Product Data Sheet
October 2015
320-10-010-DS_REV-F

Paine 320-10-010 Series Pressure Transmitter

Digital, High Precision, **+150°C**, Pressure and Temperature

Designed for new tool designs and retrofits our digital **320-10-010 Series** is fully compensated and calibrated for pressure ranges from 0-5,000 PSIA (0-345 BAR) to 0-30,000 PSIA (2069 BAR) with a 0.025% full scale accuracy.

It is an excellent choice for harsh downhole applications providing designers the digital network flexibility and programmability of a highly precise pressure and temperature measurements at temperatures of -40°F to +302°F (-40°C to +150°C).

Solutions

- **High Temperature & High Pressure.**
- Digital Measurement Accuracy.
- Harsh/Extreme Environment Ready.
- Excellent Long Term Stability.

Potential Applications

- Downhole Tools (MWD, LWD, Wireline & more).
- Offshore Energy Exploration
- Artificial Lift & Subsea Risers.
- Industrial Control Systems & Automation.

Features

- **Accuracy:** 0.025%
- **Repeatability:** ±0.015%
- **Pressure Range:** 0-5,000 to 0-30,000 PSIA (345 to 2069 BAR).
- **Operating Temperature:** -40°F to +311°F (-40°C to +155°C).
- **Digital Output:** RS-485. Other options, RS-232, Modbus®, CANbus®,CANopen® & SPI.
- **Temperature Output:** °F or °C.
- **Temperature Measurement:** 0°F to +302°F (-18°C to +150°C).
- **Temperature Resolution:** 12 Bits Minimum, Better Than 0.05°F.

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Specifications

Calibration: Calibration Certificates are supplied with each unit and available on-line.

Performance

Accuracy: ± 0.025% of the Full Scale (F.S.) at 75°F to +302°F (-24°C to +150°C). Accuracy is relative to primary standard at time of calibration and includes resolution, hysteresis, non-repeatability and thermal effects.
Repeatability: ± 0.015% F.S. over the calibration temperature range.
Pressure Output in PSI: Fully compensated for the effects of temperature & non-linearity.
Pressure Resolution: 16 Bits minimum (see Pressure Table).
Temperature Output: °F or °C.
Temperature Measurement: -0°F to +302°F (-18°C to +150°C).
Temperature Resolution: 12 Bits minimum. Better than 0.05°F.

Environmental

Operating Temperature Range: -40°F to +311°F (-40°C to +155°C).
Calibrated Temperature Range: +74°F to +302°F (+23°C to +150°C)
Pressure Media: Fluids and gases compatible with NO7718, solution annealed and aged to a maximum hardness of 40 HRC.
Proof Pressure: See Pressure Table.
Burst Pressure: See Pressure Table.

Mechanical

Pressure Range: Contact factory for additional pressure ranges.

Pressure Table

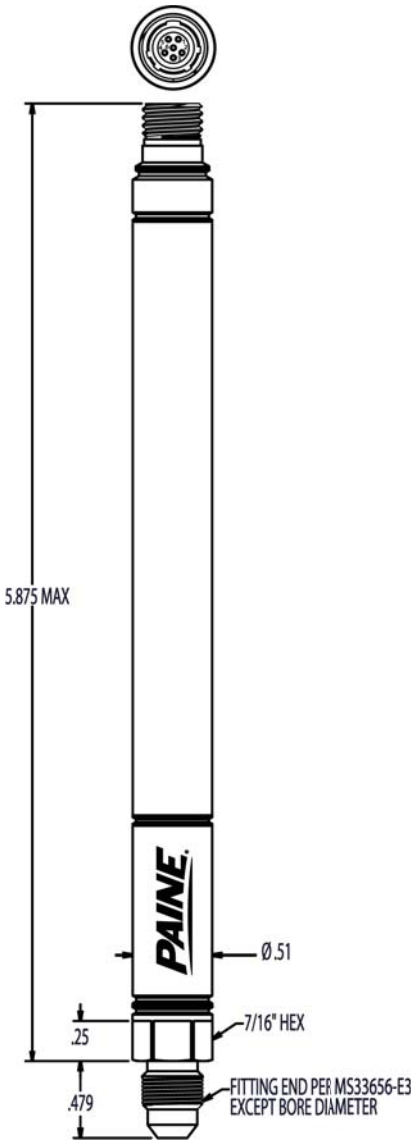
Standard Part Number	Pressure Range PSIA (BAR)	Proof Pressure PSIA (BAR)	Burst Pressure PSIA (BAR)	Pressure Resolution (Better Than)	Seal Part Number
320-12-0010-10K0	0-10,000 (689)	15,000 (1034)	20,000 (1378)	0.16 PSI	247-99-250-01
320-12-0010-20K0	0-20,000 (1378)	25,000 (1723)	20,000 (1378)	0.31 PSI	247-99-250-01
320-12-0010-30K0	0-30,000 (2068)	35,000 (2413)	50,000 (3443)	0.46 PSI	247-99-250-02

Pressure Fitting: Per MS33656-E3 except bore diameter.
Installation Information: Mount using annealed Inconel® 600 Replaceable Seal. Thermal coefficient of the mounting expansion should not exceed 8.3 x 10^ - 6 in/in °F for operation above 100°C.
Recommended Installation Torque: 125 to 150 in-lb (14-17 Nm).
Mounting: Transmitter must be mechanically restrained for use in high shock and/or vibration applications.

Electrical

Digital Output: RS-485. Refer to Paine document 200.100 for more information.
Input Voltage: 5.00 VDC ± 0.25 VDC.
Input Current: 35 mA maximum.
Insulation Resistance: All pins together to case. 1,000 MΩ minimum at 50 VDC and 75°F ±10°F (24°C to ± 6°C).
Over Voltage Protection: Protected from damage up to 5.5 VDC.
Reverse Polarity: "POWER IN" is not protected from the application of reverse polarity.
Electrical Connection: Mates with Glenair P/N: 801-007-16Z16-7SA. Connector sold separately.
Sleep Pin Functionality: Transmitter is fully functional when sleep pin is held to logic low (0.00 VDC). When sleep pin is held to logic high (5.00 VDC) the transmitter will be in standby mode.
User Guide and Programming: Document 200.107 provided.
Electrostatic Discharge (ESD): This transmitter is susceptible to ESD, per ANSI/ESD STM5.1 Human Body Model (HBM) Class 3A and must be protected.

Dimensions (inches)



Connections

PIN	FUNCTION
1	POWER IN
2	RS-485 "B" *
3	RS-485 "A" *
4	POWER RETURN / COMMUNICATION RETURN
5	CASE GROUND
6	SLEEP
7	NOT USED

* **Per TIA-485-A**

Emerson Process Management
Rosemount Specialty Products, LLC
5545 Nelpar Drive, East Wenatchee WA 98802
T +1 509 881 2100
F +1 509 881 2115
E Paine.Products@emerson.com
www.EmersonProcess.com

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Product Data Sheet
September 2015
220-10-020-DS_REV-H

Paine 220-10-020 Series Pressure Transmitter

Digital, RS485, **+60°C**, 0-10,000 PSIA (689 BAR) Pressure & Temperature

Designed to reduce space, lower installation costs and eliminate the need for A/D conversion, our **220-10-020 Series** incorporates proprietary sensor technology with innovative microprocessor-based programmability for high accuracy measurements.

The **220-10-020 Series** is fully compensated and calibrated for pressure ranges from 0-100 (6 BAR) to 0-10,000 PSIA (689 BAR) and provides designers with digital network flexibility for easy to control and monitoring of pressure and temperature measurements in the toughest remote applications!

Solutions

- Harsh / Extreme Environment Ready.
- Digital Accuracy.
- Longer & Simpler Network Connections.

Potential Applications

- Subsea Exploration.
- ROV & AUV Controls & Measurements.
- Remote / Extreme Pressure Monitoring.
- Test Stands & Industrial Automation.

Features

- **Operating Temperature:** -40°F to +260°F (-40°C to +126°C).
- **Digital Output:** RS-485. Other options, RS-232, Modbus®, CANbus®,CANopen® & SPI.
- **Pressure Range:** 0-100 (6 BAR) to 0-10,000 PSIA (0 to 1034 BAR).
- **Resolution:** 16 Bits Minimum. 0.077 PSI for 5,000 PSI (344 BAR) Full Scale.
- **Temperature Output:** °F or °C.
- **Temperature Resolution:** 16 Bits Minimum, Better Than 0.1°F.

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Paine 220-10-020 Series Pressure Transmitter
220-10-020-DS_REV-H

Product Data Sheet
September 2015

Specifications

Calibration: Calibration Certificates are supplied with each unit and available on-line.

Performance

Total Error Band of Digital Pressure Output: See Pressure Table, over the calibrated temperature range.
Pressure Output in PSI: Fully compensated for temperature, non-linearity, zero offset and full scale output.
Pressure Resolution: 16 Bits minimum (see Pressure Table).
Temperature Output: °F or °C.
Temperature Measurement: -40°F to +260°F (-40°C to +126°C).
Temperature Resolution: 16 Bits minimum. Better than 0.1°F.
Operating Life Expectancy: See industrial digital chart DS-473.

