Reading VW Sensors with the CR10 Data Logger

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Introduction

About This Manual

This manual tells how to read VW sensors using Campbell Scientific CR10 and CR10X data loggers with the AVW1 or AVW100 interface and the AM416 or AM16/32 multiplexer.

CR10 and CR10X Instructions

The CR10 provides instruction 28 to read VW sensors. The CR10X provides instruction 28 and instruction 131 to read VW sensors. Both loggers use the instruction 4 to read thermistors or RTDs.

VW Interface Modules

There are three vibrating wire interfaces modules available, the AVW1, the AVW4, and the AVW100. We discuss only the AVW1 and AVW100. The AVW1 can be used with either instruction 28 or instruction 131. The AVW100 works only with instruction 131.

Multiplexer

The older AM416 multiplexer has been replaced by the AM16/32 multiplexer. Either multiplexer can be used to control 16 VW sensors with temperature or 32 VW sensors without temperature.

Logger Software

Logger software called PC208 or LoggerNet is used to create and transfer a monitoring program to the logger and later to retrieve stored data from the logger. You can find sample monitoring programs at www.slopeindicator.com. Go to Support - Tech Notes - Sample Programs for CR10X.

You can modify these programs to meet your needs. If you need help, you can request programming services from Slope Indicator. Note that Slope Indicator cannot provide unpaid support for these programs.

About Data Reduction

VW sensors return a frequency signal that must be converted to units of pressure, strain, or displacement. The conversion process and other data reduction issues are discussed in the manual for each type of sensor.

Instruction 28 with AVW1 Interface

Instruction 28

1. Use instruction 28 to excite the sensor. It returns $(kHz)^2$.

   04 - Starting Freq (units = 100 Hz): Enter a frequency below the lowest frequency in the test data on the calibration sheet (e.g. 14 for 1400 Hz). See Sensors and Sweeps, page 5.

   05 - End Freq (units = 100 Hz): Enter a frequency higher than the highest frequency in the test data on the calibration sheet (e.g. 35 for 3500 Hz). See Sensors and Sweeps, page 5.

   06 - No. of Cycles: Enter 250 (typical). See Sensors and Sweeps, page 5.

   09 - Mult: Enter 1.0

   10 - Offset: Enter 0

2. Use instruction 39 to obtain the square root of the reading obtained with instruction 28. The value will now be kHz.

3. (Optional) Use instruction 55 to apply polynomial factors to convert the readings to engineering units. The “manual ABC” listed on the sensor calibration record are intended to operate on Hz readings, so they must be adjusted for the kHz value returned by instruction 39 above. See below.

   04 - C0: Enter the C factor listed in the calibration record for the C0 parameter. Do not modify this value.

   05 - C1: Multiply the B factor by 1,000 (move the decimal three places to the right) and enter the resulting value for the C1 parameter.

   06 - C2: Multiply the A factor by 1,000,000 (move the decimal six places to the right) and enter the resulting value for the C2 parameter.

   07 - C3: Enter 0.

   08 - C4: Enter 0.

   08 - C5: Enter 0.

Instruction 131 with AVW1 Interface

Instruction P131

Instruction 131 returns two values, a reading in Hz, and a second value that can be used by the monitoring program to test the quality of the reading. The instruction has 14 parameters.

Reps: Enter a 1. Do not use this instruction to obtain a second reading. Instead, call instruction 131 a second time, after an appropriate delay.

Range Option: Enter a 2 (or 1).

SE Channel: Choose an input channel.

Ex Channel: Choose an excitation channel.

Starting Freq (Hz): Enter a starting frequency for the excitation sweep. See Sensors and Sweeps on page 5.

Ending Freq (Hz): Enter an ending frequency for the excitation sweep. See Sensors and Sweeps on page 5.

T (Sweep, Units=ms): Enter the duration of the sweep in milliseconds. See Sensors and Sweeps on page 5.

N (no. of Steps): Enter the number of steps in the sweep frequency. See the Sensor Table and Sweep Table for a value.

Delay after Excit. (Units=ms): Enter a delay of 25 milliseconds.

Cycles to Measure: Enter the number of cycles. See the Sensor Table and Sweep Table for a value.

Rep Delay (Units = 0.01 sec): Enter zero.

Loc: Enter a label up to 9 characters long. PC208W then assigns an input location. Behind the scenes, PC208 actually assigns two input locations, one for the reading and the other for the comparison reading. Both readings are in Hz. The sample program uses the label "Freq_1," so PC208W automatically generates a second label, "Freq_2."

Mult: Enter 1.

Offset: Enter zero.

Instruction 131 with AVW100 Interface

Instruction P131

Instruction 131 returns two values, a reading in Hz, and a second value that can be used by the monitoring program to test the quality of the reading. The instruction has 14 parameters.

