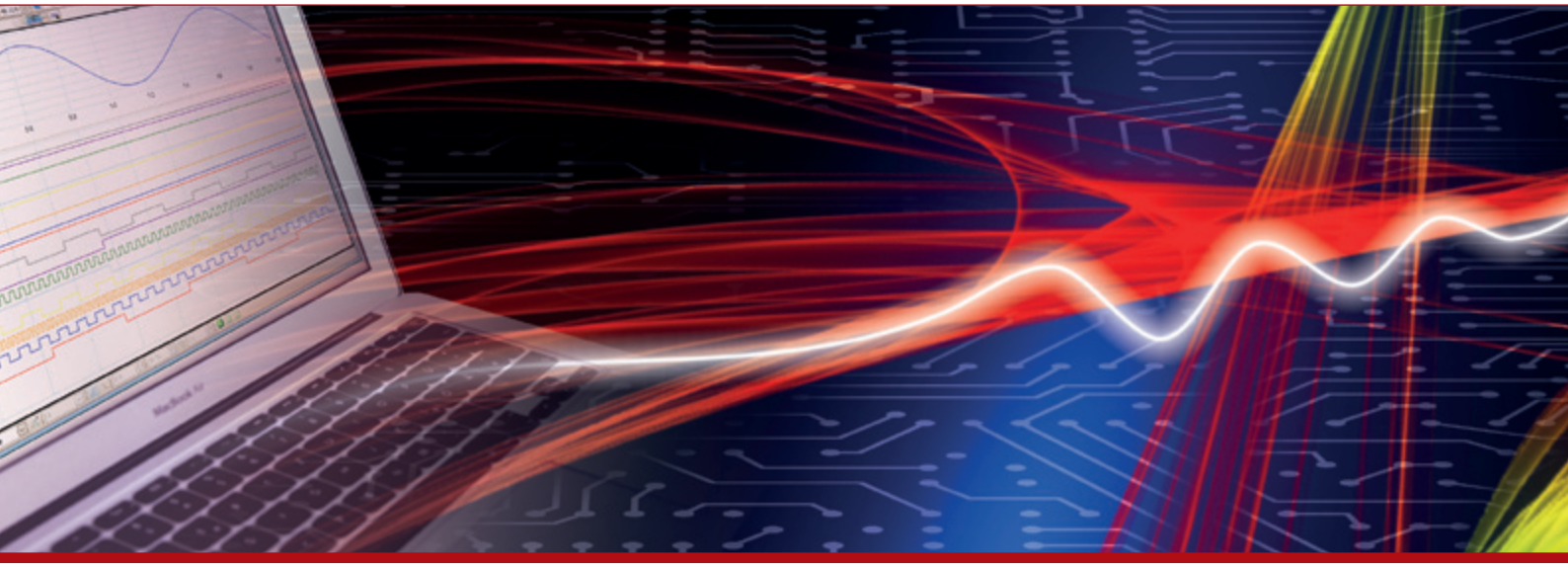
Product Datasheet - Technical Specifications



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Your contact

Technical and commercial sales, price information, quotations, demo/test equipment, consulting:

Tel.: **+49 - (0)81 41 - 52 71-0**

FAX: **+49 - (0)81 41 - 52 71-129**

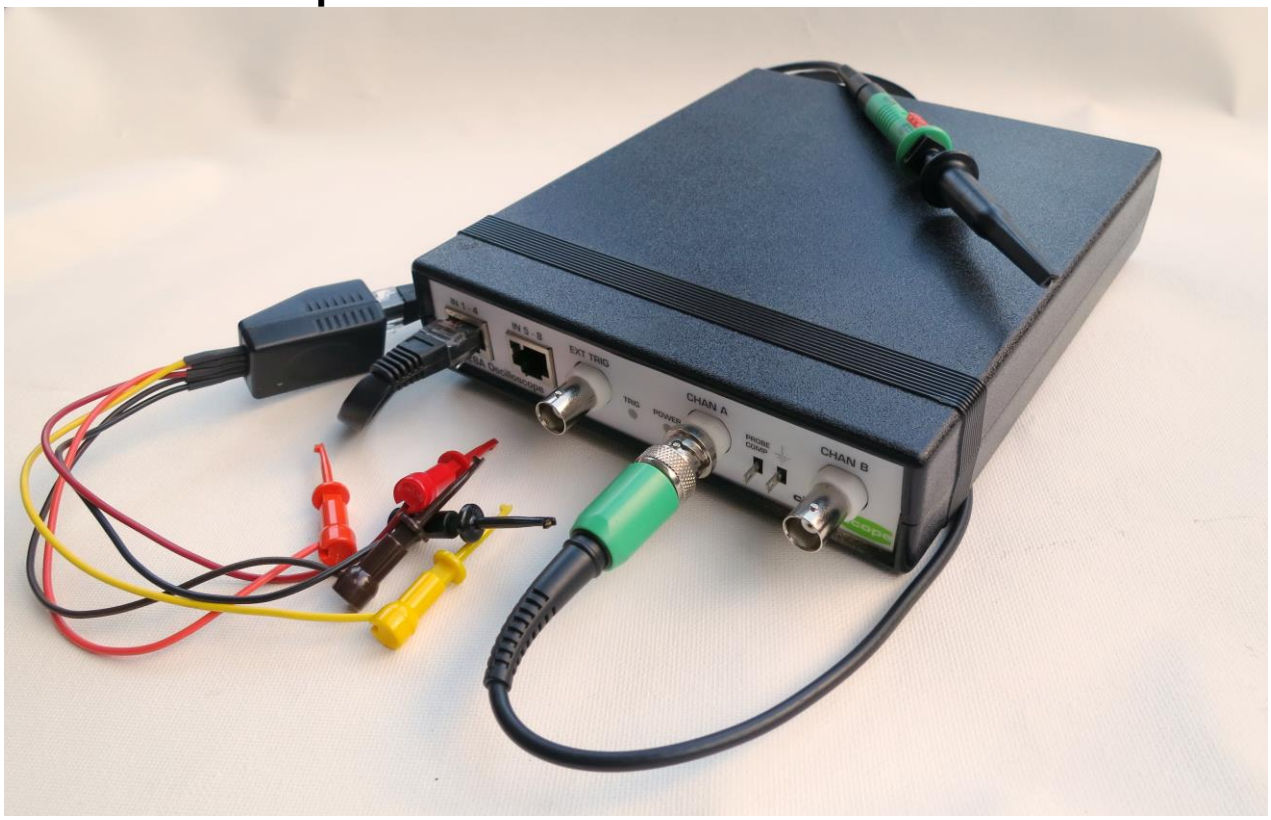
E-Mail: **sales@meilhaus.com**

Meilhaus Electronic GmbH
Am Sonnenlicht 2
82239 Alling/Germany

Tel. **+49 - (0)81 41 - 52 71-0**
Fax **+49 - (0)81 41 - 52 71-129**
E-Mail **sales@meilhaus.com**

www.meilhaus.com

Cleverscope Model CS320A - CS328A Data Sheet



Summary

Cleverscope Model CS320A or CS328A is a USB or Ethernet connected, PC hosted oscilloscope and spectrum analyser. It's easy to use Windows program integrates with standard office applications. Graphs and data can be copied and pasted to other applications, saved or loaded from disk, and printed. The CS320A is the same as the CS328A, except it has not digital inputs.

Cleverscope hardware resources include:

- Two 12 or 14 bit analog channels sampling simultaneously at 100 MSa/sec.
- One external trigger.
- Eight digital inputs sampling at 100 MSa/sec (not CS320A).
- A rear panel I/O connector with a 100 Mbit/sec bi-directional LVDS/RS422 link, and three RS422 outputs.
- Eight Mega samples of storage per channel, providing two or more frames of signal of 20 or 40 ms of storage with 10 ns resolution. (Total storage is 64 Mbytes, distributed over the sample space).
- Moving average (6 time constants) and 20 MHz Anti-alias filter for improved Spectrum Analysis performance and ENOB.
- A dual triggered system allow triggers on edge, slope, period, count conditioned by digital values.
- Triggered LED on the front panel
- Two optional plug-in signal generators, one is 0-10MHz, sine, square or triangle, the other is isolated (300V Cat II) 0-65 MHz sine wave.
- An optional External Sample clock input (range 1-105 MHz).

