

# CS205/107, CS505, CS515

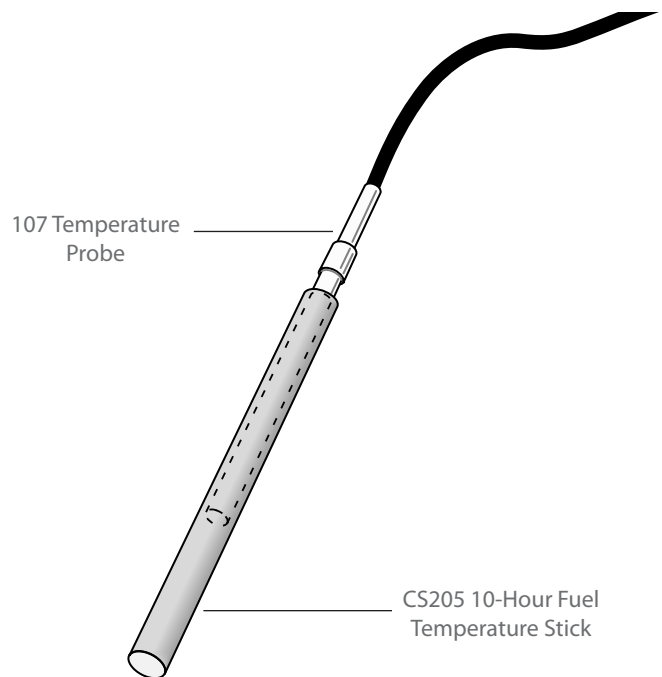
## 10-Hour Fuel Temperature/ Moisture Sensors



Campbell Scientific offers sensors that emulate and measure the moisture content and temperature of similarly-sized twigs on the forest floor. These 10-hour fuel moisture and fuel temperature sensors are often incorporated in our pre-configured or custom fire-weather stations. When connected to a datalogger with telemetry capability, the user can automatically monitor changing fuel conditions without having to visit the measurement site. The fuel moisture and fuel temperature sensors are compatible with our CR510, CR800, CR850, CR10X, CR1000, and CR3000 dataloggers. Compatible telemetry options include spread spectrum radios, narrow-band radios, cellular phones, and satellite transmitters.

### CS205/107 Fuel Temperature

To measure fuel temperature, both the CS205 Fuel Temperature Stick and a 107 Temperature Probe are required. The CS205 provides a ponderosa pine dowel that is fabricated to USFS specifications. A hole is bored into one end of the dowel, where our thermistor-based 107 probe is inserted. The 107 measures the temperature inside of the dowel. The CS205 and the 107 are sold separately.



A transparent view shows a 107 temperature probe inserted inside of the CS205 10-hour Fuel Temperature Stick.