Environmental

Operating Temperature Range: -40°F to +260°F (-40°C to +126°C).
Calibrated Temperature Range: +32°F to +250°F (0°C to +121°C).
Operating Media: Any compatible with Inconel® 725.

Mechanical

Pressure Range: Contact factory for additional pressure ranges.

Pressure Table

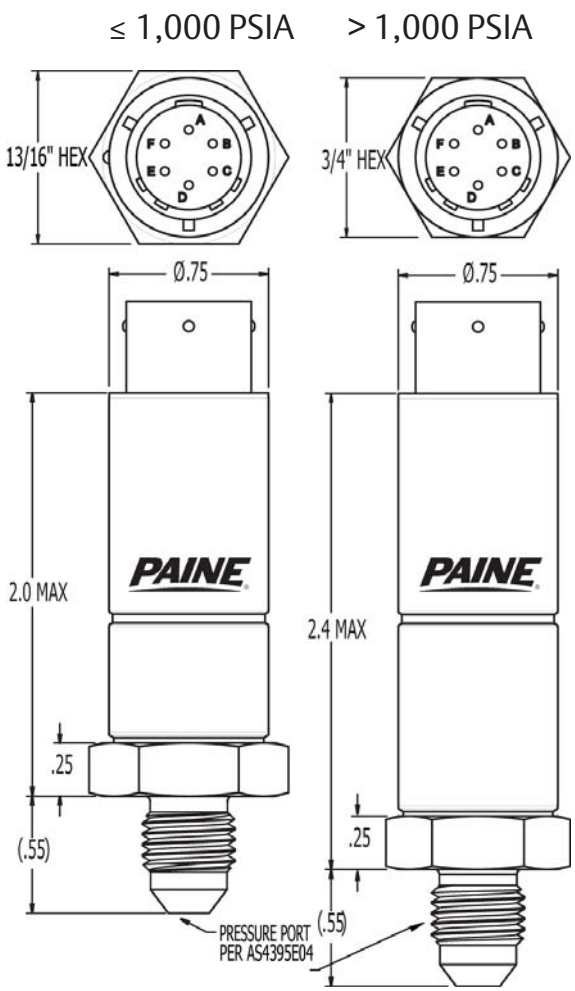
Standard Part Number:	Pressure Range PSIA (BAR)	Proof Pressure PSIA (BAR)	Burst Pressure PSIA (BAR)	Resolution PSI, Better Than	Total Error Band (%FS)
220-10-020-01	100 (6)	150 (10)	250 (17)	0.002	0.50%
220-10-020-02	500 (34)	750 (51)	1,250 (86)	0.008	0.20%
220-10-020-03	1,000 (68)	1,500 (103)	2,500 (172)	0.016	0.20%
220-10-020-04	5,000 (344)	7,500 (517)	12,500 (861)	0.077	0.10%
220-10-020-05	10,000 (689)	15,000 (1034)	20,000 (1723)	0.153	0.10%

Operating Media: Fluids and gases compatible with 15-5 PH CRES.
Pressure Fitting: Per AS4395E04 (37° flare JIC-4).

Electrical

Input Voltage: +5.00 VDC ± 0.25 VDC.
Input Current: 30 mA maximum @ 5 VDC.
Over Voltage Protection: Not protected from damage by the application of over voltage. Do not exceed 5.5 VDC.
Reverse Polarity: "POWER IN" is protected from the application of reverse polarity.
Digital Output: RS-485, 19.2k Baud, Odd Parity.
Electrical Connections: 6 Pin bayonet locking electrical connector. Mates with MS3116-10-6S. (P/N: 247-99-100-02 sold separately).
Insulation Resistance: All pins together to case 100MΩ minimum at 50 VDC and 75°F, ± 10°F.
User Guide and Programming: Document 200.100 provided.

Dimensions (inches)



Connections

PIN	FUNCTION
A	POWER IN
B	RS 485 "B" *
C	RS 485 "A" *
D	POWER RETURN
E	COMMUNICATION RETURN
F	NOT USED

* **Per TIA-485-A**

Emerson Process Management
Rosemount Specialty Products, LLC
5545 Nelpar Drive, East Wenatchee WA 98802
T +1 509 881 2100
F +1 509 881 2115
E Paine.Products@emerson.com
www.EmersonProcess.com

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Product Data Sheet
September 2015
220-30-020-DS_REV-E

Paine 220-30-020 Series Pressure Transmitter

Digital, CANopen®,Submersible, **+60°C**, Pressure & Temperature

Designed for remote subsea systems, our **220-30-020 Series** meets the requirements of API 17F / ISO 13628-6 and CIA 443 (SIIS Level 2 device) and provides designers with an intelligent CANopen® networking solution for pressure and temperature measurement.

Designed for pressure ranges of 0-15,000 PSIA (1034 BAR) and temperature measurement from +25°F to +140°F (-4°C to +60°C) the **220-30-020 Series** also features a micro Subconn®MCBH4F subsea connector and all welded construction for long term subsea operation.

Solutions

- Subsea Environment Ready.
- Digital CANopen® Accuracy.
- Longer & Simpler Network Connections.
- Extreme Depths & Pressure.

Potential Applications

- Subsea Production & Controls Systems.
- Remote / Extreme Pressure Monitoring.
- Corrosive Environment Pressure Monitoring.
- Submersible Subsea Applications.
- ROV's & AUV's.
- Subsea Valves & Manifolds.

Features

- **Operating Temperature:** +25°F to +140°F (-4°C to +60°C).
- **Digital Output:** CANopen® Fault Tolerant.
- **Pressure Range:** 0-15,000 PSIA (0 to 1034 BAR).
- **Accuracy:** 0.1%.
- **Repeatability:** ± 0.015%.
- **Resolution:** 16 Bits Minimum. 0.08 PSI for 5,000 PSI (344 BAR) Full Scale.
- **Temperature Output:** °F or °C.
- **Temperature Resolution:** 10 Bits Minimum, Better Than 0.5°F.

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Specifications

Calibration: Calibration Certificates are supplied with each unit and available on-line.

Performance

Accuracy: ± 0.1% of the Full Scale (F.S.). Accuracy is relative to primary standard at time of calibration and includes resolution, hysteresis, non-repeatability and thermal effects.
Pressure Output in BAR: Compensated for the effects of temperature and non-linearity.
Pressure Resolution: 16 Bits Minimum. See Pressure Table.
Temperature Output: °F or °C.
Temperature Measurement: 20°F to +150°F (-6°C to +65°C).
Temperature Resolution: 10 Bits minimum. Better than 0.5°F (+28°C).

Environmental

Operating Temperature Range: +25°F to +140°F (-4°C to +60°C).
Calibrated Temperature Range: +32°F to +100°F (0°C to +38°C).
Operating Media: Any compatible with Inconel® 725.

Mechanical

Pressure Range: Contact factory for additional pressure ranges.

Pressure Table

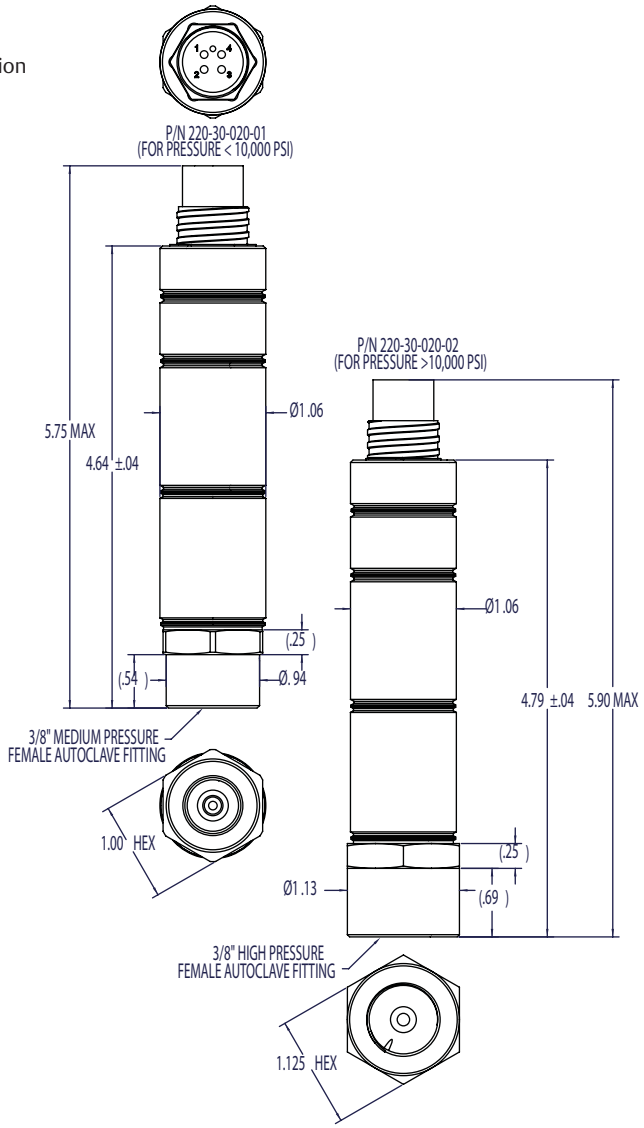
Standard Part Number	Pressure Range PSIA (BAR)	Proof Pressure PSIA (BAR)	Burst Pressure PSIA (BAR)	MAX External Case Pressure PSIA (BAR)	MAX Fitting End Pressure PSIA (BAR)	Pressure Resolution (Better Than) PSI (BAR)
220-30-020-01	0-10,000 (0-689)	15,000 (1034)	20,000 (1378)	10,000 (689)	20,000 (1378)	0.38 PSI (.026)
220-30-020-02	0-15,000 (0-1034)	22,500 (1551)	30,000 (2068)	10,000 (689)	60,000 (4136)	0.23 PSI (.016)

