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Accessories Guide for CS548 Series Isolated Channel Oscilloscopes

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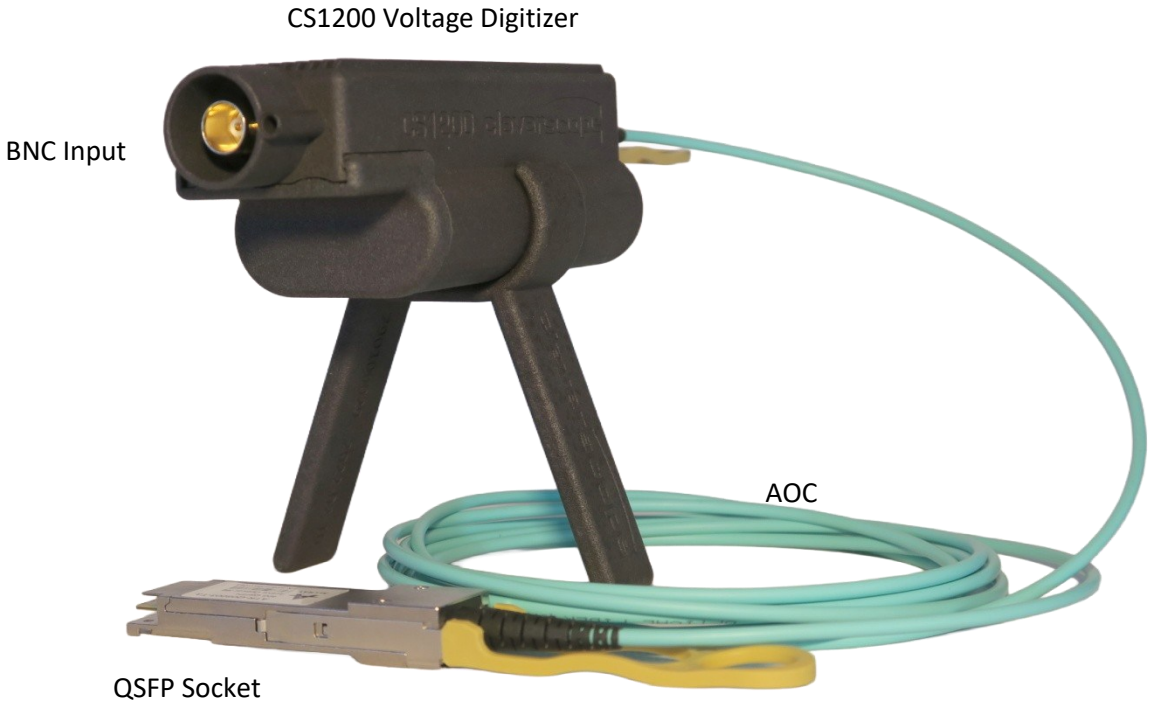
System Accessories Overview

CS1200 Voltage Digitizer

The CS1200 remote isolated Voltage Digitizer (VD) is used with the CS548 when higher isolation voltage is required or to make measurements in a safety cage, or further away from the CS548. Each uses a standard QSFP terminated active optical cable (AOC) to connect the CS1200 to the QSFP remote sockets on the CS548 front Panel. The CS1200 input specification is identical to the CS548 internal channels.



The CS1200 allows time aligned measurements to be made between locations up to 60m apart (using 30 m cables), and measurements in hazardous, high voltage situations. The VD batteries are standard 21700 5AHr cells and offer more than 6 hours operation before recharge. One set of cells can be recharged while the other set is being used. Cleverscope supplies two sets of batteries, and a charger.

CS1200 Voltage Digitizer (VD)

- 30 kV isolation provided >150 mm spacing between Digitizer and other structures.
- Pod enclosure isolation to BNC > 1 kV
- 2 pF free space capacitance >50 mm above reference plane
- 100 dB CMRR at 50 MHz
- 14 bit resolution, 100 dB dynamic range
- 200 MHz Analog BW
- Two hardware ranges:
  ±0.8 V with 100 µV resolution
  ±8 V with 1 mV resolution
- 1 MΩ // 21 pF input impedance

