

## Lightning Danger Detector

Lifesaving warning  
before lightning strikes

### Overview

The CS110 Electric Field Meter measures the vertical component of the atmospheric electric field at the earth's surface. These

atmospheric electric field measurements are useful for assessing the local lightning hazard and for thunderstorm research.

### Benefits and Features

- › Low power consumption
- › Senses potential for lightning, providing warning before lightning strikes
- › Extensive diagnostic self-checking for each measurement reduces or eliminates scheduled maintenance
- › Easy maintenance—stator easily removed for cleaning
- › Rugged construction
- › SG000 Strike Guard can be used in conjunction with our CS110 to create a complete lightning-threat measurement and analysis system

### Reciprocating Shutter

The CS110 uses a reciprocating shutter instead of the traditional rotating vane field mill. The reciprocating shutter is electrically connected to ground potential by a flexible stainless-steel strap. The strap operates below its fatigue limit, resulting in an ultra-reliable electrical ground connection to the shutter.

The reciprocating approach provides better low-frequency error performance than the traditional rotating vane field mill because it has a convenient zero-field (closed shutter) reference. The zero-field reference allows the CS110 to measure and then correct for

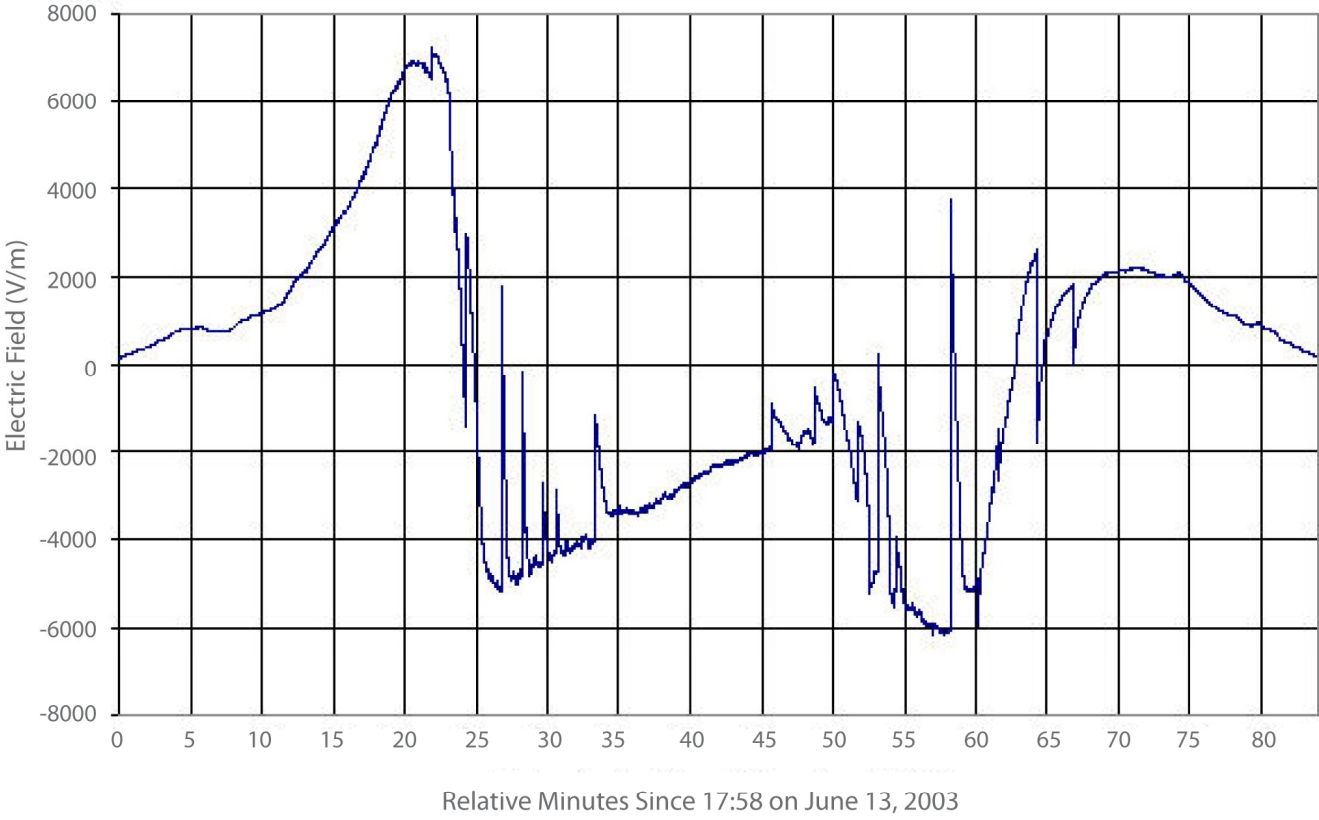
electronic offset voltages, contact potentials, and leakage currents of each individual measurement (U.S. Patent No. 6,984,971).