Reps: Enter a 1. Do not use this instruction to obtain a second reading. Instead, call instruction 131 a second time, after an appropriate delay.

Range Option: Enter a 4.

SE Channel: Choose an input channel.

Ex Channel: Choose an excitation channel.

Starting Freq (Hz): Enter a starting frequency for the excitation sweep. See Sensors and Sweeps on page 5.

Ending Freq (Hz): Enter an ending frequency for the excitation sweep. See Sensors and Sweeps on page 5.

T (Sweep, Units=ms): Enter the duration of the sweep in milliseconds. See Sensors and Sweeps on page 5.

N (no. of Steps): Enter the number of steps in the sweep frequency. See the Sensor Table and Sweep Table for a value.

Delay after Excit. (Units=ms): Enter a delay of 25 milliseconds.

Cycles to Measure: Enter the number of cycles. See the Sensor Table and Sweep Table for a value.

Rep Delay (Units = 0.01 sec): Enter zero.

Loc: Enter a label up to 9 characters long. PC208W then assigns an input location. Behind the scenes, PC208 actually assigns two input locations, one for the reading and the other for the comparison reading. Both readings are in Hz. The sample program uses the label “Freq_1,” so PC208W automatically generates a second label, “Freq_2.”

Mult: Enter 1.

Offset: Enter zero.

Sensors and Sweeps

Sensor Table

Find your sensor and its required sweep. You can also find sweeps and usage in the sensor manual. After you find the sweep, look at the Sweep Table below.

Name	Part Number	Required Sweep
Crackmeter	5263608x	Sweep 3 or 2
Displacement Sensor , Extensometer	526363xx	Sweep 3 or 2
Piezometer	526110xx, 526210xx	Sweep 3
Settlement Cell, 50 or 100 psi	52612020, 52612030	Sweep 3
Strain Gauge, Arc-Weldable	52630306	Sweep 2 or 1
Strain Gauge, Embedment	52640126	Sweep 2 or 1
Strain Gauge, Spot-Weldable	5260210x	Sweep 2 or 3
Stress Station, VW Transducers	526081xx, 526114xx	Sweep 3
Total Pressure Cell	526082xx,5260828x	Sweep 3
Total Pressure Cell, Radial	5260826x	Sweep 3
Total Pressure Cell, Tangential	5260827x	Sweep 3

Sweep Table

Each row lists a sweep and the values needed for instruction 28 and 131. (Instruction 28 does not use T or N). If your sensor is not listed above, check your sensor calibration sheet to find the lowest and highest frequencies in the calibration, and then choose the sweep that is closest to those frequencies.

	Starting Freq	Ending Freq	T	N	Cycles
Sweep 1*	450	1125	70	40	100
Sweep 2*	800	2000	22	26	100
Sweep 3	1400	3500	14	32	250
Sweep 4	2300	6000	8	27	500
* These sweeps are not used with instruction 28.					

Check for Reading Quality Instruction 131 Only

Instruction 131 instruction returns two frequency values in consecutive locations. The first value, Freq_1, is produced from the full number of cycles. The second value, Freq_2, is produced from the first 20% of the full number of cycles.

The deviation between the two frequencies is a measure of reading quality. Deviation is defined as:

$$Deviation = ABS\left(1 - \frac{\text{Freq\_2}}{\text{Freq\_1}}\right)$$

The maximum allowable deviation for each sweep range is shown in the table below. If the deviation is less than the maximum, the Freq_1 value can be accepted as a good reading. If the deviation is greater, the reading should be taken again. (Always provide a delay of at least two seconds before repeating a reading).

Sweep Range	Maximum Allowable Deviation
1	0.008
2	0.008
3	0.0032
4	0.0016

Instruction 4 for Thermistors and RTDs

Reading Thermistors

1. Use instruction 4 to read the thermistor.

   02 - Range Option: Enter 25 (60 Hz rejection, 2500 mV range)

   05 - Delay (units .01 sec): Enter 1

   06 - mV Excitation: Enter 2500

   08 - Mult: Enter .001

   09 - Offset: Enter 0

2. Then use instruction 55 to apply factors to convert the reading to °C.

   04 - C0: Enter -104.78

   05 - C1: Enter 378.11

   06 - C2: Enter -611.59

   07 - C3: Enter 544.27

   08 - C4: Enter -240.91

   09 - C5: Enter 43.089

Reading the RTD

1. Use instruction 4 to read the RTD.

   02 - Range Option: Enter 25 (60 Hz rejection, 2500 mV range)