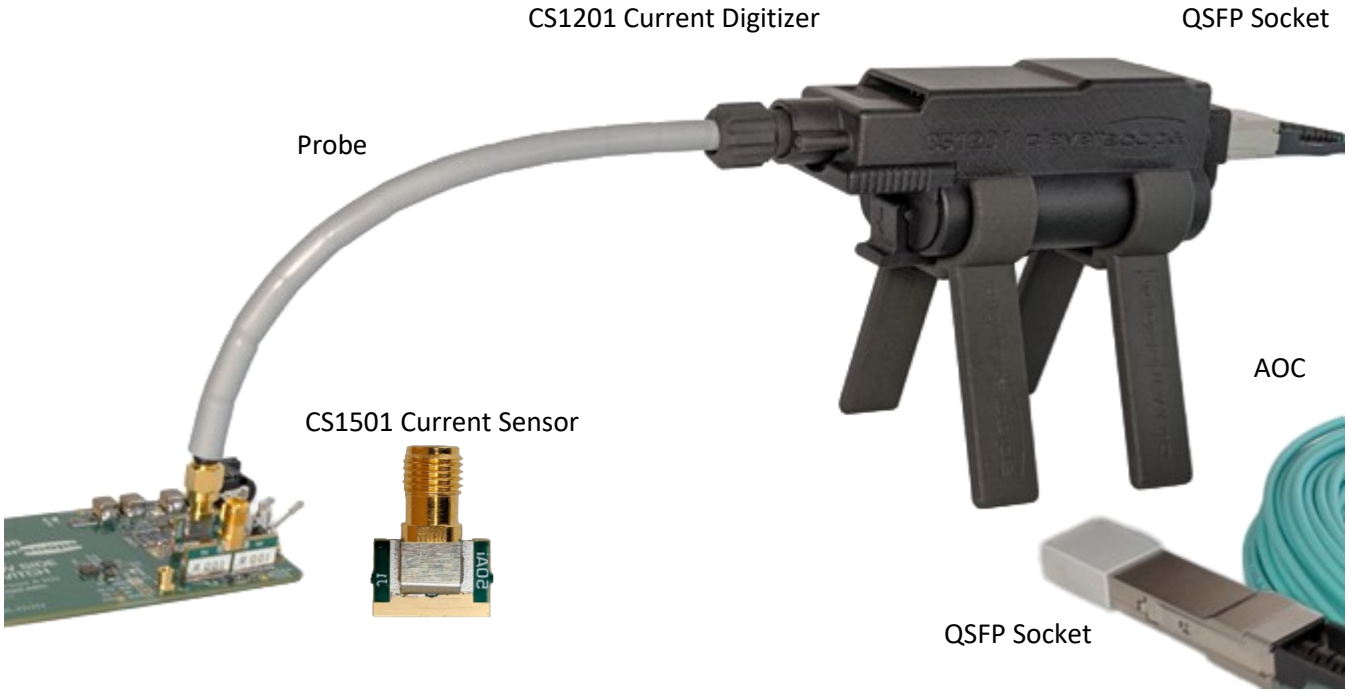
It is assumed that the CS1200 will be used with the standard oscilloscope probes supplied with the CS548.

The standard Active Optical Cable length is 3m. Lengths of 5, 10, 20 and 30 m are available on request. See section further below.

If you need specialized probing tips for the CS1200, please contact your local Cleverscope partner or reach out to us via sales@cleverscope.com or via our webpage https://cleverscope.com/contact/

CS1201 Current Digitizer

The CS1201 remote isolated Current Digitizer (CD) are used with the CS548 when higher isolation voltage is required or to make measurements in a safety cage, or further away from the CS548. It uses standard QSFP terminated active optical cable (AOC) to connect the CS1201 to the QSFP remote sockets on the CS548 front Panel. The CS1201 is designed to use the CS1501 1mΩ shunt sensor.



The CS1201 allow time aligned measurements to be made between locations up to 60 m apart (using 30 m cables), and measurements in hazardous, high voltage situations. The CD batteries are standard 21700 5 AHr cells and offer more than 6 hours operation before recharge. One set of cells can be recharged while the other set is being used. Cleverscope supplies two sets of batteries, and a charger.

