Instrumentation Northwest, Inc.
Protecting our water resources since 1982

APPLICATION NOTE

USE OF THE PS9105 PRESSURE TRANSDUCER WITH THE CAMPBELL SCIENTIFIC, INC. CR10 (Standard Performance) November 1995

Introduction

The purpose of this document is to provide a basic overview of the operation of the PS9105 submersible pressure transducer and how it is used with the Campbell Scientific CR10 Measurement and Control Module.

First, it is important to note the difference between the PS9104 and the PS9105 transducers. The PS9104 is intended to be used with the PST system and may also be used with the CR10. The PS9105 is not compatible with the PST and is intended to be used with the CR10 datalogger in standard and enhanced performance applications. Due to the internal sensor configuration, the excitation polarity may not be reversed with the PS9105. This means that **the measurements for the PS9105 should be made with the CR10 P8 or custom INW P29 instruction and not the P6** instruction.

The PS9105 transducer is a ratiometric, differential (mV) device. To obtain the specified temperature performance, the differential output voltage (V_O) must be normalized to the excitation current (i.e., computing V_O/I), giving a quantity with the dimension Ohms.
This is done by using a precision resistor in series with the transducer.

Measurements are made when power is applied to the transducer by the datalogger. One input channel is used to measure the differential output voltage (V_O) from the transducer and another is used to measure the voltage across the precision series resistor (V_R). The normalized quantity (L) is obtained as follows:

$$L = V_O/I = V_O/(V_R/R) = (V_O/V_R) * R \quad \text{(Ohms)} \quad \{1\}$$

It is this quantity that we scale to our desired units (e.g., feet) using a multiplier and offset. The multiplier and offset are determined from the information given in the calibration certificate.

To pull these concepts together, we will go through an example of wiring the transducer to the CR10 panel, calculating the required parameters and generate a sample CR10 instruction set.

Wiring Requirements

Figure 1.0 gives an example of how the four wires from the cable are used together with a resistor and one jumper wire. Instrumentation Northwest has a kit available (P/N 6-E-685) which contains a precision 100 Ohm, 0.01%, 2.5 ppm/^{o}C resistor and three jumper wires of various lengths (1.5", 2.5" and 3.5"). It is important to insure that solid, reliable connections are made at the wiring panel. **It should be noted that the additional two wires in the cable (orange and white) are connected to the excitation leads at the transducer so care must be taken in terminating these leads.** In addition, the shield needs to be tied to ground.

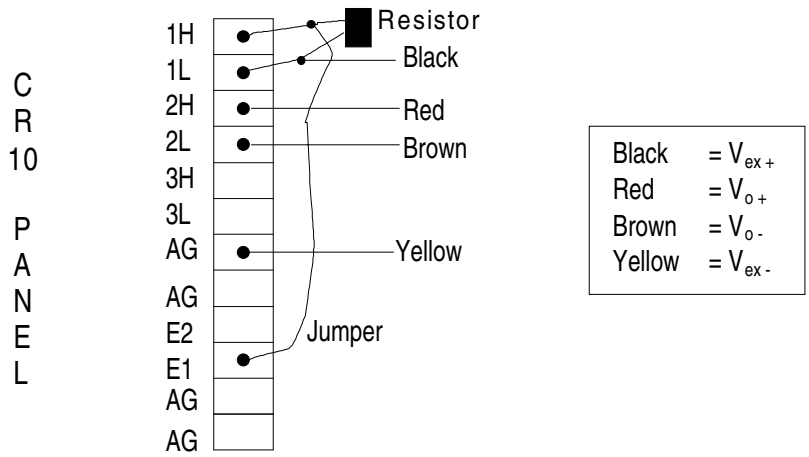

Figure 1.0: Connection Scheme

Calculation of Multiplier and Offset Parameters

Before programming the datalogger, the multiplier and offset parameters must be determined. These are used to convert the signal into the desired units based on a straight line relationship with water depth (d). The equation of the line defining this relationship is as follows:

$$d = m[V_o/(V_R/R)] + b = mL + b \qquad \{2\}$$

where m and b are the multiplier and offset parameters, respectively.

To determine the values of m and b for a particular transducer, data from the serialized calibration sheet is utilized with the following equations:

$$m = (d_{max} - d_{min})/(L_{max} - L_{min}) \qquad \{3\}$$

$$b = -mL_{min} \qquad \{4\}$$

As an example, we use the following sample calibration data and assume a 5 psig device. Using 2.31 feet of water per psi, the full scale depth is 11.55 feet.

Sample Calibration Data

P(psig)	0.00	2.50	5.00
L(Ohms)	-1.186	35.266	71.361

In general, the resistor value and the excitation level are selected such that both voltage measurements (V_o and V_R) fit within the +/- 25 mV input range of the CR10 over the entire temperature and pressure range. A 100 Ohm resistor is standard and the recommended excitation level is 0.8 V.

Using equations 3 and 4, we determine the multiplier and offset for the sample calibration data:

m = (11.55 - 0)/[71.361 - (-1.186)] = 0.1592

b = (-0.159)*(-1.186) = 0.1888

CR10 Programming

The following is and example of an instruction set to tell the CR10 to power the circuit, take the appropriate measurements, process the measurements and convert the result to feet of water. For the PS9105, we use two P8 **(not P6)** instructions (one instruction with two reps) to obtain the measurements, a P38 to calculate the voltage ratio and a P37 followed by a P34 to scale the data to the desired units. In this example, the value assigned to F in the P37 instruction is the product of the resistor value R and the multiplier m. That is, F = 100*0.1592=15.92.

sample instruction set

01:	P8	Excite, Delay, Volt(DIFF)		
01: 2		Reps		
02: 3		25 mV slow Range		
03: 1		IN Chan		
04: 1		Excite all reps w/EXchan 1		
05: 1		Delay (units=.01sec)		1 unit delay is
06: 800		mV Excitation		recommended
07: 1		Loc:		
08: 1.0		Mult		
09: 0.0		Offset		
02:	P38	Z=X/Y	Calculate voltage ratio V_o/V_R	
01: 2		X Loc:		
02: 1		Y Loc:		
03: 3		Z Loc:	Result in input location 3	
03:	P37	Z=X*F	Mult. ratio by R and m	
01: 3		X Loc:		
02: 15.92		F		
03: 3		Z Loc:	Result back in location 3	
04:	P34	Z=X+F	Add offset (b)	
01: 3		X Loc:		
02: .1888		F		
03: 3		Z Loc:	Result in input location 3	

Following the execution of these instructions, location 3 contains the measured depth in feet of water. This result may be further processed or written to final storage memory.

Instrumentation Northwest appreciates any comments you may have regarding this application note. Please call or write to:

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