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NATA   AIDN

Communications Signal Analyzers

▶ CSA7000 Series

▶ **Features & Benefits**

Real-time Oscilloscope Platform

Up to 4 GHz Bandwidth

Up to 2.5 Gb/s Optical and Electrical Serial Data Stream Rates

Built-in Compliance Mask Tests Supporting a Wide Range of Telecom and Datacom Standards

Broad Wavelength Optical Response Increases Versatility

Integrated Optical Reference Receiver Protects Integrity of System Calibration

Integrated Clock Recovery

32-Bit Serial Trigger for Isolation of Pattern-dependent Effects

Complete Eye Pattern Measurements Suite Including Extinction Ratio, Q-factor, Eye Height/width, Jitter and Noise

Waveform Database Acquisition Technology for Accurate Parametric Measurements on Eye Patterns

10 MHz Timebase Reference Input

Up to 20 GS/s Real-time Sample Rate

More than 400,000 Waveforms/Second Waveform Capture Rate

▶ *The CSA7404 Communications Signal Analyzer performs mask testing and signal analysis for optical and electrical communications signals at rates up to OC-48 /STM-16; 2.5 Gb/s.*

Versatile, High-performance Real-time Digital Oscilloscopes Dedicated to Rapid Design Analysis and Verification of Communications Signals Up To 2.5 Gb/s Rates (OC-48/STM-16 or Fibre Channel FC2125)

The CSA7000 Series of Communications Signal Analyzers reduces product development time by providing one tool that spans circuit development and physical layer testing. With the CSA7000 Series, engineers can test designs for compliance to network communications standards as well as analyze critical internal parameters such as signal integrity, timing margins and jitter.

The CSA7000 Series analyzers integrate broad wavelength optical response, clock recovery, serial pattern triggering and mask testing into the highest performance digital phosphor oscilloscopes. Instrument operation is familiar and intuitive through direct controls and a graphical interface. Open access to the Windows operating system enables unprecedented customization and extensibility. This unique combination of performance, simplicity and connectivity speeds the development of network communications circuit designs.

▶ **Applications**

Design Development and Compliance Testing of Optical and Electrical Signals to 2.5 Gb/s Rates

Physical Layer Characterization of Communication Signals in Backplane, Midplane and Embedded Designs

Optical and Electrical Signal Integrity, Margin Verification, Jitter and Timing Analysis

Tektronix

Enabling Innovation

Communications Signal Analyzers

▶ CSA7000 Series

Superior Performance

Industry Leading DPO

Up to 4 GHz bandwidth and high-speed single-shot signal acquisition combined with up to 32 MB memory provide critical insight into design behavior. In addition, patented third generation DPX™ technology enables waveform capture rates of more than 400,000 waveforms per second. High performance jitter analysis is achieved through exceptional trigger and acquisition performance, deep memory and applied software. Versatile high bandwidth probes, including 6 GHz single-ended and 3.5 GHz differential models ensure high fidelity access to signals.

Clock Recovery

CSA7000 Series analyzers include clock recovery for electrical and optical serial data streams from 1.5 MBaud to 2.5 GBaud. Users can easily and reliably perform mask testing and parametric analysis with a single connection. Recovered clock and data signals are available on the front panel for connection to other equipment, such as a BER analyzer.

Serial Pattern Trigger

The CSA7000 Series includes hardware-based serial pattern trigger to isolate data patterns. Serial trigger provides a direct means to analyze pattern dependent issues, even on a single-shot basis. The combination of serial trigger and signal averaging reduces random noise, enhancing acquisition of low power signals. Users can specify patterns with up to 32 bits, including "don't-care" bits. The serial trigger system can be clocked from an external source or internal clock recovery can be applied, providing single-connection convenience.

Unprecedented Simplicity

Integrated Optical Reference Receiver

Compliance testing for optical standards requires calibrated optical reference receiver response. CSA7000 Series models include a broad wavelength optical input enabling them to conveniently address a wide range of standards. A complete library of optical reference receiver filters ensures versatility and eliminates the need for reconfiguring external modules or plug-ins. Filters can easily be disabled to provide full-bandwidth analysis on optical signals. The CSA7404 includes reference receiver filters implementing fourth-order Bessel-Thompson response for the following standards and bit rates:

▶ SONET/SDH OC-48/STM16, OC-12/STM4, OC-3/STM1, OC-1/STM0

▶ Fibre Channel 2125, 1063, 531, 266, 133

▶ Gigabit Ethernet

▶ InfiniBand 2.5 Gb/s

▶ IEEE 1394b S1600, S800, S400

The integrated O/E architecture of the CSA7000 Series provides a robust, fully calibrated signal path and eliminates the need to match an external O/E adapter to a specific instrument. The real-time architecture of the CSA7000 Series is quickly user-configurable with an optical channel and three electrical inputs or with four electrical inputs. The output of the O/E is available on the front panel for use with other instrumentation.
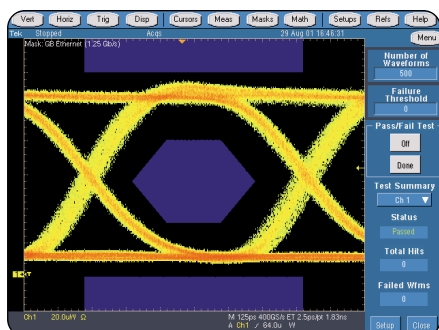
Mask Testing

The CSA7000 Series provides a complete portfolio of masks for verifying compliance to optical and electrical standards. Engineers can verify circuit design performance and perform interface compliance testing with one real-time instrument, even when developing multi-standard and multi-rate designs.