Cleverscope software resources include:

- Separate, freely moveable, windows to display the signal, a zoomed signal view, and the frequency spectrum of the signal.
- Spectrum analysis with a variety of conditioning windows.
- Signal averaging and filtering.
- Protocol decoding – I^2C, SPI , UART and parallel bus.

- Matlab live link via Maths process
- Full mathematical functions including + - / * sqrt, transcendental functions, integral differential and filtering. Up to 10 user defined mathematical equations.
- Logging of derived values – Frequency, RMS, p-p, period, DC, std dev and marker values.
- Signal measurement, including peak, RMS, DC, pulse width, period and frequency.
- Copy and Paste to other applications.
- Save and Open from disk, including autosave following trigger.
- Continuous save to disk at up to 1.5 MSPS. Pan and zoom over 500G sample space.
- User chosen units and scaling.
- Text annotation of each graph.
- Link two units for 4 channel operation
- 64bit Control Driver with sample code in labview, Matlab, C#, C++, Python and VB .Net

Specification

Acquisition

Acquisition Outputs	Waveforms: Sampled, Peak Detected, Filtered, Averaged in PC, Averaged in Acquisition Unit, and Spectrum
Acquisition Modes	Single Shot, Triggered, Automatic, Repetitive (High Frequency), Multiple Frame
Acquisition Rate to PC, via USB	20 Frames per second
Acquisition Rate, multiple frame	Continuous capture until buffer is full (2 - 3000 frames of 4M - 1300 samples)
Filtering	Moving average filter with 40n – 1.28us time constant. Resolution improvement to 12 or 14 bits. 20 MHz anti-alias filter.

Analog Inputs

Number	2
Input Coupling	DC, AC, GND
Input Impedance, DC coupled, all channels	1 MΩ ±2% in parallel with 20 pF ±3 pF
Probe Attenuation	1X, 10X
Maximum Voltage between Signal and Common at input BNC	300 Vrms (420V peak, duty cycle <50%, pulse width <100 msec) For steady state sinusoidal waveforms, derate at 20 dB/decade above 100 kHz to 10 Vpk at 3MHz and above.
Time delay between channels, typical	200 ps
Channel to Channel Crosstalk, typical	-70 dB at 10 MHz, 4V p-p signal.

Vertical

Digitizers	12 or 14 bit resolution (depending on option module)
Full Scale Volts Range	20 mV to ±20V, 1X probe
Resolution	0.02 mV for 20 mV Full Scale.
Position Range	Full Scale Range as above moved anywhere in the range ±2.5V with 10mV resolution for full scale less than 5V, and anywhere in the range ±20V with 100mV resolution for full scale greater than 5V.
Analog Bandwidth	100 MHz, -3dB
Instantaneous Capture Bandwidth	25 Mhz

Repetitive Sampling Bandwidth	100 MHz, -3 dB
Analog Bandwidth in Peak Detect Mode	50 MHz
Analog Bandwidth with Anti-Aliasing filter on	20 MHz
Analog Bandwidth with Moving average filter on	0.3 - 20 MHz (6 settings)
Lower Frequency limit, AC coupled	10 Hz, 1x probe, 1Hz, 10x probe
Rise time at the BNC, typical	<3.5 ns
Peak detect response	Captures all pulses >10 ns in duration.
DC Gain accuracy	±1% for Sample or Averaged acquisition mode
DC Measurement accuracy	±1% for Sample or Averaged acquisition mode +0.1 division.
Delta Volts measurement	Volts between any two points, ±1% for Sample or Averaged acquisition mode +0.02 division.

