Accutech

Smart Process Instrumentation

AI-1500 Smart, Two-Wire Temperature Transmitter with HART® Communications

For Industrial Thermocouple or
RTD Temperature Measurements

STABILITY.
Automatic self-calibration and automatic cold-junction compensation result in exceptional long-term and ambient-temperature stability.

ABSOLUTE ACCURACY.
No weak links — sensor accuracy and system accuracy. The temperature you measure is what the temperature is.

VERSATILITY.
Compact design, one-size-fits-all gives you more installation options than any available transmitter.

EASE-OF-USE.
You can configure the AI-1500 with a HART hand-held terminal, with a Windows™ based PC program or with the optional plug-in display.

BULLETIN AI-1500 7/99

Stability

Stable measurements from process instrumentation are key to increasing process stability. They start paying immediate dividends by allowing you to increase process throughput, improve product quality and yield.

Over a decade ago, Accutech pioneered self-calibrating instrumentation to achieve dramatic improvements in measurement stability. The continued development of self-calibration technology has kept Accutech way ahead of the competition in the area of measurement stability. Today, the Accutech AI-1500 allows you to combine the proven advantages of automatic self-calibrating instrumentation with the benefits of HART communication.

Automatic Compensation for Long-term Drift and Ambient Temperature Changes

Automatic self-calibration means that your temperature measurements will stay precise over the long haul, and over changes in ambient conditions. The AI-1500 stands up to the rigors of the industrial environment. Accutech's unique design and manufacturing techniques keep the AI-1500 on target, time and time again. To achieve that high level of stability, each and every AI-1500 goes through a rigorous calibration procedure in ambient temperatures from -40°F to +185°F. On-board references are read against NIST-traceable calibration equipment, so you can count on the precision of your measurements regardless of the variations in ambient temperatures.

How sure are we of the AI-1500 performance over time? We stand behind it. Automatic self-calibration to on-board reference standards ensures measurement stability over time, so the AI-1500 is the only temperature transmitter with a three-year calibration guarantee.

Automatic Compensation for Sensor Connection Drift

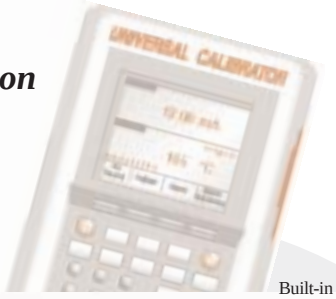
You can improve the accuracy and stability of virtually any industrial temperature measurement under 1,000°F simply by using a true 4-wire RTD measurement. These sensors have proven stability and the measurements obtained are extremely repeatable. The 4-wire measurement techniques used in the Accutech AI-1500 automatically compensate for unbalanced sensor resistances. These resistances can creep, unnoticed, into 2 and 3-wire RTD sensor connections. The error can exceed ±10˚C[1] and can be quite detrimental to your process. The Accutech AI-1500 automatically compensates a 4-wire RTD connection for sensor lead imbalances and termination corrosion of connection terminals that accumulate over time. For comparatively little additional cost, a 4-wire RTD provides you with a much higher value than a normal 3-wire sensor. Matching a 4-wire RTD with an Accutech AI-1500 transmitter makes an unbeatable combination for measurement accuracy and stability over long periods of time.

Rapid Response

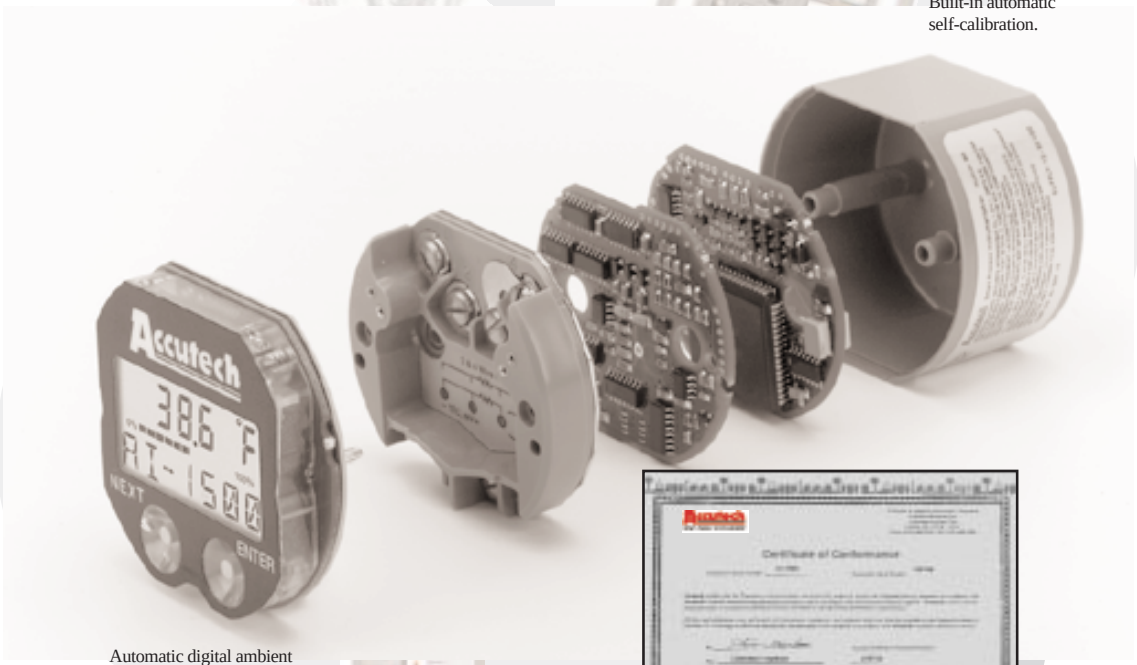
Chances are that the ambient temperature, the line voltage or the electrical noise in your process will change faster than your process temperature. At seven updates per second, the AI-1500 can execute automatic self-calibration, internal self tests and measurement parameter validation, while, at the same time, giving you rapid response to changes. In short, the AI-1500 can report any temperature changes in the process, as well as quickly compensate and self-correct for changes in the environment. Slower transmitters just cannot measure up.

