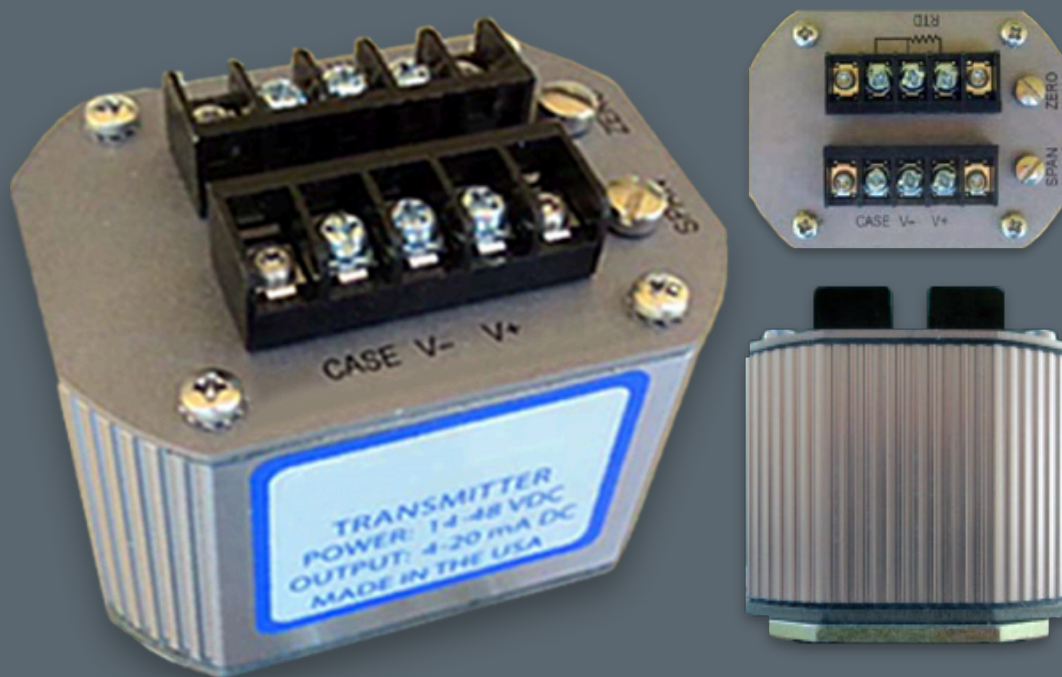


# N7030 RTD and N7040 thermocouple analog transmitter



## Key features

- True analog transmitter
- Qualified per IEEE 323 Class 1E Mild Environment
- Qualified per IEEE 344 Class 1E Seismic
- Loop powered 14 to 48 VDC
- Analog ANSI-ISA, NAMUR 43
- EMC, NRC RG 1.180, CE

## Overview

The N7030 and N7040 analog temperature transmitter series are two-wire 4-20 mA DC current loop powered temperature transmitters. They are analog signal conditioning devices designed to accept standard RTD or thermocouple inputs and convert the input to a linearized 4-20 mA DC output signal that is proportional to the input. The transmitter is nominally powered from a 24 VDC supply but will accept any regulated DC supply such that the voltage measured at the transmitter's terminals is between 14 and 48 VDC under all conditions.

# Technical specifications

## Nuclear power plant applications

The Analog Temperature Transmitter provides high accuracy transmission of temperature measurements specifically designed for nuclear power plant applications. Each transmitter has an enclosure which is moisture and impact resistant and provides a high degree of EMI/RFI protection. For on-machine applications and potentially harsh plant environments, a NEMA 4X IP66 housing is available. The transmitter is insensitive to age related drift and ambient temperature changes to ensure stability and accuracy over its mission life.

- Reactor coolant system (RCS) temperature
- Pressurizer temperature
- RCS hot leg wide range
- Pressurizer return line temperature
- Pressurizer level reference leg temperature
- RCS cold leg narrow range
- RCS hot leg narrow range
- Pressurizer heater return line temperature
- External pipe and pressure vessel temperature
- Reed switch level transmitter
- Millivolt transmitter
- Potentiometer transmitter
- Containment temperature
- Fuel pool
- Spent fuel
- Radioactive waste treatment

## Replacement for obsolete transmitters and signal conditioners including these discontinued models

- Rosemount™ Model 444 Alphaline® temperature transmitter\*
- FOXBORO™ 893 temperature transmitter\*
- FOXBORO™ 694A resistance-to-current converter\*
- FOXBORO™ 693A millivolt-to-current converter\*
- Weed Instrument N7000 series including models N7013, N7014

\*FOXBORO™ is a trademark of Schneider Electric Systems USA, Inc. Rosemount® and Alphaline® are trademarks of Rosemount Inc, a subsidiary of Emerson Electric Company. All product and company names are trademarks™ or registered® trademarks of their respective holders. Use of them does not imply any affiliation with or endorsement by them.

## Qualifications at a Glance (see below for further detail):

- Nuclear qualified per IEEE 323/344 Class 1E Mild Environment
- Qualified life of 40 years at 25°C (77°F)
- Vibration and seismic qualified
- Analog Signals meet ANSI-ISA, NAMUR 43, and ANSI-ISA-50.00.01-1975 requirements
- EMC qualification per US NRC Regulatory Guide 1.180 Rev. 1 Oct. 2003
- CE Mark Certification

Transmitter will be used with the ITS-90 temperature scale. Sensor type and temperature range must be specified when ordering.