External Case Pressure: 10,000 PSIA (689 BAR).
Secondary Containment: 15,000 PSI (1034 BAR), Safety factor 1.25 minimum.
Pressure Fitting: 220-30-010-01: 3/8" medium pressure female autoclave fitting.
220-30-010-02: 3/8" high pressure female autoclave fitting.

Electrical

Input Voltage: +20.00 to +27.00 VDC.
Input Current: 25 mA maximum.
Baud Rate: 50K default.
Over Voltage Protection: Protected from damage up to 36 VDC.
Reverse Polarity Protection: "Power In" is protected from application of reverse polarity.
Baud Rate: 50K default.
Electrical Connections: Subconn® MCBH4F subsea bulkhead connector. Mates with MCIL4M (not supplied).
Insulation Resistance: All pins together to case 100MΩ minimum at 50 VDC and 75°F, ± 10°F (24°C, ± 6°C).
User Guide: Document 200.302 provided.

Dimensions (inches)



Connections

PIN	FUNCTION
1	POWER IN
2	POWER RETURN
3	CAN HIGH
4	CAN LOW

Emerson Process Management
Rosemount Specialty Products, LLC
5545 Nelpar Drive, East Wenatchee WA 98802
T +1 509 881 2100
F +1 509 881 2115
E Paine.Products@emerson.com
www.EmersonProcess.com

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Product Data Sheet
March 2017
328-12-0010-DS, Rev B

Paine 328-12-0010 Series Pressure Transmitter

Digital, High Precision, Data Logger, +175 °C, Pressure and Temperature

The 328-12-0010 Series is our high precision, digital data logger offering output of both pressure and temperature measurements at a full scale accuracy of ±0.05% and designed to operate to +347 °F (+175 °C).

The 328-12-0010 Series data logging functionality is provided through onboard memory allowing the sensor to automatically acquire large amounts of data for analysis at a later time. Features include continuously logging at predetermined intervals, automatically at power-on, at any combination of pressure, temperature and time stamp, as well as providing data readouts during logging and dynamically logging changes to pressure only.

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Solutions

- Digital data logging capability.
- High temperature and high pressure.
- Digital measurement accuracy.
- Harsh/extreme environment ready.
- Excellent long term stability.

Potential Applications

- Downhole tools (MWD, LWD, Wireline, and more).
- Offshore energy exploration.
- Artificial lift and subsea risers.
- Subsea hydraulic controls.

Features

- **Accuracy:** 0.05%*
- **Repeatability:** ±0.05%
- **Pressure Range:** 0–5,000 to 0–30,000 PSIA (345 to 2069 BAR).
- **Operating Temperature:** -40 °F to +347 °F (-40 °C to +175 °C).
- **Digital Output:** RS-485.
- **Temperature Output:** °F or °C.
- **Temperature Measurement:** -40 °F to +356 °F (-40 °C to +180 °C).
- **Temperature Resolution:** 12 Bits minimum. Better than 0.09 °F (0.05 °C).

Specifications

Calibration: Calibration Certificates are supplied with each unit and available on-line.

Performance

Default Dataset: Pressure, Temperature, and Time Stamp.

Data Storage: 699,050 data sets or 2,097,152 individual data points.

Relative Time Stamp Resolution: 1 second (default), adjustable (.001 second to 49 days).

Data logging Rates: 1 sample/second (default), adjustable from 20 samples/second to 1 sample/300 days.

Accuracy:* ±0.05% of the Full Scale (F.S.) over the calibrated temperature range. Accuracy is relative to primary standard at time of calibration and includes resolution, hysteresis, non-repeatability and thermal effects.

Repeatability: ±0.05% F.S. over the calibration temperature range.

Pressure Output in PSI: Fully compensated for the effects of temperature and non-linearity.

Pressure Resolution: 16 Bits minimum (see Pressure table).

Temperature Output: °F or °C.

Temperature Measurement: -40 °F to +356 °F (-40 °C to +180 °C).

Temperature Resolution: 12 Bits minimum. Better than 0.09 °F (0.05 °C).

Environmental

Operating Temperature Range: -40 °F to +347 °F (-40 °C to +175 °C).

Calibrated Temperature Range: +23 °F to +347 °F (+73 °C to +175 °C).

Pressure Media: Fluids and gases compatible with NO7718, solution annealed and aged to a maximum hardness of 40 HRC.

Proof Pressure: See Pressure table .

Burst Pressure: See Pressure table .

Contents

Mechanical

Pressure Range: Contact factory for additional pressure ranges.

Pressure table					
Standard part number	**Pressure range PSIA (BAR)**	**Proof pressure PSIA (BAR)**	**Burst pressure PSIA (BAR)**	**Pressure resolution (better than)**	**Seal part number**
328-12-0010-10K0	0–10,000 (689)	15,000 (1034)	20,000 (1378)	0.16 PSI	247-99-250-01
328-12-0010-20K0	0–20,000 (1723)	25,000 (1723)	30,000 (2068)	0.31 PSI	247-99-250-01
328-12-0010-30K0	0–30,000 (2068)	37,500 (2586)	50,000 (3443)	0.46 PSI	247-99-250-02

Pressure Fitting: Per MS33656-E3 except bore diameter.

Installation Information: Mount using annealed Inconel 600 Replaceable Seal. Thermal coefficient of the mounting expansion should not exceed 8.3 3 10^-6 in/in °F for operation above 100 °C.

Recommended Installation Torque: 125 to 150 in-lb (14 to 17 N-m).

Mounting: Transmitter must be mechanically restrained for use in high shock and/or vibration applications.

Electrical

Digital Output: RS-485. Refer to document 200.106 for more information.

Input Voltage: 5.0 VDC ± 0.25 VDC.

Input Current: 25 mA maximum. Less than 1 mA when transmitter is in sleep mode.

Insulation Resistance: All pins except pin 5 together simultaneously to case, 100 MΩ minimum at 50 VDC and 73 °F ± 9 °F (23 °C to ± 5 °C).

Over Voltage Protection: Do not exceed 5.25 VDC.

Reverse Polarity: "POWER IN" is protected from the application of reverse polarity.

Electrical Connection: Mates with Glenair P/N: 801-007-16Z16-7SA. Connector sold separately.

Sleep Pin Functionality: Transmitter is fully functional when sleep pin is held to logic low (GROUND). When sleep pin is left floating the sensor will be in standby mode.

User Guide and Programming: Document 200.106 provided with each unit.

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

Qualification Summary

Halt Testing

HALT (Highly Accelerated Life Testing, a “margin discovery process”) was used in the design process for this product. In order to ruggedize the product for extreme downhole environments, the root cause of any failure was determined and the problems corrected until the fundamental limit of the technology was reached. This process yields the widest possible margin between product capabilities and the environment in which it will operate, thus increasing the product's reliability, reducing field failure and/or downtime and realizing long-term savings. Throughout all testing, units operated within manufacturer's specifications.

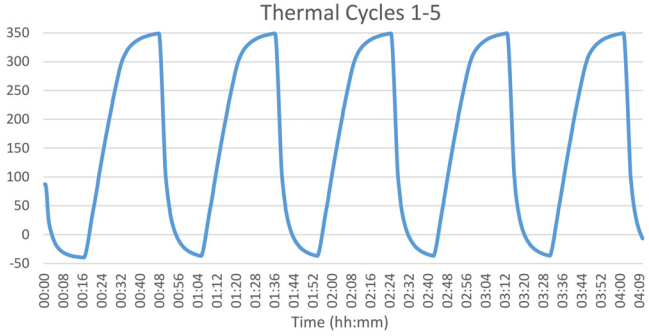
Life Testing

3,000 Hours: Proven to operate within specification 3,000 hours at 355 °F (179 °C) and 212 thermal cycles at 100 °F to +350 °F (37 °C to +176 °C).