Horizontal

Sample Rate Range	100 MSa/sec to 1500 samples/sec
Waveform interpolation	Sin(x)/x
Record Length	1024 – 4 000 000 samples for each channel
Sec/Div Range	1 ns/div to 5 s/div in 1,2,5 sequence

Vertical

Sample Rate and Delay time Accuracy	+/50 ppm over any >1 ms interval
Sample Clock jitter, typical	1 ps rms
Delta Time Measurement Accuracy	(±1 sample interval + 50 ppm +0.4 ns).
Position Range	+/- 21.47 secs of the trigger point, with 10 ns resolution.
Captured Sample window duration	1 usec – 40 msec with 10ns resolution 40 msec – 40 secs with 10ns - 10 us resolution. (Lower sample rates are used for smaller capture buffer sizes)

Trigger

Number of triggers	2
Trigger sources	Each trigger can be independently set to source from Channel A, Channel B, Ext Trig, Link Input, and Digital Inputs 1-8 as a pattern.
Trigger Sensitivity, Edge Triggered	Analog Channels – 0.2 Div from DC to 50 MHz External Trigger – 50 mV from DC to 100 MHz Digital Inputs – 100 mV from DC to 100 MHz
Trigger Modes	Edge, Pattern, Pulse Duration, Voltage slope, Voltage Window, Count, OR. Combination of duration and count.
Trigger Filtering	Noise reject, HF reject, LF reject
Trigger Level Range	Internal: defined by scope graph. External: -8 to +18V in 40 mV increments Digital: 0 – 8V in 10 mV steps
Trigger Level Accuracy	Internal: ±1% External: ±3% + 50 mV Digital: ±3% + 100 mV
Trigger Delay Range	0 – 21.47 secs with 10ns resolution.

Digital Inputs (CS328A)

Number	8
Input impedance	100kΩ ±2% in parallel with 10 pF ±2 pF
Input voltage range	-16 to + 20V
Threshold range	0 – 8V in 10 mV steps
Threshold sensitivity	100 mV
Sample Rate	100 MSa/sec

PC Interface

Types of Interface	USB 2.0 (480 Mbit/sec) or Ethernet (100 MBit/sec)
Effective Throughput rate	USB – 18 Mbyte/sec, Ethernet – 6 Mbyte/sec
Isolation	USB, none, Ethernet – 20 pF, 1500VAC isolation
Ethernet connectivity	DHCP or Point-to-Point or IP addresses. Cable direction auto-sense.

Calibration

Calibration method	Automatic self calibration
Calibration Voltage Source	Range ±2.5V Resolution 1 mV Drift 11 ppm/°C Accuracy ±1%
Temperature Compensation	Via Internal temperature sensor, ±1.5°C accuracy

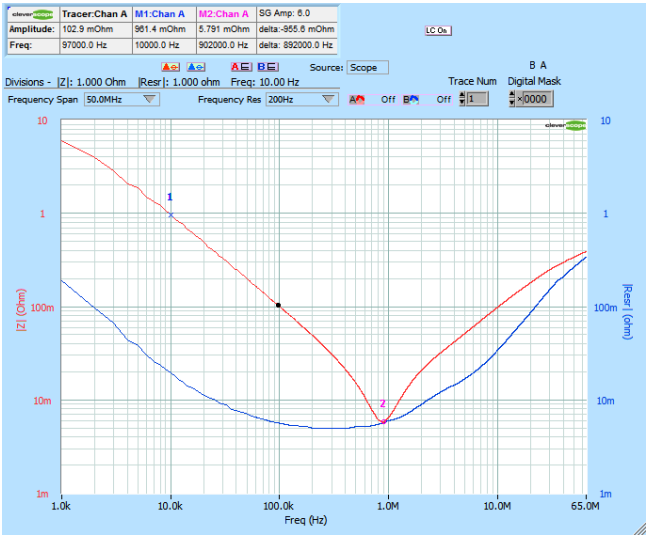
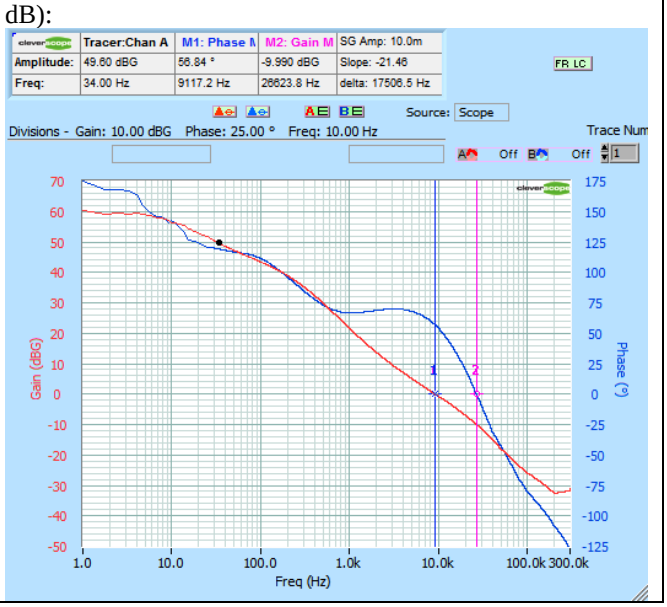
Displays