Inside each and every AI-1500 — absolute accuracy, automatic self-calibration and guaranteed performance.

At seven updates per second, the AI-1500 can adapt to rapidly changing conditions.



Built-in automatic self-calibration.



Automatic digital ambient temperature compensation.

Every AI-1500 includes a NIST calibration certificate.

Lower Maintenance Costs

Guaranteed stability means eliminating frequent transmitter calibrations. Extending the useful calibration life will slash your yearly maintenance costs.

On-Board RFI Rejection

In the real world, you need to count on stable measurements—even when your measurements are taken in an electrically noisy environment. How do we address this challenge? We design the Accutech AI-1500 transmitters to meet the tough standards required for "CE" Mark certification. Each and every AI-1500 transmitter is certified for protection against electrical interference. That includes those transmitters that are not mounted in a metal housing or enclosure! You don't pay extra for this feature. It's built into the AI-1500.

Hold it right there!

With the AI-1500, your temperature measurement stays precise. And we mean that. We guarantee the calibration accuracy of our AI-1500 for three years.

Accuracy

Of course, everybody talks "Accuracy", but what do they really deliver? Just the sum of repeatability, hysteresis and conformity to a non-linear curve. At Accutech, the industry standard definition is not good enough. At Accutech, "Accuracy" means "Absolute Accuracy" – the measured temperature is the actual temperature.

Absolute Accuracy

Accutech introduced the concept of absolute accuracy a decade ago. Right out of the box, your Accutech instruments read the actual temperature, with full NIST traceability. The AI-1500 automatically self-calibrates to compensate for changes in the ambient temperature, variations in line voltages, and fluctuations in internal electrical component values. This self-calibration automatically corrects for long-term drift and stray electrical noise, resulting in absolute accuracy, and giving you much better measurements than you have been able to make in the past – even though you thought that your old devices were highly "Accurate". For a full discussion please see Reference 2.

If you want to really cut your measurement errors, order full temperature measurement systems. We have systematically reduced the measurement error from each component in the measurement system and routinely deliver instrument systems with absolute accuracy better than ±0.25°C. If you require even greater precision, please call us at 1-800-879-6576 for measurement systems with absolute accuracy better than ±0.05°C.

Repeatability vs. Accuracy

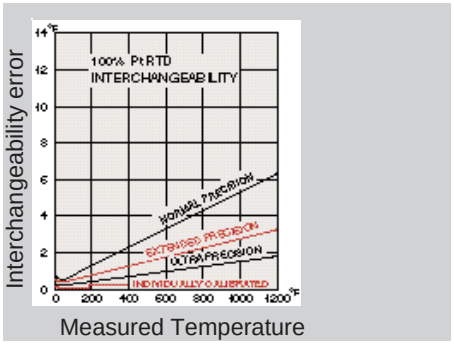
In the old days of single-loop feedback control, repeatability was good enough for industrial measurement equipment. However, today's more complex control strategies and interacting variables require that one measurement be compared to another measurement. When two measurements are compared, repeatability is no longer good enough. These measurements demand absolute accuracy. This is particularly true whenever two variables are compared in a computer-based control system. Measurements must be compared on an absolute accuracy basis.

The old saying, "Garbage in, garbage out", holds true. You need good data going into the control systems to get good control decisions coming out. Repeatability is no longer sufficient to achieve a high level of measurement system accuracy.