Standard masks include:

▶ SONET/SDH GR 253-Core (51.4 Mb/s to 2.488 Gb/s)

▶ Ethernet IEEE Std 802.3, ANSI X3.263 (125 Mb/s to 1.25 Gb/s)

▶ Fibre Channel ANSI X3.230 (132.8 Mb/s to 2.125 Gb/s)

▶ Fibre Channel Electrical (132.8 Mb/s to 2.125 Gb/s)

▶ InfiniBand (2.5 Gb/s)

▶ ITU-T G.703 (1.544 Mb/s to 155.52 Mb/s)

▶ ANSI T1.102 (1.544 Mb/s to 155.52 Mb/s)

▶ USB (12 Mb/s, 480 Mb/s)

▶ Serial ATA (1.5 Gb/s)

▶ IEEE 1394b (393 Mb/s to 1.5729 Gb/s)

Several powerful features allow users to easily tailor mask testing for specific requirements:

▶ One-button Autoset matches instrument settings to signal characteristics and specific mask requirements

▶ Optional Auto-Fit process optimizes signal position within the mask to minimize hits

▶ Mask Margin control adjusts tolerance during testing

▶ Hit-counting identifies location and degree of failures

▶ Optional test-related actions including notification, logging and hardcopy

▶ Built-in mask editing allowing users to copy and adjust mask values from a standard, or create new masks

▶ *Figure 1. Versatile and easy to use, the CSA7000 Series combines optical reference receiver filters, clock recovery, serial pattern trigger and mask testing into a real-time oscilloscope.*

▶ *Figure 2. Waveform database acquisition, statistical techniques and eye pattern-specific measurements produce stable, accurate characterization of communications designs. Color grading in this example highlights the most frequent occurrences in red.*

Communications Measurements

The CSA7000 Series provides a broad suite of eye-pattern related measurements that are fundamental for analysis of serial communications signals, including extinction ratio, Q-factor, eye height/width, jitter and noise. These are complemented with a wide array of general purpose amplitude, time and histogram-related measurements.

Application-specific Software Extensions

Applied measurement extensions can be installed to enhance CSA7000 capabilities. These software applications build on the precision acquisition performance of CSA7000 Series to address the need for application-specific measurements to quickly quantify device and system performance. Optional applications include:

▶ Jitter analysis for high speed clock and data signal characterization

▶ Compliance testing for signaling defined in ITU-T G.703 and ANSI T1.102 communications standards

▶ Compliance testing for signaling defined in USB1.0 standard and USB2.0 draft standard

▶ Disk drive read channel, head and media measurements to IDEMA standards; PRML measurements

▶ VocalLink™ voice control software for TDS7000 Series instruments

Mask testing results are reported live, providing real-time feedback. Mask hits are highlighted on the display and accompanied by readouts indicating waveforms tested, pass/fail results and hit counts. A log file summarizing test results can also be generated automatically. Users can take advantage of the open Windows platform to quickly copy and paste test result screen images or log file information into reports created with WordPad or other applications on the instrument.

External Timebase Reference

The reference oscillator in CSA7000 Series analyzers can be phase-locked to an external 10 MHz source to match system stability or synchronize multiple instruments. This phase-lock technique also enables characterization of very low frequency wander and modulation effects.
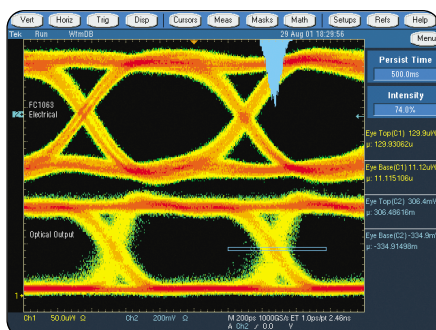
Waveform Database and Parametric Measurements

The CSA7000 Series includes waveform database acquisition mode to provide information over a much larger sample of data. The waveform database is a three-dimensional accumulation of source waveform data as it is continuously acquired. In addition to amplitude and timing information, a waveform database has a third dimension of count. The count represents the number of times a specific waveform point (time and amplitude) has been acquired. Color-graded displays based on counts can be used to highlight waveform activity. Parametric measurements derived from the database use statistical techniques to produce more stable, accurate results.

Communications Signal Analyzers

▶ CSA7000 Series

Complete Connectivity

The CSA7000 Series combines a high performance real-time oscilloscope with a PC processor in a self-contained unit. With open access to the Windows operating environment, built-in applications such WordPad, Paint and Internet Explorer allow users to concurrently maintain lab notes and reference design information while working with the instrument, saving time and reducing errors. The built-in floppy disk drive provides a convenient means of transporting results while the standard network interfaces allow easy file sharing and remote control.