Thermal Testing

100 Cycles: -40 °F to +356 °F (-40 °C to +180 °C).

Figure 1. Cycles of Temperature transitioning between the Cold and Hot Extremes

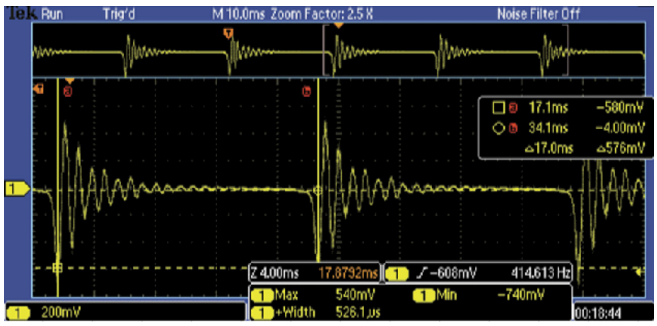


Demonstrated repeatable digital output during thermal cycling, continuing to operate within specification.

Shock

25,000 Shocks: Proven to operate within specification after 25,000 shocks per axis at 500 g with 1 ms Full Width Half Max (FWHM).

Figure 2. Shock Profile

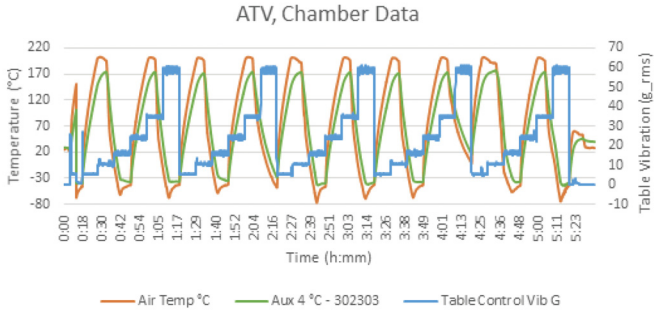


The 328-12-0010 Series is designed to survive the violent shocks encountered during drilling, exploration, and other applications.

Thermal Vibration

Subjected to repetitive vibration g levels exceeding 50 grms[1] and temperatures exceeding 175 °C (347 °F).

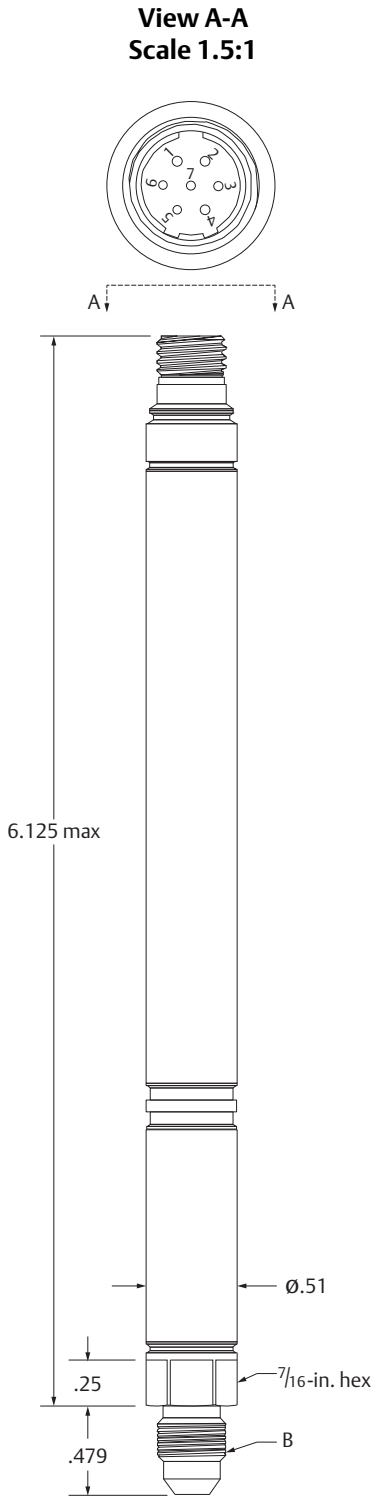
Figure 3. Levels of Vibration introduced during Repeated Cycles of Temperature and Rates of Temperature Changes



1. *Grms is used to define the overall energy or acceleration level of vibration. Grms (root-mean-square) is calculated by taking the square root of the area under the Probability Density Function (PSD) curve.*

Dimensional Drawings

Figure 4. Paine 328-12-0010 Series



Connections	
PIN	**Function**
1	Power in
2	RS-485 “B”
3	RS-485 “A”
4	Power return/Communication return
5	Case ground
6	Sleep
7	Not used

B. Fitting end per MS33656-E3 except before diameter
Dimensions are inches.

Rosemount Specialty Product LLC
Emerson Automation Solutions
5545 Nelpar Drive
East Wenatchee, WA 98822, USA
+1 509 881 2100
+1 509 881 2115
Paine.Products@Emerson.com

Linkedin.com/company/Emerson-Automation-Solutions

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Product Data Sheet
November 2018
320-12-0010, Rev G

Paine™ 320-12-0010 Series Pressure Transmitter

Digital, High Precision, +175 °C, Pressure and Temperature

The 320-12-0010 Series is our high precision, digital transmitter offering output of both pressure and temperature measurements at a full scale accuracy of ±0.05%, and designed to operate to +347 °F (+175 °C).

Utilizing the latest in micro-computer based technology providing precise digital measurements in a simple and easy to use communications interface, the 320-12-0010 Series has the added benefit of a small external package size combined with the ability to operate in corrosive environments. The 320-12-0010 Series is the perfect solution for designers looking for digital measurement in extreme environments.

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Solutions

- High temperature and high pressure
- Digital measurement accuracy
- Harsh/extreme environment ready
- Excellent long term stability

Potential applications

- Downhole tools (MWD, LWD, Wireline, and more)
- Offshore energy exploration
- Artificial lift and subsea risers
- Subsea hydraulic controls

Features

- **Accuracy:** 0.05%*
- **Repeatability:** ±0.05%
- **Pressure range:** 0–5,000 to 0–30,000 PSIA (345 to 2069 BAR)
- **Operating temperature:** -40 °F to +347 °F (-40 °C to +175 °C)
- **Digital output:** RS-485.
- **Temperature output:** °F or °C.
- **Temperature measurement:** -40 °F to +347 °F (-40 °C to +175 °C)
- **Temperature resolution:** 12 Bits minimum. Better than 0.09 °F (0.05 °C)

Specifications

Calibration: Calibration certificates are supplied with each unit and available on-line.

Performance

Accuracy:* ±0.05% of the Full Scale (F.S.) over the calibrated temperature range. Accuracy is relative to primary standard at time of calibration and includes resolution, hysteresis, non-repeatability and thermal effects.

Repeatability: ±0.05% F.S. over the calibration temperature range.

Pressure output in PSI: Fully compensated for the effects of temperature and non-linearity.

Pressure resolution: 16 Bits minimum (see Table 1 on page 3).

Temperature output: °F or °C.

Temperature measurement: -40 °F to +347 °F (-40 °C to +175 °C).

Temperature resolution: 12 Bits minimum. Better than 0.09 °F (0.05 °C).

Environmental

Operating temperature range: -40 °F to +347 °F (-40 °C to +175 °C).

Calibrated temperature range: 75 °F to +347 °F (23.9 °C to +175 °C).

Pressure media: Fluids and gases compatible with NO7718, solution annealed and aged to a maximum hardness of 40 HRC.

Proof pressure: See Table 1 on page 3.

Burst pressure: See Table 1 on page 3.

Contents

Mechanical

Pressure range: Contact factory for additional pressure ranges.

Table 1. Pressure Table

Standard part number	Pressure range PSIA (BAR)	Proof pressure PSIA (BAR)	Burst pressure PSIA (BAR)	Pressure resolution (better than)	Seal part number
320-12-0010-10K0	0–10,000 (689)	15,000 (1034)	20,000 (1378)	0.16 PSI	247-99-250-01
320-12-0010-20K0	0–20,000 (1723)	25,000 (1723)	30,000 (2068)	0.31 PSI	247-99-250-01
320-12-0010-30K0	0–30,000 (2068)	37,500 (2586)	50,000 (3443)	0.46 PSI	247-99-250-02

Pressure fitting: Per MS33656-E3 except bore diameter.

Installation information: Mount using annealed alloy 600 replaceable seal. Thermal coefficient of the mounting expansion should not exceed 8.3 × 10^-6 in/in °F for operation above 100 °C.

Recommended installation torque: 125 to 150 in-lb (14 to 17 N-m).

Mounting: Transmitter must be mechanically restrained for use in high shock and/or vibration applications.

Electrical

Digital output: RS-485. Refer to document 200.107 for more information.

Input voltage: 5.0 VDC ± 0.25 VDC.

Input current: 25 mA maximum.

Insulation resistance: All pins except pin 5 together simultaneously to case, 100 MΩ minimum at 50 VDC and 75 °F ± 5 °F (23.9 °C to ± 2.8 °C).

Over voltage protection: Do not exceed 5.25 VDC.

