

CS110

Electric Field Meter



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.

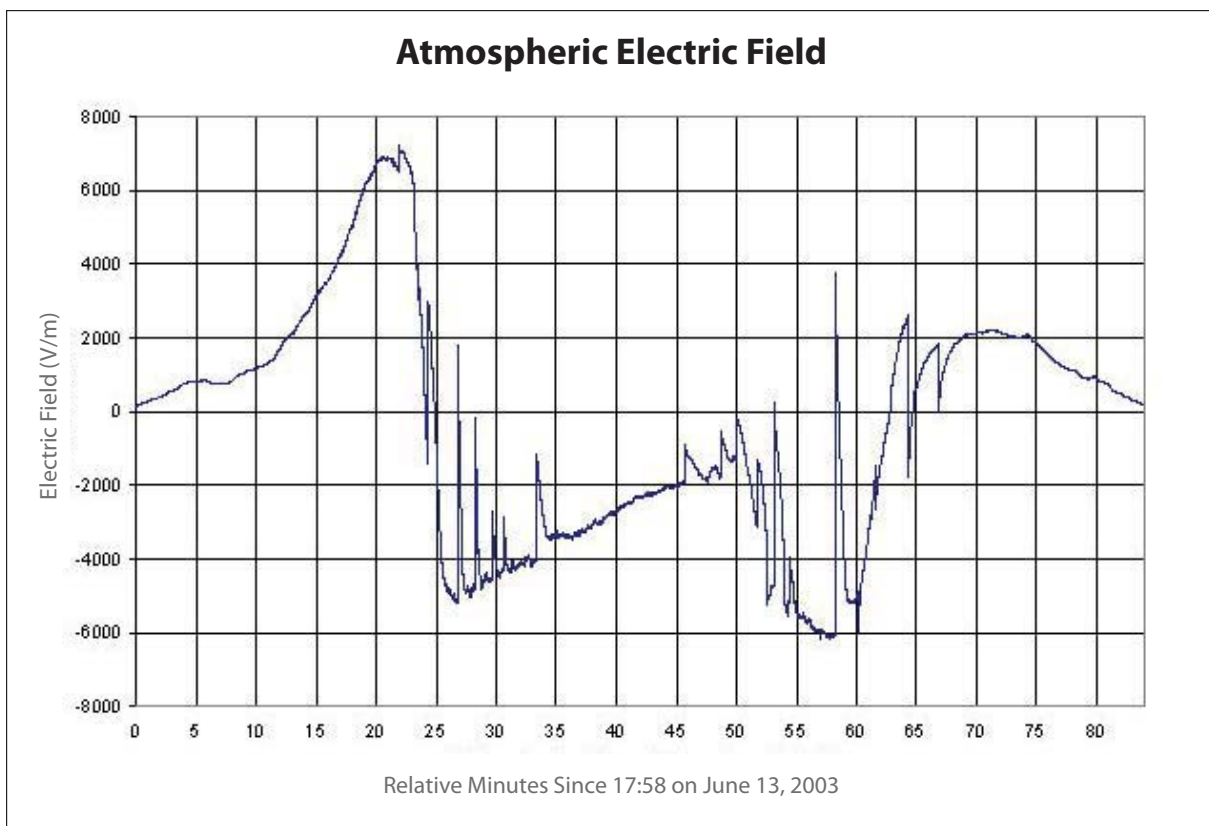
Reciprocating Shutter

Instead of the traditional rotating vane field mill, the CS110 uses a reciprocating shutter 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 (Patent Pending).



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.



Data recorded by the CS110 during a thunderstorm in Cache Valley Utah is shown above. The rapid changes of the electric field are due to lightning discharges, some of which are hazardous cloud-to-ground strikes.



The CS110's internal datalogger can measure additional meteorological sensors—making the CS110 the center of a full weather station.

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 p/n 18292) is required. 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.

Programming

The CR1000's on-board programming language, CRBasic, provides data processing and analysis routines that support user control over sample (measurement) rates and setting of alarm conditions. LoggerNet Datalogger Support Software facilitates programming, communications, and data retrieval between the CS110 and a PC.



Logan High School in Logan Utah has installed a lightning warning system that includes the CS110. The CS110 is mounted to a CM110 10-ft stainless-steel tripod that sits on a roof next to the football field (left). Lights included in the system indicate the likelihood of lightning (right).

SG000 Strike Guard Lightning Sensor

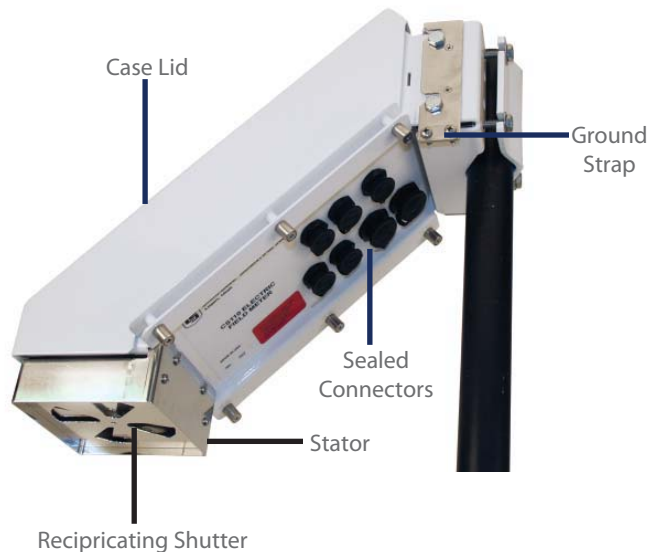
The SG000 Strike Guard is an optical-coincidence lightning sensor that detects actual cloud-to-cloud and cloud-to-ground lightning strikes within a 20-mile radius. It is used in conjunction with the CS110 to create a complete lightning-threat measurement and analysis system.