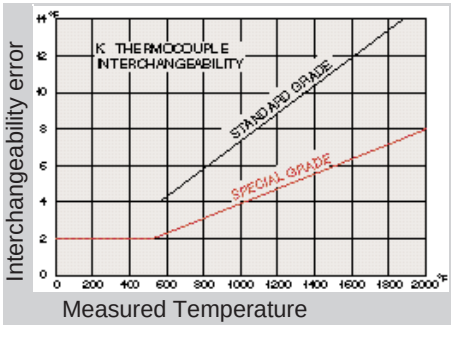
Sensor Precision

There is no point purchasing a superior transmitter and connecting it to a poor sensor. Sensor error is a major portion of the total measurement system error. The two graphs below show you why. Sensor-to-sensor interchangeability is shown for two very common sensors, the Type "K" T/C and the Platinum RTD. Interchangeability is the error you would expect from swapping sensors. Interchangeability measures the deviation a given sensor has from the ideal, standard performance curve for that type sensor. Thus, interchangeability is a good measure of the absolute accuracy you could expect from your sensor, and can be thought of as sensor error or sensor accuracy.

Two grades of Type "K" thermocouples are available, the standard grade and the special grade. A variety of grades are available for the Platinum RTD's. Normal and Extended Precision are generally used in industrial applications. Ultra Precision and individually calibrated RTD's are also available from Accutech.



The Platinum RTD enjoys widespread industrial usage. It is available in a variety of precision grades. The normal precision and extended precision are widely used in industrial applications. Ultra precision and individually calibrated RTD's are also available from Accutech for higher accuracy applications.



The Type "K" is representative of thermocouples in widespread industrial usage. It is a bit more precise than the Type "J" thermocouple and a bit less precise than the Type "R" or "S". Two precision grades are available for "K" T/C's, a standard grade and the special grade.

Temperature Measurement Systems

Good temperature measurements require a complete measurement system – starting with a sensor and ending with reliable information driving a control device. It's easy to place a weak link in this chain and wind up with poor results.

You can get great temperature measurements by thinking about the entire measurement system and weeding out the errors in each part. Start by cutting the sensor error. Check the accompanying graphs and simply specify the sensor precision grade that you need in your application.

Next, minimize the sensor measurement error. Using a 2 or 3-wire RTD can introduce measurement errors of over 10˚C[1]. Using the Accutech true 4-wire RTD measurement, you can reduce the sensor measurement error to a fraction of a degree. This technique also automatically compensates for imbalances in lead wire resistance and terminal corrosion that accumulate over time in industrial applications.

Finally, cut the transmitter error. The error in the AI-1500 is remarkably small. Performance specifications are even higher than those of much more expensive transmitters. Automatic self-calibration and rapid response compensate for extraneous environmental influences - and give you a reading you can count on.

NIST Traceability

Each AI-1500 is calibrated using NIST traceable equipment and includes a NIST calibration certificate. Direct traceability simplifies your ISO 9000 certification. The AI-1500 goes even further by accounting for the ambient temperature impact on the measurements. Install your AI-1500 in ambient temperatures between -40°F to +185°F. Your NIST certificate is still valid. For more demanding requirements, special transmitter calibration is available as an option.

Accurate Measurement Systems

Start with a precise sensor. Minimize the sensor measurement error and add an accurate transmitter to make an accurate temperature system. With Accutech measurement systems, you are assured that your total measurement system accuracy will meet your specifications.

For industrial measurements up to 200°F, an absolute accuracy better than ±0.5°F is readily obtainable. At 1,000°F this error band is slightly higher at ±0.75°F. Tighter error bands are possible with extra care, but temperature measurements to better than ±1˚F can be maintained in most industrial process applications.

For tighter accuracy, consider using Accutech Ultra-Precision RTDs. These RTDs are fully interchangeable to the tolerance specified on the previous page. With Accutech Ultra-Precision RTDs, you can achieve better accuracy than is possible with individually fitted Callendar-Van Dusen sensor coefficients.

System Accuracy at 150°C

Model AI-1500	±0.08°C
Ultra-Precision RTD	±0.16°C
Total	±0.24°C

Not only do you get better measurement precision; you have complete sensor interchangeability. No recalibration or loading of coefficients is necessary when you swap sensors or transmitters – just wire them up and go! For even better measurement accuracy, specify Accutech's Individually Calibrated RTDs.

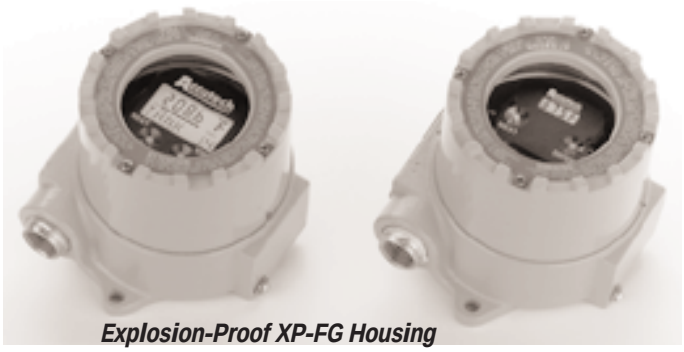
Accutech also offers the AI-2000 UP transmitter, which allows you to achieve a total measurement system to a precision of ±0.1°F with NIST traceability. Please call Accutech at 1-800-879-6576 for further information.