Windows	Simultaneous Capture, Tracking, Spectrum, Information, Maths, XY, Control Panel and Protocol setup windows
Capture window functions	Defines capture specification for signal acquisition unit, defining amount of time before trigger, amount of time after the trigger, lower amplitude limit, upper amplitude limit. Defines Tracking graph time position, when tracking graph is linked. Defines trigger level and direction Full zoom and Pan in both axis. Annotations. Custom colours
Tracking window functions	Displays zoomed section of captured signal. Resolution from 10ns to 5s/div. Full zoom and Pan in both axis. Annotations. Custom colours
Spectrum window functions	Display spectrum of signal captured in capture window. User definable resolution Full zoom and Pan in both axis. Annotations. Custom colours
Maths window function	Displays results of Maths equations. Maths equations are user entered expressions involving any of the inputs (analog and digital), previous maths equation line results, and an arbitrary number of function results (+ - * / sqrt, power, log, ln, all transcendental functions, equality functions). Provide live Matlab link.
XY window function	Displays XY graph from source (Capture, tracking, spectrum, or Maths

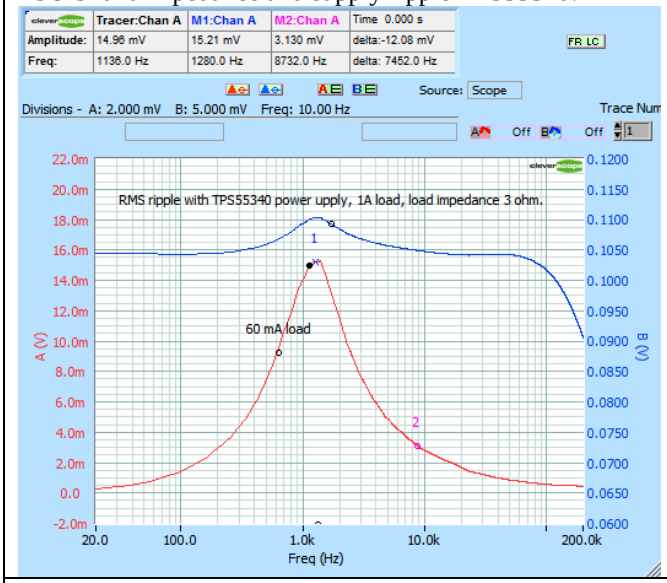
Information window functions	Displays automated measurements (see below) Used to log derived information values to disk, with a period of between 0.05 – 86,400 secs per sample. Live logging to Excel DDE live value transfer to Excel.
Control window functions	Provides Trigger settings – analog and digital Provides Sample control – single, triggered or automatic. Provides access to tools – Pan, Zoom, Annotate Controls Frame store Controls Spectrum resolution, acquisition method and averaging
Frequency Response Analysis (FRA)	FRA control panel is used to setup up oscilloscope/signal generator to make automated measurements of these values vs frequency: • RMS Amplitude • Power • Power Density • Gain/Phase • Impedance + R_{ESR} or Q/D Factor or Phase • Capacitance + R_{ESR} or D Factor or Phase • Inductance + R_{ESR} or Q Factor or Phase • Shunt Impedance (magnitude without phase for low impedances) • PSU Gain/Phase - for finding Gain/Phase of powered up power supplies • PSU PSRR - for finding PSRR of powered up power supplies • PSU Output Impedance - for finding Output Impedance of powered up power supplies • PSU Input Impedance - for finding Input Impedance of powered up power supplies • Probe calibration functions for maximum accuracy.
Protocol Setup	Provides protocol setup for I^2C, SPI , UART and parallel bus.