The analysis and connectivity software of the CSA7000 Series provides a comprehensive software infrastructure for faster, more versatile operations. Industry-standard protocols, such as VISA and ActiveX Controls, are included for using and enhancing Windows applications such as Excel for data analysis and documentation. Or, create custom software to automate multi-step processes in waveform collection and analysis with Visual BASIC, C, C++, MATLAB, HP VEE, and other common development environments. By hosting applications on the instrument and using the embedded PCI bus, waveform data can be moved directly from the acquisition system to analysis applications at much faster speeds than conventional cable connections.

Integration of the instrument with external PCs and non-Windows hosts is also supported by CSA7000 Series software solutions. Plug-and-play drivers are included to enable fast and easy communication with LabVIEW, Lab Windows and HP VEE programs using GPIB and LAN connections. Applications using a local area network can connect directly to a CSA7000 Series analyzer using the VXI 11.2 server included in the instrument.

▶ Characteristics

▶ Vertical System

	CSA7154	CSA7404
Input Channels	4	4
Analog Bandwidth (–3 dB)	1.5 GHz	4 GHz
Calculated Rise Time 100 mV/div to 1 V/div (Typical)	240 ps	100 ps
Input Coupling	DC, Gnd	
Input Impedance	50 Ω	
Input Sensitivity	2 mV/div to 1 V/div	
Vertical Resolution	8 bits, (>11 bits with averaging)	
Max. Input Voltage	<1 V$_{RMS}$ for <100 mV/div, <5 V$_{RMS}$ for ≥100 mV/div settings. Also determined by TekConnect accessory	
Offset Range	2 mV to 50 mV/div ±0.5 V 50.5 mV to 99.5 mV ±0.25 V 100 mV to 500 mV ±5 V 505 mV to 1 V/div ±2.5 V	
DC Gain Accuracy 100 mV/div to 1 V/div	$\pm(2\% + (2\% \times$ net offset/10)) net offset = voltage level at center screen (vertically)	

▶ Optoelectronic System

Specifications assume use of the included 013-0327-00
O-to-E Output to CH1 interconnect (unless otherwise specified).

	CSA7154	CSA7404
Optical Channel Unfiltered Bandwidth	1.6 GHz	2.4 GHz
Input Connector	Rifocs universal connector	
Wavelength Range	700 nm to 1650 nm	
Calibrated Wavelengths	780 nm, 850 nm, 1310 nm, 1550 nm	
O/E Gain	$\geq$0.27 V/mW (0.35 V/mW typical) @ 780 nm $\pm$20 nm $\geq$0.33 V/mW (0.40 V/mW typical) @ 850 nm $\pm$20 nm $\geq$0.64 V/mW (0.75 V/mW typical) @ 1310 nm $\pm$20 nm $\geq$0.64 V/mW (0.75 V/mW typical) @ 1550 nm $\pm$20 nm	
Sensitivity (smallest average power for mask test). Assumes scale factor is set to minimum uW/div settings and signal is at least 4 divisions peak-to-peak	40 uW$_{p-p}$ at 1310 nm and 1550 nm. >20 uW$_{p-p}$, 10 uW (–17 dBm) average power assuming 50% average duty cycle. 80 uW$_{p-p}$ at 780 nm and 850 nm. 40 uW (–14 dBm) average power assuming 50% average duty cycle.	
RMS Noise	$\leq$2.0 uW + (6.5% of W/div setting) at 780 nm $\leq$1.6 uW + (6.5% of W/div setting) at 850 nm $\leq$0.85 uW + (6.5% of W/div setting) at 1310 nm and 1550 nm	$\leq$2.6 uW + (6.5% of W/div setting) at 780 nm $\leq$2.1 uW + (6.5% of W/div setting) at 850 nm $\leq$1.1 uW + (6.5% of W/div setting) at 1310 nm and 1550 nm
Input Range	10 uW/div to 500 uW/div. Optical reference receiver typically available over the following range: 40 uW (–14 dBm) to 400 uW (–4 dBm) at wavelength <1200 nm; 25 uW (–16 dBm) to 250 uW (–6 dBm) at wavelength >1200 nm.	
Absolute Maximum Nondestructive Optical Input	5 mW average; 10 mW peak at wavelength (1300 nm) with highest relative responsivity	
Maximum Nonsaturating Linear Response to Transient Input (Typical)	<170 uW average input (340 uW peak) at 850 nm <120 uW average input (240 uW peak) at 1310 and 1550 nm	
Fiber Input	62.5 um core multimode fiber	
Input Return Loss (Typical)	With 50 um or 62.5 um core multimode fiber (CPC6) attached: >14 dB for 780 nm $\pm$20 nm >14 dB for 850 nm $\pm$20 nm With 9 um core single mode fiber (SMF-28) attached: >28 dB for 1310 nm $\pm$20 nm >28 dB for 1550 nm $\pm$20 nm	

Communications Signal Analyzers

▶ CSA7000 Series

▶ Optical Reference Receiver System

Fourth-order Bessel-Thompson filter response at the following rates:

	CSA7154	CSA7404
SONET/SDH	OC-1/STM0 (51.84 Mb/s) OC-3/STM1 (155.52 Mb/s) OC-12/STM4 (622.08 Mb/s)	OC-1/STM0 (51.84 Mb/s) OC-3/STM1 (155.52 Mb/s) OC-12/STM4 (622.08 Mb/s) OC-48/STM16 (2488.3 Mb/s)
Gigabit Ethernet	1.25 Gb/s	1.25 Gb/s
Fibre Channel	FC133 (132.7 Mb/s) FC266 (265.6 Mb/s) FC531 (531.2 Mb/s) FC1063 (1063.5 Mb/s)	FC133 (132.7 Mb/s) FC266 (265.6 Mb/s) FC531 (531.2 Mb/s) FC1063 (1063.5 Mb/s) FC2125 (2127 Mb/s)
IEEE 1394b	S400 (491.5 Mb/s) S800 (983.04 Mb/s)	S400 (491.5 Mb/s) S800 (983.04 Mb/s) S1600 (1.9661 Gb/s)
InfiniBand		2.5 Gb/s (2127 Mb/s)

▶ Clock Recovery System

	CSA7154	CSA7404
Channel Type	Electrical, Multimode Optical, Single Mode Optical	
Clock Recovery Phase Locked Loop Bandwidth	Fbaud/1600 typical	
Tracking/Acquisition Range	5% typical	
Clock Recovery Jitter (Typical)	<0.2% bit period RMS or 8 ps_{RMS} whichever is greater for PRBS data patterns	
Input Sensitivity for Clock Recovery	1 division peak-to-peak displayed signal	
Input Data Rates	1.5 Mbaud to 1.5 Gbaud	1.5 Mbaud to 2.5 Gbaud

▶ Communications Mask Testing

	CSA7154		CSA7404
SONET/SDH GR 253-CORE (Issue 3 9/21/2000)	OC-1/STM0 OC-3/STM1 OC-12/STM4		OC-1/STM0 OC-3/STM1 OC-12/STM4 OC-48/STM16
ITU-T G.703 (10/98)	DS1 Rate, DS2 Rate Sym Pair, DS2 Rate Coax, DS3 Rate E1 Sym Pair, E1 Coax, E2, E3 E4 Binary 0, E4 Binary 1 32 Mb, 97 Mb STM 1E 0/Bin 0, STM 1E 1/Bin 1		
ANSI T1.102-1993 (R1999)	DS1, DS1A, DS1C, DS2, DS3, DS4NA, DS4NA Max Output STS-1 Pulse, STS-1 Eye STS-3, STS-3 Max Output		
Ethernet IEEE Std 802.3 and ANSI X3.263-1995	100Base-T STP, 100Base-T UTP 1000Base-SX Short Wave Optical 1000Base-LX Long Wave Optical		
Fibre Channel Optical (ANSI X3.303-1997)	FC133, FC266, FC531, FC1063, FC1063 Draft Rev 11		FC133, FC266, FC531, FC1063, FC1063 Draft Rev 11 FC2125 Draft Rev 11
Fibre Channel Electrical (ANSI X3.303-1997)	FC133E, FC266E, FC531E, FC1063E, FC1063E Normalized Beta, Delta, Gamma Transmit FC1063E Absolute Beta, Delta, Gamma Transmit FC1063E Absolute Beta, Delta, Gamma Receive		FC133E, FC266E, FC531E, FC1063E, FC1063E Normalized Beta, Delta, Gamma Transmit FC1063E Absolute Beta, Delta, Gamma Transmit FC1063E Absolute Beta, Delta, Gamma Receive, FC2125E Normalized Beta, Delta, Gamma Transmit FC2125E Absolute Beta, Delta, Gamma Transmit FC2125E Absolute Beta, Delta, Gamma Receive
USB 1.1 / 2.0 (draft)	FS:T1, T2, T3, T4, T5, T6 HS:T1, T2, T3, T4, T5, T6		
InfiniBand (draft)			2.5 Gb/s Optical 2.5 Gb/s Electrical
IEEE 1394b (draft)	S400 Optical S400b T1, S400b T2 S800 Optical S800b T1, S800b T2		S400 Optical S400b T1, S400b T2 S800 Optical S800b T1, S800b T2 S1600 Optical S1600b T1, S1600b T2
Serial ATA (draft)	G1: G1 Rx, G1 Tx		

Communications Signal Analyzers

▶ CSA7000 Series

▶ Timebase System

	CSA7154	CSA7404
Timebase Range	50 ps to 10 s/div	
Timebase Delay Time Range	16 ns to 250 s	
Channel to Channel Deskew Range	±25 ns in 1 ps steps	
Time Interval Accuracy, Single-shot Sample Mode	(0.06/sample rate + 2.5 ppm x |reading|) RMS	
Trigger Jitter	7.5 ps$_{RMS}$, 6 ps$_{RMS}$ typical	
Long Term Sample Rate and Delay Time Accuracy	±2.5 ppm over ≥100 ms interval; aging <1 ppm per year from date of factory calibration	
External Timebase Reference	Rear Panel Connection	
External Reference Input Frequency Range	9.8 MHz to 10.2 MHz	
External Reference Input Sensitivity	V_{in} ≥200 mV$_{p-p}$	
External Reference Maximum Input Signal	7 V$_{p-p}$	
Internal Reference Output Frequency	±2.5 ppm over ≥100 ms interval; aging <1 ppm per year from date of factory calibration	
Internal Reference Output Voltages	V_{out} (Hi) ≥2.5 V open circuit; ≥1.0 V into 50 Ω load to gnd V_{out} (Lo) ≤0.7 V into a load of ≤4 mA; ≤0.25 V into 50 Ω load to gnd	