# Technical specification

Feature	Description
Transmitter types	<ul style="list-style-type: none"> <li>Analog transmitter (<math>\Omega</math>, RTD, mV, thermocouple) inputs</li> </ul>
N7030 input - RTD	<ul style="list-style-type: none"> <li>Single element Platinum 100<math>\Omega</math> or 200<math>\Omega</math></li> <li>3 or 4 wire per model configuration table</li> <li>Factory set, non-field configurable</li> <li>Temperature coefficients (alphas <math>\alpha</math> available by request):                             <ul style="list-style-type: none"> <li>Curve A: 0.003902 <math>\Omega/\Omega/^\circ\text{C}</math> (US Standard)</li> <li>Curve B: 0.00385055 <math>\Omega/\Omega/^\circ\text{C}</math> (ASTM-1137, IEC-60751, DIN 43760, ITS-90)</li> </ul> </li> </ul>
N7040 input - thermocouple	<ul style="list-style-type: none"> <li>Types: B, E, J, K, N, R, S, and T thermocouples                             <ul style="list-style-type: none"> <li>10 mV to +100 mV per model configuration table</li> </ul> </li> <li>Factory set, non-field configurable</li> </ul>
Input range and spans	<ul style="list-style-type: none"> <li><math>\Omega</math> Range: 18.52<math>\Omega</math> (Pt100@-200<math>^\circ\text{C}</math>) to 788.72<math>\Omega</math> (Pt200@+850<math>^\circ\text{C}</math>)</li> <li><math>\Omega</math> minimum span: 3<math>\Omega</math></li> <li><math>\Omega</math> maximum span: 754<math>\Omega</math></li> <li>RTD Pt Range: -200<math>^\circ\text{C}</math> to 850<math>^\circ\text{C}</math> (-328<math>^\circ\text{F}</math> to +1562<math>^\circ\text{F}</math>) per ITS-90</li> <li>RTD Pt 100 minimum span: 10<math>^\circ\text{C}</math> (18<math>^\circ\text{F}</math>)</li> <li>RTD maximum span: 1050<math>^\circ\text{C}</math> (1890<math>^\circ\text{F}</math>)</li> <li>mV Range: -10 mV to +100 mV</li> <li>mV minimum span: 5 mV</li> <li>mV maximum span: 110 mV</li> <li>Thermocouple temperature ranges per ITS-90</li> </ul>
Output	<ul style="list-style-type: none"> <li>Single isolated loop powered 4-20 mA</li> <li>Measurement valid from 3.8 mA to 20.5 mA</li> <li>Sensor Fault indicated by <math>\leq 3.6</math> mA or <math>\geq 21.0</math> mA</li> <li>Linear to temperature for RTD inputs</li> <li>Linear to mV for thermocouple inputs</li> </ul>
Response time (for a 1-time constant response (63.2%) to a step change input)	<ul style="list-style-type: none"> <li>N7030 RTD input transmitter: 134 ms, transmitter only</li> <li>N7040 thermocouple input transmitter: 232 ms, transmitter only</li> </ul>

# Technical specification

Feature	Description
<b>Functional</b>	
Isolation between any of: 4-20 mA current loop, sensor input or transmitter case	<ul style="list-style-type: none"> <li>• <math>\geq 1 \text{ M}\Omega</math> (50 VDC for 60 s, &lt;50 <math>\mu\text{A}</math> leakage)</li> </ul>
Zero and span adjustability	<ul style="list-style-type: none"> <li>• Zero: <math>\pm 13.8^\circ\text{C}</math> (<math>\pm 25^\circ\text{F}</math>)</li> <li>• Span: <math>\pm 20\%</math> of calibrated span</li> <li>• Non-interactive</li> </ul>
Zero and span setability	<ul style="list-style-type: none"> <li>• <math>\pm 0.05\%</math> span</li> </ul>
Turn on time	<ul style="list-style-type: none"> <li>• 1 minute to achieve rated accuracy</li> </ul>
Power supply	<ul style="list-style-type: none"> <li>• Single 4-20 mA loop: 14 to 48 VDC terminal voltage</li> <li>• Power budget: <math>23\text{mA} \times 48 \text{ VDC} = 1104 \text{ mW}</math> maximum</li> </ul>
In-rush current	<ul style="list-style-type: none"> <li>• Less than 100 mA for less than 15 ms excluding the output current</li> </ul>
Power supply input protection	<ul style="list-style-type: none"> <li>• +48V Maximum input voltage</li> <li>• -48V Reverse voltage protection</li> </ul>
Sensor wiring protection	<ul style="list-style-type: none"> <li>• No damage due to sensor miswiring or short circuits between sensor leads</li> <li>• Warning: connecting power to the sensor inputs will damage the transmitter</li> </ul>
Output maximum load limits	<ul style="list-style-type: none"> <li>• Single Loop: determined from the following equation</li> <li>• <math>(\text{Power supply voltage} - 14\text{V}) / 0.022\text{A}</math></li> <li>• Maximum loop resistance vs. some typical supply voltages:                             <ul style="list-style-type: none"> <li>◦ <math>0\Omega</math> at 14 VDC</li> <li>◦ <math>455\Omega</math> at 24 VDC</li> <li>◦ <math>1,545\Omega</math> at 48 VDC</li> </ul> </li> <li>• Conforms to: ANSI/ISA-50.00.01 Class 2L transmitter</li> </ul>