VERSATILITY

The Accutech AI-1500 gives you true versatility. Choose your mounting configuration, your input and your set-up to suit a variety of applications. The precision of the AI-1500 will meet any application, while it is priced far below other high-performance transmitters. It is the one temperature transmitter that can easily become a plant standard and give excellent performance anywhere you need it.

Mounting is simple. The compact design allows installation in the field, in a control panel, in a rack, or in an explosion-proof housing.

FIELD MOUNTING



Explosion-Proof XP-FG Housing
Shown with DK-2 and DK-1 displays.

Pipe Mount
Shown with DK-2 display

Explosion-Proof XP-HEAD and XP-FN
These low-cost housings may be used without displays.

Weatherproof Mounting
For Intrinsically Safe installations, or if explosion-proof protection is not required, the low-cost WP-HEAD provides a very cost-effective solution.

PANEL MOUNTING

DIN Rail
A simple DIN Rail mounting adapter kit is available.

Gang Mounting
Various multiple transmitter enclosures are available. Please consult factory when your application requires this configuration.

Input Versatility

The AI-1500 will accept an input from virtually any thermocouple or RTD. The on-board, non-volatile memory has all the input curves stored. Input linearization is performed to a precision of 0.05 °C!

A 22-point user-defined curve is also a standard feature. This is often handy when you want to use the millivolt or ohm input on your AI-1500 to represent a non-linear process variable. For other complex linearization requirements, such as non-linear milliamps or voltage inputs, consider the Accutech SC-2000 Signal Conditioner.

Unique Configuration Versatility

The AI-1500 has unmatched configuration versatility. The AI-1500 supports hand-held configuration, PC Configuration or Display configuration. The AI-1500 Device Description is registered with the HART Communications Foundation. Any HART Download Facility, including Accutech, can download the AI-1500 DD so that you can access all configuration menus with your HART hand-held. PC Configuration allows full configuration of the AI-1500 using our Windows-based software program with your PC. Use the plug-in DK-2 Display for configuration right at the transmitter. No other transmitter gives you this kind of configuration versatility.

Application Versatility

The high performance and attractive price of the Accutech AI-1500 combine to provide advantages in a wide range of process industry environments. The AI-1500 meets the measurement stability and absolute accuracy requirements of virtually any temperature measurement application. Its mounting flexibility and HART-based design allows communications with other HART-based field devices. The input versatility accommodates virtually any thermocouple, RTD, millivolt or ohm input.

Today's complex control systems are particularly well suited for the AI-1500. Because it delivers absolute accuracy, it fits well into control strategies that demand more than one variable to be compared, or require verification by laboratory measurements.

With the AI-1500, it is even possible to compute on-line enthalpy balances around critical operations. The data can be matched directly to data obtained in the laboratory to achieve increased throughput and yield. Please see Reference 2 for a further discussion of this point.

Wherever you need to increase throughput, improve yields, cut waste, lower calibration maintenance costs or reduce spare parts inventory, you will find a home for the AI-1500.

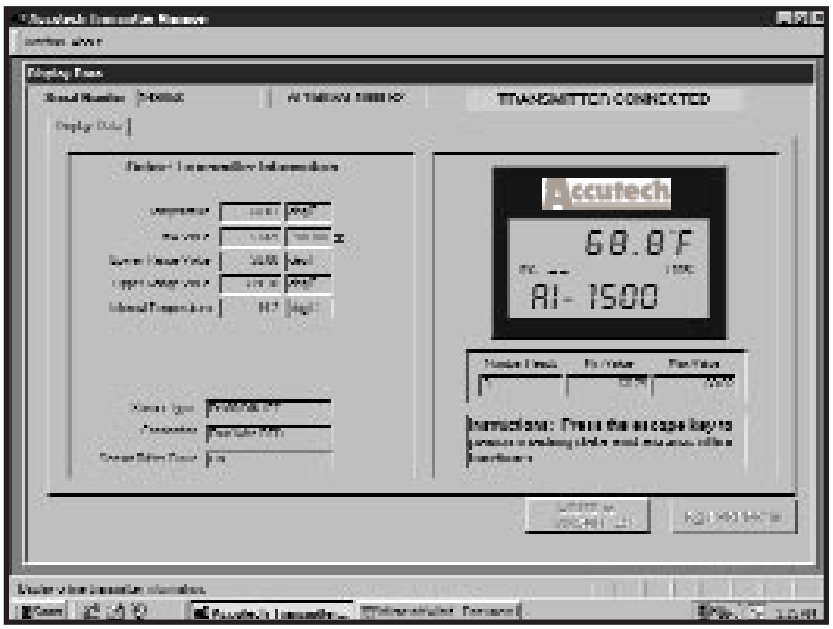
Why be tied to a hand-held terminal when you want to set up a HART transmitter? With the Accutech AI-1500, you now have a choice. You can perform your set-up with a hand-held terminal, with a local display or with a Windows based program. Choose any one, at any time.