   05 - Delay (units .01 sec): Enter 2

   06 - mV Excitation: Enter 2500

   08 - Mult: Enter .001

   09 - Offset: Enter 0

2. Then use instruction 55 to apply factors to convert the reading to °C.

   04 - C0: Enter 2412.6

   05 - C1: Enter -3442.5

   06 - C2: Enter 1904.4

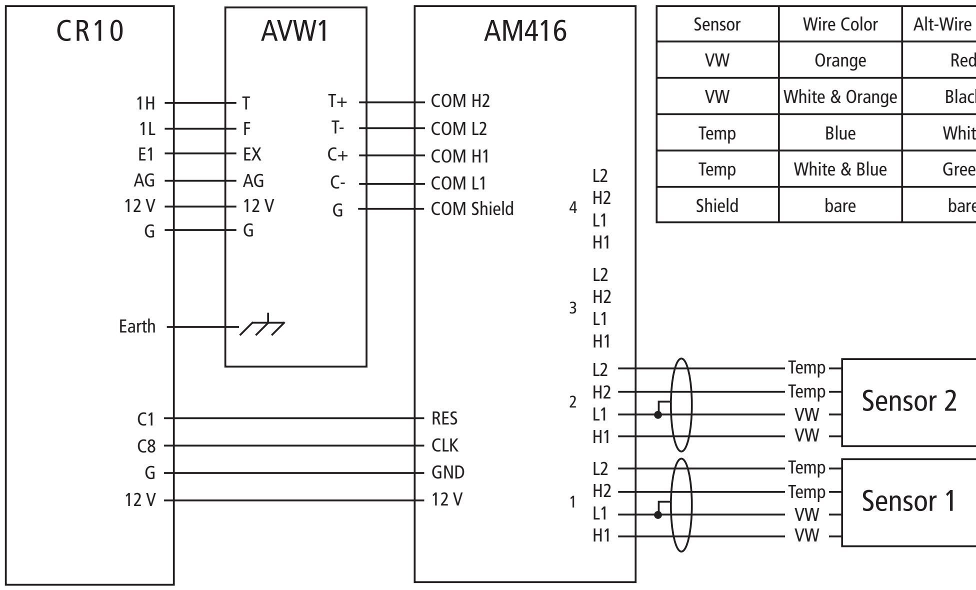
   07 - C3: Enter -435.97

   08 - C4: Enter 0

   09 - C5: Enter 0

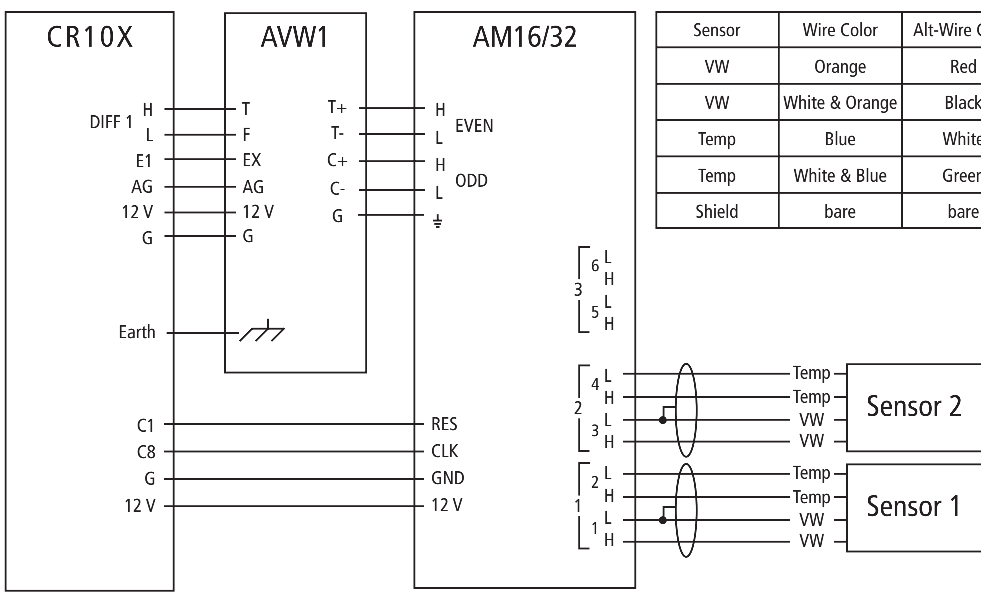
Wiring Diagrams

Diagram 1 CR10, AVW1 and AM416



Sensor	Wire Color	Alt-Wire Color
VW	Orange	Red
VW	White & Orange	Black
Temp	Blue	White
Temp	White & Blue	Green
Shield	bare	bare