▶ Acquisition System

Real-time Sample Rates	CSA7154	CSA7404
1 channel (Max. rate)	20 GS/s	
2 channels (Max. rate)	10 GS/s	
3-4 channels (Max. rate)	5 GS/s	
Equivalent Time Sample Rate (Maximum)	1 TS/s	
Maximum Record Length per Channel with Standard Memory	400 k (1 ch), 200 k (2 ch), 100 k (4 ch)	
With Memory Opt. 1M	2 M (1 ch), 1 M (2 ch), 500 k (4 ch)	
With Memory Opt. 2M	8 M (1 ch), 4 M (2 ch), 2 M (4 ch)	
With Memory Opt. 3M	16 M (1 ch), 8 M (2 ch), 4 M (4 ch)	
With Memory Opt. 4M	32 M (1 ch), 16 M (2 ch), 8 M (4 ch)	

▶ Maximum Duration at Highest Real-time Resolution (1 ch)

	CSA7154	CSA7404
Time Resolution (single-shot)	50 ps (20 GS/s)	
Maximum Duration with Standard Memory	20 us	
Maximum Duration with Opt. 1M	100 us	
Maximum Duration with Opt. 2M	400 us	
Maximum Duration with Opt. 3M	800 us	
Maximum Duration with Opt. 4M	1.6 ms	

▶ Acquisition Mode

	CSA7154	CSA7404
FastAcq Acquisition	FastAcq optimizes the instrument for analysis of dynamic signals and capture of infrequent events	
Maximum FastAcq Waveform Capture Rate	>400,000 wfms/sec	
Sample	Acquire sampled values	
Waveform Database (WfmDB)	Accumulate waveform database providing three-dimensional array of amplitude, time and counts	
Peak Detect	Captures narrow glitches at all real time sampling rates	
Minimum Peak Detect Pulse Width	400 ps	
Average	From 2 to 10,000 waveforms included in average	
Envelope	From 2 to 2x10^9 waveforms included in min-max envelope	
Hi-Res	Real-time boxcar averaging reduces random noise and increases resolution	
FastFrame Acquisition	Acquisition memory divided into segments; maximum trigger rate >150,000 waveforms per second. Time of arrival recorded with each event	

▶ Trigger System

	CSA7154	CSA7404
Sensitivity		
Internal DC Coupled, Main Trigger	0.35 div from DC to 50 MHz, ≤1 div at 1.5 GHz	0.35 div from DC to 50 MHz, ≤1.5 div at 3 GHz
External (Auxiliary Input)	250 mV from DC to 50 MHz increasing to 350 mV at 500 MHz	
Main Trigger Modes	Auto, Normal and Single	
Trigger Sequences	Main, Delayed by Time, Delayed by Events. All sequences can include separate horizontal delay after the trigger event to position the acquisition window in time	
Trigger Level Range		
Internal	±12 divisions from center of screen	
External (Auxiliary Input)	+8 V	
Line	fixed at 0 V	
Trigger Coupling	DC, AC (attenuate <60 Hz), HF Rej (attenuate >30 kHz), LF Rej (attenuates <80 kHz), Noise Reject (reduce sensitivity)	
Trigger Holdoff Modes	Random, Automatic or User-Specified Time	
Trigger Holdoff Range	250 ns minimum to 12 seconds maximum	

Trigger Modes

Edge – Positive or negative slope on any channel or front-panel auxiliary input. Coupling includes DC, AC, noise reject, HF reject and LF reject.

Comm – Support for AMI, HDB3, BnZS, CMI, MLT3 and NRZ encoded communications signals.
AMI encoding: Standards include DS1, DS1A, DS1C, DS3, E1, E2, E3, STS-1 or a custom bit rate. Select between positive or negative isolated one, zero pulse form or eye patterns.
HDB3 encoding: Standards include E1, E2, E3, DS1A or custom bit rate. Select between positive or negative isolated one pulse or eye pattern.

BnZS encoding: Standards include DS1, DS1C, DS2, DS3, STS-1 or custom bit rate. Select between positive or negative isolated one pulse or eye pattern.
CMI encoding: Standards include STS-3, STM1E, DS4NA, E4 or a custom bit rate. Select between positive or negative isolated one pulse, zero pulse or eye pattern.
MLT3 encoding: Standards include 100Base-TX.
NRZ encoding: Standards include OC1/STM0, OC3/STM1, OC12/STM4, OC48/STM16, GB Ethernet, FC133, FC266, FC531, FC1063, FC2125, InfiniBand 2.5, G1 ATA, FS USB, HS USB, IEEE 1394b S400b, S800b, S1600b; eye patterns only. CSA7154 limited to standards ≤1.25 Gb/s.

Serial Pattern – 32-Bit serial word recognizer, bits specified in binary (high, low, don't care) or hex format. Trigger on NRZ-encoded data up to 1.25 Gbaud.

Glitch – Trigger on or reject glitches of positive, negative, or either polarity. Minimum glitch width is 1.0 ns with 200 ps resolution.

Width – Trigger on width of positive or negative pulse either within or out of selectable time limits (1 ns to 1 s).

Runt – Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again. Optional time qualification.