PC WINDOWS CONFIGURATION

Database

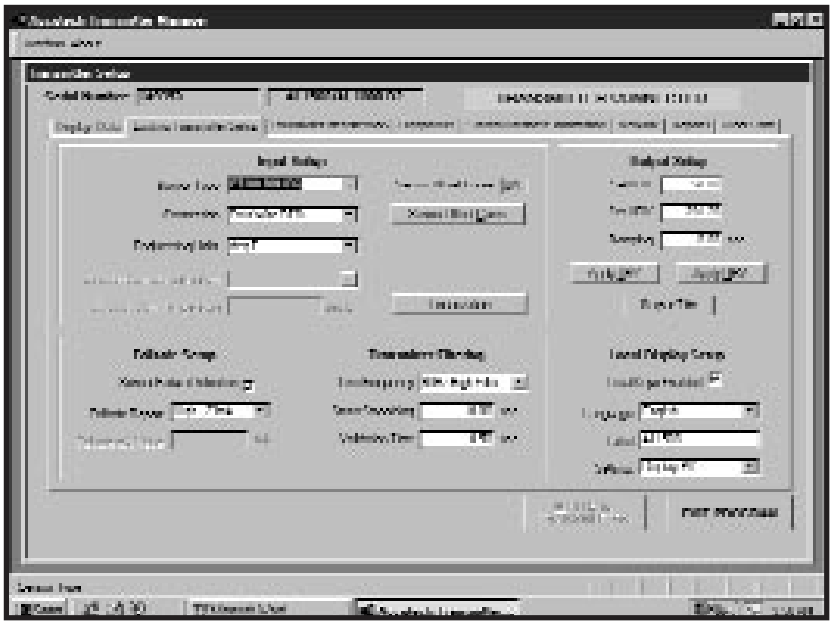
The database window gives you easy access to any stored data. Set-up parameters and configuration from an existing transmitter may be identified with key words and tags, stored in the database, and retrieved when needed. The data is stored in a run-time ACCESS database. In this format, you can create your own ACCESS database with your own plant-specific data and information. The data from your AI-1500 will tie right in!

Display Data



The display data window gives you an on-line look at the live data and key set-up parameters. The minimum and maximum values displayed also let you easily check the process stability over time.

Existing Transmitter Set-Up

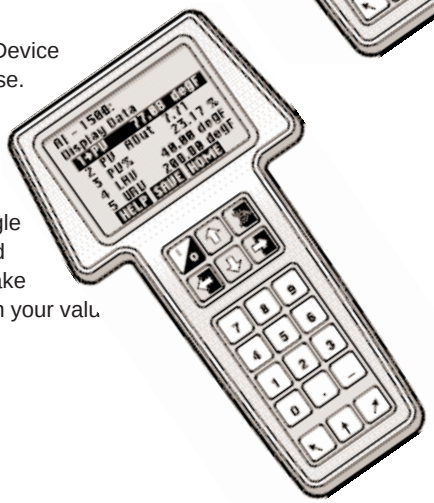


This window lets you set up the transmitter that is connected to the PC. The Windows™ program uploads the stored set-up data from the transmitter to the windows screen. You can set up all the transmitter parameters from a single screen. Changed values are highlighted and downloaded to the transmitter at your command. Validity checks in the program prevent out-of-bounds values from being loaded.

HAND-HELD TERMINAL CONFIGURATION

The Device Description (DD) for the Accutech AI-1500 is registered with the HART® Foundation. It can be loaded on to a HART® hand-held terminal. New 8 meg memory modules for the common terminals generally come pre-loaded with this Device Description. With the AI-1500 Device Description, you can access all the functionality of the AI-1500.

The Accutech AI-1500 Device Description is easy to use. The main levels can be quickly accessed. The selections for each main level fit conveniently onto a single screen on the hand-held terminal. You simply make your choices and type in your valu



Device Description Function Map

Display Data (Read Only)
- *Process Variable in EGU's*
- *Process Variable in mA Output*
- *Process Variable in % of Range*
- *Lower Range Value (LRV)*
- *Upper Range Value (URV)*

Review Setup (Read Only)
- *Sensor Setup Information*
- *Connection*
- *Linearization*
- *Lower Range Value (LRV) in EGU's*
- *Upper Range Value (URV) in EGU's*
- *Offset Curve Status*
- *Failure Detection System*
- *Fail Safe Report*
- *Line Frequency & Filter*
- *Damping*
- *Xmtr Serial Number*
- *Sensor Serial Number*

Transmitter Setup
- *Input Setup*
- *Output Setup*
- *Fail Safe Setup*
- *Output Trim*
- *Other Setup*