CS1201 Current Digitizer (CD)

- 30kV isolation provided >150mm spacing between Digitizer and other structures.
- Pod enclosure isolation to SMA > 1kV
- 2 pF free space capacitance >50 mm above reference plane
- 140 dB CMRR at 50 MHz
- 14 bit resolution, 100 dB dynamic range
- 200 MHz Analog BW
- Two hardware ranges:
  ±63 A with 63 mA resolution continuous square wave
  ±630 A with 630 mA resolution DPT only
- 2 Ohm compensated input impedance

The CS1201 is supplied with one CS1501 1 mΩ shunt sensor and with one 200 mm probe cable to connect the shunt to the digitizer.

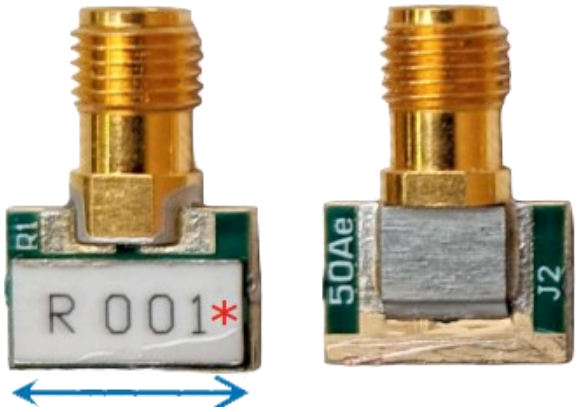
The standard Active Optical Cable length is 3 m. Lengths of 5, 10, 20 and 30 m are available on request. See section further below.

CS1501 – Current Shunt (CS1201 mandatory)

The CS1501 is the corresponding current shunt sensor to the CS1201 remote current digitizer. It is mandatory to use the CS1201 with its integrated compensation mechanism.

It uses vertical current path architecture to accurately control self-inductance and -capacitance with a small loop area. By doing so, a compensation mechanism can be implemented into the current digitizer CS1501.

The shunt has 1 GHz Bandwidth with 1 mΩ resistance.



14 mm

CS1501 Current Shunt

- 1 GHz bandwidth
- 1 mΩ resistance
- 1 pF self-capacitance
- 20 pH self-inductance
- 12 x 2 mm footprint
- ±44 A_{RMS} and ±63 A_{PEAK} square wave
- ±630 A_{PEAK} in low duty cycle Double Pulse Test

CS1026 Fiber Cables for Digitizers CS12xx (mandatory for CS12xx)

For every CS12xx digitizer, an Active Optical Fiber (AOC) is needed. Select one cable per digitizer. 3 m fiber comes standard with digitizer. Other fiber lengths are available:

Active Optical Fiber Options:

CS1026-1	1 meter Fiber cable for CS12XX devices
CS1026-5	5 meter Fiber cable for CS12XX devices
CS1026-10	10meter Fiber cable for CS12XX devices
CS1026-20	20 meter Fiber cable for CS12XX devices
CS1026-30	30 meter Fiber cable for CS12XX devices