Reverse polarity: "POWER IN" is protected from the application of reverse polarity.

Electrical connection: Mates with Glenair P/N: 801-007-16Z16-7SA. Connector sold separately.

Sleep pin functionality: Transmitter is fully functional when sleep pin is held to logic low (GROUND). When sleep pin is left floating the sensor will be in standby mode.

User guide and programming: Document 200.107 provided with each unit.

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

Qualification summary

Halt testing

HALT (Highly Accelerated Life Testing, a “margin discovery process”) was used in the design process for this product. In order to ruggedize the product for extreme downhole environments, the root cause of any failure was determined and the problems corrected until the fundamental limit of the technology was reached. This process yields the widest possible margin between product capabilities and the environment in which it will operate, thus increasing the product's reliability, reducing field failure and/or downtime, and realizing long-term savings. Throughout all testing, units operated within manufacturer's specifications.

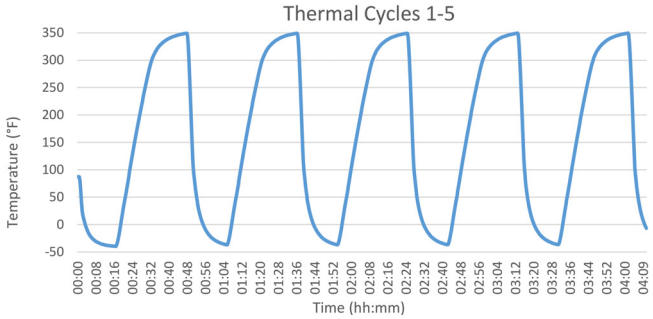
Life testing

3,000 hours: Proven to operate within specification 3,000 hours at 355 °F (179 °C) and 212 thermal cycles at 100 °F to +350 °F (37 °C to +176 °C).

Thermal testing

100 cycles: -40 °F to +356 °F (-40 °C to +180 °C).

Figure 1. Cycles of Temperature Transitioning between the Cold and Hot Extremes

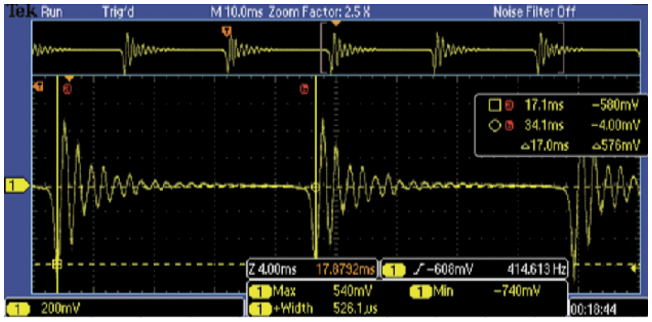


Demonstrated repeatable digital output during thermal cycling, continuing to operate within specification.

Shock

25,000 shocks: Proven to operate within specification after 25,000 shocks per axis at 500 g with 1 ms Full Width Half Max (FWHM).

Figure 2. Shock Profile

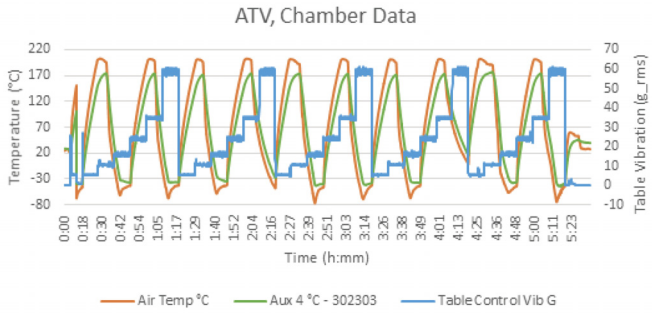


The 320-12-0010 Series is designed to survive the violent shocks encountered during drilling, exploration, and other applications.

Thermal vibration

Subjected to repetitive vibration g levels exceeding 50 grms[1] and temperatures exceeding 175 °C (347 °F).

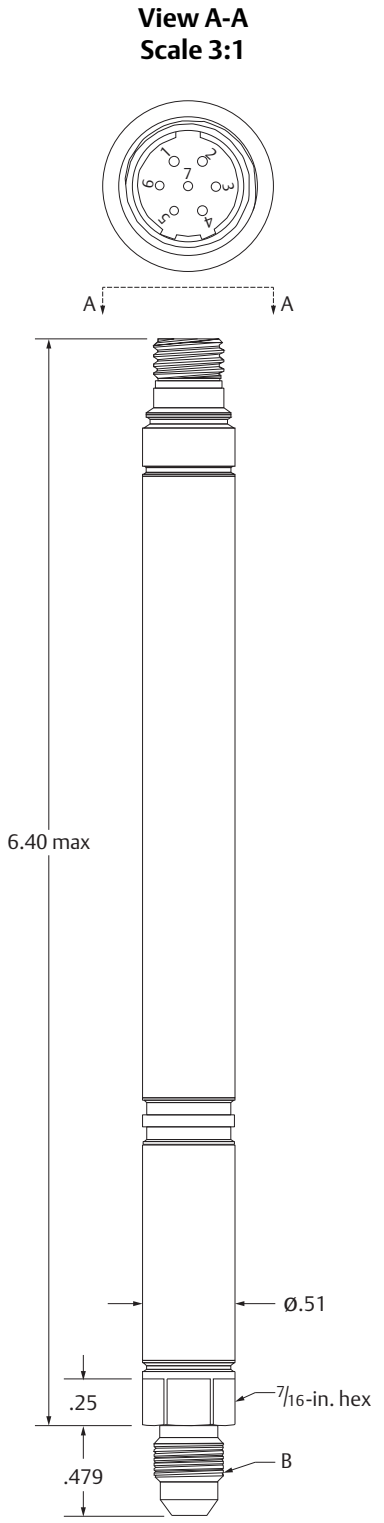
Figure 3. Levels of Vibration Introduced during Repeated Cycles of Temperature and Rates of Temperature Changes



1. *Grms is used to define the overall energy or acceleration level of vibration. Grms (root-mean-square) is calculated by taking the square root of the area under the Probability Density Function (PSD) curve.*

Dimensional drawings

Figure 4. 320-12-0010 Series



Connections	
PIN	**Function**
1	Power in
2	RS-485 “B”
3	RS-485 “A”
4	Power return/Communication return
5	Case ground
6	Sleep
7	Not used

B. Fitting end per MS33656-E3 except before diameter
Dimensions are inches.

Rosemount Specialty Product LLC
Emerson Automation Solutions
5545 Nelpar Drive
East Wenatchee, WA 98822, USA
+1 509 881 2100
+1 509 881 2115
Paine.Products@Emerson.com

Linkedin.com/company/Emerson-Automation-Solutions

Twitter.com/Rosemount_News

Facebook.com/Rosemount

Youtube.com/user/RosemountMeasurement

Google.com/+RosemountMeasurement

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Product Data Sheet
July 17, 2019
420-22-0010, Rev D

Paine 420-22-0010 Series Pressure Transmitter

Digital, Ultra Capacitance, 175°C, Pressure and Temperature

The 420-22-0010 Series is our high precision digital transmitter offering output of both pressure and temperature measurements. With full scale accuracy of .02%, long term stability of .02 % per year and designed to operate to 20,000 PSIA (1379 BAR) and 347°F (175°C). Utilizing proprietary, high precision-ultra capacitance technology, the 420-22-0010 Series is designed for harsh, long term petroleum and natural gas applications, providing unsurpassed precision, performance, and stability over a wide temperature range.

Features

- Custom hybrid electronics exhibit extremely low thermal transient error for high reliability during rapid changes in temperature.
- Compensation for thermal gradients commonly experienced in exploration and production activities provides increased accuracy.
- Self-calibrating gain and offset techniques reduce added thermal error.
- Slim 0.51” (1.29 cm) diameter form factor saves critical tool space.
- Customizable interface options available for fit-for-use designs.

Specifications

- Paine Standard Part Number: **420-22-0010-20K0**
- Accuracy: .02%
- Long Term Stability: .02% per year.
- Pressure Range: 0-20,000 PSIA (1379 BAR).
- Operating Temperature: 14°F to 347°F (-10°C to 175°C).
- Calibrated Temperature: 75°F to 347°F (23.9°C to 175°C).
- Digital Output: UART-TTL, I2C
- Temperature Output: °F or °C.
- Temperature Measurement: -40°F to 347°F (-40°C to 175°C).
- Temperature Resolution: 12 Bits Minimum, Better Than .09°F (.05°C)
- User Guide: Refer to user guide 200.203 for more information, instructions and product details.