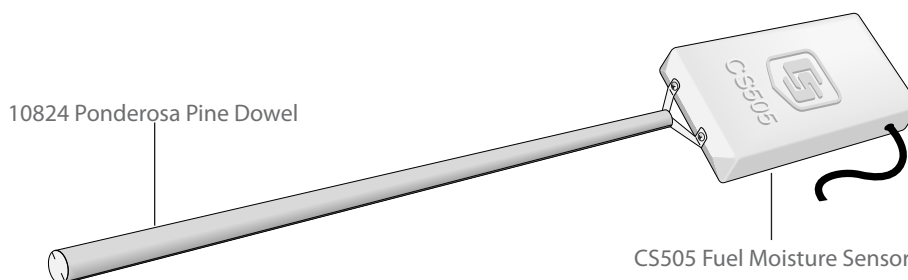
### Fuel Moisture

#### *CS505 Fuel Moisture Sensor*

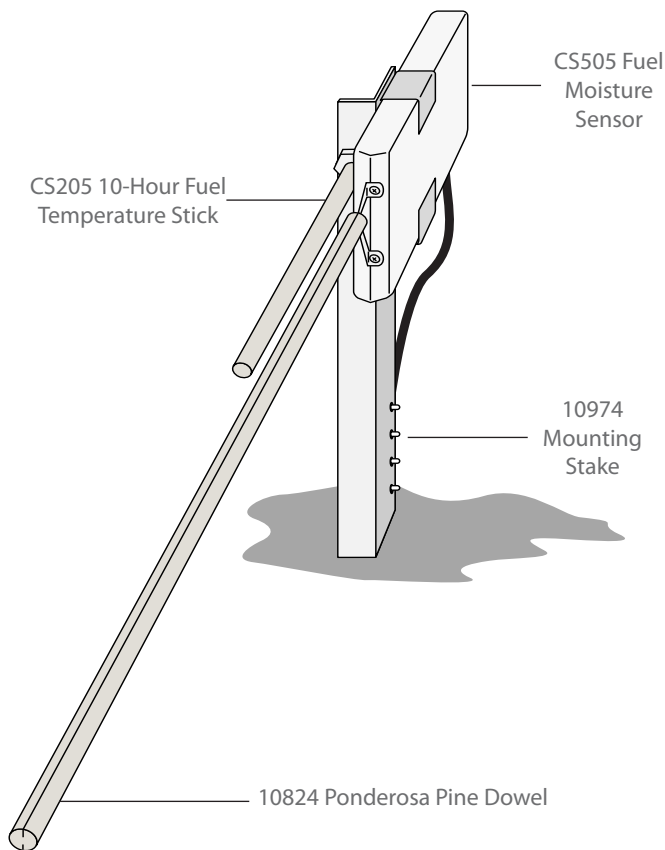
Our fuel moisture sensor, the CS505, reports the status of small-diameter (10-hour) forest fire fuels as percent moisture by weight (1%=1 g). It consists of an epoxy-encapsulated electronics package that uses Time Domain Reflectometry (TDR) technology to measure the moisture content of the 10824 10-hour Fuel Moisture Stick. The sensor produces a  $\pm 2.5$ -Vdc square-wave frequency that is read using an analog or pulse channel on a Campbell Scientific datalogger. The datalogger then converts the frequency measurement to percent fuel moisture via a quadratic calibration.

#### *10824 10-Hour Fuel Moisture Stick*

The 10824 10-hour Fuel Moisture Stick consists of a ponderosa-pine dowel fabricated to USFS specifications. It has a 1/2-inch diameter and a 20-inch length—the same dimensions as those used on the traditional weighing fuel moisture racks. Each dowel has undergone two additional sorts to optimize probe-to-probe repeatability and to allow probe interchangeability without individual calibration. The response of the CS505 sensor is similar to the traditional weighing racks because the entire dowel surface is exposed for moisture exchange.



The CS505 requires the purchase of a 10824 10-hour Fuel Moisture Stick.



The 10974 is available for mounting the CS505/10824 and CS205/107 10-hour fuel moisture sensors. The CS515-QD and CS515-LQ include the 10974, CS505, 10824, CS205, and 107.

## 10974 Fuel Moisture/Temperature Mounting Stake

The 10974 Mounting Stake is often used to mount the sensors in the field. This stake places the CS505/10824 and the CS205/107 probes twelve inches above the forest floor. Because the probes are mounted parallel to each other, shadowing is minimized. Cable ties are included for securing the cables to the side of the stake.

## CS515 Fuel Sensors for RAWS Stations

The CS515-QD and CS515-LQ are intended for our Remote Automated Weather Stations (RAWS). They consist of a CS505 Fuel Moisture Probe, a 10824 10-hour Fuel Moisture Stick, a CS205 Fuel Temperature Stick, and a 107 Thermistor mounted on a 10974 Fuel Moisture/Temperature Mounting Stake.