# Technical specification

Feature	Description
Sensor fault signalling	<ul style="list-style-type: none"> <li>• Sensor breakdown information per NAMUR NE 43</li> <li>• RTD sensor: any sensor lead wire open, RTD sensor shorted</li> <li>• Thermocouple sensor: sensor lead open <math>\leq 3.6</math> mA or <math>\geq 21.0</math> mA (specified when ordering)</li> </ul>
Humidity range	<ul style="list-style-type: none"> <li>• 5% to 95% non-condensing</li> </ul>
Humidity effect	<ul style="list-style-type: none"> <li>• Less than <math>\pm 0.25\%</math> of span for 15%-95% change in relative humidity (non-condensing)</li> </ul>
Temperature limits operating/storage	<ul style="list-style-type: none"> <li>• <math>0^{\circ}\text{C}</math> to <math>70^{\circ}\text{C}</math> (<math>32^{\circ}\text{F}</math> to <math>158^{\circ}\text{F}</math>) / <math>-40^{\circ}\text{C}</math> to <math>100^{\circ}\text{C}</math> (<math>-40^{\circ}\text{F}</math> to <math>212^{\circ}\text{F}</math>)</li> </ul>
<b>Performance</b>	
Accuracy (includes linearity and repeatability)	<ul style="list-style-type: none"> <li>• <math>\pm 0.1\%</math> of span or <math>\pm 0.05^{\circ}\text{C}</math> (<math>\pm 0.09^{\circ}\text{F}</math>); whichever is larger, excluding sensor error for RTD</li> <li>• <math>\pm 0.15\%</math> of span in mV or <math>\pm 20</math> <math>\mu\text{V}</math>; whichever is larger, excluding sensor and cold junction compensation errors for mV and thermocouples</li> </ul>
Stability (drift)	<ul style="list-style-type: none"> <li>• <math>\pm 0.2\%</math> of span per year maximum</li> </ul>
Cold junction compression error	<ul style="list-style-type: none"> <li>• <math>\pm 0.5^{\circ}\text{C}</math> (<math>\pm 0.9^{\circ}\text{F}</math>) (thermocouple input only)</li> </ul>
Ambient temperature effect	<ul style="list-style-type: none"> <li>• RTD: <math>\pm [0.15^{\circ}\text{C} (0.27^{\circ}\text{F}) + 0.05\% \text{ span}]</math> for a <math>5.5^{\circ}\text{C}</math> (<math>10^{\circ}\text{F}</math>) change</li> <li>• Thermocouple: <math>\pm [1^{\circ}\text{C} (1.8^{\circ}\text{F}) + 0.1\% \text{ span in mV}]</math> for a <math>5.5^{\circ}\text{C}</math> (<math>10^{\circ}\text{F}</math>) change</li> </ul>
Power supply effect	<ul style="list-style-type: none"> <li>• <math>\pm 0.02\%</math> of span/Volt</li> </ul>
EMI/RFI effect	<ul style="list-style-type: none"> <li>• <math>\pm 0.1\%</math> of span</li> </ul>