Communications Signal Analyzers

▶ CSA7000 Series

Timeout – Trigger on an event which remains high, low, or either, for a specified time period, selectable from 1 ns to 1 s with 200 ps resolution.

Transition – Trigger on pulse edge rates that are faster or slower than specified. Slope may be positive, negative or either.

Setup/Hold – Trigger on violations of both setup time and hold time between clock and data present on any two input channels.

Pattern – Trigger when pattern goes false or stays true for specified period of time. Pattern (AND, OR, NAND, NOR) specified for four input channels defined as HIGH, LOW or Don't Care.

State – Any logical pattern of channels (1, 2, 3) clocked by edge on channel 4. Trigger on rising or falling clock edge.

Trigger Delay by Time – Trigger Delay by Time 16 ns to 250 seconds.

Trigger Delay by Events – Trigger Delay by Events 1 to 10,000,000 Events.

Waveform Measurements

Amplitude – Amplitude, High, Low, Maximum, Minimum, Peak-to-Peak, Mean, Cycle Mean, RMS, Cycle RMS, Positive Overshoot, Negative Overshoot.

Time – Rise Time, Fall Time, Positive Width, Negative Width, Positive Duty Cycle, Negative Duty Cycle, Period, Frequency, Delay.

Combination – Area, Cycle Area, Phase, Burst Width.

Histogram-related – Waveform count, Hits in box, Peak hits, Median, Maximum, Minimum, Peak-to-Peak, Mean (μ), Standard Deviation (σ), $\mu+1\sigma$, $\mu+2\sigma$, $\mu+3\sigma$.

Eye Pattern-related – Extinction Ratio (absolute, % and dB), Eye Height, Eye Top, Eye Base, Eye Width, Crossing %, Jitter (peak-to-peak, RMS and 6σ), Noise (peak-to-peak and RMS), S/N ratio, Cycle Distortion, Q-factor.

Waveform Processing/Math

Algebraic Expressions – Define extensive algebraic expressions including waveforms, scalars and results of parametric measurements e.g. (Integral (Ch. 1-Meas(Ch. 1))*1.414.

Arithmetic – Add, subtract, multiply, divide waveforms and scalars.

Relational – Boolean result of comparison $>$, $<$, $\geq$, $\leq$, $==$, $!=$.

Calculus – Integrate, differentiate.

Frequency Domain Functions – Spectral magnitude and phase, real and imaginary spectra.

Vertical Units – Magnitude: Linear, dB, dBm. Phase: degrees, radians.

Window Functions – Rectangular, Hamming, Hanning, Kaiser-Bessel, Blackman-Harris, Gaussian, Flattop2, Tek Exponential.

Display Characteristics

Display Type – Liquid crystal active-matrix color display; integral touch screen.

Display Size – 211.2 mm (W) x 158.4 mm (H), 264 mm (10.4 in.) diagonal.

Display Resolution – 640 horizontal x 480 vertical pixels.

Waveform Styles – Vectors, Dots, Variable Persistence, Infinite Persistence.

Computer System and Peripherals

CPU – 566 MHz Celeron Processor.

PC System Memory – 256 MB.

Hard Disk Drive – Rear-panel, removable hard disk drive, >4.3 GB capacity.

Floppy Disk Drive – Front-panel 3.5 in. floppy disk drive, 1.44 MB capacity.

CD-ROM Drive – Rear-panel CD-ROM drive.

Mouse – Logitech thumb wheel model included, USB interface.

Input/Output Ports

Probe Compensation Output – Front-panel BNC connector, requires Probe Cal-Deskew Fixture (included) for probe attachment. 400 mV $\pm$20% into >10 kΩ load (V_{OH}=2 V, V_{OL}=1.6 V typical). 200 mV $\pm$20% into a 50 Ω load (V_{OH}=1 V, V_{OL}=0.8 typical).

Recovered Clock Out – Front-panel SMA connector provides output of clock signal recovered from specified channel. Output compatible with ECL terminated with 50 Ω to GND. Peak-to-peak output swing at 625 MHz is at least 200 mV$_{p-p}$ into 50 Ω. Higher frequencies will be further attenuated by $\approx$ 6 dB per octave above 625 MHz.

Recovered Data Out – Front-panel SMA connector provides regenerated data output from clock recovery system. Serial data output baud rate $\leq$1250 Mbaud. Output swing at this baud will be at least 200 mV into 50 Ω.

Optical In – Optoelectronic converter input, 700 nm to 1650 nm, Rifocs connector.

O/E Output – Front-panel BMA connector providing electrical output of optoelectronic converter. SMA adapter included.

Analog Signal Output Amplitude – Rear-panel BNC connector, provides a buffered version of the signal that is attached to the Channel 3 input when Ch. 3 is selected as trigger source. Frequency response: 1 GHz into a 50 Ω load. Amplitude: 20 mV/div $\pm$20% into a 1 MΩ load, 10 mV/div $\pm$20% into a 50 Ω load.

Auxiliary Output – Rear-panel BNC connector, provides a TTL-compatible, polarity switchable pulse when the oscilloscope triggers or optionally, upon mask test failure or test completion.

External Timebase Reference In – Rear-panel BNC connector, timebase system can phase-lock to external 10 MHz reference.