The CS110 also contains circuitry to measure and compensate for insulator leakage currents occurring on the charge amplifier input, eliminating measurement errors caused by fouled insulators. If insulator surfaces become conductive because of surface contamination, a leakage current compensation circuit applies an equal and opposite polarity current to the charge-amplifier input that prevents saturation of the electronics (U.S. Patent No. 7,109,698).

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[www.campbellsci.eu/cs110](http://www.campbellsci.eu/cs110)

# Atmospheric Electric Field Chart



The above graph shows data recorded by the CS110 during a thunderstorm in Cache Valley Utah. The rapid changes of the electric field were due to lightning discharges, some of which were hazardous cloud-to-ground strikes.

## Using the CS110 as a Weather Station

The CS110 has sealed connectors for attaching meteorological sensors and three digital control ports for controlling external devices and/or triggering alarms. An embedded CR1000M datalogger module (ordered as pn #18292) is required for every CS110 purchased; see ordering information. The datalogger measures the sensors, processes the measurements, stores the data in tables, and can initiate communications.

Communication options compatible with the CR1000 include direct connect, Ethernet, phone modems (land-line and cellular), radios, short haul modems, GOES satellite transmitters, and multidrop modems.

Connector/Compatible Sensors	
<b>Connector</b>	<b>Compatible Sensors (one sensor per connector)<sup>1</sup></b>
<b>Temp/RH</b>	107, 108, HMP60, or EE181
<b>Wind</b>	05103
<b>Solar</b>	CS305-ET pyranometer, CS100 or CS106 barometer <sup>2</sup>
<b>Rain</b>	TE525, TE525WS, or TE525MM

<sup>1</sup>Choose the -C cable termination option (except for the CS305-ET and barometers).

<sup>2</sup>The barometers use the #17460 cable to connect to the CS110, and must be housed in a separate enclosure.

## SG000 Strike Guard Lightning Sensor

The SG000 is an optical-coincidence lightning sensor that detects actual cloud-to-cloud and cloud-to-ground lightning strikes within a 20 mile radius. It is used in conjunction with the CS110 to create a complete lightning-threat measurement and analysis system.

The SG000 connects to the CS110 using the FC100, #14291 Field Power Cable, and FC100CBL1-L, and one of the following products (depends on the port that the CS110 is connected to):

- CS I/O Port**
- CS110CBL2-L (typically 9 feet)
  - SC932A
  - #16987 Peripheral Mounting Kit

- RS-232 Port**
- CS110CBL1-L (typically 9 feet)

# Ordering Information

## Electric Field Meter and Lightning Detector

- CS110** Electric Field Meter. Requires the #18292 CR1000M Datalogger installed inside CS110. Also need to choose a temperature range option.
- SG000** Strike Guard Lightning Sensor (Must be sold with CS110).