Transmitter Identification
- *Tag Setup*
- *Device Information (Read Only)*

Diagnostics
- *Xmtr Internal Diagnostics*
- *Xmtr Internal Variables (Read Only)*

PLUG-IN DISPLAY CONFIGURATION

The plug-in DK-2 display offers a very convenient set-up option. A small, inexpensive and easy-to-carry tool, it is used for local readouts of process temperature. You can plug in the display without powering down the unit. The display will immediately begin reading the process variables and give you an indication of the analog output. You can then program the transmitter or check its set-up parameters right from the display. The DK-2 works with any Accutech AI-1500, AI-1000 R2, or VR-1500. There is no set up required to get a local indication on any of these transmitters – just plug it in! The DK-2 is a real bonus to plant technicians and engineers. You get a local indication any time and you can quickly configure the transmitter for just about any application.

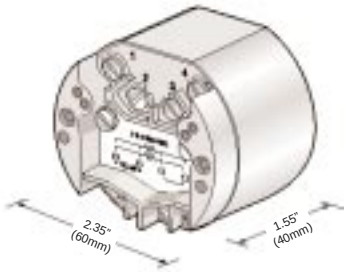
SELECT SENSOR

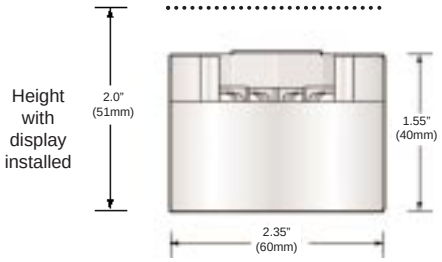
SET UPPER OR LOWER RANGE VALUE

NORMAL OPERATION WITH DK-2 DISPLAY

DIMENSIONS

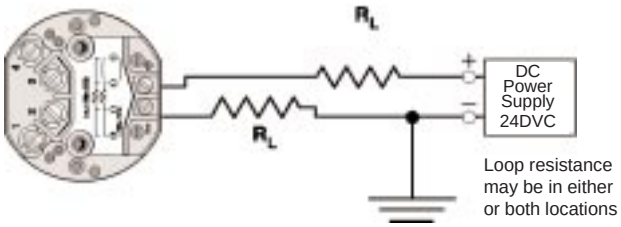
Model AI-1500



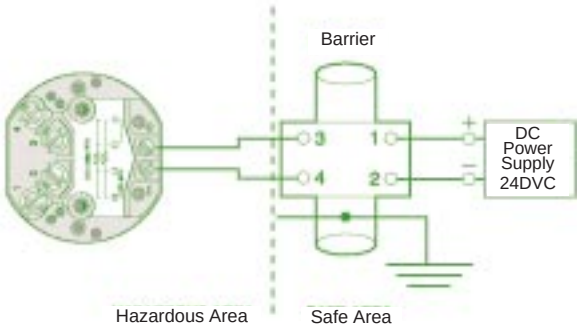


CONNECTIONS

Normal Installation

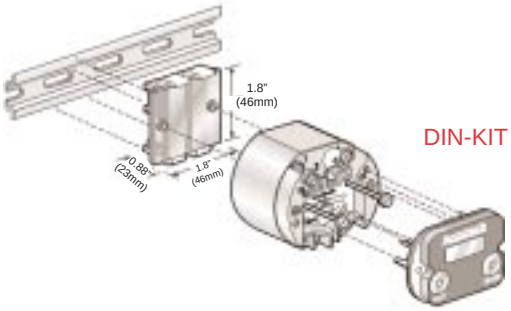


Intrinsically Safe Installation

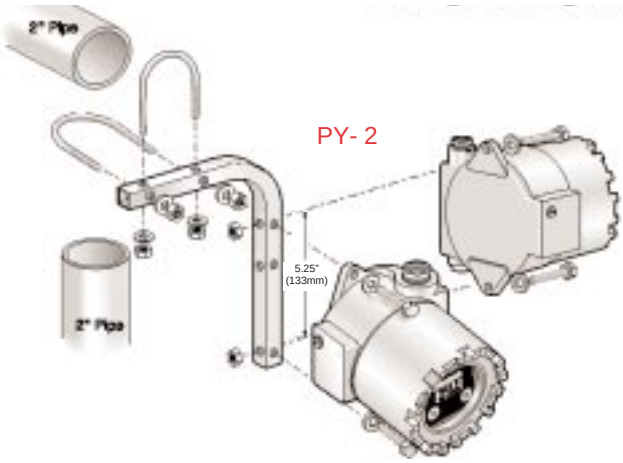


MOUNTING

DIN Rail Bracket



DIN-KIT R2



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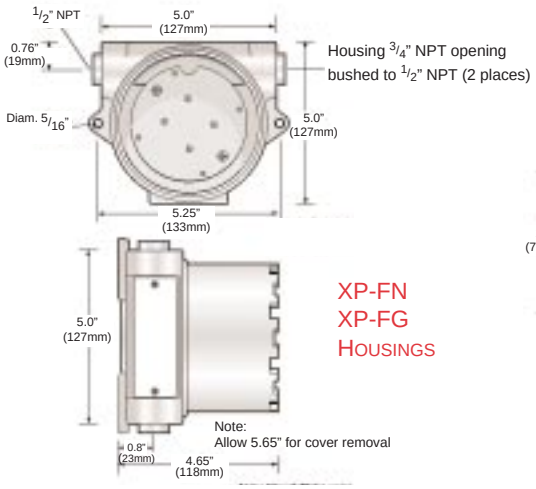
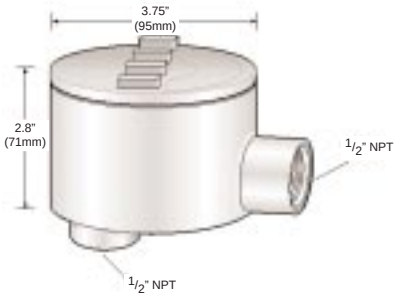
ENCLOSURES

Explosion Proof Housing

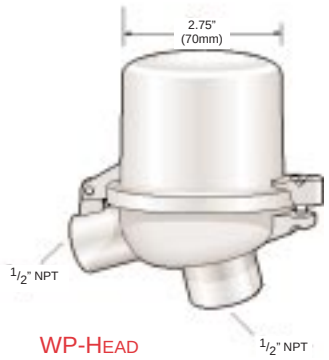


XP-FN
XP-FG
Housings

XP-Head



Weather Proof



WP-Head

AI-1500 SPECIFICATIONS

SENSOR INPUT	RANGE, °F	ACCURACY	RANGE,°C	ACCURACY
Thermocouple Type B	+109 to +3,308 °F	±0.99 °F	+43 to +1,820 °C	±0.55°C
Thermocouple Type C	+32 to +4,208 °F	±0.72 °F	0 to +2,320 °C	±0.40°C
Thermocouple Type E	-454 to +1,832 °F	±0.18 °F	-270 to +1,000 °C	±0.10°C