Diagram 2 CR10X, AVW1, AM16/32

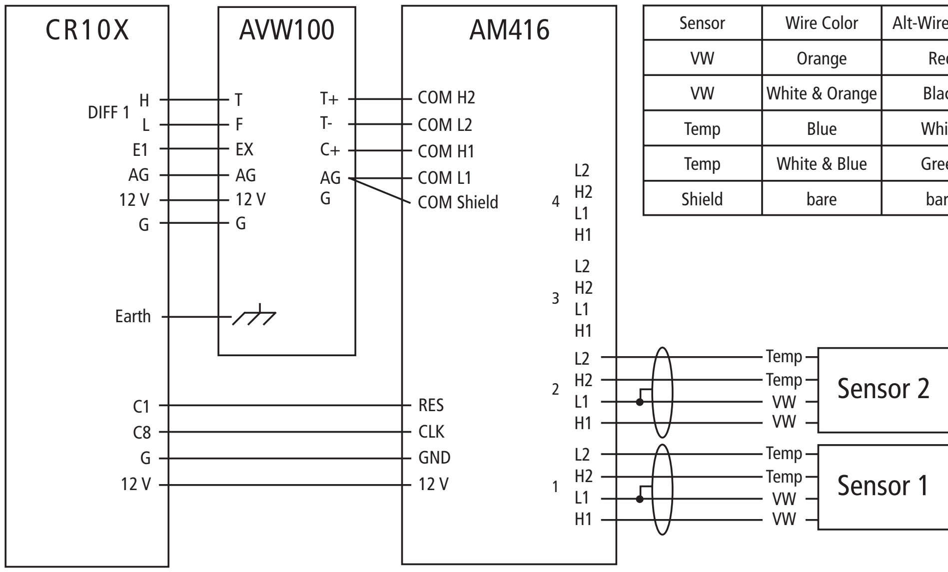


Sensor	Wire Color	Alt-Wire Color
VW	Orange	Red
VW	White & Orange	Black
Temp	Blue	White
Temp	White & Blue	Green
Shield	bare	bare

Ground Connections Connect the CR10's earth ground to the grounding lug of the enclosure. Connect the lug to a grounding rod. Connect the AVW1's earth ground in the same way.

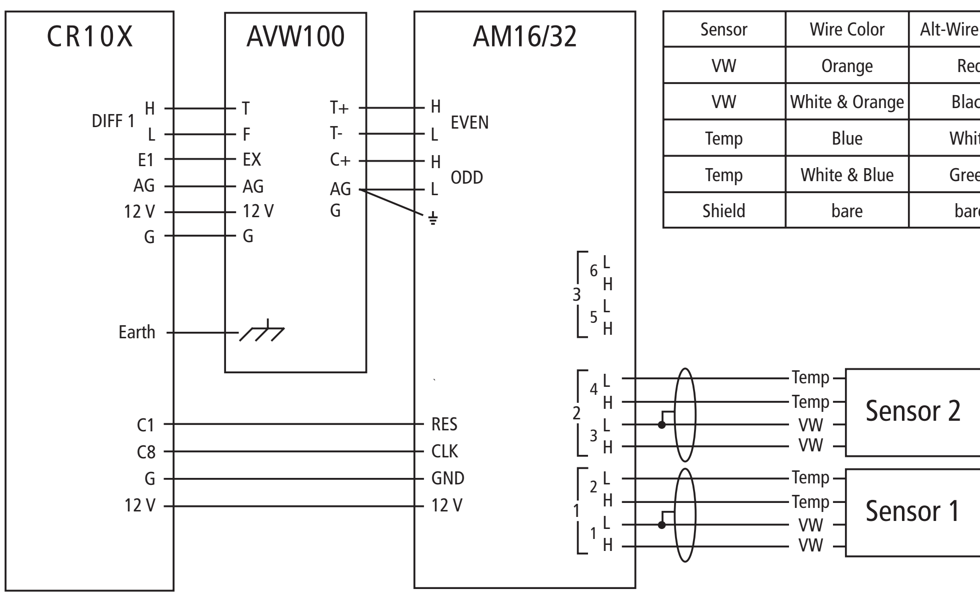
Shield Connections: The shield wire from the sensor is connected to L1 on the multiplexer. Shield wires are not connected to any of the "shield" terminals on the multiplexer. This allows switching of the shield so that the shield on one signal cable cannot affect the shield on another.

Diagram 3 CR10X, AVW100, AM416



Sensor	Wire Color	Alt-Wire Color
VW	Orange	Red
VW	White & Orange	Black
Temp	Blue	White
Temp	White & Blue	Green
Shield	bare	bare

Diagram 4 CR10X, AVW100, AM16/32



Sensor	Wire Color	Alt-Wire Color
VW	Orange	Red
VW	White & Orange	Black
Temp	Blue	White
Temp	White & Blue	Green
Shield	bare	bare

Ground Connections Connect the CR10's earth ground to the grounding lug of the enclosure. Connect the lug to a grounding rod. Connect the AVW100's earth ground in the same way.

Shield Connections: The shield wire from the sensor is connected to L1 on the multiplexer. Shield wires are not connected to any of the "shield" terminals on the multiplexer. This allows switching of the shield so that the shield on one signal cable cannot affect the shield on another..