Frequency Response Analysis Functions (FRA)

The Frequency Response Analysis (FRA) system uses the optional signal generator to provide stimulus for component, system or power supply measurements. The measurements available are shown in the Displays/FRA section of the data sheet. Here are a collection of measurements made using the FRA system (zoom on the PDF to see the detail):

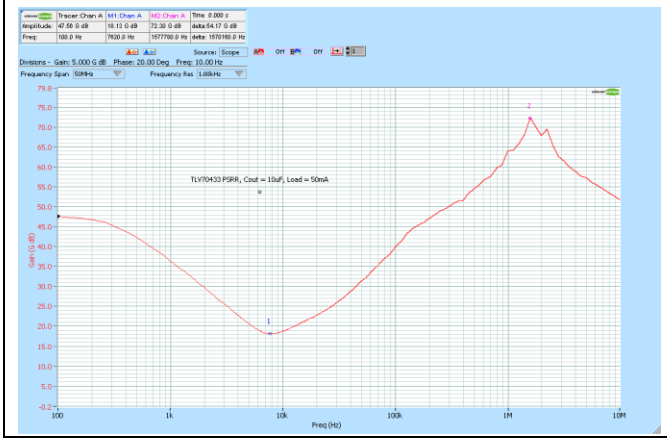
Impedance of a ceramic capacitor	PSU Gain Phase of switching power supply TPS55340 showing Phase Margin (56.8 deg) and Gain Margin (20 dB):
	

PSU Shunt Impedance and supply ripple TPS55340:

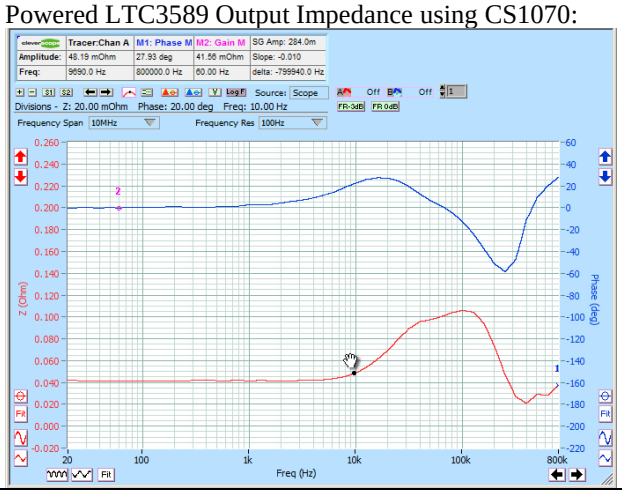


Gain/Phase of a 10.7 MHz filter:

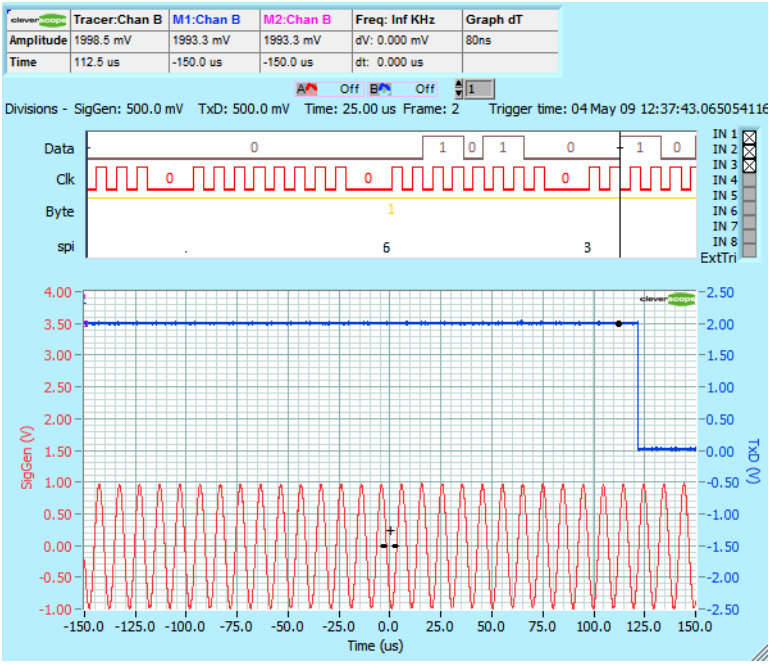
TLV70433 PSRR using CS1070 (1A 50 MHz op-amp):



