CS625

Water Content Reflectometer for CR200(X)-Series Loggers

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WHEN MEASUREMENTS MATTER

The CS625 Water Content Reflectometer measures the volumetric water content of porous media using time-domain measurement methods that are sensitive to dielectric permittivity. The probe consists of two 30 cm long stainless steel rods connected to a printed circuit board. The circuit board is encapsulated in epoxy, and a shielded four-conductor cable is connected to the circuit board to supply power, enable probe, and monitor the output. The probe rods can be inserted from the surface or the probe can be buried at any orientation to the surface.

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 analog 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 analog channels 1 through 4.

The CS625 (bottom) is used exclusively with the CR200(X)-series datalogger (top). A maximum of four CS625 probes can be measured by one CR200(X) datalogger. Valid channel options are analog channels 1 through 4.

Reflectometer measurement method

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 rise-times 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.

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

CS625 Response Characteristics

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.

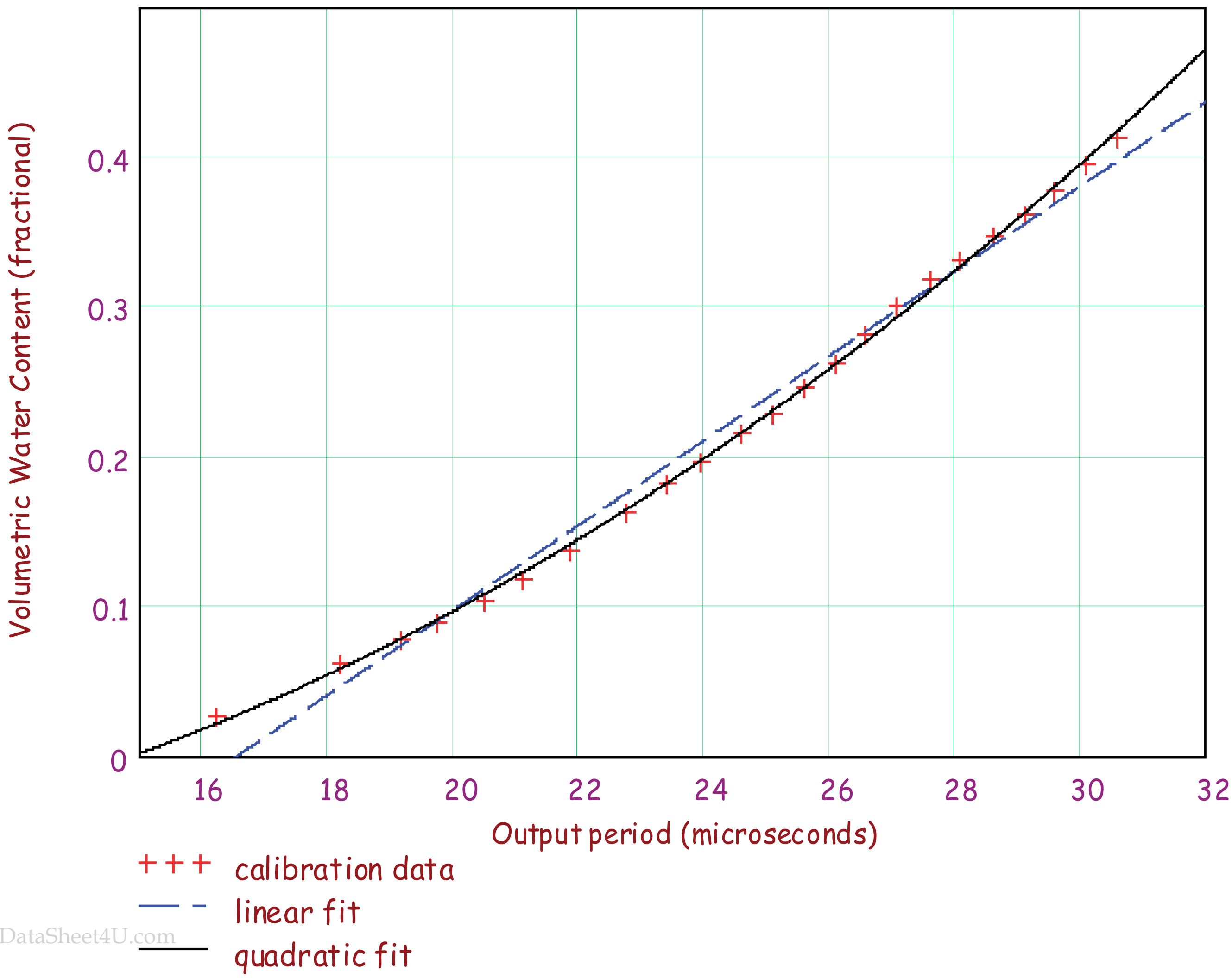
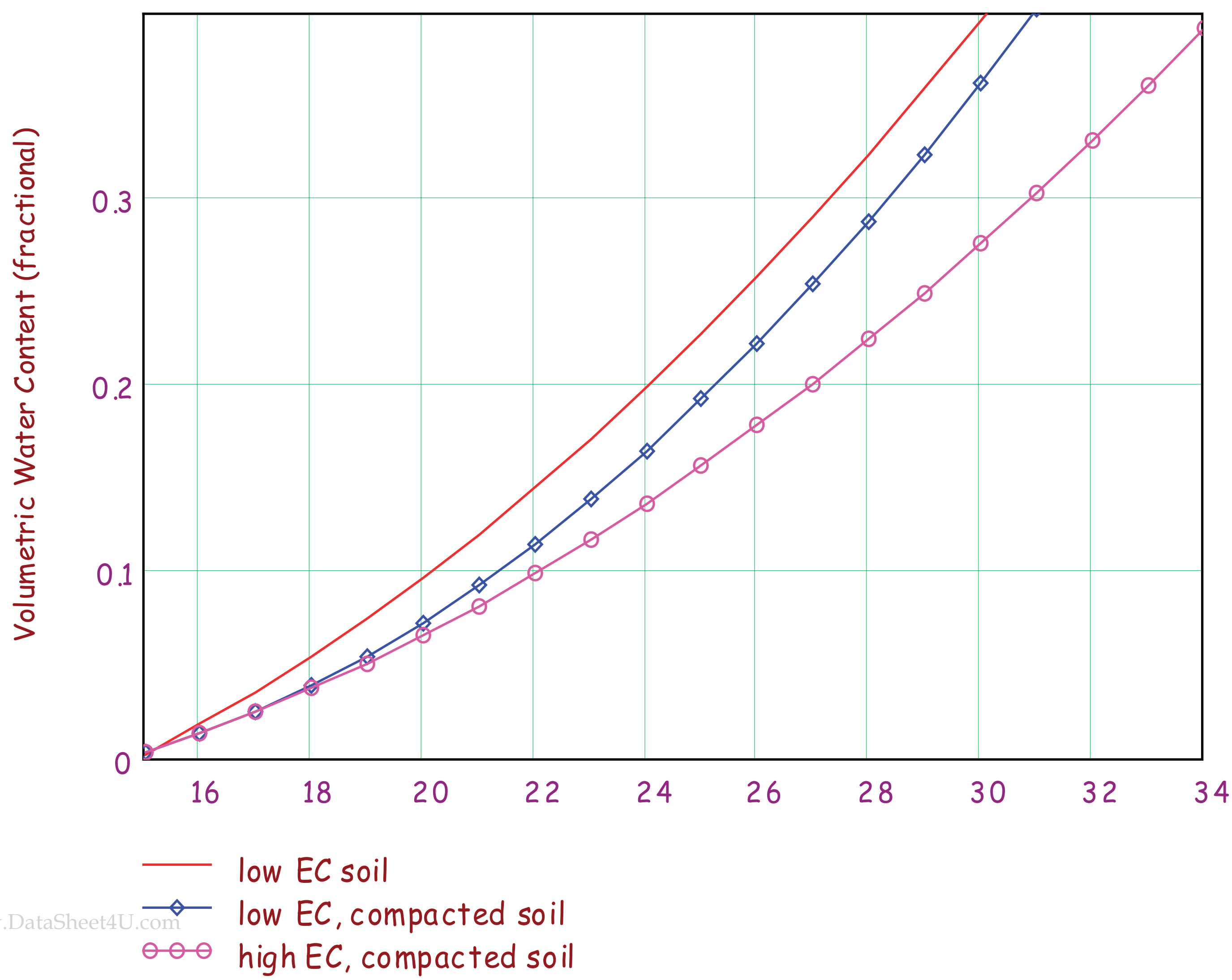