Timebase Reference Out – Rear-panel BNC connector, provides TTL-compatible output of internal 10 MHz reference oscillator.

Parallel Port – IEEE 1284, DB-25 connector.

Audio Ports – Miniature phone jacks for stereo microphone input and stereo line output.

USB Port – Allows connection or disconnection of USB keyboard, mouse or other peripherals while oscilloscope power is on.

Keyboard Port – PS-2 compatible.

Mouse Port – PS-2 compatible.

LAN Port – RJ-45 connector, supports 10Base-T and 100Base-T.

Serial Port – DB-9 COM1 port.

SVGA Video Port – DB-15 female connector; connect a second monitor to use dual-monitor display mode. Supports Basic requirements of PC99 specifications.

GPIB Port – IEEE 488.2 standard.

Scope VGA Video Port – DB-15 female connector, 31.6 kHz sync, EIA RS-343A compliant, connect to show the oscilloscope display, including live waveforms on an external monitor or projector.

Power Source

Power – 100 to 240 V_{RMS}, ±10%, 50/60 Hz CAT II. 115 V_{RMS} ±10%, 400 Hz CAT II. < 300 Watts (450 VA).

Physical Characteristics

BENCHTOP CONFIGURATION

Dimensions	mm	in.
Height	277	10.9
Width	455	17.9
Depth	425	16.75
Weight	**kg**	**lb.**
Net	18	39.6
Shipping	37	81.4

RACKMOUNT CONFIGURATION

Dimensions	mm	in.
Height	277	10.9
Width	502	19.75
Depth	486	19.125
Weight	**kg**	**lb.**
Net	19	41.8
Shipping	5.6	12.32

MECHANICAL

Required Clearance	mm	in.
Top	0 or >76	0 or >3
Bottom	0	0
Left side	76	3
Right side	76	3
Front	0	0
Rear	0	0

Environmental

Temperature –
Operating: 0°C to +50°C, excluding floppy disk and CD-ROM drives.
+10°C to +45°C, including floppy disk and CD-ROM drives.
Nonoperating: –22°C to +60°C.

Humidity –
Operating: 20% to 80% relative humidity with a maximum wet bulb temperature of +29°C at or below +50°C, noncondensing. Upper limit derated to 25% relative humidity at +50°C.
Nonoperating: With no diskette in floppy disk drive, 5% to 90% relative humidity with a maximum wet bulb temperature of +29°C at or below +60°C, noncondensing. Upper limit derated to 20% relative humidity at +60°C.

Altitude –
Operating: 10,000 ft. (3,048 m).
Nonoperating: 40,000 ft. (12,190 m).

Random Vibration –
Operating: 0.00015 g^2/Hz from 5 to 350 Hz,
–3 dB/octave from 350 to 500 Hz,
0.000105 g^2/Hz at 500 Hz.
Overall level of 0.27 g_{RMS}.
Nonoperating: 0.0175 g^2/Hz from 5 to 100 Hz,
–3 dB/octave from 100 to 200 Hz,
0.0875 g^2/Hz from 200 to 350 Hz,
–3 dB/octave from 350 to 500 Hz,
0.006132 g^2/Hz at 500 Hz.
Overall level of 2.28 g_{RMS}.

Electromagnetic Compatibility – EN 61326 (EU EMC Directive 89/336EEC).
AS/NZS 2064 (Australian EMC Framework).

Safety – UL 3111-1, CSA-22.2 No. 1010.1, EN61010-1.

▶ Ordering Information

CSA7404

4 GHz Communications Signal Analyzer.

CSA7154

1.5 GHz Communications Signal Analyzer.

All Models Include: Accessory pouch, front cover, mouse, probe calibration and deskew fixture (067-0405-xx), O/E Electrical Output to Ch. 1 Input Adapter (013-0327-xx), Fiber cleaning kit (020-2357-xx), Quick Reference (020-2404-xx), User Manual (071-7010-xx), GPIB Programmer's Reference, TDS/CSA7000 Series Product Software CD-ROM, TDS/CSA7000 Series operating system restoration CD-ROM, Optional Applications Software CD-ROM, Oscilloscope Analysis and Connectivity Made Easy Kit, Option SM and ST User Manual (071-1035-xx), Performance verification procedure PDF file, NIST, MIL-STD-45662A, ISO9000 Calibration Certificate and Power Cord.

CSA7404 also includes: (4) TekConnect™ to SMA adapters (TCA-SMA).

CSA7154 also includes: (4) TekConnect to BNC adapters (TCA-BNC).

Options

Acquisition Memory

Opt. 1M – 2 Msamples max, 500 ksamples/ch.

Opt. 2M – 8 Msamples max, 2 Msamples/ch.

Opt. 3M – 16 Msamples max, 4 Msamples/ch.

Opt. 4M – 32 Msamples max, 8 Msamples/ch.

Mounting

Opt. 1K – K4000 Scope cart.

Opt. 1R – Rackmount kit.

Software

Opt. CP2 – TDSCPM2 Compliance Testing for ITU-T G.703 and ANSI T1.102 communications standards.

Opt. J1 – TDSJIT2 Jitter Analysis Software.

Opt. JT3 – TDSJIT3 Jitter Analysis Software.

Opt. J2 – TDSDDM2 Disk Drive Analysis Software.