Potential Applications

- Well Monitoring
- Well Logging
- Artificial Lift
- Production Control Monitoring

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Specifications

Performance specifications

Performance

Accuracy: ± .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 ground.
Stability: .02% F.S. maximum per year at the maximum calibrated temperature and pressure.
Operating Pressure Range: 0-20,000 (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 (Pressure Measurement): 75°F to 347°F (+23.9°C to 175°C)
Storage Temperature Range: -40°F to 347°F (-40°C to 175°C)
Pressure Output in PSI: Fully compensated for the effects of temperature & non-linearity.
Pressure Resolution: 16 bits min, .0001% FS RMS and .0043% F.S. peak to peak with a 10 second sample rate.
Temperature Output: °F or °C.
Temperature Measurement: -40°F to 347°F (-40°C to 175°C).
Temperature Resolution: 12 bits minimum. Better than .09°F (.05°C).
Temperature Calibration Accuracy from 60°F to 212°F (20°C to 100°C): ± 1°C

Functional specifications

Electrical

Digital Output: UART-TTL, I2C (Input Voltage Level).
Pressure Output in PSI: Fully compensated for the effects of temperature and non-linearity.
Input Voltage: 2.9 to 5.0 VDC, calibration valid at 5.0 ± .01 VDC.
Input Current: 30 mA maximum at 5.0 VDC.
Reverse Polarity: "POWER IN" is protected from the application of reverse polarity.
Over Voltage Protection: Do not exceed 5.25 VDC.
Insulation Resistance: All conductors except pin 5, together simultaneously to case: 100MΩ minimum at 50 VDC and 75°F ± 5°F (23°C ± 2.8°C). The case must be connected or coupled to ground for accurate results.
Electrical Connection Functions: See Figure 1.

Pin 1: Power In
Pin 2: UART Rx
Pin 3: UART Tx
Pin 4: Power Return / Communication Return
Pin 5: Case Ground
Pin 6: I2C SDA
Pin 7: I2C SCL

Physical specifications

Material selection

Emerson provides a variety of Paine product 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, configuration or materials of construction selected.

Pressure Media: Fluids and gases compatible with UNS NO7718, solution annealed and aged to a maximum hardness of 40 HRC.
Electrical Connection: Mates with Glenair® P/N: 801-007-16Z16-7SA. Connector sold separately.
Pressure Fitting: HiP HM2.
Recommended Installation Torque: 75 in-lb. (8.5 Nm).
Installation Information:

- Transmitter body must be mechanically restrained for use in high shock and/or vibration applications.
- Thermal coefficient of the mounting expansion should not exceed 8.3X10^ -6 in./ in.°F for operation above 100°F

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

Mechanical Specifications

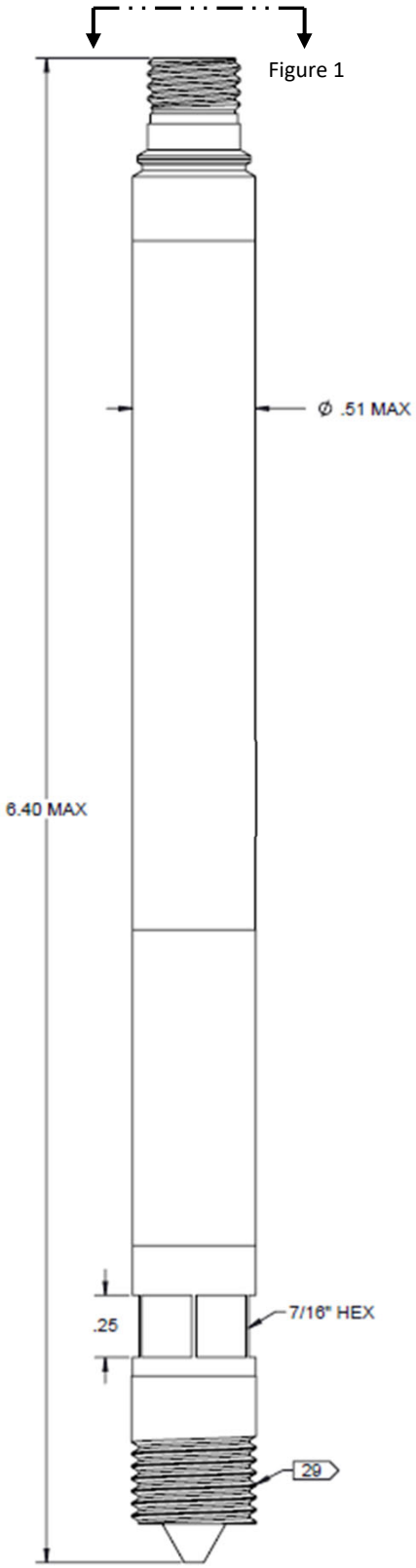
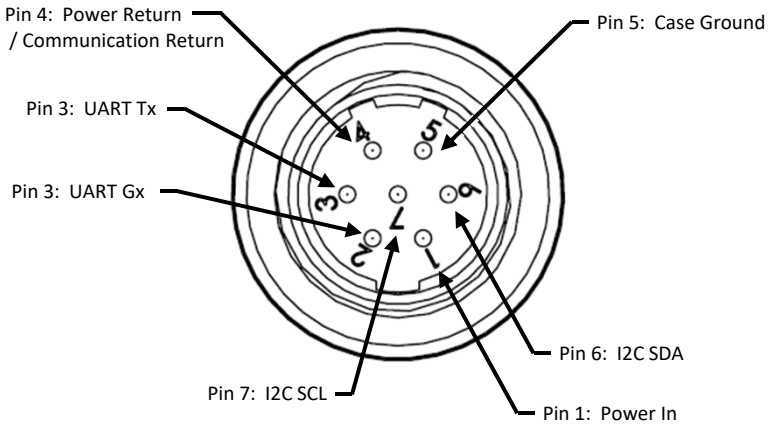


Figure 1



Global Headquarters
Emerson Automation Solutions
6021 Innovation Blvd.
Shakopee, MN 55379, USA
+1 800 999 9307 or +1 952 906 8888
+1 952 949 7001

Rosemount Specialty Product LLC
Emerson Automation Solutions
5545 Nelpar Drive
East Wenatchee, WA 98822, USA
+1 509 881 2100
+1 509 881 2115
Paine.Products@Emerson.com

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Product Data Sheet
September 2017
214-35-5XX, Rev F

Paine™ 214-35-500 Series Pressure Transmitter

4-20 mA, Rugged, Submersible, +110 °C, 0-20,000 PSIA (1,378 BAR)

The Paine 214-35-500 Subsea Pressure Transmitter is a pressure measurement device engineered for remote subsea environments. For application flexibility, this transmitter is designed with a 3-wire or SEA CON® Subsea Bulkhead Connector options. This submersible transmitter is all-welded and highly corrosion resistant to withstand extreme depths, and is engineered with a rugged external enclosure to provide maintenance-free performance.

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Solutions

- 3-wire connection or SEA CON Subsea Bulkhead
- All-welded, sealed construction
- Harsh/extreme environment ready
- Extreme depths and pressure

Potential applications

- Offshore oil and gas subsea production systems
- Remote/extreme pressure monitoring
- Corrosive environment pressure monitoring
- Submersible subsea applications
- ROV's and AUV's
- Wave energy hydraulic monitoring

Features

- **Static error band:** Includes the effects of non-linearity, hysteresis, and repeatability. The static error band shall not exceed ±0.50% of the Full Scale (F.S.).
- **Thermal zero shift:** 0.01% of F.S. per °F maximum across the compensated temp range
- **Output:** 4–20 mA
- **Operating temperature:** –65 to +230 °F (–53 to +110 °C)
- **Pressure range:** 0–1,000 to 0–20,000 psia (68 to 1,378 bar)
- **Operating media:** Compatible with 17-4 PH and 15-5 CRES
- **Pressure fitting:** 1/4-18 NPT internal thread

Specifications

Calibration: Calibration certificates are supplied with each unit and available on-line.

Performance

Static error band: Includes the effects of non-linearity, hysteresis, and repeatability. The static error band shall not exceed ±0.50% of the F.S.

Thermal zero shift: 0.01% of F.S. per °F maximum across the compensated temperature range.

Thermal sensitivity shift: 0.01% of F.S. per °F maximum across the compensated temperature range.

Zero pressure output: 4.00 ± 0.16 mA

Output at F.S. pressure: 20.00 ± 0.16 mA

Environmental

Operating temperature range:
214-35-520-XX: –65 to +230 °F (–53 to +110 °C),
214-35-530-XX: –65 to +185 °F (–53 to +85° C)

Compensated temperature range:
214-35-520-XX: –25 to +185 °F (–31 to +85 °C),
214-35-530-XX: –25 to +160 °F (–31 to +71 °C)

Operating media: Any compatible with 17-4 PH and 15-5 CRES

Contents

Mechanical

Pressure range: Lower and higher temperature ranges are available.

