

Paine™ 420-52-0010 Series Pressure Transmitter

Digital, Ultra Capacitance, Pressure, and Temperature



- Custom hybrid electronics designed to reduce intermetallic formation failure modes for high reliability during extended time frames at extreme temperature.
- Compensation for temperatures commonly experienced in exploration and production activities provides increased accuracy.
- Self-calibrating gain and offset techniques reduce added thermal error.
- Slim 0.51 in. (1.29 cm) diameter form factor saves critical tool space.
- Customizable interface options available for fit-for-use designs.

Pressure sensing technology targeted for high stability and high accuracy applications

The Paine 420-52-0010 Series Pressure Transmitter is a single-crystal, integrated capacitance sensor that provides high stability and high reliability in downhole and subsea environments. Designed to stabilize rapidly to thermal effects while exhibiting excellent long-term drift behavior, the 420-52-0010 Series thermal transient error is less than that of the quartz-based sensors allowing for larger, continuously changing thermal gradients with fewer errors, and an increase in duration between zeroing.

Potential applications

- Downhole well monitoring
- MWD / LWD
- Subsea chemical injection
- Formation characterization

New single crystal integrated capacitance technology

A new technology that can be configured to target specific applications and has the potential to reduce costs and increase yield in downhole exploration and production.

The transmitter stabilizes rapidly to thermal effects while exhibiting excellent long-term drift behavior. The thermal transient error is less than that of higher priced sensors, allowing for larger continuously changing thermal gradients with fewer errors. This stability allows for an increase in duration between zeroing, unlike typical piezoresistive sensor specifications.

Paine 420-52-0010 design

The digital output of the transmitter is a Raw Period Modulated Oscillator Digital with an incorporated 500 Ω RTD that operates down to 2.9 Vdc with very low current consumption of 2.5 mA maximum at 5.5 Vdc . The transmitters are calibrated and coefficients are provided to translate the relative pressure output to PSI. The electronics are high reliability hybrid based with like metal wire bonds and no solder connections.

The packaging and electronics of the Paine 420-52-0010 Series is customizable for a wide array of solutions. Process adapter fittings can be readily customized to fit customer applications with minimal non-recurring engineering.

The configuration of the transmitters is specifically tailored toward data rates of 1Hz or less, 347 °F (175 °C) operation, and tolerance to H2S containing environments.

Performance test data

Performance testing of the Paine 420-52-0010 Series pressure transmitter was done as a means of design assurance to understand and validate the transmitters expected performance at a given workload or point of time. The goal of the performance testing was to determine the transmitter's long term stability, pressure drop response, and thermal transient error.

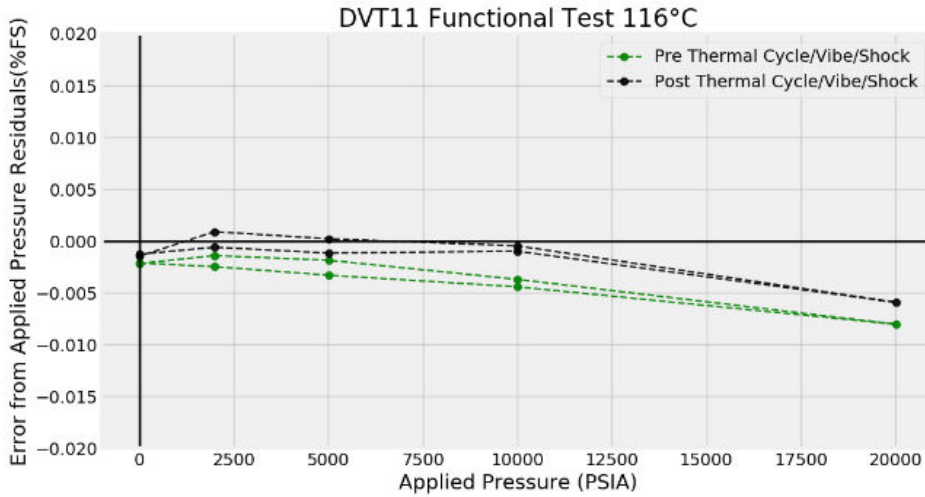
Advanced Well Equipment Standards Group (AWES) testing

Testing of the Paine 420-52-0010 Series pressure transmitter was performed per the Advanced Well Equipment Standards Group (AWES) Document: 3362-36. An initial functional test and post functional test were performed to validate the performance of the transmitter after exposing it to 10 thermal cycles, >10 grms ambient random vibration, and four mechanical shocks at each of a total of six directions with a level of 500 g minimum, 0.5 ms half sine.