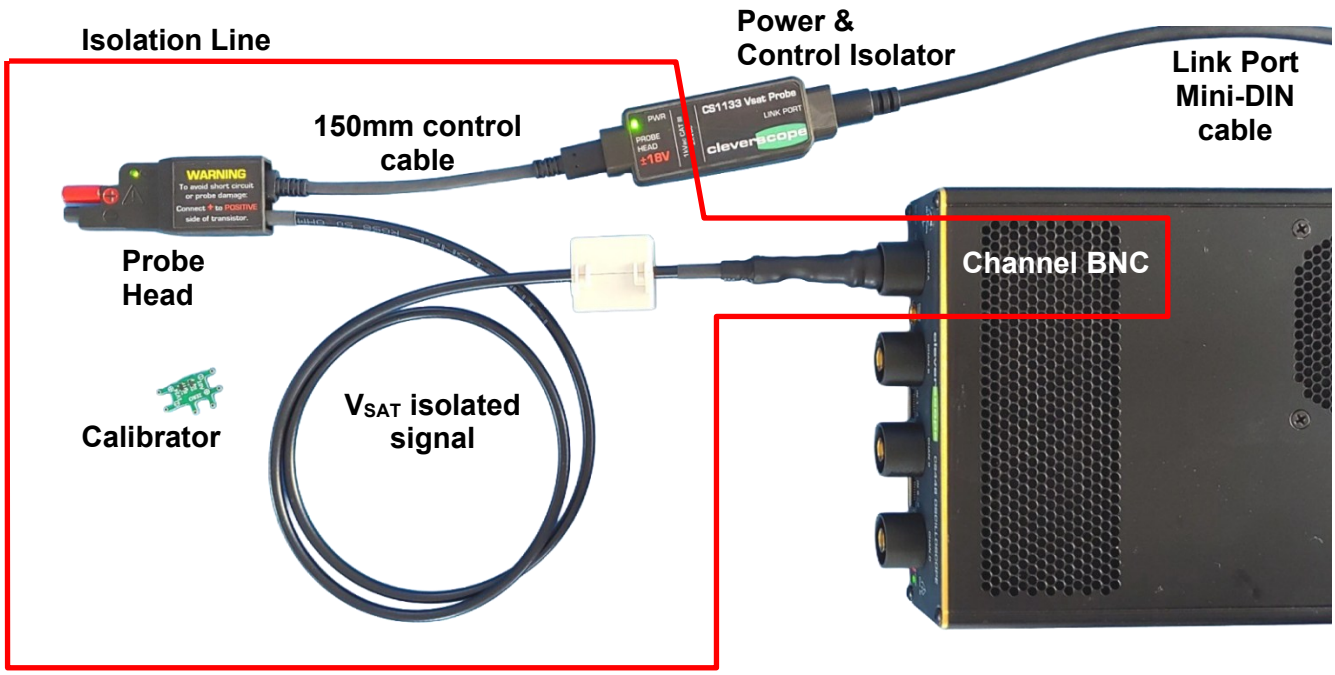
CS1133 V_{SAT} Probe

The CS1133 **V_{SAT} probe** is used to measure the saturation voltage of a switching transistor. It uses a 30 mA high compliance current source to measure the transistor forward voltage while the voltage across the device is less than the clip level. The clip level can be set to 3 ranges; approximately 15 V, 1.5 V and 150 mV. Above the clip level the V_{SAT} probe is disconnected from the Unit Under Test (UUT). It is expected that the UUT will have a good deal more than 30mA flowing through it so this small additional current will not significantly change the saturation voltage. The CS1133 output cable is terminated with a 50 Ω load. The CS1133 is rated for operation over the input voltage range of 0 V to +3.3 kV. It can also withstand negative overshoot on the UUT down to -100 V for short term transients.

The CS1133 is powered by +5V sourced by the CS548 LINK PORT (pin 1) and 0V (pin 2) via an 8 pin Mini Din Connector. It also includes two controls to select clip level; IN1 (pin 8) & IN2 (pin 5). The power and control signals are isolated via a low capacitance isolated power supply and optical isolators housed in a separate unit. The maximum working isolation voltage is 1 kV_{AC} CAT III or 2 kV_{DC}. In addition, the active portion of the CS1133 is shielded to ensure it can be used to measure the high side transistor while it is switching.

System Isolation

When used with the input channel isolation of the CS548 the CS1133 can be used to measure V_{SAT} of a high side or floating transistor. This diagram shows where the isolation occurs



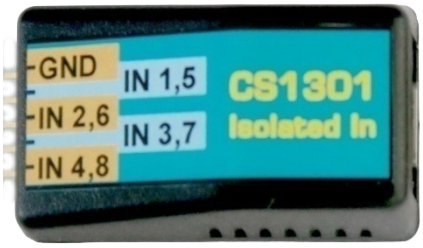
All items within the isolation line (Channel A, Probe Head, Coax cable and output of Isolator) have a common reference connection which will be connected to the UUT Source (or Emitter). If the Source is a high side transistor in a half bridge this whole isolation island will move with the switching edges of the half bridge. A common mode choke (as supplied with the CS548) may be required on the coax cable to suppress common mode induced LC ringing between the coax outer inductance and the CS548 isolation capacitance.

CS1133 V_{SAT} Probe

- +3.3 kV maximum V_{DS}
- 50 ns recovery time (1 kV falling edge)
- 2 kV_{DC} working isolation voltage (1 kV_{AC} CAT III)
- Clip Levels: 15 V, 1.5 V and 150 mV
- Gain Accuracy <± 1 %

CS1300 Series Pods

The CS1300 Pods are used to extend the capability of the CS548 oscilloscope. Two Pod connectors are provided on the CS548. Pods use LVDS communications capable of 400 Mbps for good noise immunity, low EMI, and reliability. These pods are available now:



1. **<u>CS1301 Isolated digital inputs (standard with delivery)</u>**

   Two CS1301 pods are included with the CS548.