Powered LTC3589 Output Impedance using CS1070:



Example Mixed Signal Window



Measurements

Cursors	Voltage Difference between cursors Time difference between cursors Reciprocal of ΔT in Hertz (1/ΔT).
Automated measurements	<table><tr><th>Function</th><th>Function</th><th>Function</th><th>Function</th></tr><tr><td>DC</td><td>0 -> 1 Time</td><td>DC</td><td>A at F</td></tr><tr><td>RMS</td><td>1 -> 0 Time</td><td>RMS</td><td>B at F</td></tr><tr><td>Max</td><td>V '1'</td><td>Fsignal</td><td>A max</td></tr><tr><td>Min</td><td>V '0'</td><td>Vsignal</td><td>A min</td></tr><tr><td>Pk-Pk</td><td>V swing</td><td>F1</td><td>B max</td></tr><tr><td>Std Dev</td><td>Overshoot</td><td>V1</td><td>B min</td></tr><tr><td>Period</td><td>Slew rate</td><td>F2</td><td>Amax at 0 B</td></tr><tr><td>Fundamental Frequency</td><td>Pulse Period</td><td>V2</td><td>Amin at 0 B</td></tr><tr><td>Fundamental Peak amp</td><td>Pulse Frequency</td><td>F3</td><td>Bmax at 0 A</td></tr><tr><td>Pulse Length</td><td>Pulse Length</td><td>V3</td><td>Bmin at 0 A</td></tr><tr><td>Duty Cycle</td><td>Duty Cycle</td><td>SINAD</td><td>A -3dB L: H</td></tr><tr><td></td><td></td><td>THD</td><td>B -3dB L: H</td></tr><tr><td></td><td></td><td>HD2+3</td><td></td></tr></table>
Custom units	6 characters
Custom signal names	20 characters
Custom scaling	Scale + offset by defining two (Vin,Vout) points
User definable colours	Signals, Background, Major Grid, Minor Grid

Mathematical Functions

Functions over the signal	Differentiation, Integration, Filtering, Power functions, Matlab interface, Signal Processing functions
Functions on a data point	Addition, subtraction, multiplication, division, squaring, square root, (inverse) sine, cosine, tangent, tangent, log, sign etc. Equality operations.
Maximum number of sequential mathematical equations	10

Spectrum Analysis

Frequency Range	User definable, Range = 0- 1/Scope Graph ΔT Frequency axis – log or linear.
Analysis Output	RMS Amplitude, Power, Power Density, Gain/Phase
Frequency Resolution	Spectrum has from 1024 to 1048576 points (50 Hz in 50 MHz).
Output type	Volts, Power, Gain/Phase in linear , dB, degree or radian values. Custom units can be applied.
Window types	None, Hanning, Hamming, Blackman-Harris, Flat top, Low Sidelobe
Averaging	Moving average, block average, peak hold.
Averaging method	Vector averaging in time domain if triggered. RMS averaging in frequency domain if not triggered.

Protocol Decode

Protocols	I^2C, SPI , UART and parallel bus.
Protocol decode inputs	Digital Inputs 1-8, External trigger, Channels A, B User defined threshold when using analog inputs
Protocol decode variables	Number of bits, Clock edge rising or falling, Bit invert/non Invert, Select Hi/Lo, MSB first or not, Number of stop bits.
Output display type	Naming label. Character, Hexadecimal or Decimal Number. Colour.