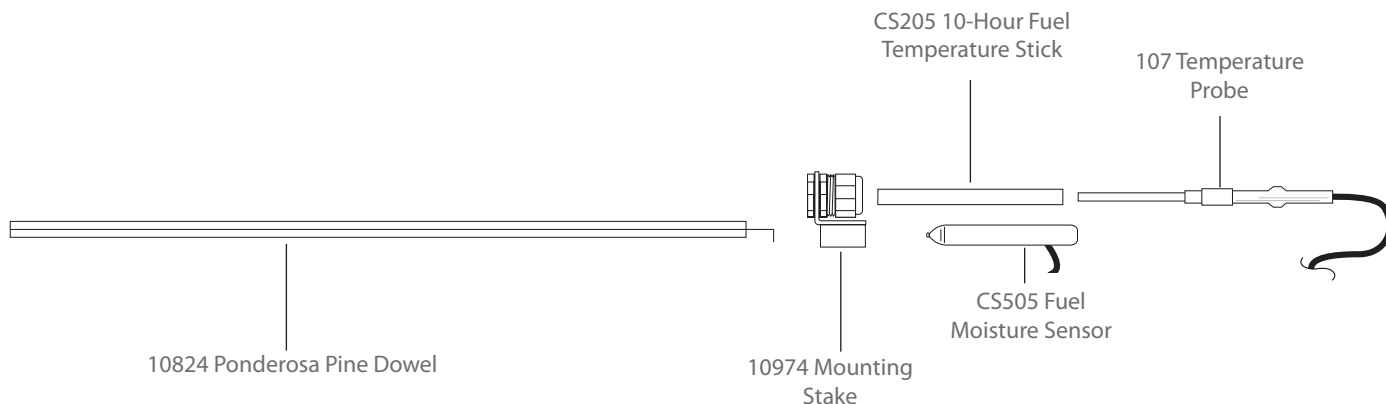
### CS515-QD

With the CS515-QD, the cables for the CS505 and 107 probes have a 12-foot length and are fitted with a military-style connector. The connector attaches to the enclosure of a RAWS-F Quick Deployment Fire Weather Station.

### CS515-LQ

With the CS515-LQ, the cables for the CS505 and 107 probes are also fitted with a military-style connector, but the cables have a user-specified length. The CS515-LQ is intended to be used with the RAWS-P Permanently Mounted Station.

## Top View of Fuel Sensors Assembly



This exploded view shows how the CS505 Fuel Moisture Sensor, 10824 10-Hour Fuel Moisture Stick, CS205 10-Hour Fuel Temperature Stick, and 107 Temperature Probe fit into the 10974 Fuel Moisture/Temperature Mounting Stake.

## Ordering Information

### Fuel Temperature

You must order both a fuel temperature stick and a temperature probe. Typically the fuel temperature stick/probe is measured along side a fuel moisture sensor/stick (see below). The sensors can be mounted side-by-side on a Fuel Moisture & Temperature Mounting Stake (at bottom right).

**CS205** 10-hour Fuel Temperature Stick (requires a 107-L or 107-LC temperature probe; see below)

### Temperature Probes (choose one)

**107-L** Temperature Probe (-35° to +50°C) with user-specified cable length. Enter cable length, in feet, after the -L; standard length is 25 feet. Must choose a cable termination option (see below).

**107-LC** Temperature Probe (-35° to +50°C) for MetData1 Weather Station. Enter cable length, in feet, after the -LC; standard length is 25 feet (i.e., 107-LC25).

### Cable Termination Options for 107-L (choose one)

- PT** Cable terminates in stripped and tinned leads for direct connection to datalogger's terminals.
- PW** Cable terminates in a connector for attachment to a prewired enclosure.

### Fuel Moisture

You must order both a fuel moisture stick and a moisture probe. Typically the fuel moisture stick/probe is measured along side a fuel temperature sensor/stick (see above). The sensors can be mounted side-by-side on a Fuel Moisture & Temperature Mounting Stake (at right).

**10824** 10-hour Fuel Moisture Stick (requires a CS505-L or CS505-LC probe; see below)

### Fuel Moisture Probes (choose one)

**CS505-L** Fuel Moisture Sensor/10-hour Fuel Moisture Stick with user-specified cable length. Enter cable length, in feet, after the -L; standard length is 25 feet. Must choose a cable termination option (see below).

**CS505-LC** Fuel Moisture Sensor/10-hour Fuel Moisture Stick for MetData1 Weather Station. Enter cable length, in feet, after the -LC; standard length is 25 feet (i.e., 107-LC25).

### Cable Termination Options for CS505-L (choose one)

- PT** Cable terminates in stripped and tinned leads for direct connection to datalogger's terminals.
- PW** Cable terminates in a connector for attachment to a prewired enclosure.