Thermocouple Type J	-346 to +2,129 °F	±0.27 °F	-210 to +1,200 °C	±0.15°C
Thermocouple Type K	-454 to +2,502 °F	±0.27 °F	-270 to +1,372 °C	±0.15°C
Thermocouple Type L	-328 to +1,652 °F	±0.27 °F	-200 to +900 °C	±0.15°C
Thermocouple Type N	-454 to +2,372 °F	±0.36 °F	-270 to +1,300 °C	±0.20°C
Thermocouple Type R	-58 to +3,214 °F	±0.81 °F	-50 to +1,768 °C	±0.45°C
Thermocouple Type S	-58 to +3,214 °F	±0.90 °F	-50 to +1,768 °C	±0.50°C
Thermocouple Type T	-454 to +752 °F	±0.18 °F	-270 to +400 °C	±0.10°C
Thermocouple Type U	-328 to +1,112 °F	±0.18 °F	-200 to +600 °C	±0.10°C
100Ω Platinum RTD DIN Curve (α = 0.00385)	-328 to +1,562 °F	±0.09 °F	-200 to +850 °C	±0.05°C
100Ω Platinum RTD SAMA Curve (α = 0.003923)	-328 to +1,202 °F	±0.09 °F	-200 to +650 °C	±0.05°C
Call Factory for 100Ω Ni, 120Ω Ni, and 10Ω Cu				
Millivolt	-15 to 115mV	±0.006 mV		
Ohm	0 to 500 Ω	±0.002 Ω		

TRANSMITTER ACCURACY: ± 0.01% of the millivolt or ohm equivalent input reading, or the value from the Accuracy Table, whichever is greater; plus ±0.04% of the span. For thermocouples, add ±0.5°C (0.9°F) for cold junction effect.
Accuracy includes transmitter repeatability, hysteresis and linearity as well as A/D conversion error, analog output error, line voltage effects, humidity effect under non-condensing conditions, vibration effect to 2g's & 500Hz.

TRANSMITTER AMBIENT TEMPERATURE EFFECT:
One-half the transmitter accuracy per 28°C (50°F).

TRANSMITTER REPEATABILITY: One-half the transmitter accuracy.

COLD-JUNCTION COMPENSATION: Digital self-correcting over the ambient temperature range to ±0.5°C.

LINEARIZATION: Thermocouple and RTD linearization to ±0.05°C. Custom linearization with 22 point curve via HART® Communications.

OUTPUT: Analog, Two wire 4 to 20mA.
Digital, HART® simultaneous communication

OUTPUT RANGING ADJUSTMENTS:
Analog Zero: } { 100% of Sensor range – Noninteracting
Analog Full-scale: } { Normal or Reverse Acting

LONG TERM STABILITY: Stability deviation per year is less than: (0.04% of output the span + 0.05% of the milivolt or ohm equivalent reading.)