Contents

Pressure sensing technology targeted for high stability and high accuracy applications.....	2
Specifications.....	5
Dimensional drawing.....	8

Figure 1: DVT11 Functional Test



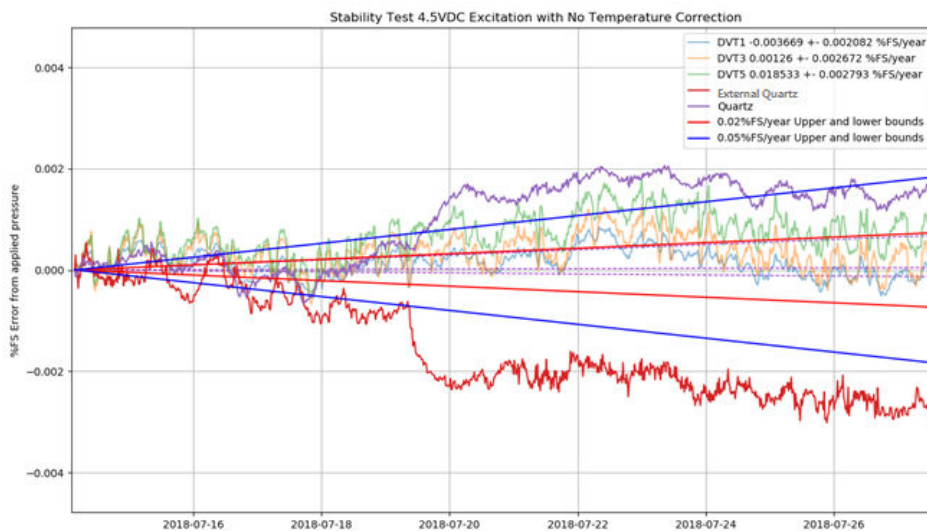
Test result: Post performance testing recorded only a slight shift in full scale output that is within the repeatability of the test equipment.

Long term stability

The purpose of long term stability testing is to provide performance evidence that the overall output of the transmitter only varies within specification over time under the influence of a maximum stimulus of environmental factors.

The single crystal integrated capacitance sensors were stability tested at the maximum calibrated pressure and temperature for 14 days. The transmitters were compared to a quartz thickness shear mode based sensor inside a thermally controlled environmental chamber, and another laboratory standard quartz-based sensor located at ambient temperature outside of the chamber for comparison. No thermal correction was applied to the data of the Paine 420-52-0010 Series.

Figure 2: Long Term Stability



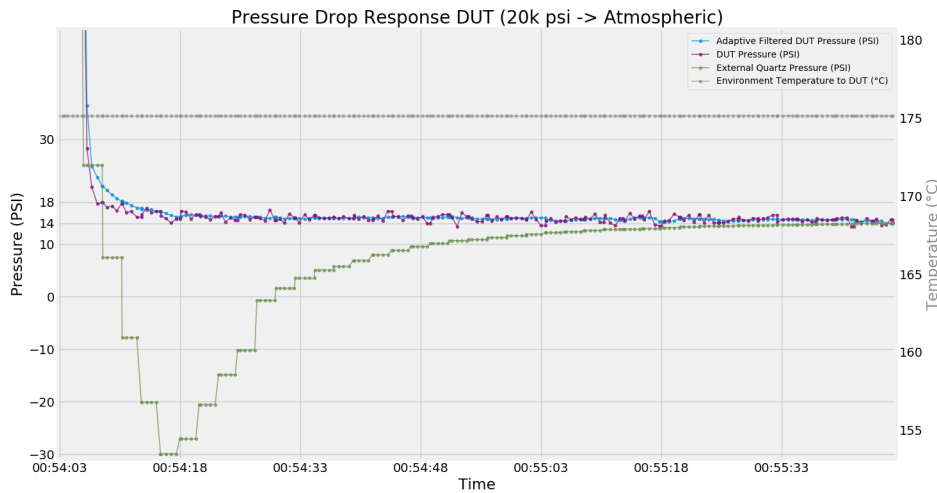
Test result: The transmitters performed as good if not better than the quartz-based sensors rated to have less than 0.02 percent full scale drift per year.

