the time between the samples in the waveform record. Also, see the footnote for the characteristics *Sample Rate Range or Interpolated Waveform Rates* in Table 2–4, on page 2–10.

3 The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. The TRIG'D LED stays constantly lighted when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.

4 The minimum signal levels required for stable logic or pulse triggering of an acquisition, or for stable counting of a DC-coupled, events-delay signal. Also, see the footnote for *Sensitivity, Edge-Type Trigger, DC Coupled* in this table. (Stable counting of events is counting that misses no events and produces no extra, phantom events.)

5 The minimum signal levels required for stable runt pulse triggering of an acquisition. Also, see the footnote for *Sensitivity, Edge-Type Trigger, DC Coupled* in this table. (Stable counting of events is counting that misses no events.)

Table 2–16: Typical Characteristics — Triggering System (Cont.)

Name	Description

[6] The minimum signal levels required for stable pulse width or glitch triggering of an acquisition. Also, see the footnote for *Sensitivity, Edge-Type Trigger, DC Coupled* in this table. (Stable counting of events is counting that misses no events.)

[7] For Logic, time between channels refers to the length of time a logic state derived from more than one channel must exist to be recognized. For Events, the time is the minimum time between a main and delayed event that will be recognized if more than one channel is used.

[8] For Slew Rate Triggering, this is the minimum transition time, defined to be the time the user's signal spends between the two trigger threshold settings.