# Temposonics®

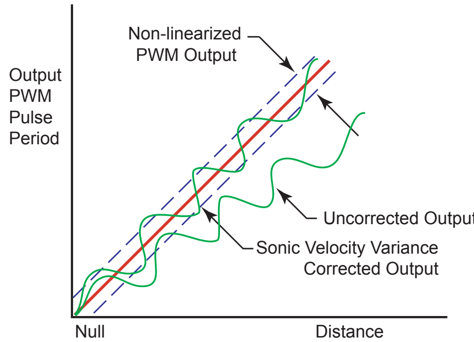
Magnetostrictive Linear-Position Sensors

MTS SENSORS

Using PWM Outputs with C-Series Sensors

551021 A

**Technical Tip**




## PWM Outputs; Sonic Velocity Compensation

The speed of sound in the sensor, or rather, the velocity of the strain pulse used to measure distance varies slightly from sensor to sensor. Though MTS industrial sensors sometimes express this value as a "gradient" (i.e., time required for a given unit of distance traveled by the pulse) the C-Series products have standardized on sonic velocity (sonic velocity = distance traveled per unit time). Compensating for these differences can be used to increase the accuracy of the sensor.

For C-Series PWM (Pulse-Width Modulated), the average strain pulse velocity deviation from sensor to sensor is specified at less than or equal to ± 3.3% without end point correction. The average velocity of propagation along each sensor's stroke, known as sonic velocity, can be determined and used by the application's controller to improve overall accuracy such that sonic velocity and null errors are nearly zero. Calibration adjustment for differences in sonic velocity between sensors is made as a post measurement task in controller software using a sonic velocity value from the printed number on each sensor or derived from a simple process.

Analog output sonic velocity correction is accomplished at the factory by setting the analog output full scale point and the null to the appropriate prescribed physical points for each sensor. This is sufficient for analog sonic velocity correction to about ± 1%. No further sonic velocity correction is necessary for C-Series analog outputs.

Using sonic velocity to correct PWM readings is simple. The controller only needs to multiply the counts for any measurement by the sonic velocity redefined as distance measured/count (or divide the total counts by the redefined gradient as counts/unit measure) to derive the current position without sonic velocity error. The application's controller counter/timer period is used to redefine the sonic velocity or gradient values into distance measured/count or counts/unit measure respectively.

The sensor's average sonic velocity is encoded in the serial number printed on the side of the sensor's blue tube. It is defined in the last three digits (digits 14 through 16) and is encoded as a hexadecimal number such as "BB9". To determine the average sonic velocity, convert the hexadecimal number to decimal. BB9 in the example is 3001. Then divide the decimal number by 10, which results in 300.1 in the example. Then add 2600 for the final average velocity number in meters/second, producing 2900.1 in the example.

## Measuring Sonic Velocity

The sonic velocity can be determined manually in either of two methods if it's not possible to use the value printed on the side of the sensor's blue tube. (For packaged sensors, the blue tube can be read by removing the cover and slipping the Core sensor out.)

### Method 1

*(Use the following procedure when the sensor can be measured in a bench fixture before installation in the application.)*

1) Set up a counter/timer with sufficient frequency (short clock period) to measure at least the desired resolution and connect it to the PWM output of the sensor. Lower frequencies will yield less correction; higher will yield more. For example, a 28 megahertz clocked counter will result in a resolution of about 0.1 mm.

2) Manually move the magnet to the full stroke position using a micrometer, vernier or digital caliper, or equivalent measurement technique to locate the leading edge (toward the sensor's head) of the standard magnet (or other magnet if specially ordered) at the desired full stroke position and securely fix the magnet at that location. (Full-stroke can be defined as less than the full-stroke position given in the sensor specification sheets, but not more.)

3) Take a measurement of the PWM period in total counts of the counter/timer. Some deviation from reading to reading may be noticed due to minor electronics jitter. This can be averaged out by taking readings over at least 0.3 seconds and dividing the sum of the readings by the number of readings. (Ensure that the mag net is securely fixed at that position.)

4) Move the magnet to the desired zero position using the measurement tool from step 2) and repeat step 3. (The zero position can be defined as greater than that given in this spec sheet but not less.)

5) Subtract the zero reading counts from the full-scale counts.

6) Divide the result into the stroke in mm (or inches). The result is the average distance traveled in a single clock tick or unit time measurement and is the sonic velocity for that sensor. The inverse would be the average clock ticks for unit distance traveled, or gradient.

### Method 2

*(Use the following procedure when the sensor is installed in the application.)*

1) Perform step 1 from method 1.
2) Stroke the application's actuator to the full stroke position.

3) Perform step 3 from method 1.

4) Stroke the application's actuator to the null position and repeat step 3.

5) Subtract the zero reading counts from the full-scale counts.

6) Divide the result into the stroke in mm (or inches). The result is the average distance traveled in a single clock tick or unit time measurement and is the sonic velocity for that sensor. The inverse would be the average clock ticks for unit distance traveled, or gradient.

The measurement time period for zero in either method can be used to define zero or null and eliminate any zero offset due to sonic velocity differences between sensors.

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