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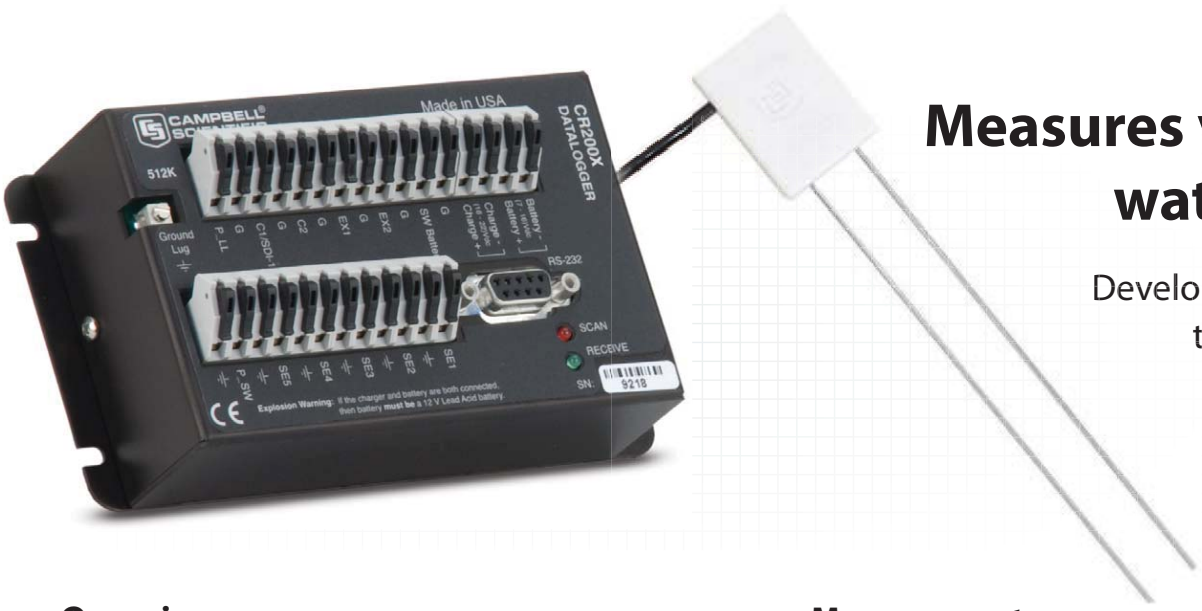
WHEN MEASUREMENTS MATTER

CS625

Water Content Reflectometer for CR200(X) Series



Measures volumetric water content

Developed specifically for the CR200(X) series

Overview

The CS625 Water Content Reflectometer measures the volumetric water content of porous media using time-domain measurement methods. A cable tester such as the TDR100 is not required.

The probe consists of two stainless steel rods connected to a PCB. A shielded 4-conductor cable is connected to the circuit board to supply power, enable the probe and monitor the pulse output. The circuit board is encapsulated in an epoxy block.

The CS625 has been developed specifically for the CR200(X)-series dataloggers and is not compatible with other dataloggers. Another reflectometer, the CS616, can be used with a CR510, CR800, CR850, CR10X, CR1000, CR3000, or CR5000 datalogger. The CS625 connects directly to one of the datalogger's single-ended analogue inputs. A datalogger control port is used to enable the CS625 for the amount of time required to make the measurement. Datalogger instructions convert the probe square-wave output to period which is converted to volumetric water content using a calibration.

Note: A maximum of four CS625 probes can be measured by one CR200(X) datalogger. Valid channel options are analogue channels 1 through 4.

Measurements

The differentially-driven probe rods form a transmission line with a wave propagation velocity that is dependent on the dielectric permittivity of the medium surrounding the rods. Nanosecond risetimes produce waveform reflections characteristic of an open-ended transmission line. The return of the reflection from the ends of the rods triggers a logic state change which initiates propagation of a new wavefront. Since water has a dielectric permittivity significantly larger than other soil constituents, the resulting oscillation frequency is dependent upon the average water content of the medium surrounding the rods. The megahertz oscillation frequency is scaled down and easily read by a Campbell Scientific CR200(X)-series datalogger.

Typical Applications:

- Agricultural research
- Forestry and ecology
- Civil engineering
- Studies in avalanche prediction

Benefits and Features

- No expensive cable tester required
- Rugged probes; not subject to ice damage
- Low cost
- Direct connection to datalogger
- Stable calibration
- Long cables available
- Easy to use

Summary of Measurement Performance

- probe-to-probe variability: ±0.5% VWC in dry soil, ±1.5% VWC in typical saturated soil
- accuracy ±2.5% VWC using standard calibration with bulk electrical conductivity ≤0.5 deciSiemen meter^{-1} (dS m^{-1}) and bulk density ≤1.55 g cm^{-3} in measurement range 0% VWC to 50% VWC
- precision 0.1% VWC
- resolution 0.1% VWC

Response Characteristics / Calibration

The signal propagating along the parallel rods of the CS625 is attenuated by free ions in the soil solution and conductive constituents of the soil mineral fraction. In most applications, the attenuation is not enough to affect the CS625 response to changing water content, and the response is well described by the standard calibration. However, in soil with relatively high soil electrical conductivity levels, compacted soils, or soils with high clay content, the calibration should be adjusted for the specific medium. Guidance for making these adjustments is provided in the operating manual.