## Temperature Range Option for CS110

- ST** -25° to +50°C
- XT** -40° to +85°C

## Embedded Datalogger (required for each CS110 purchase)

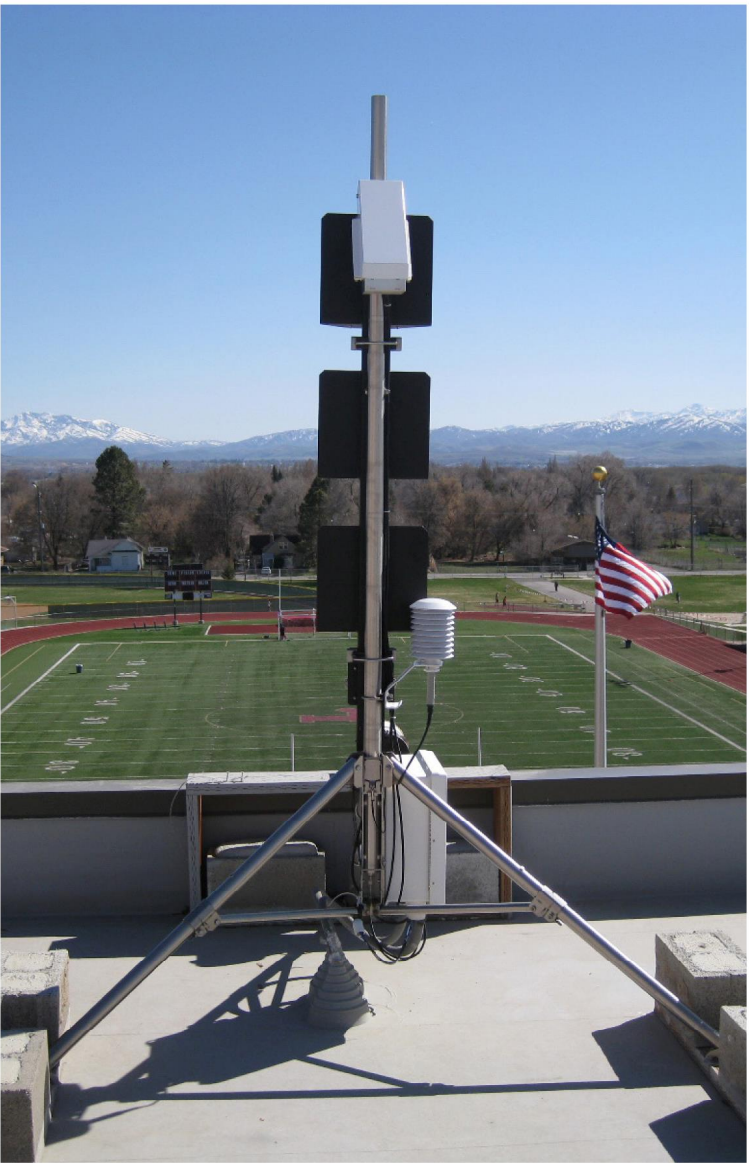
- 18292** CR1000M installed inside CS110. Choose a temperature range.

## Temperature Range Option for 18292

- ST** -25° to +50°C. Select if you chose the -ST option for the CS110.
- XT** -40° to +85°C. Select if you chose the -XT option for the CS110.



The SG000 interfaces with a datalogger, CS110, or PC using the FC100 fiber optic module and fiber optic accessories (see above).



Logan High School in Logan Utah has a lightning warning system that consists of the CS110 mounted to a 10-ft stainless-steel tripod and lights that indicate the likelihood of lightning. The tripod sits on a roof next to the football field.

## CS110 Accessories

- CS110CBL1-L** CS110 RS-232 (DTE) Cable handles serial communication between the CS110 and a laptop, SG000, or a telemetry device with an RS-232 port (such as the RF401). Enter the cable length, in feet, after the -L.
- CS110CBL2-L** CS110 CS I/O Cable connects the CS110 to the CS I/O port of the SG000 or a communication device such as the COM220, COM320, or NL201. Enter the cable length, in feet, after the -L.
- CS110CBL3-L** CS110 Power Cable is required for the CS110 to operate. In most applications, the cable carries 12 V power from the system power supply. In applications where an additional datalogger is located at the measurement site, this cable will facilitate SDM communication between the two loggers (one being embedded in the CS110).
- #17642** CS110 Zero Electric Field Cover used to check the electric field offset voltage of the CS110. If the measured electric field is  $\geq |60 \text{ V/m}|$  with the Zero Electric Field Cover on, then inspection and cleaning of the electrode surfaces is recommended.

## Fiber Optic Module and Fiber Optic Accessories

- FC100** Fiber Optic Converter used to interface the SG000 with a Campbell Scientific datalogger, the CS110, or PC. The FC100CBL1 cable is required (see below).
- FC100CBL1-L** Simplex PMMA Plastic Fiber Optic Cable used to connect the FC100 to the SG000. Enter the cable length, in feet, after the -L.
- #14291** Field Power Cable allows the FC100 to be powered from a suitable 12 Vdc battery.
- #18663** Null Modem Cable 9-Pin Male to Male used to connect the FC100 to the datalogger's RS-232 port.
- SC932A** CS I/O to 9-Pin RS-232 DCE Interface used to connect the FC100 to the CS I/O port of a datalogger or the CS110. The CS110CBL2 cable (see left column) is also required to connect the SG000 to the CS110's CS I/O port.
- 16987** Peripheral Mounting Kit provides hardware for affixing an SC932A to an enclosure backplate.

# Electric Field Measurement Performance

The overall gain of an electric field meter is dependent upon the electric-field enhancement or attenuation caused by a given site configuration. Consequently, it is necessary to reference a specific site configuration when discussing measurement performance. The CS110 is factory calibrated using large (1 m hexagonal plates) parallel-plate electric-field calibrator. This parallel-plate configuration is equivalent to an outdoor unit mounted facing upward with the sense aperture flush with the surface of the earth. Inverted and elevated mounting is more practical and recommended for outdoor applications. Inverting and elevating the CS110 results in electric-field enhancement as compared to the parallel-plate configuration, with the enhancement dependent upon instrument height above the ground.