Figure 1. CS625 linear and quadratic calibration derived from loam soil.

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 labeled “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..



Ordering Information

Water Content Reflectometer

CS625-L Water Content Reflectometer for CR200(X)-Series Dataloggers. Enter cable length, in feet, after -L. Recommended cable length is 25, 50, 75, or 100 ft (8, 15, 23, or 31 m); maximum length is 1000 ft (300 m). Must choose a cable termination option (see below).

Cable Termination Options (choose one)

-PT Cable terminates in stripped and tinned leads for direct connection to a datalogger's terminals.

-PW Cable terminates in connector for attachment to a prewired enclosure.

Installation Tools

14383 Installation Tool that helps maintain the proper spacing and parallel orientation of the rods during probe insertion. Often used with the 14384 Pilot Tool (see below).

14384 Pilot Tool that helps the insertion of the CS625 in high density or rocky soils. Best results are obtained when the 14384 is used with the 14383 Installation Tool (see above).

The 14384 Pilot Tool has rods with similar diameters and the same spacing as the CS625. The tool can be driven into the soil using force levels that might damage the CS625. After removing the 14384, the CS625 is inserted into the established holes.

The 14383 Installation Tool can be used to help maintain the proper spacing and parallel orientation of rods during insertion. Use of the 14383 may reduce measurement errors by minimizing soil disturbance.

Specifications

Output:	0 to 3.3 V square wave with frequency dependent on water content
Power:	65 mA @ 12 Vdc when enabled, 45 µA quiescent typical
Power Supply Voltage:	5 Vdc minimum, 18 Vdc maximum
Enable Voltage:	4 Vdc minimum, 18 Vdc maximum
Maximum Cable Length:	1000 feet (305 m)
Electromagnetic Compatibility:	The RF emissions are below FCC and EU limits as specified in EN61326 if the CS625 is enabled less than 0.6 ms, and measurements are made no more frequently than once a second. 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 and motors. The CS625 meets EN61326 requirements for protection against electro-static discharge.
Rod Dimensions	
Length:	300 mm (11.8 inch)
Diameter:	3.2 mm (0.13 inch)
Spacing:	32 mm (1.3 inch)
Probe Head Dimensions	
Height:	85 mm ((3.3 inch)
Width:	63 mm (2.5 inch)
Depth:	18 mm (0.7 inch)
Weight	
Probe (without cable):	280 g (9.9 oz.)
Cable:	35 g per m (0.38 oz. per ft)
14384:	2 oz.. (57 g)
14383:	9.2 oz (260 g)

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