Table 1. Pressure Table

Standard part number	Pressure range PSIA (BAR)	Proof pressure PSIA (BAR)	Burst pressure PSIA (BAR)	External case pressure	Total error band (%F.S.)
211-37-520-01	0–1,000 (0–68)	1,500 (103)	2,000 (137)	6,500 PSI (448)	±0.50%
214-35-520-02	0–1,500 (0–103)	2,250 (155)	3,000 (206)	6,500 PSI (448)	±0.50%
214-35-520-03	0–2,000 (0–137)	3,000 (206)	4,000 (275)	6,500 PSI (448)	±0.50%
214-35-520-04	0–2,500 (0–172)	3,750 (258)	5,000 (344)	6,500 PSI (448)	±0.50%
214-35-520-05 **214-35-530-01**	0–3,000 (0–206)	4,500 (310)	6,000 (413)	6,500 PSI (448) 10,000 PSI (689)	±0.50%
214-35-520-06 **214-35-530-02**	0–5,000 (0–344)	7,500 (517)	10,000 (689)	6,500 PSI (448) 10,000 PSI (689)	±0.50%
214-35-520-07 **214-35-530-03**	0–7,500 (0–517)	11,250 (775)	15,000 (1,034)	6,500 PSI (448) 10,000 PSI (689)	±0.50%

Pressure fitting: 1/4-18 NPT internal thread

Installation and maintenance: Torque to 150 in-lb using sealant compatible with pressure media. Transmitter does not contain user serviceable components.

Electrical

Input voltage: 214-35-520-XX: +10 to + 24 VDC.
214-35-530-XX: +15 VDC minimum at zero series resistance varying to +40 VDC at 1300 Ω series resistance. +40 VDC maximum, all loads. Reverse polarity protected.

Signal current: 4–20 mA

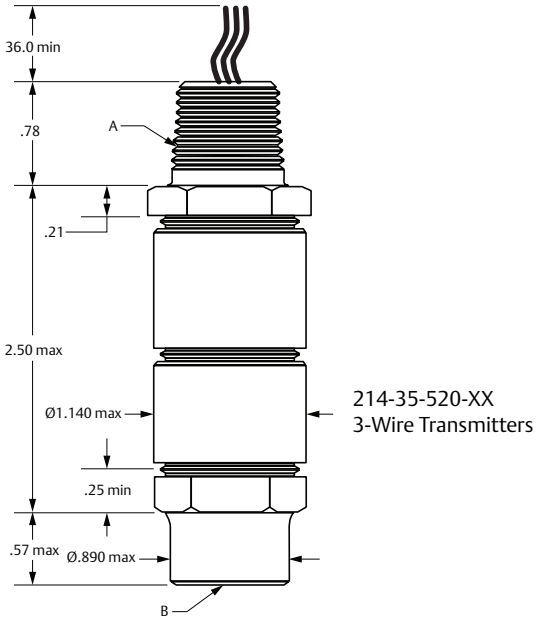
Electrical connections: 214-35-520-XX: Insulated wires, 18 AWG minimum
214-35-530-XX: SEA CON XSEE-3-BCR Bulkhead receptacle

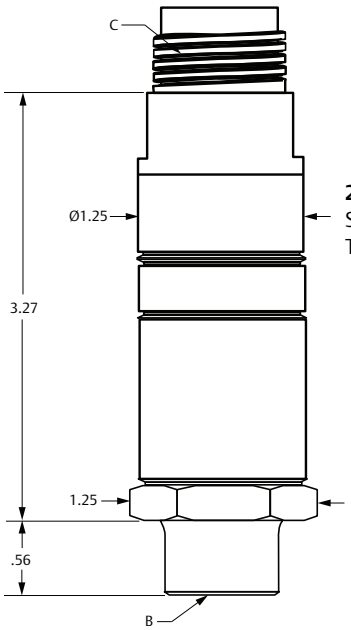
Weight: 214-35-520-XX: 10 ounces maximum (0.28 kg)
214-35-530-XX: 15 ounces maximum (0.42 kg)

Insulation resistance: 214-35-520-XX: Black and White leads to case: 100 m Ω minimum at 100 VDC
214-35-530-XX: Pin A and Pin B leads to case: 100 m Ω minimum at 500 VDC at 75 °F. Line transients are suppressed to 100 VDC.

Dimensional Drawings

Figure 1. Paine 214-35-500 - Wire Transmitters





WIRE/PIN	214-35-520	214-35-530
BLACK/A	+ INPUT	+ INPUT
WHITE/B	INPUT RETURN	INPUT RETURN
GREEN/C	CASE GROUND	CASE GROUND

A. 1/2-14 NPT thread
B. 1/4-18 NPT thread (Internal)
C. SEA CON XSEE-3-BCR Bulkhead Connector receptacle
Dimensions are shown in inches.

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Rosemount Specialty Product LLC
Emerson Automation Solutions
5545 Nelpar Drive
East Wenatchee, WA 98822, USA
+1 509 881 2100
+1 509 881 2115
Paine.Products@Emerson.com

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Product Data Sheet
00813-0100-4282, Rev AA
September 2019

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

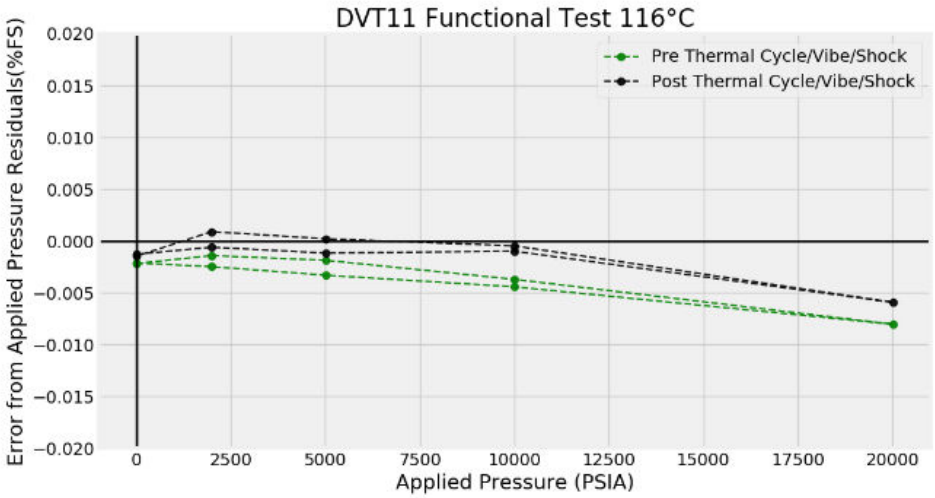
Performance testing of the Paine 420-52-0010 Series pressure transmitter was done as a means of design assurance to understand and validate the transmitters expected performance at a given workload or point of time. The goal of the performance testing was to determine the transmitter's long term stability,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

Figure 1: DVT11 Functional Test



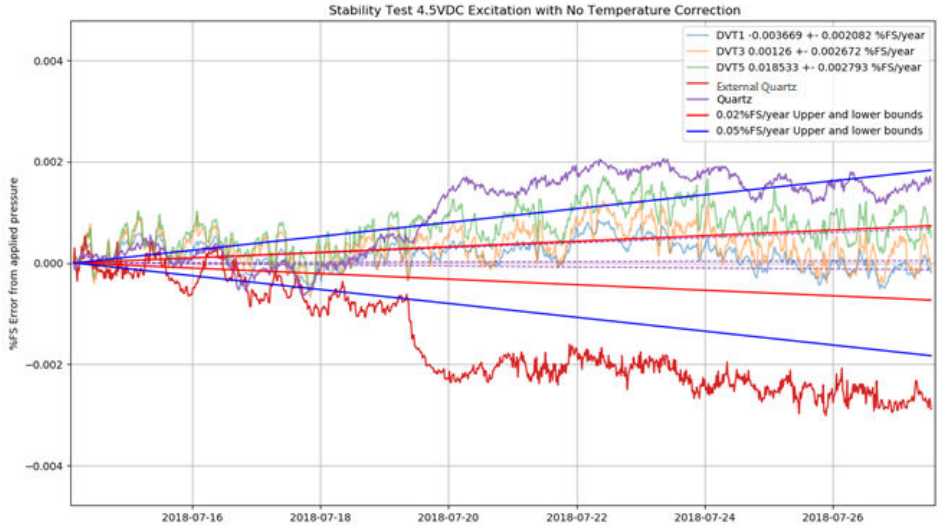
Test result: Post performance testing recorded only a slight shift in full scale output that is within the repeatability of the test equipment.

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



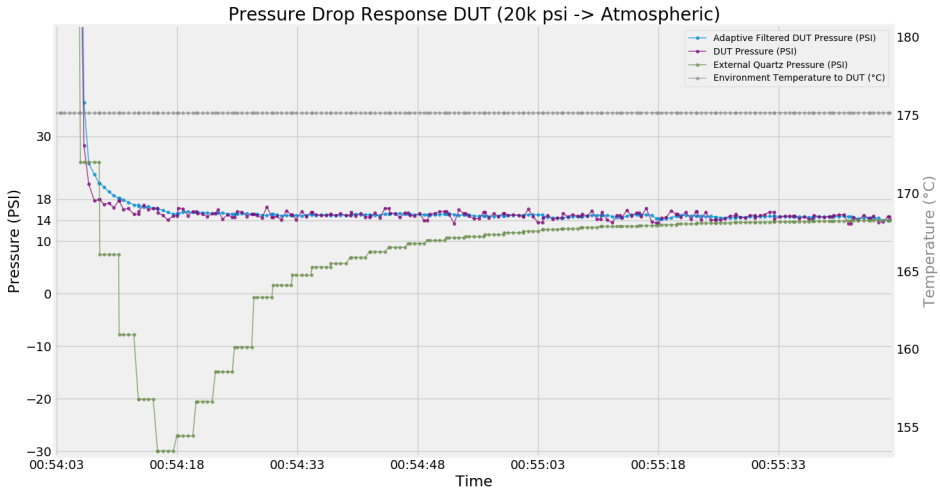
Test result: The transmitters performed as good if not better than the quartz-based sensors rated to have less than 0.02 percent full scale drift per year.