Opt. USB – TDSUSBS USB2.0 Compliance Test Software; used in conjunction with TDSUSBF USB test fixture.

Probes

Opt. 37 – Add (1) P6245 1.5 GHz Active Probe (CSA7154 only).

Opt. 39 – Add (1) P6248 1.7 GHz Differential Probe. (CSA7154 only).

Opt. 51 – Add (1)P7240 4 GHz Active Probe (CSA7404 only).

Opt. 52 – Add (1) P7330 3.5 GHz Differential Probe (CSA7404 only).

Service

Opt. C3 – Additional 2 years of calibration.

Opt. C5 – Additional 4 years of calibration.

Opt. D1 – Calibration data report.

Opt. D3 – Calibration data report for Opt. C3.

Opt. D5 – Calibration data report for Opt. C5.

Opt. R3 – Additional 2 years of repair.

Opt. R5 – Additional 4 years of repair.

Power Cord Options

Opt. A1 – Universal European power cord (220 V, 50 Hz).

Opt. A2 – UK power cord (240 V, 50 Hz).

Opt. A3 – Australia power cord (240 V, 50 Hz).

Opt. A5 – Switzerland power cord (220 V, 50 Hz).

Opt. A99 – No power cord.

Opt. AC – China power cord.

Communications Signal Analyzers

▶ CSA7000 Series

Recommended Accessories

AFTDS – Telecom differential electrical interface adapter (for line rates <8 Mb/s; requires TCA-BNC adapter).

AMT75 – 1 GHz precision 75 Ω adapter (for line rates >8 Mb/s; requires TCA-BNC adapter).

TDSUSBF – USB test fixture; used in conjunction with Option USB, USB 2.0 Compliance Test Software.

P6701B – Optical-to-Electrical Converter; 500 nm to 950 nm (requires TCA-BNC adapter).

P6703B – Optical-to-Electrical Converter; 1100 nm to 1650 nm (requires TCA-BNC adapter).

TCP202 – DC to 50 MHz Current Probe (requires TCA-BNC adapter).

P7260 – 6 GHz Active Probe (TekConnect).

P6150 – 9 GHz Low Capacitance Passive Voltage Probe (requires TCA-SMA adapter).

P6158 – 3 GHz Low Capacitance Passive Voltage Probe (requires TCA-BNC adapter).

CT6 – 2 GHz AC Current Probe (requires TCA-BNC adapter).

CT1 – 1 GHz AC Current Probe (requires TCA-BNC adapter).

TCA-1MEG Amplifier – High-impedance buffer; 1 MEG Ω/10 pF; TekProbe BNC-to-TekConnect; includes P6139A.

VCLNKP – VocalLink™ Pro Voice Controlled Software.

VCLNKB – VocalLink™ Basic Voice Controlled Software.

WSTRO – WaveStar™ waveform capture and documentation software.

Keyboard – Fits in pouch, PS-2 interface; Order 118-9402-00.

Keyboard – Full size, USB interface; Order 119-6633-00.

Services Manual – Order 071-7011-00.

Transit Case – Order 016-1522-00.

GPIB Cable (1M) – Order 012-0991-01.

GPIB Cable (2M) – Order 012-0991-00.

Centronics Cable – Order 012-1214-00.

Optical Connector Adapters

FC/PC – Order 119-5115-00.

SC/PC – Order 119-5116-00.

ST/PC – Order 119-4513-00.

DIN/PC 47256 – Order 119-4546-00.

Diamond 2.5 – Order 119-4556-00.

Diamond 3.5 – Order 119-4558-00.

SMA 2.5 – Order 119-4517-00.

SMA – Order 119-4557-00.

TekConnect Adapters

TCA-SMA – TekConnect-to-SMA Adapter.

TCA-BNC – TekConnect-to-BNC Adapter.

TCA-N – TekConnect-to-N Adapter.

Instrument Upgrades

Order a **CSA7UP** kit and select the appropriate option from the following list according to current and intended configuration.

Acquisition Memory Upgrades

Acquisition memory upgrades equivalent to Options 1M to 4M can be ordered to extend instrument performance after initial purchase. Users can install upgrades without opening the instrument case or requiring on-site service (refer to table).

For example, to upgrade from Standard Memory to Opt. 4M, order CSA7UP Opt. M04.

Software Upgrade Options

Opt. CP2 – TDSCPM2 Compliance Testing for ITU-T G.703 and ANSI T1.102 communications standards.

Opt. J1 – TDSJIT2 Jitter Analysis Software.

Opt. JT3 – TDSJIT3 Jitter Analysis Software.

Opt. J2 – TDSDDM2 Disk Drive Analysis Software.

Opt. USB – TDSUSBS USB2.0 Compliance Test Software; used in conjunction with TDSUSBF USB test fixture.

For the most up-to-date product information visit our web site at **www.tektronix.com**

▶ Acquisition Memory Upgrades

	To Opt. 1M	To Opt. 2M	To Opt. 3M	To Opt. 4M
From Standard Memory	Opt. M01	Opt. M02	Opt. M03	Opt. M04
From Opt. 1M	–	Opt. M12	Opt. M13	Opt. M14
From Opt. 2M	–	–	Op. M23	Opt. M24
From Opt. 3M	–	–	–	Opt. M34

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