   - The pod supports 4 isolated digital inputs with one common, and fixed voltage threshold of V_{HI} > 2.3 V, V_{LO} <0.9 V, and +18 V, -15 V overload protection.
   - Isolation is 600 V_{RMS} Cat III (UL), or 800 V_{DC} (VDE), based on an ISOW7844FDWE, and PCB creepage. Common mode rejection is 100 V/ns.

2. **<u>CS1302 Isolated digital outputs (optional accessory)</u>**

   The pod has 1 input, and 4 outputs, one of which may be assigned as a high speed clock. The pod allows high speed generation of arbitrary signals, optionally synched to the clock, with simultaneously recording of the input signal. It may also be used as a fast isolated SPI or UART port. The application supports arbitrary pulse generation, PWM, and double pulse testing using the CS1302.

   The output level is 5V (V_{SEL} open), or 3V3 (V_{SEL} pulled low).

   Isolation is 600 V_{RMS} Cat III (UL), or 800 V_{DC} (VDE), based on an ISO7840DW and ISOW7744DFMR, and PCB creepage. Common mode rejection is 100 V/ns.

3. **<u>CS1308 Fiber Isolated Digital Input Pod (optional accessory)</u>**
   CS1308 Fiber Isolated 4x Input Pod
   - Similar operation to the CS1301 but with fiber connections for greater isolation. Requires CS1027 fibers to be purchased separately.
   - Data transmission at signal rates from DC up to 50 MBd
     - Can be used with digital signals from DC to 25MHz
     - Up to 50 m distance with 1 mm Polymer Optical Fiber
     - Transmitter module for CS1308 inputs is Versatile Link Fiber Optic Transmitter AFBR-1624Z
     - These modules should be included in the device being tested, for example a gate driver board.

4. **CS1309 Fiber Isolated Digital I/O Pod (optional accessory)**

CS1309 Fiber Isolated 4x Output 1x Input Pod

- Similar operation to the CS1302 but with fiber connections for greater isolation. Requires CS1027 fibers purchased separately.
- Data transmission at signal rates from DC up to 50 MBd
  - Can be used with digital signals from DC to 25MHz
  - Up to 50 m distance with 1 mm Polymer Optical Fiber
  - Receiver module for CS1309 output is Versatile Link Fiber Optic Receiver AFBR-2624Z
  - Transmitter module for CS1308 inputs and CS1309 input is Versatile Link Fiber Optic Transmitter AFBR-1624Z
  - These modules should be included in the device being tested, for example a gate driver board.

5. **CS1027 Fiber Cables for CS1308 (4 required) and CS1309 (5 required)**

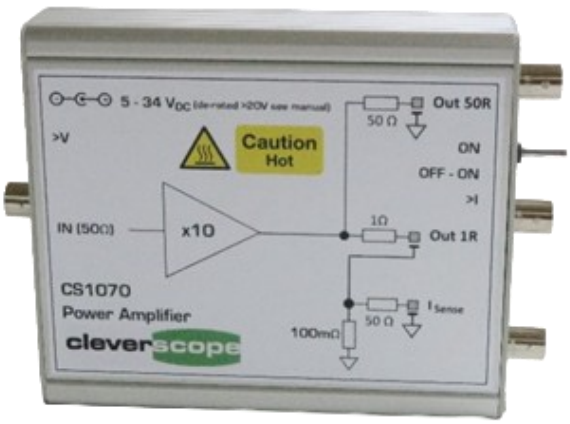
CS1027-x are required to operate the CS1308 and SC1309. Please choose the cable size alongside your pod.

CS1027-1 1 meter Fiber cable for CS1308 or CS1309

CS1027-10 10 meter Fiber cable for CS1308 or CS1309

CS1070 1A, 50 MHz, 34V_{pp} Power Amplifier

The CS1070 1A power amplifier is useful for PSRR, Impedance and Gain/Phase measurements. Used when internal Signal Generator is not sufficient.