Charting

Sampling Rate	1 SPS – 1.5 MSPS
Sample preparation	Peak capture or Moving average filter prior to decimation. Using 1.28us filter with 12 or 14 bit ADC we achieve 16 bits ENOB at 1 MSPS.
Sample storage	Up to 500 G samples. Samples are stored in multiple smaller files to increase speed.
Review capabilities	Zoom and pan anywhere in sample space. Samples are displayed peak captured (ie 1us pulse will still be visible in 1 day long sample record).
Export capabilities	Export tab delimited text, binary, or cleverscope format file. Output between markers, or current display. Set output depth.

Data Export

File types output	Cleverscope proprietary, Tab delimited tex (Excel compatible), Excel file (for signal information logging).
Live Data output	DDE to Exel, direct placement of data into live Excel sheet Live data output to and return from Matlab

Windows facilities

Standard Functions	Copy and Paste Save and Open native format (saves full setup) Save and Open tab delimited text file Save and Open binary file (start time, dt, data) Print with Date/Time, File Name and Description. Print Setup
Windows	Dynamically resized Can be placed anywhere on desktop
User settable units	6 characters
User settable signal names	20 characters
User settable scaling	Scale + offset by defining two (Vin,Vout) points
User definable colours	Signals, Background, Major Grid, Minor Grid

Probe Compensator Output

Output Voltage, typical	2V into >100kΩ load
Output Frequency	1 kHz

Power Source

Source voltage into unit	7 - 15V DC
Power Consumption	6W
Standard power adaptor voltage range	100 – 240VAC 50-60 Hz

Environmental

Temperature	Operating: 0°C to +40°C Storage: -20°C to +60°C
Cooling Method	Convection
Humidity	0°C to +40°C <90% relative humidity >40°C <60% relative humidity
Altitude	Operating 3,000 m Non-operating 15,000m

Mechanical

Size	Height 35 mm Width 153 mm Depth 195 mm (including BNC)
Weight (approx)	Standard packaging: 1.6 kg

Expansion Capability

Signal Generator Plug-in CS700A

Function	Generate Sine, Square or Triangle output signals
Generation Method	Direct Digital Synthesis
Output Sampling Rate	50 MSa/sec
Frequency Range	Sine, Square: 0.2 Hz – 10 MHz Triangle: 0.2 – 1 MHz
Resolution	0.003 (<750 kHz) or 0.2 (<10 Mhz) Hz
Accuracy	50 ppm in 1 year, 0-40 deg C
Output Voltage Range	300mV – ±5V p-p including DC offset
Output Voltage Resolution	10 mV
Output Impedance	50 ohm
Output Voltage Offset Range	-4 to +4V
Output Voltage Offset Resolution	10 mV
Frequency Shift Range	Any two frequencies in range 0.2Hz – 10 MHz
Signal to Noise Ratio	-60 dBc typical
Total Harmonic Distortion	0 – 1 MHz : < -60 dBc > 1 MHz: < -45 dBc
Amplitude Flatness	± 0.2 dB
Amplitude Accuracy	± 2%
Square Wave Rise/Fall Times	< 12 ns
Protection	Short Circuit Protected ± 10V peak overdrive < 1 min

Signal Generator Plug-in CS701

Function	Sine Wave Generator with future AWG capability
Frequency Range	0 - 65 MHz (-3 dB)
Frequency Step	50 mHz with 50 kHz upper frequency limit
	10 Hz with 65 MHz upper frequency limit

DAC resolution	14 bit
Output Impedance	50 ohms
Freq Accuracy	50 ppm
SFDR to Nyquist	87 dBc at 10 MHz Fout
Phase Noise	1kHz offset, -150 dBc/Hz
IMD	88 dBc at 10 MHz Fout
Amplitude Range	0 - 6.8V p-p
Offset Range	0 - +/-3.4V (with clipping at +/-3.4V)
AWG	4096 samples maximum at 167.772 MHz sampling rate
	The sample rate may be reduced in steps of 6ns.
	Continuous at 50 ksps
Modulation	Phase, frequency, amplitude
Isolation	300 V RMS, Class III
Isolation Capacitance	7.3 pF (Output BNC shell to Cleverscope Ground)
Common Mode dV/dt	25 kV/µs

Sampling Channels

Increase in sampling channels	Stack two units on top of each other. Uses two USB links, and Trigger link cable. Delivers 4 analog, and 16 digital channels.

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