Parallel-Plate Configuration				2 m CM110 Tripod Configuration <sup>2</sup>			
<b>Accuracy:</b> ±1% of reading + 60 V m <sup>-1</sup> offset <sup>1</sup>				<b>Accuracy:</b> ±5% of reading + 8 V m <sup>-1</sup> offset <sup>1</sup>			
Measurement Range <sup>3</sup> (V m <sup>-1</sup> )	Resolution (V m <sup>-1</sup> )	Sensitivity (µV/V m <sup>-1</sup> )	Noise (V m <sup>-1</sup> RMS)	Measurement Range <sup>3</sup> (V m <sup>-1</sup> )	Resolution (V m <sup>-1</sup> )	Sensitivity (µV/V m <sup>-1</sup> )	Noise (V m <sup>-1</sup> RMS)
±(0 to 21,000)	3	12	4.0	±(0 to 2,200)	0.32	1.2	0.42
±(21,000 to 212,000)	30	118	18.0	±(2,200 to 22,300)	3.2	13	1.9

<sup>1</sup>Typical offset for clean electrodes is ≤|30 V m<sup>-1</sup>| for the parallel-plate configuration, which is reduced by the field enhancement factor for typical inverted and elevated mounting configurations.

<sup>2</sup>Field enhancement due to typical inverted and elevated mounting requires additional site correction, estimated at ±5% accuracy when done in appropriate high field conditions. Practical outdoor CS110 electric field measurement accuracy is estimated at ±5% of reading + 8 V m<sup>-1</sup> for the CS110 2 meter CM110 Tripod Site.

<sup>3</sup>The CS110 incorporates automatic gain ranging between two input ranges. The measurement is first tried on the lowest input range. If the signal is too large for the lowest range, the larger range is used.

## Specifications

### CS110

- CE Compliance Standards to which conformity is declared: BS EN61326:2002
- Calibrations: NIST Traceable calibration certificate included.
- EU Declaration of Conformity document available at: [www.campbellsci.eu/cs110](http://www.campbellsci.eu/cs110)
- Lightning Protection: Multi-stage transient protection on all external interfaces
- Power Requirement: 11 to 16 Vdc
- Baud Rates: Selectable from 300 to 115.2k bps
- Sample (Measurement) Rate: Programmable sample rate up to 5 samples per second, variable sample rates possible. Variable example: sample every 10 seconds until field exceeds threshold then sample once a second until field returns to normal.
- ASCII Protocol: one start bit, one stop bit, eight data bits, no parity
- Communications Protocols: PakBus; FTP; email; Web page interface via web browser
- Operating Relative Humidity: 0 to 100% RH
- Mounting: vertical pipe with outer diameter of 1.91 to 6.35 cm (0.75 in to 2.5 in)
- Dimensions: 15.2 x 15.2 x 43.2 cm (6 x 6 x 17 in)
- Weight: 4 kg (9 lb)

### Current Drain

- Peak Current Demand (occurs during motor operation): 750 mA
- Average at 1 sample per 10 second: 7 mA
- Average at 1 sample per second: 60 mA
- Average at 2 samples per second: 120 mA
- Average at 5 samples per second: 300 mA

### Communication Ports

- RS-232 port
- CS I/O port used to interface with our peripherals such as a COM320 Voice Modem
- Digital Control Ports 1, 2, and 3 for alarm, asynchronous communications, or SDI-12 communications

### Warranty<sup>4</sup>

- One year warranty against defects in materials and workmanship

### SG000

- Detection Range: up to 20 mile radius
- Enclosure Rating: NEMA 4X

<sup>4</sup>Campbell Scientific does not warrant that the CS110 will meet customer's requirements or that its operation will be uninterrupted or error-free. Atmospheric or local electric field conditions or different site characteristics may cause false information, late data, or otherwise incomplete or inaccurate data. The CS110 only measures conditions that make lightning more likely. Just as with weather forecasts, the CS110 measurements only help assess the probability of lightning. Lightning can occur causing personal injury, even death, or damage to property without any warning from the CS110. Campbell Scientific is not liable for special, indirect, incidental, or consequential damages from the use, failure, or malfunction of the CS110. A full statement of the CS110's Warranty is contained in the CS110 Manual.