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



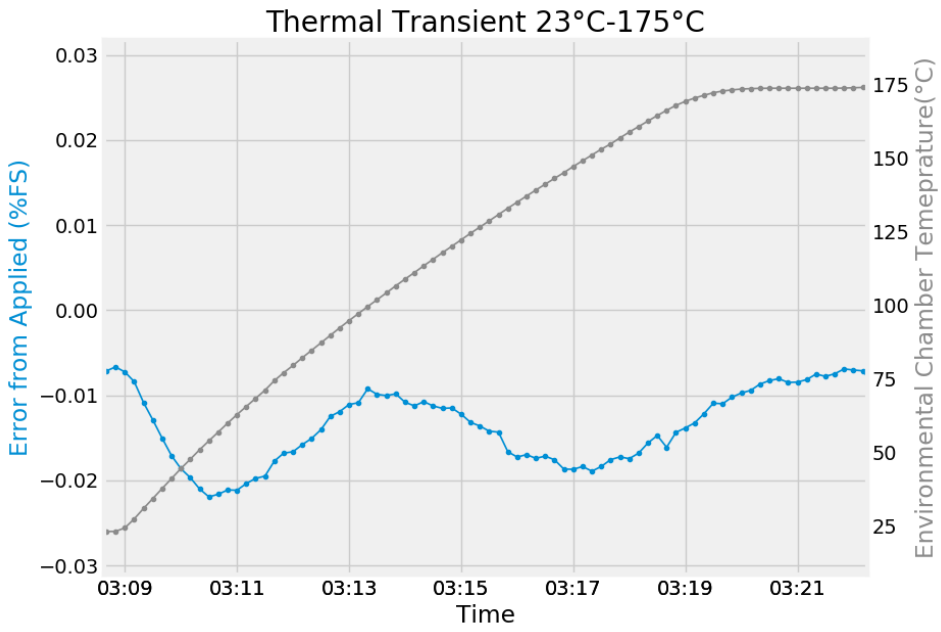
Test result: No undershoot was evident in the Paine 420-52-0010 Series transmitter.

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

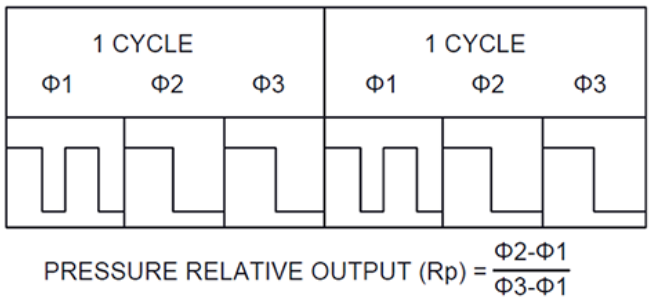
Performance specifications

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 Releative Output



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

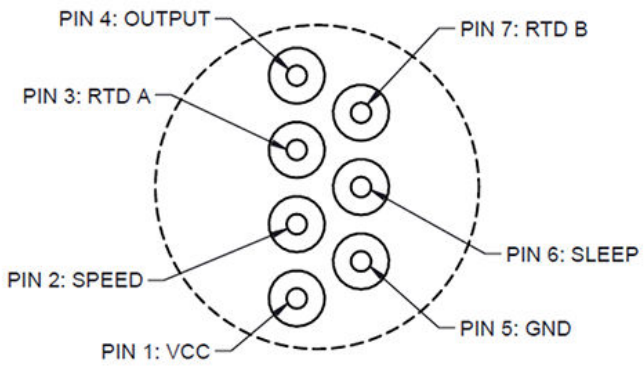
Pin 1: VCC
Pin 1: VCC
Pin 4: Output
Pin 5: Ground
Pin 6: Sleep
Pin 7: RTD "B"

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.

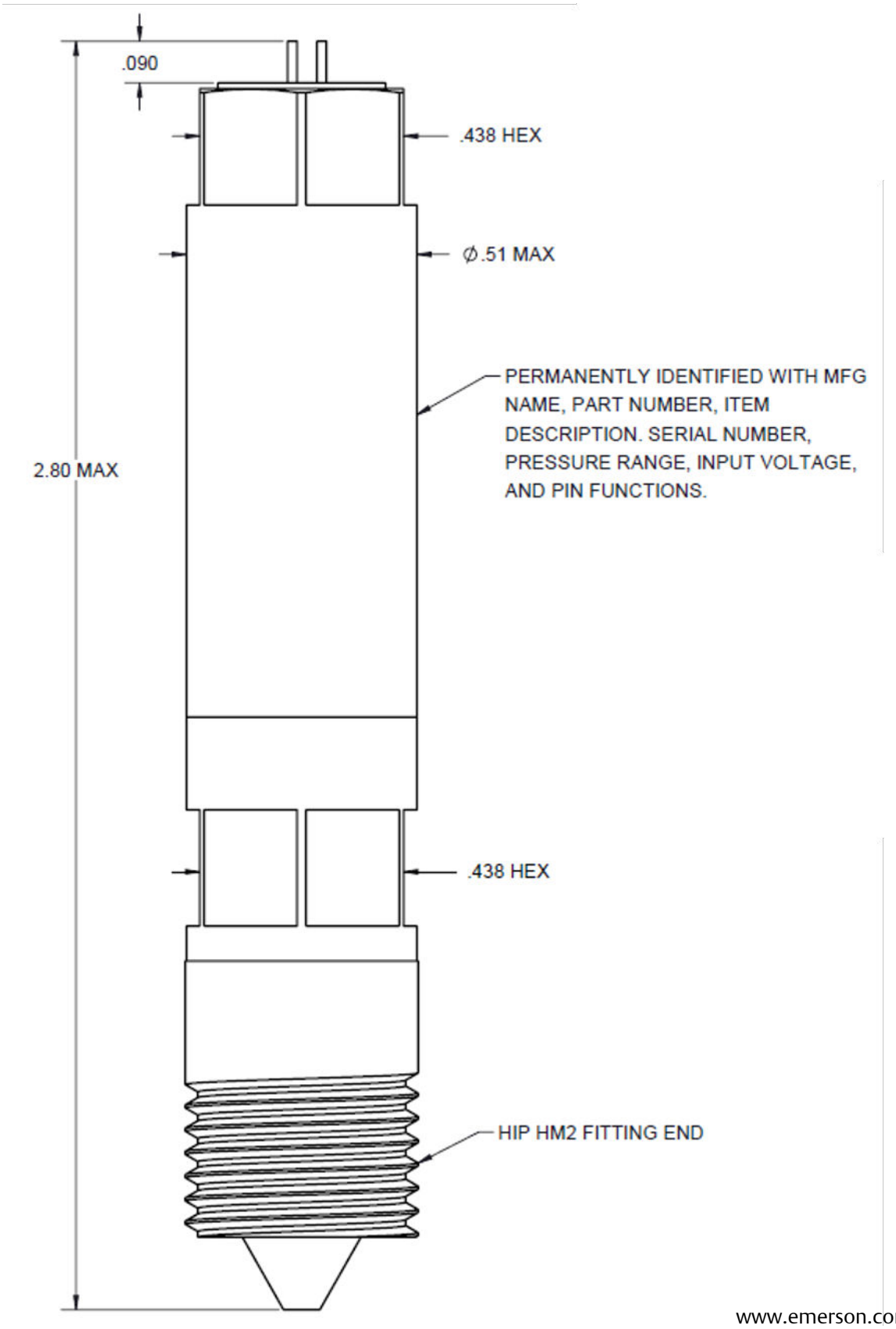
Figure 6: Pin Functions



Physical specifications

Material selecton:	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 NO7718, 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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Global Headquarters
Emerson Automation Solutions
6021 Innovation Blvd.
Shakopee, MN 55379, USA
+1 800 999 9307 or +1 952 906 8888
+1 952 949 7001

Rosemount Specialty Product LLC
Emerson Automation Solutions
5545 Nelpar Drive
East Wenatchee, WA 98822, USA
+1 509 881 2100
+1 509 881 2115
Paine.Products@Emerson.com

Emerson: https://www.linkedin.com/company/emerson automation solutions/

Paine Measurement Solutions: https://www.linkedin.com/groups/12008678/

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