Pressure drop response testing

The purpose of pressure drop response testing is to provide performance evidence of the output readings during a significant and rapid drop in pressure.

The transmitters were held at 20,000 psi for five minutes. Pressure was then rapidly released while data was being recorded from the transmitter. A quartz-based laboratory standard sensor was used for comparison during the pressure drop testing.

Figure 3: Pressure Drop Testing



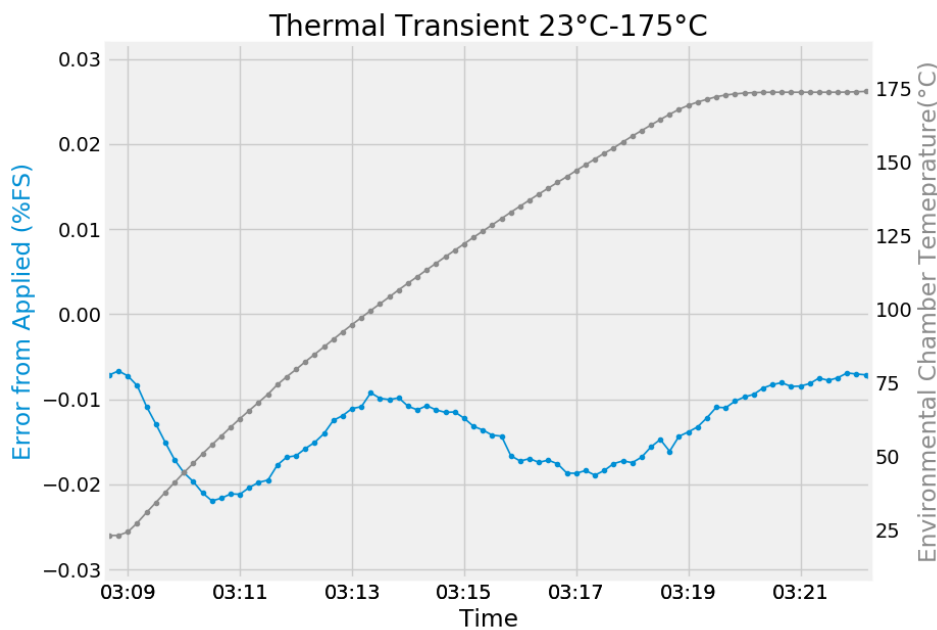
Test result: No undershoot was evident in the Paine 420-52-0010 Series transmitter.

Thermal transient testing

The purpose of thermal transient testing is to provide performance evidence of the output readings during a significant and rapid change in temperature.

The transmitter was tested in a liquid CO2 cooled environmental chamber in both positive and negative directions.

Figure 4: Thermal Transient Testing



Test result: The thermal response error was between 167 °F (75 °C) and 347 °F (175 °C) with a temperature ramp rate of ~60.8 °F/min (~16 °C/min).

Specifications

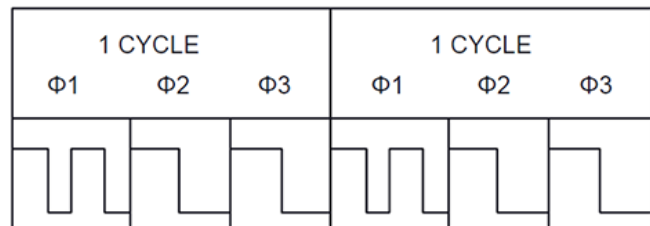
Performance specifications

Accuracy:	± 0.02% of the Full Scale (F.S.) over the calibrated temperature range. Accuracy is relative to primary standard at time of calibration and includes nonlinearity, hysteresis, non-repeatability and thermal effects as compared to a serial number specific polynomial model P(T,Rp). Transmitter body needs to be coupled to digital ground
Stability:	0.02% F.S. maximum per year at the maximum calibrated temperature and pressure
Operating pressure range:	0-20,000 psia (1379 bar) Contact factory for custom pressure ranges
Proof pressure:	25,000 psia (1723 bar)
Burst pressure:	30,000 psia (2413 bar)
Operating temperature range:	14 °F to 347 °F (-10 °C to 175 °C). Do not pressurize below 14 °F (-10 °C)
Calibrated temperature range:	73.4 °F to 347 °F (+23 °C to 175 °C)
Storage temperature range:	-40 °F to 356 °F (-40 °C to 180 °C)
Pressure output:	Period modulated oscillator
Temperature:	500 Ω RTD