OPERATING TEMPERATURE RANGE:

-40°C to +85°C	-40°F to +185°F	Electronics
-20°C to +70°C	-4°F to +158°F	Display (Full Visibility)
-40°C to +85°C	-40°F to +185°F	Display (With reduced visibility)

STORAGE TEMPERATURE RANGE: -50°C to +85°C; -58°F to +185°F

DAMPING: Factory selectable time constant (63%) from 0 to 32 sec.

FAILSAFE: User settable to 3.6mA or 23mA or user specified value.

MOUNTING POSITION: No effect on measurement value.

WEIGHT: AI-1500: 6 oz. XP-FN & FG: 2 1/2 lbs. WP-HEAD: 12 oz.

ISOLATION: Input to Output 500VAC

INPUT IMPEDANCE: Greater than 1 MΩ

POWER SUPPLY: The transmitter operates on 12 to 42 VDC (30VDC for I/S installations) with no load. Transmitter is protected against reverse polarity connection.

LOAD LIMITATIONS: Loop resistance including optional indicator: R(KΩ) = (Supply Voltage - 12 VDC) / (23mA)

INTERCHANGEABILITY: Fully interchangeable without field calibration.

ELECTROMAGNETIC COMPATIBILITY (CE COMPLIANCE):
Transmitter operates within specification in fields from 20 to 1,000MHz with field strengths to 30V/m. Meets EN 50082-1 Generic Immunity Standard and EN 55011 Compatibility Emissions Standard.

DYNAMIC RESPONSE:
UPDATE RATE: 150 milliseconds (7 times per second), typical.
RESPONSE TO STEP CHANGE: 250 milliseconds, minimum; 1 second, typical.
START-UP TIME: 7 sec. Operation to specification less than 30 sec.
AMBIENT TEMPERATURE CHANGE: Self-correcting for ambient temperature changes up to 20°C/hr.

HAZARDOUS LOCATION CERTIFICATIONS:
Explosion Proof: Explosion Proof Housings available with and without windows; CSA and FM approved for Class I, Div I & Div II, Groups B, C, & D; Class II, Div I & II, Groups E, F & G, Class III and are rated for NEMA 4X and NEMA 7 environments.
Nonincendive: Transmitter is CSA and FM rated nonincendive in Class I, Div II, Groups A, B, C & D; Class II, Div II, Groups F & G, Class III, Div II, CENELEC Ex N IIC T4-T6 KEMA Certificate Ex-97.Y.9183 X
Intrinsic Safety: The Intrinsically Safe Rated Model AI-1500 I/S is CSA and FM rated Intrinsically Safe for Class I, Div I, Groups A, B, C & D & Class II, Div I, Groups E, F, & G, & Class III, Div I, when installed per AIC Drawing 6022588, Rev A. See manual for details.
CENELEC EEx ia IIC T4-T6 Intrinsically safe KEMA Certificate Ex-97.D.9182 X

OPTIONS:
INTRINSIC SAFETY: Order the AI-1500 I/S
HOUSINGS:
XP-FN: NEMA 7 Explosion-Proof, NEMA 4X Housing
XP-FG: NEMA 7 Explosion-Proof, NEMA 4X with Window
XP-HEAD: NEMA 7 Explosion-Proof, Rain-tight Head
WP-HEAD: IP66 Weatherproof Head
DISPLAYS:
DK-1: One-Line Local Display and Keyboard
DK-2: Two-Line Smart Local Display and Keyboard
THERMOWELLS: Order as required. See Accutech Bulletin PROB
SENSORS: Order as required. See Accutech Bulletin PROB
EXPLOSION-PROOF CERTIFICATION: Consult factory for details
MOUNTING: PY-2: 2" Pipe Yoke for XP-FN & XP-FG housings
DIN-KIT R2: DIN Rail Mounting Adapter

STANDARD CONFIGURATION:

Sensor Input	J Type Thermocouple
LRV (4mA)	40°F Lower Range Value
URV (20mA)	200°F Upper Range Value
Damping	0 seconds
Output	Linear with Temperature
Failsafe	Upscale (23mA)

ORDERING INFORMATION: Please order Model AI-1500. Specify custom configuration, options and companion products as desired.
NOTE: Please note that specifications are determined with the factory default software settings or with the various software parameters set to optimize the performance for a given specification.

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Reference 1 *is Intech Magazine, Volume 42, Number 5, page 40, copyright 1995, entitled "Four-Wire Techniques Minimize Temperature Measurement Errors."*

Reference 2 *is Chemical Engineering Magazine, May 1998, Volume 105, Number 5, pages 90-94, entitled "Make the Most of More-Precise Temperature Measurements."*

Accutech™

Smart Process Instrumentation

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