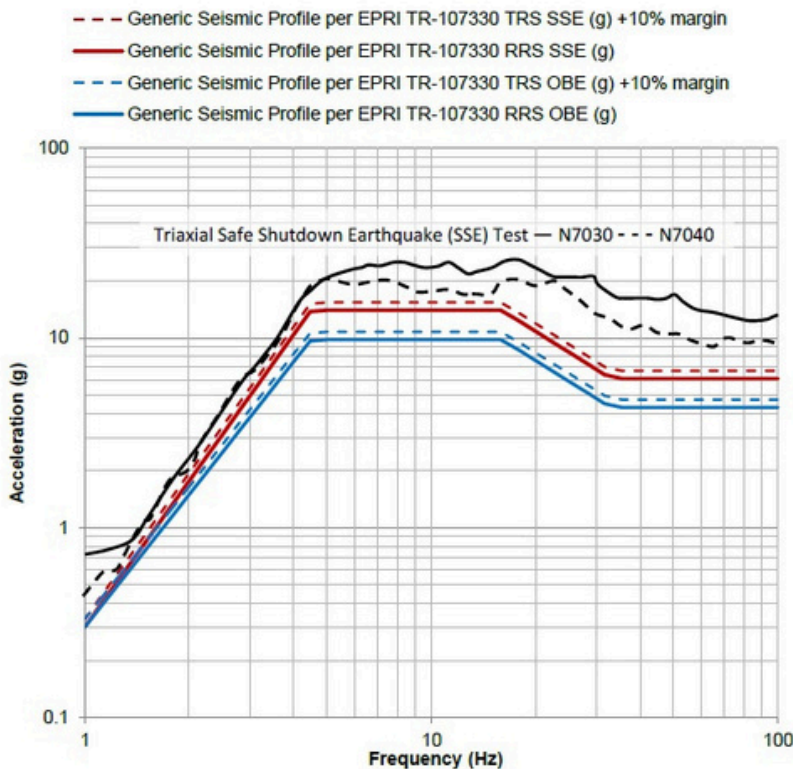
# Technical specification

Feature	Description
Mounting position effect	<ul style="list-style-type: none"> <li>None</li> </ul>
Reference conditions	<ul style="list-style-type: none"> <li>24 VDC terminal Voltage</li> <li>25°C (77°F) ambient conditions</li> <li>385 Pt 100 Ω - IEC 60751 at 0°C (32°F), Type K Thermocouple at 0°C (32°F)</li> </ul>
Reliability	<ul style="list-style-type: none"> <li>Mean-Time-Between-Failure predication in accordance with MIL-HDBK-271F, FN2: MTBF at 25°C (77°F) of 1.8 million hours or greater</li> </ul>
<b>Physical</b>	
Housing, mounting	<ul style="list-style-type: none"> <li>DIN rail mount</li> <li>Panel mount</li> <li>IP67 head mount options</li> <li>Other enclosures as a special</li> </ul>
Connection	<ul style="list-style-type: none"> <li>Terminal strip</li> <li>Ring lugs not required</li> <li>16 to 24 AWG wire</li> </ul>
Weight	<ul style="list-style-type: none"> <li>Transmitter 0.6 lbs (0.27 kg):</li> <li>With panel mount 0.7 lbs (0.32 kg)</li> <li>With DIN rail 0.9 lbs (0.41 kg)                             <ul style="list-style-type: none"> <li>In ADALET XIHMKFCX connection head 3.9 lbs (1.77 kg)</li> <li>In Hoffman/Pentair junction box A606CHNF 5.3 lbs (2.40 kg)</li> </ul> </li> </ul>
<b>Nuclear qualifications</b>	
Quality assurance and certification or origin	<ul style="list-style-type: none"> <li>Product is designed, manufactured, and qualified by Ultra Energy in the USA under its 10CFR50 App. B QA program</li> </ul>

# Technical specification

Feature	Description
Nuclear power and environmental qualifications	<ul style="list-style-type: none"> <li>IEEE 323/344 Class 1E Mild Environment</li> </ul>
Qualified life	<ul style="list-style-type: none"> <li>40 years at 25°C (77°F)</li> </ul>
Vibration, seismic profile	<ul style="list-style-type: none"> <li>Generic Seismic Profile per EPRI TR-107330. Required Response Spectra for all mounting options (DIN rail, panel, and Ex d connection head), see US NRC Regulatory Guide 1.209. Spectra below, TRS has 10% margin added to the RRS</li> </ul>

## Seismic Test Profile - N7030/N7040 5% Damping Ratio - Horizontal and Vertical



Generic seismic profile per EPRI TR-107330 (Required Response Spectra). TR-107330 provides seismic test levels taken from SQRTS-01 (assumes floor motion typical of lower level plant location and applies cabinet amplification factors.)

Freq. (Hz)	Generic Seismic Profile per EPRI TR-107330 RRS SSE (g)	Generic Seismic Profile per EPRI TR-107330 TRS SSE (g) +10% margin	N7030 Safe Shutdown Earthquake (SSE) Tests Actual (g)
1	0.3	0.33	0.9
5	14.0	15.4	20
16	14.0	15.4	20
36	6.1	6.71	15
100	6.1	6.71	12

# Technical specification

## Radiation

$\leq 103$  rads (10 Gy). The commonly used radiation threshold for concern for electronics that contain metal oxide semiconductors (MOS) is 103 rads (10 Gy) (US NRC Regulatory Guide 1.209).

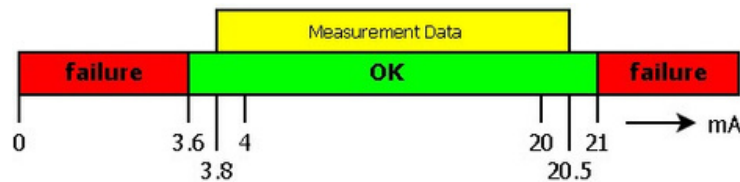
Radiation aging for electronic equipment not required to perform a safety-related function in a high-energy line break environment and subject to lifetime doses of less than 103 rads (10 Gy) is not required for mild qualification.

## Compliance

Summary: CE, RoHS, EMC per US NRC Reg. Guide 1.180, UL94 V-0 flame retardancy, and general electrical safety.

## Compatibility of Analog Signals: ANSI-ISA, NAMUR 43

ANSI-ISA-50.00.01-1975 R2012 Compatibility of Analog Signals for Electronic Industrial Process Instruments Approved 17 July 2012. NAMUR NE 43 analog output over range and under range annunciations.



## EMC, NRC RG 1.180, CE

EMC per US NRC Reg. Guide 1.180. European EMC Directive 2014/30/EU by conforming to applicable EN and IEC Standards: Compliance testing to the EN 61000 Series standards, CE mark declaration.

## Class 1E Mild Environment according to IEEE 323- 1974/1983/2003 & IEEE 344-1975/1987/2004

IEEE 323-1974/1983/2003

Both Regulatory Guide 1.89, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants," issued November 1974, and Revision 1 of Regulatory Guide 1.89, issued June 1984, endorse IEEE Std. 323-1974.

Regulatory Guide 1.89 focuses on the environmental qualification of equipment intended for use in harsh environments that are subject to design-basis accidents. Additional guidance is warranted to address qualification for mild environmental conditions as needed for computer-based technologies.