Figure 1 shows calibration data collected during laboratory measurements in a loam soil with bulk of density 1.4 g cm^{-3} (porosity = 0.47). The bulk electrical conductivity at saturation was 0.4 dS m^{-1} (solution electrical conductivity @ 2 dS m^{-1}). The linear calibration works well in the typical water content range of 10% and 40%. Outside this range, a quadratic calibration may be needed.

In soil with relatively high soil electrical conductivity levels, compacted soils, or soils with high clay content, the calibration must be adjusted for the specific application to maintain measurement accuracy. Figure 2 compares the CS625 response in a loam soil to a higher density sandy clay loam for two different electrical conductivities. The bulk density for both sandy clay loam soils is 1.6 cm^{-3}. The electrical conductivity at saturation for the sandy clay loam labelled "compacted soil" is 0.4 dS m^{-1}. The "compacted soil, high EC" had an electrical conductivity at saturation of 0.75 dS m^{-1}.

The low EC soil response curve is shown for reference. The compacted soil response curve shows the effect of compaction. Since fine textured soils seldom have a water content of less than 10%, the adjustment is essentially an offset. The compacted soil, high EC response curve shows the expected bulk electrical conductivity increase with increasing water content. Again, the response above 10% volumetric water content is nearly linear, which simplifies the calibration adjustment.

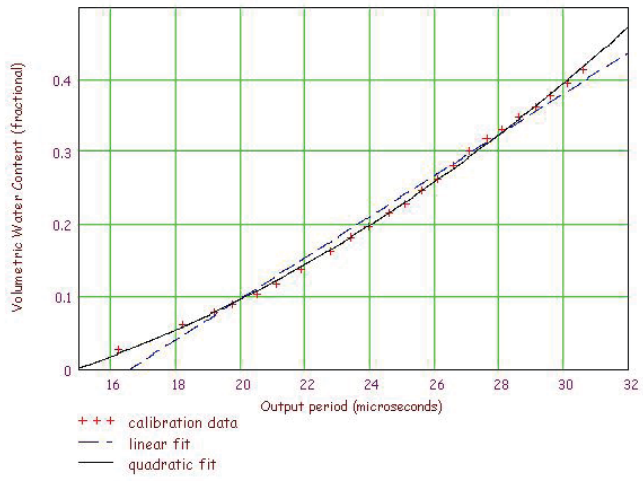


Fig. 1 CS625 linear and quadratic calibration derived from loam soil

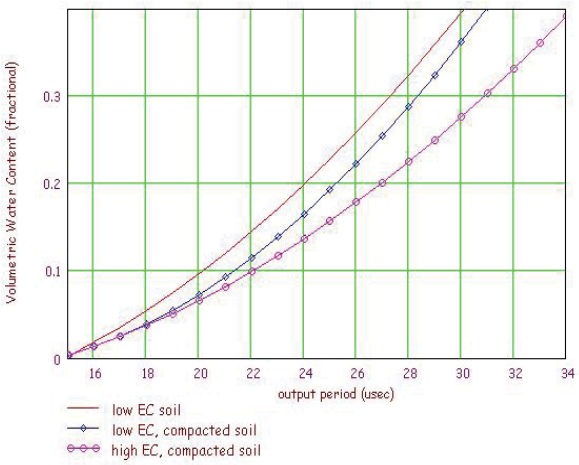


Fig. 2 CS625 response in compacted, sandy clay loam soil and low EC loam for comparison

Specifications

Accuracy
±2.5% VWC using standard calibration iwith bulk electrical conductivity ≤ 0.5 deciSiemen metre^{-1} (dSm^{-1}) and bulk density ≤1.55g cm^{-3} in measurement range 0% VWC to 50% VWC

Precision (reproducability) 0.05% VWC

Resolution 0.1% VWC

Probe-to-probe variability ±0.5% VWC in typical saturated soil

Output
0 to 3.3 V square wave with frequency dependent on water content

Typical Power Requirements
65mA @ 12V DC during measurement

45µA quiescent

Measurement Time
With the CS625 Instruction: 0.50ms

Power Supply Voltage
5V DC minimum, 18V DC maximum

Enable Voltage
4V DC minimum, 18V DC maximum

Maximum Cable Length
The maximum cable length available is 300m.

Dimensions
Rods: 300mm long; 3.2mm diameter; 32mm spacing

Head: 110 x 63 x 20mm

Weight
Probe (without cable): 280g

Cable: approximately 35gm^{-1}

Electromagnetic Compatibility (EMC)
The RF emissions are below FCC and EU limits as specified in EN61326 if the CS625 is enabled less than 0.6 milliseconds, and measurements are made no more frequently than once a second. The CS625 instruction limits the enable time to less than 0.6 milliseconds. As a consequence of the principle of operation, external RF sources can also affect the CS625 operation. Consequently, the CS625 should be located away from significant sources of RF such as AC power lines, radio transmitters and motors. The CS625 meets EN61326 requirements for protection against electrostatic discharge.

Ordering Information

Water Content Reflectometer

CS625 Water Content Reflectometer for CR200(X)-Series with user-specified cable length. Recommended cable length is 3, 5, 10, 15 or 20 m, maximum length is 300 m (1000 ft).

Installation Tool

CS650G Rod Insertion Guide Tool with Pilot Rod that helps maintain the proper spacing and parallel oreitnation of the rods during probe insertion. It also helps the insertion of the probe in high density or rocky soils.