### Fuel Sensors for RAWS Stations

**CS515-QD** Fuel Moisture & Temperature Sensor for the RAWS-F Quick Deployment Fire Weather Station. Sensors have a 12-foot cable length and are mounted on the 10974 mounting stake.

**CS515-LQ** Fuel Moisture & Temperature Sensor for the RAWS-P Permanently Mounted Station; must specify a fuel moisture sensor cable length and a temperature sensor cable length (see below). The sensors are mounted on the 10974 mounting stake.

### Cable lengths for the CS515-LQ

Cable lengths of 25, 50, 75, or 100 ft (8, 15, 23, or 31 m) are recommended.

- LQ** Fuel moisture sensor cable length. Enter the cable length, in feet, after the -LQ.
- LT** Temperature probe cable length. Enter the cable length, in feet, after the -LT.



The CS515 attaches to the connectors labeled FM/FT on the RAWS connector panel (shown above).

### Mounting Stake

**10974** Fuel Moisture & Temperature Mounting Stake

### Replacement Dowels

*Dowel replacement is recommended every spring; more frequent replacement may be required in some environments (i.e., those with a large number of wet/dry cycles).*

**10824** 10-hour Fuel Moisture Stick

**CS205** 10-hour Fuel Temperature Stick

← The dowels of the fuel moisture stick (model 10824) and fuel temperature stick (model CS205) are easily replaced in the field with a Phillips screwdriver and an adjustable wrench.

# Specifications

## CS205 10-Hour Fuel Temperature Stick

**Material:** Ponderosa Pine  
**Length:** 4.5 inch (11.4 cm)  
**Diameter:** 0.5 inch (1.3 cm)  
**Weight:** 0.32 oz (9.07 g)

## 107 Temperature Probe

**Sensor:** -BetaTherm 100K6A1 Thermistor  
**Measurement Range:** -35° to +50°C  
**Steinhart-Hart Equation Error (CRBasic data-loggers only):** <±0.01°C over -35° to +50°C  
**Polynomial linearization accuracy (Edlog data-loggers only):** Typically <±0.5°C over -38° to +50°C range, <±0.1°C over -24° to +48°C range  
**Interchangeability error:** Typically <±0.2°C over 0° to 50°C range  
**Length:** 4.1 inch (10.4 cm)  
**Diameter:** <0.3 inch (0.5 cm)  
**Weight:** 5 oz. with 10-foot cable (136 g with 305 cm cable)

## 10824 10-Hour Fuel Moisture Sticks

**Material:** Ponderosa Pine  
**Diameter:** 0.5 inch (1.3 cm)  
**Length:** 8.4 inch (21.3 cm)  
**Weight:** 0.1 lbs (45 g)

## CS505 10-Hour Fuel Moisture Sensors

**Operating Range:** 0 to 70% moisture content

### Fuel Moisture Accuracy:

range	worst case	rms error
0 to 10%	±2%	±1%
10 to 20%	±3%	±1.5%
20 to 30%	±5%	±2.2%
30 to 40%	±8%	±2.4%
40 to 70%	±12% (est.)	

**Power Supply:** 9 to 18 Vdc  
**Enable Voltage:** 1.3 to 20 Vdc  
**Current Use:** 70 mA active; 10 µA quiescent  
**Output Signal:** ±2.5 Vdc square wave with an output frequency of 600 to 1500 Hz  
**Weight**  
**Potted molding:** 0.4 lbs (181 g)  
**Cable:** 0.4 lbs per 10-foot length (181 g per 305 cm)  
**Potted Molding Dimensions:** 2.8-inch x 4.3-inch x 0.9-inch (7.1-cm x 10.9-cm x 2.3-cm)

Experiments were conducted to characterize measurement error and to determine the calibration polynomial coefficients used to convert the output signal to percent moisture content. The full scale range is broken into four subranges: 0-10, 10-20, 20-30, and 30-50 percent. For each range band, an error band was determined in which more than 90 percent of all measurements fall.

EXPERIMENTAL DATA ERROR DISTRIBUTION