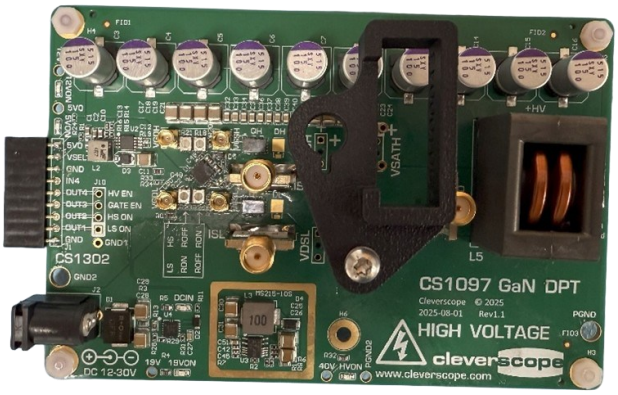
It has 50 MHz BW, and can swing ±17 V, and can be offset up to a maximum of 32 V. The 50R output is useful for driving impedance matched coaxial cables, while the 1R output can drive low impedance loads such as power and ground planes and power supplies. If battery driven it can be isolated using the CS548 isolated signal generator.

CS1102 CS548 FRA Test fixtures

The CS548 Test Fixtures contain three boards. One for low impedance (1 mΩ – 1 kΩ), another for high impedance (1 Ω – 25 kΩ), and the third for transformer testing (B-H, X primary, X leakage, Cww, N, and Xmutual)

CS1097 GaN Double Pulse Demonstration Board

The CS1097 Gallium-Nitride Double Pulse Demo Board provides test capabilities for Low- & High-Test. The board is ready to use for High-Side measurements. It can be changed by user to Low-Side testing by resoldering the inductive load connection.



Demo board is equipped with 3x CS1501 current shunts for use with CS1201 for testing source currents on High- & Low-Side (one each) and for inductance load current.

MMCX connectors for Gate-Source-Voltage V_{GS}.

And socket for Drain-Source-Voltage V_{DS} with standard passive probe and for CS1133 V_{SAT} probe.

The board is controlled via an isolated CS1302 I/O pod.

The rise times of the on and off voltages can be adjusted by trimming the potentiometers for R_{ON} and R_{OFF}.

Connection Accessories Overview

One of CS1042 or CS1043 is delivered as standard at the time of purchase of the scope.

CS1042 Ethernet SFP Copper Module

Using an RJ45 Ethernet socket connected copper SFP module to your control PC. Transformer based isolation.

Supports Ethernet 10/100/1000.

CS1043 Ethernet SFP Fibre Module

Gigabit (1G) Ethernet using an LC fibre cable connected optical module to your control PC. Full optical isolation.

Supports Ethernet 1000BASE-LX

CS1124 CS5x8 link port extension for 4 devices

The CS1124 allows up to four CS1133's to be used with a CS548, one per channel.

Needed if you want to operate several CS1133 V_{SAT} probes at a time or CS1070 units. Each Link Port output acts independently from each other.

CS1021 CS548 Link Cable for Link Out and Link In

The CS1021 Link Cable allows two units to be synchronized to form an 8-channel oscilloscope. Use multiple CS1021 to extend your channel count up to 16 channels with the Csope Control Software or even higher with self-written code.

Analog probes

<u>You can choose if you would like to have one 100x probe or one 200x probe per analog channel as standard scope of delivery. Please specify within the quote inquiry or latest at the time of purchase!</u>

Quick Overview:

Name	**CS1001**	**CS1002**	**CS1003**	**CS1008**
Attenuation Ratio /Sensitivity	1:1 1:10	1:100	1:1000	1:200
Bandwidth	6 MHz 250 MHz	250 MHz	40 MHz	300 MHz
Rise Time	2.3 ns	1.4 ns	<7 ns	1.4 ns
Input Impedance	1 MΩ 10 MΩ	100 MΩ	100 MΩ	100 MΩ
Voltage / Current	600 V_{DC} incl. AC_{PEAK}	Cat II: 1.5 kV, 2 kV_{DC}	10 kV_{DC} / 20 kV_{pp} pulsed	Cat II: 1.5 kV / 2 kV_{DC}

CS1001 *Analog Probe 1x / 10x 250 MHz, 1x: 300 V, 10x: 600 V (Standard eqiupment)*

The CS1001 Analog probe is a switchable 1x /10x 250 MHz oscilloscope probe. One probe per analog channel comes as standard equipment with the oscilloscope.