The SG000 and CS110 are typically mounted on the same tripod or pole. They communicate via a fiber-optic link (FC100 interface and FC100CBL) that offers enhanced reliability in the lightning environment. For information about interfacing the SG000 with a CS110, visit www.campbellsci.com/sg000 or contact Campbell Scientific.



CS110 Specifications and Features

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 a large (1 meter 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.



Electric Field Measurement Performance:

Parallel-Plate Configuration				2 m CM10 Tripod Configuration ²			
Accuracy:		±1% of reading + 60 V m ⁻¹ offset ¹		Accuracy:		±5% of reading + 8 V m ⁻¹ offset ¹	
Measurement Range ³ (V m ⁻¹)	Resolution (V m ⁻¹)	Sensitivity (μV/V m ⁻¹)	Noise (V m ⁻¹ RMS)	Measurement Range ³ (V m ⁻¹)	Resolution (V m ⁻¹)	Sensitivity (μV/V m ⁻¹)	Noise (V m ⁻¹ 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

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

²Field 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⁻¹ for the CS110 2 meter CM10 Tripod Site.

³The 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.

CS110 Specifications and Features Continued

Datalogger: An embedded CR1000M datalogger module (ordered as p/n 18292) is required.

Standard Mounting: 2 m height on a tripod mast

Site Correction: Site correction factors available for several standard mounting configurations.

Programmability: CRBasic programming allows the selection of sample rate, data processing and storage options and setting output ports based on alarm conditions. LoggerNet includes the CRBasic editor and compiler.

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.

Power Requirements:

- 11 to 16 Vdc; peak-current demand is 750 mA during motor operation.
- 7 mA @ 12 V = 0.08 W average power consumption at 1 sample per 10 seconds
- 60 mA @ 12 V = 0.7 W average power consumption at 1 sample per second
- 120 mA @ 12 V = 1.4 W average power consumption at 2 samples per second
- 300 mA @ 12 V = 3.6 W average power consumption at 5 samples per second

Cables (ordered separately):

- CS110CBL3-L power cable is required for the CS110 to operate; it connects the CS110 to its power source and can be used to communicate with an additional datalogger.
- CS110CBL1-L RS-232 cable connects the CS110 to a laptop, SG000 or other devices with an RS-232 port.
- CS110CBL2-L CS I/O cable connects the CS110 to the CS I/O port of a Campbell Scientific device such as the SG000, COM220, COM320, or NL100.

Communication: 1 RS-232 port; 1 CS I/O port used to interface with our peripherals such as a Voice Modem; digital control ports 1, 2, and 3 for alarm, SDI-12 communications, or asynchronous communications

Baud Rates: Selectable from 300 to 115,200 bps

ASCII Protocol: one start bit, one stop bit, eight data bits, no parity

Lightning Protection: Multi-stage transient protection on all external interfaces

Calibrations: NIST Traceable calibration certificate included

CE Compliance

Standards to which conformity is declared: BS EN61326:2002

Rugged Construction: Ultra-reliable metallic ground connection to reciprocating shutter (no wiping contact), brushless stepper motor, powder-coated aluminum case, Teflon insulators, and electro-polished 316L stainless-steel used for corrosion protection of critical exposed metallic parts

Connector/Compatible Sensors:

Connector Label	Compatible Sensors (one sensor per connector)
Temp/RH	HMP45C-LC
Wind	05103-LC, 05106-LC, 05305-LC, 034B-LC, 03001-LC
Solar	LI200X-LC pyranometer, CS100 barometer, CS106 barometer (<i>barometers connect to the CS110 via the 17460 cable; they should be housed in a separate enclosure such as the ENC10/12</i>)
Rain	CS700-LC, TB4-LC, TE525-LC, TE525WS-LC, TE525MM-LC

Easy Maintenance: The stator is easily removed for cleaning (proper cleaning does not invalidate calibration). The CS110 also incorporates extensive diagnostic self-checking for each measurement to reduce or eliminate scheduled maintenance. The self-checking monitors internal humidity, insulator cleanliness/power supply voltage, and verifies that CS110 components such as the charge amplifier and shutter open/close are functioning properly.

Zero Electric Field Cover (ordered separately): The 17642 Zero Electric Field Cover is 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.

Operating Temperature Range :

-25° to 50°C standard, -40° to +85°C optional

RH Range: 0 to 100% RH

Dimensions: 6" x 6" x 17" (15.2 x 15.2 x 43.2 cm)

Mounting: vertical pipe 0.75" to 2.5" OD (1.91 to 6.35 cm)

Weight: 9 lbs (4 kg)

Warranty: The CS110 has a one year warranty against defects in materials and workmanship. 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.