# Technical specification

IEEE revised the industry guidance for qualification, IEEE Std. 323, in 2003. A particular distinction between IEEE Std. 323-2003 and IEEE Std. 323-1974 is that the 2003 version does not require age conditioning to an end-of-installed-life condition for equipment in mild environments where significant aging mechanisms are not present. The NRC regulatory guide 1.209 endorses IEEE Std. 323-2003. The practices in IEEE Std. 323-2003 are sufficiently comprehensive to address qualification for the less severe environmental conditions of typical plant locations where safety-related, computer-based I&C systems are generally located. These plant areas are unaffected by design-basis accidents and the most severe conditions to which the equipment is subjected, which arise from the environmental extremes resulting from normal and abnormal operational occurrences.

IEEE 344-1975/1987/2004

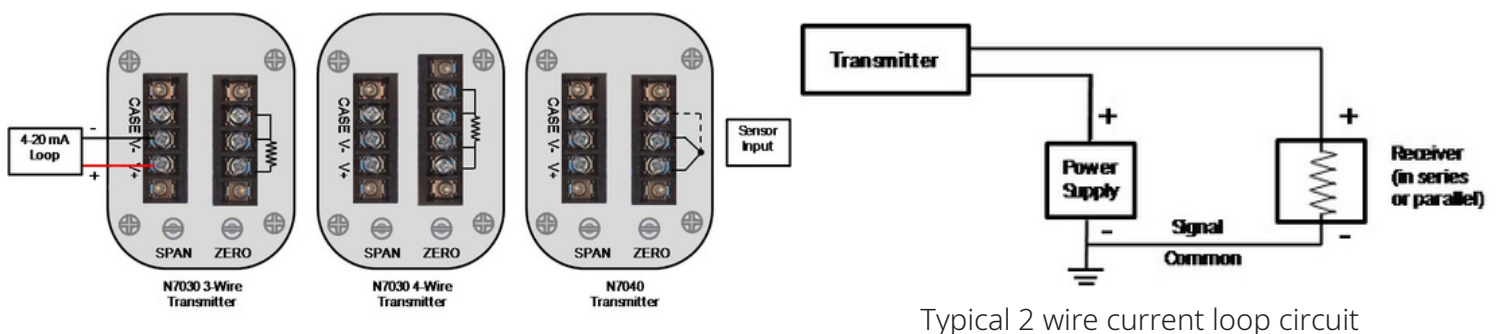
The NRC issued Revision 2 of Regulatory Guide 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants", in June 1988. With a few exceptions and clarifications, it endorsed the IEEE 344-1987, issued January 1987. NRC Regulatory Guide 1.100 Revision 3 issued September 2009 endorses, with exceptions and clarifications, IEEE Std. 344-2004.

The major change from IEEE Std. 344-1987 to IEEE Std. 344-2004 is the update and expansion of Clause 10, "Experience," which describes the use of experience data as a method for seismic qualification of Class 1E electrical equipment (including I&C components). The qualification of Ultra Energy's Analog Temperature Transmitter does not rely in any way on experience data; therefore, the qualification also meets the requirements of IEEE 344-2004 and complies with USNRC Regulatory Guide 1.100 Revision 3.

References:

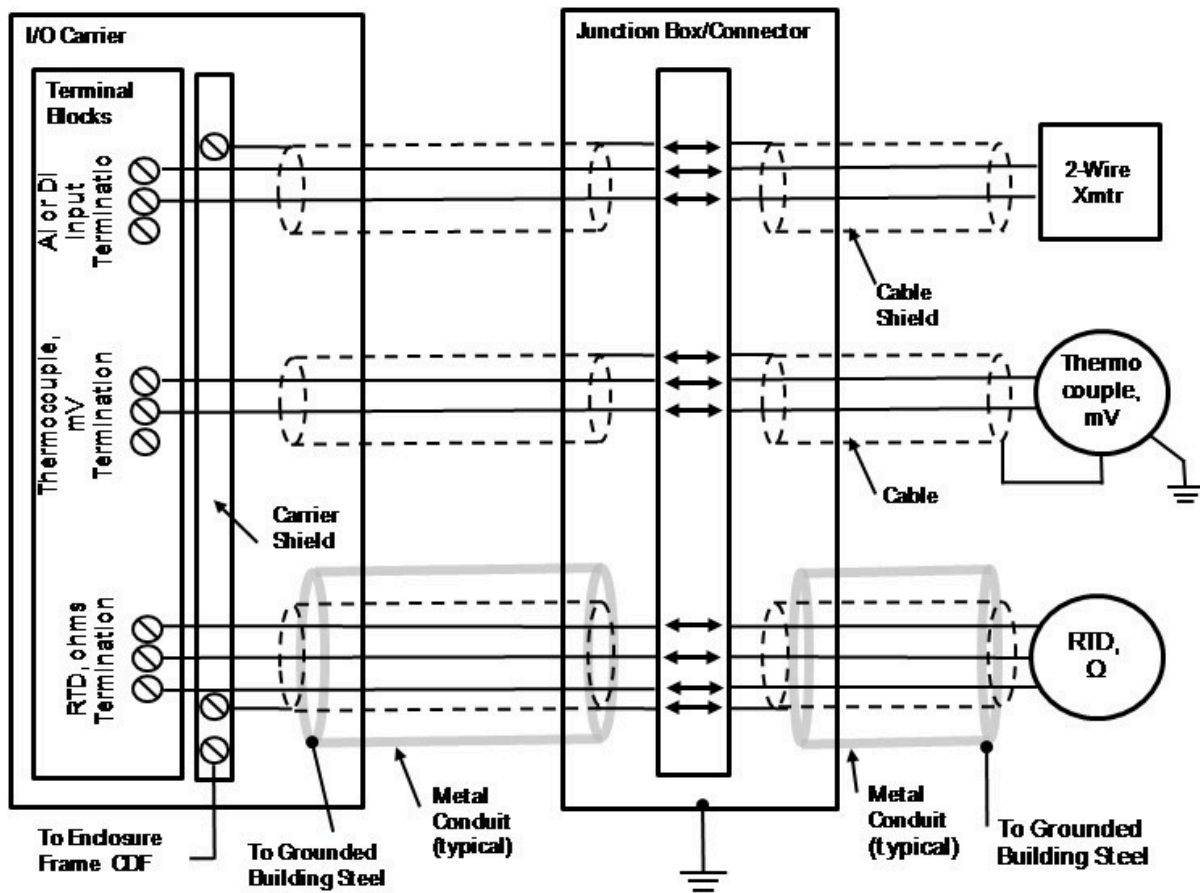
- IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations, IEEE Std. 323-1974/1983/2003, Institute of Electrical and Electronics Engineers, Piscataway, NJ
- US NRC Regulatory Guide 1.89
- Recommended Practice for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations, IEEE Std. 344-1975/1987/2004, Institute of Electrical and Electronics Engineers, Piscataway, NJ
- USNRC Regulatory Guide 1.100