Functional specifications

Digital output:	Raw period modulated oscillator
Pressure output:	Period modulated phase based oscillation, output impedance 1 KΩ. Cycle rate ~0.01/0.1 second. See Figure 5 .

Figure 5: Pressure Relative Output



$$\text{PRESSURE RELATIVE OUTPUT (Rp)} = \frac{\Phi2 - \Phi1}{\Phi3 - \Phi1}$$

Input voltage:	2.9 to 5.5 Vdc, calibration valid at 3.30 ± .02 Vdc.
Current consumptions:	2.5 mA maximum. Sample current: 1.7 mA. maximum @ 3.3 Vdc and greater than 73 °F ±5 °F (23 °C)
Reverse polarity:	Not protected
Over voltage protection:	Do not exceed 7.0 Vdc

Insulation resistance:

Do not exceed 7.0 Vdc. All conductors except pin 5, together simultaneously to case: 100 MΩ minimum at 50 VDC and 73.4 °F (23 °C). The case must be connected or coupled to ground for accurate results

Electrical connection functions: [Figure 6](#)

- Pin 1: VCC
- Pin 1: VCC
- Pin 4: Output
- Pin 5: Ground
- Pin 6: Sleep
- Pin 7: RTD "B"

Sleep pin functionality:

Transmitter is fully functional when the sleep pin is held high. Sleep Pin (Pin 6) is held logic high. When the Sleep Pin is logic low (ground), the transmitter will be in standby mode with the output pin floating. The Sleep pin should not remain floating. This enables connecting multiple transmitters to a single output bus.

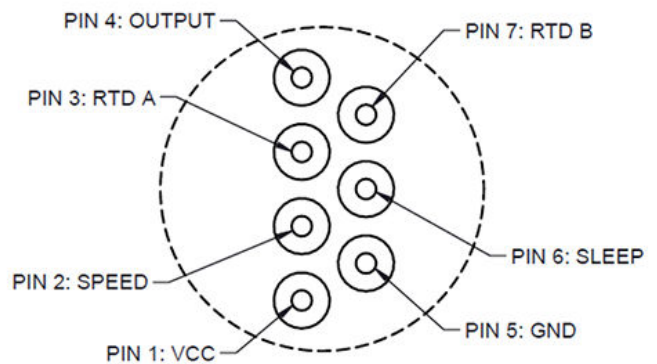
Speed pin functionality:

Transmitter will output at a cycle rate of ~100 cycles per second when the speed pin is held logic high. When the Speed pin (Pin 2) is held logic low, the cycle rate will be ~10 cycles per second. The Speed pin should not remain floating. [Figure 6](#).

Platinum resistance temperature detector (RTD):

32 °F to 356 °F (0 °C) 500 Ω, Alpha = 0.00385. See [Figure 6](#).

Figure 6: Pin Functions



Physical specifications

Material selection:

Emerson provides a variety of Paine products with various product options and configurations, including materials of construction that can be expected to perform well in a wide range of applications. The Paine product information presented is intended as a guide for the purchaser to make an appropriate selection for the application. It is the purchaser's sole responsibility to make a careful analysis of all process parameters (such as all chemical components, temperature, pressure, flow rate, abrasives, contaminants, etc.) when specifying product, materials, options, and components for the particular application. Emerson is not in a position to evaluate or guarantee the compatibility of the process fluid or other process parameters with the product, options, or materials of construction selected.

Pressure media:

Fluids and gases compatible with UNS N07718, solution annealed and aged to a maximum hardness of 40 HRC.

