

Instrumentation Northwest, Inc. (INW)

APPLICATION NOTE

ERROR COMPENSATION ON AQUISTAR® PT2X SMART SENSORS March 2004

Introduction

PT2X Smart Sensors measure pressure using industry standard strain gauge pressure transducers. Strain gauge pressure transducers consist of a thin diaphragm with four imbedded resistors, in a bridge arrangement. As pressure varies, the output signal from this bridge varies.

In an ideal world, a pressure transducer would respond only to pressure. In reality, however, pressure readings can vary as temperatures change. Also, each individual transducer introduces variations of its own.

Standard Compensation

Using techniques developed in Instrumentation Northwest's U.S. patent number 5,460,049 ("Digitally-Temperature-Compensated Strain-Gauge Pressure Measuring Apparatus"), the PT2X Smart Sensor digitally compensates for these variations, bringing the accuracy to $\pm 0.06\%$ FSO at one temperature and $\pm 0.2\%$ FSO over 0°C to 40°C temperature span.

Before leaving the factory, each PT2X is individually calibrated. Using a high precision environmental chamber, numerous sample measurements are taken at 5°C , 20°C , and 35°C at both zero and full-scale pressures.

Six calibration parameters are determined from this sample data, three for offset and three for slope. Offset and slope errors are defined as second order functions of temperature. Parameters for both are determined by least squares fit of data for known temperature and known pressure samples. These parameters are then stored in memory on each individual PT2X.

During operation, uncompensated temperature and pressure data is collected and stored in the PT2X memory. When data is retrieved from the sensor, the calibration parameters are also retrieved. The retrieving program, typically Aqua4Plus or Aqua4Palm, then applies the calibration parameters, as follows:

$$P_c = m_e * P_m + b_e$$

Where P_c is Pressure Calibrated (in psi)

Where P_m is Pressure Measured (in psi)

$$\text{Where } m_e = m_2 * T^2 + m_1 * T + m_0$$

$$\text{Where } b_e = b_2 * T^2 + b_1 * T + b_0$$

Where T = temperature in degrees C

Where m_x represents slope

Where b_x represents offset

The resultant data is highly accurate – each data point having been individually adjusted to compensate for temperature variations and individual characteristics of the particular sensor.

Custom Compensation

Custom compensation is available for a wider temperature range, bringing an accuracy of $\pm 0.2\%$ FSO over 0°C to 100°C temperature span. Using a high precision environmental chamber, numerous sample measurements are taken between 0°C to 100°C at both zero and full-scale pressures.

Eight calibration parameters are determined from this sample data, four for offset and four for slope. Offset and slope errors are defined as third order functions of temperature. Parameters for both are determined by least squares fit of data for known temperature and known pressure samples. These parameters are then stored in memory on each individual PT2X.

During operation, uncompensated temperature and pressure data is collected and stored in the PT2X memory. When data is retrieved from the sensor, the calibration parameters are also retrieved. The retrieving program, typically Aqua4Plus or Aqua4Palm, then applies the calibration parameters, as follows:

$$P_c = m_e * P_m + b_e$$

Where P_c is Pressure Calibrated (in psi)

Where P_m is Pressure Measured (in psi)

$$\text{Where } m_e = m_3 * T^3 + m_2 * T^2 + m_1 * T + m_0$$

$$\text{Where } b_e = b_3 * T^3 + b_2 * T^2 + b_1 * T + b_0$$

Where T = temperature in degrees C

Where m_x represents slope

Where b_x represents offset

Instrumentation Northwest appreciates any comments you may have regarding this application note. Please contact:

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