## Electrical connections



# Technical specification

## Electrical wiring and grounding



Typical wiring and grounding connections for cable runs

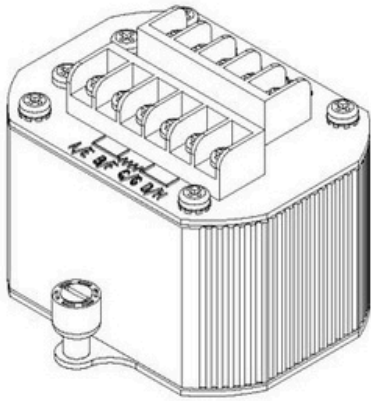
Properly grounded, dual shielded cabling (one internal and one external shield with drain wire) should be used for the input signal to ensure proper EMI/RFI performance. The transmitter's output connection provides DC power to the transmitter and transmits 4-20 mA output signals to the receiver instruments. Current loop wiring should be properly shielded and grounded to reduce effects of electrical interference.

Consult these references for additional guidance:

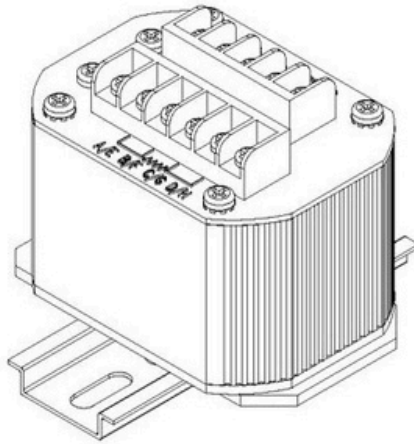
1. ANSI-ISA-50.00.01-1975 (R2012) Compatibility of Analog Signals for Electronic Industrial Process Instruments, Approved 17 July 2012.
2. Control System Power and Grounding Better Practice, David Brown, David Harrold, and Roger Hope, Control Engineering, Elsevier/Newnes, and Reed Business Information, 2004.
3. IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations, IEEE Std 1050-1996, 1996.