Electrical connection:

Nickel underplate pin. Gold finish

Pressure fitting:

HiP HM2

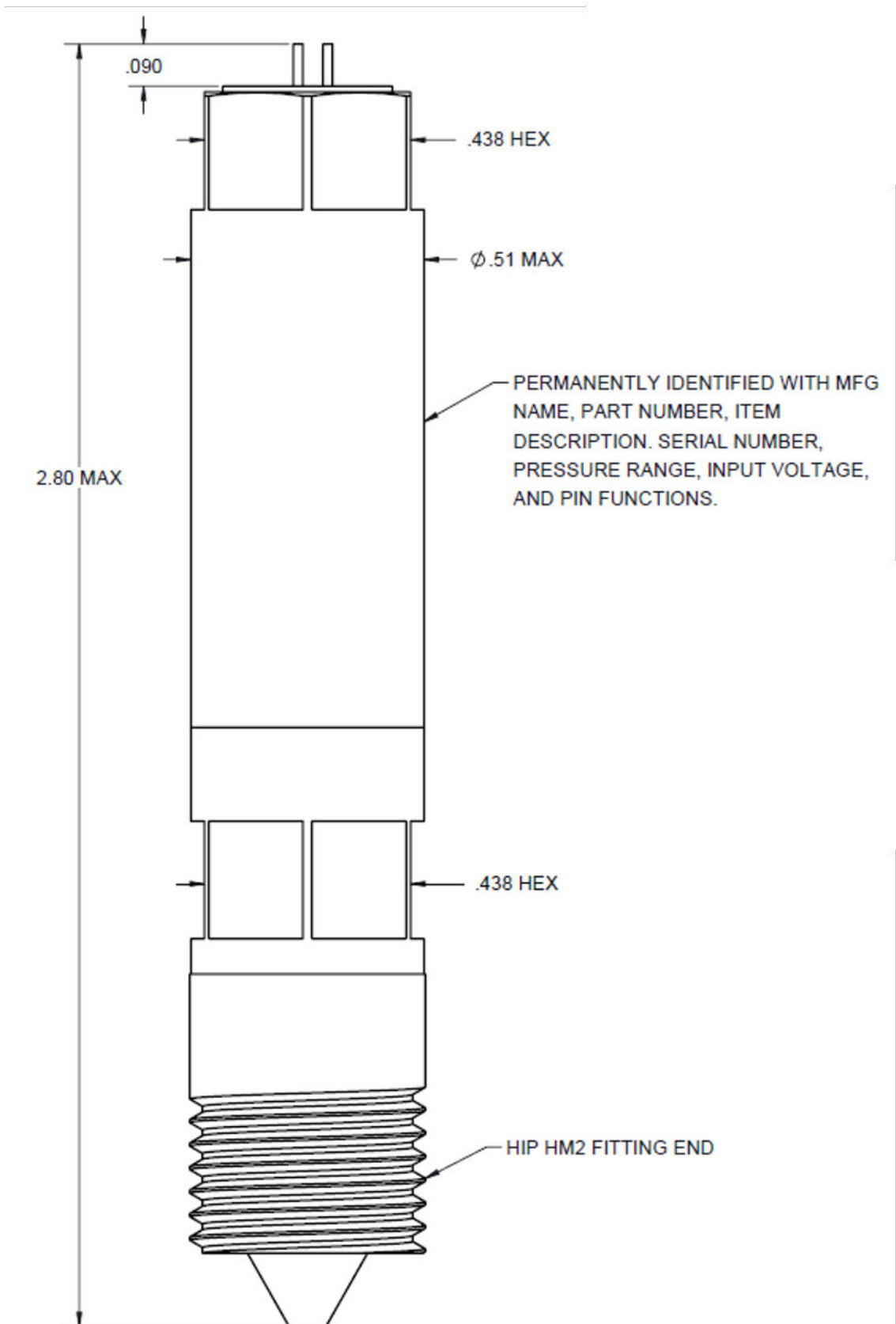
Recommended installation torque:

75 in-lb. (8.5 Nm)

Electrostatic discharge (ESD):

This transmitter is susceptible to ESD, per ANSI/ESD STM5.1 Human Body Model (HBM) Class 3A and must be protected.

Dimensional drawing



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