Item	Position x 1	Position x 10
Attenuation Ratio	1:1	10:1
Bandwidth	DC to 6 MHz	DC to 250 MHz
Rise Time	58 ns	2.3 ns
Input Resistance	1 MΩ	10 MΩ
Input Capacitance	Approx. 67 pF	Approx. 17 pF
Compensation Range		10-35 pF
Working Voltage	600 V_{DC} incl. peak AC, derated to 50 V at 10 MHz and 10 V at 100 MHz.	
Safety	Meets IEC1010-1 Cat 1.	
Cable Length	1.2 m	

CS1002 *Analog Probe 100x 250 MHz, 1.5 kV_{RMS}*

The CS1002 Analog probe is a 100x 250 MHz oscilloscope probe.

Item	Performance
Attenuation Ratio	1:100
Bandwidth	DC to 250 MHz
Rise Time	1.4 ns
Input Resistance	100 MΩ
Input Capacitance	5.5 pF
Compensation Range	10 to 35 pF
Working Voltage	Cat II:1.5kV, 2kV DC
Safety	Meets IEC1010-1 Cat II.
Cable Length	1.3 m

Accessories that are included with probe are: Channel Identifier Clip, Sprung Hook, Ground lead, Insulating Tip, Adjusting Tool, Measuring Tip, Sprung Earth Tip.

CS1008 *Analog Probe 200x 300 MHz, 1.5 kV_{RMS}*

The CS1008 Analog probe is a 200x 300 MHz oscilloscope probe.

Item	Performance
Attenuation Ratio	1:200
Bandwidth	DC to 300 MHz
Rise Time	1.4 ns
Input Resistance	100 MΩ
Input Capacitance	5.5 pF
Compensation Range	10 to 35 pF
Working Voltage	Cat II:1.5kVrms, 2kV DC
Safety	Meets IEC1010-1 Cat II.
Cable Length	1.3 m

Accessories that are included with probe are: Channel Identifier Clip, Sprung Hook, Ground lead, Insulating Tip, Adjusting Tool, Measuring Tip, Sprung Earth Tip.

CS1003 *Analog Probe 1000x 40MHz, 7 kV_{RMS}*

The CS1003 Analog probe is a 1000x 40 MHz oscilloscope probe.

Item	Performance
Attenuation Ratio	1:1000
Bandwidth	DC to 40 MHz
Rise Time	<7 ns
Input Resistance	100MΩ
Input Capacitance	Approx 3 pF
Compensation Range	5 to 50 pF
Working Voltage	DC:10kV;AC Pulse:20kV peak to peak; Sine Wave:7kV rms
Safety	Meets IEC1010-1 Cat 1.
Cable Length	2 m

Accessories that are included with probe are: Channel Identifier Clip, Sprung Hook, Ground lead, Insulating Tip, Adjusting Tool, Measuring Tip, Sprung Earth Tip.

Standard Scope of Delivery

Not all needed accessories might be included in the Scope of Delivery. Please review the Ordering Guide below.

CS1001	One piece per analog channel: 1x/10x analog probe, ±8 V / ± 80 V measurement ranges, 250 MHz, 600 V, 10 MΩ
Common Mode Choke	One piece per analog channel
CS1301-1	Isolated Digital Input Pod 1, Input 1-4
CS1301-2	Isolated Digital Input Pod 2, Input 5-8
USB-Cable	USB-C to USB-A type cable for PC connection
Power Supply	19 V power supply for CS5x8
SMA-BNC Adapter	Adapter for Signal Generator Output
Ethernet Module	Copper or Fiber wired, depending on selection
100x or 200 x probe	Depending on selection

Ordering Guide

Please choose you preferred equipment to configure your specific Cleverscope system. The steps 1 to 3 are mandatory, and the steps 4 to 7 are optional.