# Technical specification

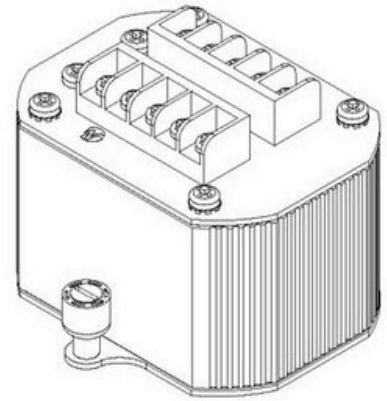
## Mounting options



N7030 4-Wire RTD Temperature Transmitter  
2-Hole Head / Panel Mount

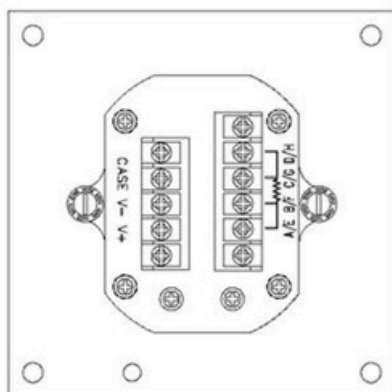
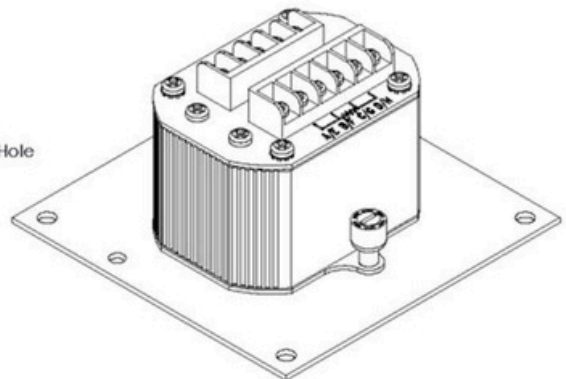
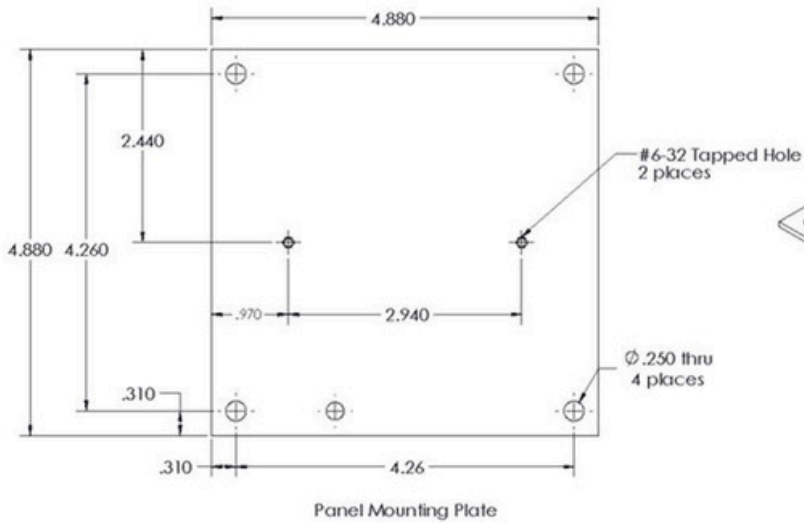


N7030 4-Wire RTD Temperature Transmitter  
DIN Rail Mount



N7040 T/C Temperature Transmitter  
2-Hole Head / Panel Mount

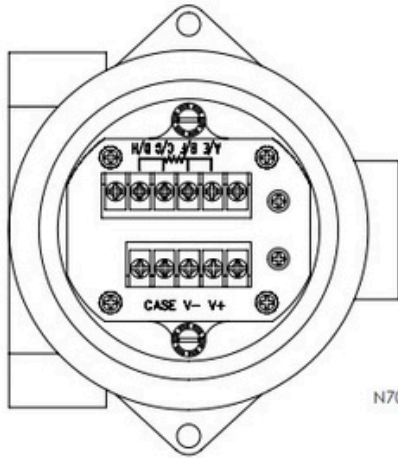
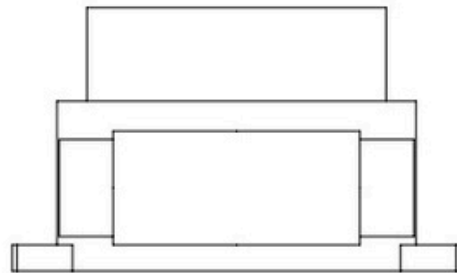
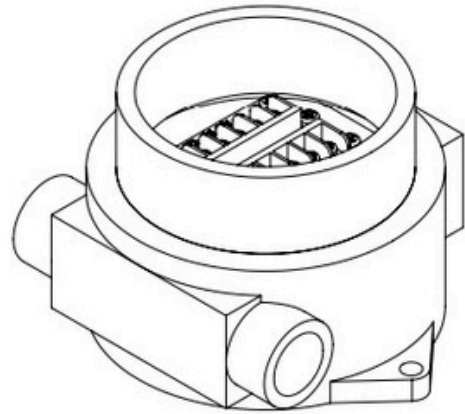
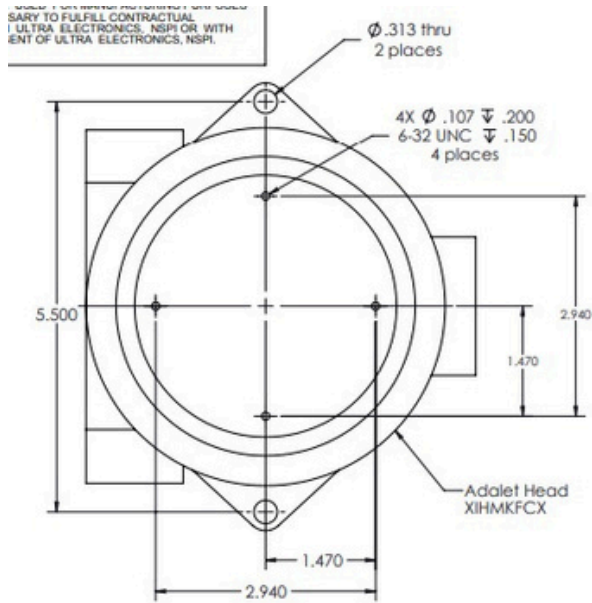
## Panel mount



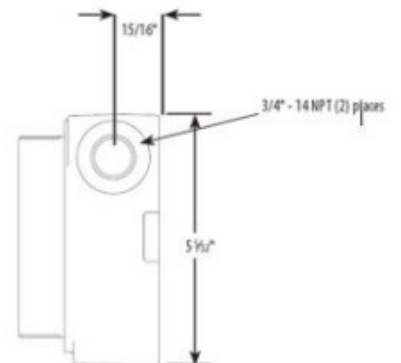
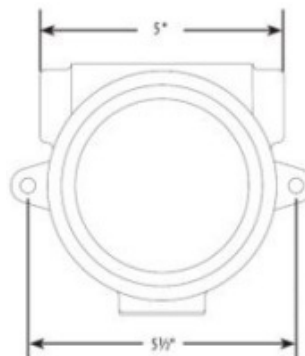
N7030 4-Wire transmitter shown

# Technical specification

## Connection head mount



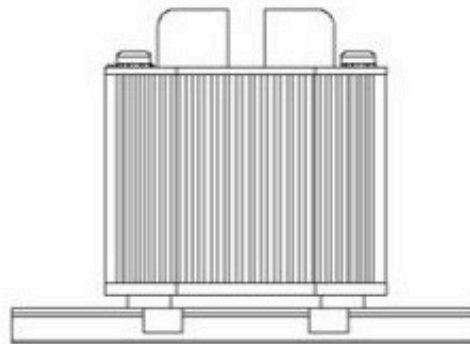
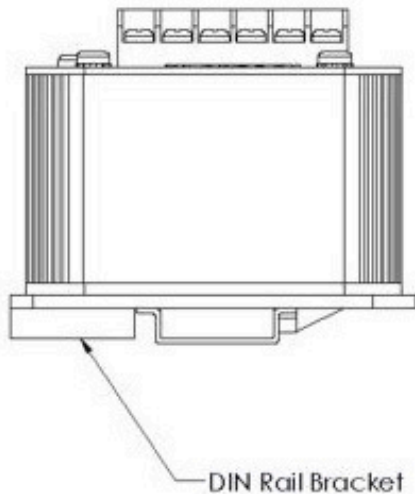
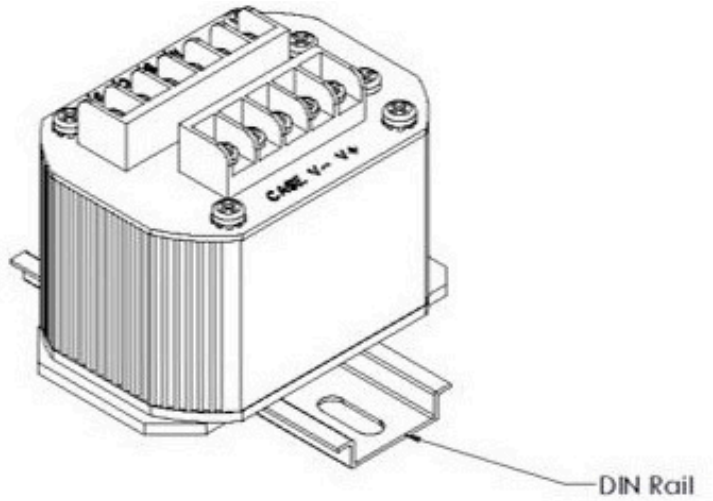
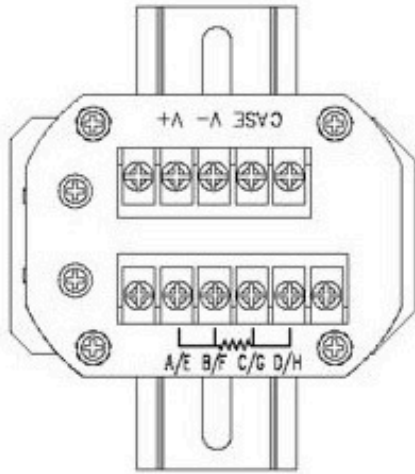
N7030 4-Wire Transmitter Shown



# Technical specification



## DIN rail mount



N7030 4-Wire Transmitter Shown

# Technical specification

## Junction box and special enclosures

Weather proof housings and engineered to order special configurations are available, contact the factory with your unique requirements.



Weather proof housing, PN 0403-100-0004 (Hoffman A606CHNF)

### INDUSTRY STANDARDS

UL 50, 50E Listed; Type 4, 12, 13; File No. E27567

cUL Listed per CSA C22.2 No. 94; Type 4, 12, 13; File No. E27567

UL 508A Listed; Type 4, 12, 13; File No. E61997

cUL Listed per CSA C22.2 No. 94; Type 4, 12, 13; File No. E61997

NEMA/EEMAC Type 4, 12, 13

CSA, File No. 42184: Type 4 and 12

IEC 60529, IP66

## Non-proprietary qualification summary reports are available upon request

1. Nuclear qualified model N7030 and N7040 analog temperature transmitter model configuration
2. Non-prop. qualification summary, N7030 RTD temperature transmitter document number: 3077-RD5086-005
3. Qualification test report, N7030 RTD temperature transmitter document number: 3077-RD5086-006
4. Non-Prop. qualification test report, N7040 thermocouple temperature transmitter 3077-RD5086-009
5. Qualification test report, N7040 thermocouple temperature transmitter document number: 3077-RD5086-007

## About Ultra Energy

Organizations working with nuclear and industrial technologies must deliver reliable production at the same time as safeguarding people, the environment and infrastructure. We develop and manufacture measurement and control solutions that give our customers complete, long-term control over systems operating in harsh environments, helping them operate safely and increasing the value derived from their investments over their total lifespan.

Part of Curtiss-Wright, Ultra Energy has worked with nuclear and industrial customers for over 60 years. We support customers across the world from facilities located in the US and UK. Our solutions are embedded in strategic national infrastructure and our people are active partners in customer programs that are focused on delivering advanced future nuclear and industrial capabilities.

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