Step 1: Choose your Cleverscope channel configuration

CS548	4 isolated analog channels, 4 remote connectors
CS538	3 isolated analog channels, 4 remote connectors
CS528	2 isolated analog channels, 4 remote connectors
CS518	1 isolated analog channels, 4 remote connectors
CS508	0 isolated analog channels, 4 remote connectors

Step 2: Choose your included probes (One piece per channel of selected type comes as standard)

The other probe can be ordered separately

CS1002	Analog Probe 100x, ±800 V range, 250 MHz, 1.5 kV_{RMS}, 100 MΩ, 1.3 m
CS1008	Analog Probe 200x, ±1.6 kV range, 300 MHz, 1.5kV_{RMS}, 100 MΩ, 1.3 m

Step 3: Choose your included ethernet module (one module comes as standard)

The other module can be ordered separately

CS1042	1000BASE-T Copper SFP Transceiver
CS1043	2.125 Gb/s Fibre SFP Transceiver

Step 4: Select your Remote Digitizers (Optional)

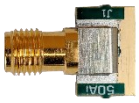
The 3 meter fiber is included in scope of delivery for each Remote Digitizer. If other fiber lengths is desired, please specify which length in your order from the table below.

Remote Digitizers

CS1200	Active Optical Fibre isolated voltage digitizer, ±800 mV / ±8 V ranges, 200 MHz, 30 kV isolation, 100 dB CMRR @ 50 MHz, 14 bit ADC, 2 pF. Use probes to extend dynamic range as in internal channels.
CS1201	Active Optical Fibre isolated current digitizer, ±63A / ±630 A ranges, 200 MHz, 30 kV isolation, 100 dB CMRR @ 50 MHz, 14 bit ADC, 2 pF, one piece of CS1501 current shunt included.

Special Remote Digitizers Accessories

CS1501	Current Shunt for CS1201: 1 mΩ Shunt (only works with CS1201 digitizer)
CS1026-1	1 meter Fiber cable for CS12XX devices
CS1026-5	5 meter Fiber cable for CS12XX devices
CS1026-10	10 meter Fiber cable for CS12XX devices
CS1026-20	20 meter Fiber cable for CS12XX devices
CS1026-30	30 meter Fiber cable for CS12XX devices



Step 5: Select Digital Pods Accessories (Optional)

CS1302 Isolated digital I/O pod for generating up to 4 outputs for double pulse, half or full bridge PWM control or arbitrary pulse sequences. It includes one input and can be used to make an isolated SPI or UART pod. Pulse Builder supported.

CS1308 [+] Fiber isolated digital input pod for measuring logic signals. Four Fibers CS1027-x to be bought separately

CS1309 [+] Fiber Isolated digital I/O pod for generating up to 4 outputs for double pulse, half or full bridge PWM control or arbitrary pulse sequences. It includes one input and can be used to make an isolated SPI or UART pod. Pulse Builder supported. Five fibers CS1027-x to be bought separately

CS1027-1 1 meter VersaLink Fiber cable for CS1308 and CS1309

CS1027-10 10 meter VersaLink Fiber cable for CS1308 and CS1309

Notes:

[+] CS1027-1 or CS1027-10 needed for operation.

Step 6: Select further CS548 Accessories (Optional)

CS1133 V_{SAT} probe, clips at 150 mV, 1.5 V and 15 V to allow isolated measurement of transistor V_{CEsat} while V_{CE} swings up to 3300 V. Includes isolated power and control Link cable to CS548.

CS1124 The CS1124 is used to expand the CS5x8 link port to serve up to 4 linked devices.

CS1021 CS548 Link Cable for Link Out & Link In. Connect two, three or four CS548 for an eight, twelve or sixteen channel scope (for multi-scope synchronization: only use Cleverscope approved cables)

CS1070 Power Amplifier, 50 MHz bandwidth, 36V p-p swing, including asymmetrical (e.g. +/-18V to +31V/-5V). Fixed 10x gain (20dB). Low noise (21nV/rtHz output noise), 1A drive current, Low distortion (-91dBc/-74 dBc at 1MHz 20Vp-p), low drift (40uV/deg C) Supplied with 19V 5A power supply and coax cable accessories. Internal negative rail generator to simplify input power requirements. Link Port controls power.

CS1102 CS548 FRA Test fixtures - A set of three boards, low impedance (1 mΩ – 1 kΩ), high impedance (1 Ω - 25kΩ), and transformer testing (B-H, X primary, X leakage, Cww, N, and Xmutual).

Step 7: Select Demo Accessory (Optional)

CS1097 GaN Double Pulse Demonstration Board, 40-70 V, 150 A, access to all nodes. Includes 3 x CS1501. Requires CS1302 to operate and CS1201 to measure current. Optionally CS1133 to measure on-voltage.

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