

# Temperature Sensor Technologies



Temperature sensor accuracy, repeatability and stability over operating life are critical for stable manufacturing processes. Designing the best sensor for an application requires knowledge of material science, thermodynamics, electrical properties, process specifications, connectivity and asset management. For example, purity of raw materials can effect sensor accuracy, isothermal design of the sensor assembly will effect repeatability of temperature measurement and materials aging will effect stability over operating life. Watlow's advanced sensor technologies and understanding of the application give us the capability to design sensor assemblies that support new semiconductor tool and process challenges.

## SERIES DX Transmitter

Watlow's new compact, accurate SERIES DX transmitter brings the flexible simplicity of distributed networking of temperature sensors with a DIN-mounted transmitter. Facility engineers can now save on wiring, labor and documentation costs by networking their distributed thermocouple sensors.



Watlow's SERIES DX transmitter is compatible with INFOSENSE sensors and the state-of-the-art INFOSENSE-P smart sensors using IEEE 1451.4 technology. The combination of DeviceNet™ communications and INFOSENSE-P smart sensors give engineers a powerful tool to help reduce process variation and drift.

### Features and Benefits

#### DeviceNet™ open protocol (ODVA)

- Works with other DeviceNet™ instruments

#### Plug and play with IEEE 1451.4 sensors

- Designed to take input directly from IEEE 1451.4 sensors

#### Reduce system costs

- Reduces wiring costs through elimination of multiple long thermocouple lines and distributed networking

## INFOSENSE™

INFOSENSE™ based temperature sensors can increase accuracy by greater than two times when calibration information of the sensor is programmed into a temperature controller or transmitter. Watlow's INFOSENSE technology records the calibration information of each batch of thermocouple wire or RTD element. Knowing the actual sensor calibration information allows more accurate compensation within the temperature controller or transmitter.



### Features and Benefits

#### Utilization of calibration information improves sensor performance

- Doubles the original sensor accuracy
- Reduction in measurement uncertainty reduces process variation

#### Four simple bar-coded calibration codes

- Reduces installation costs
- Cost effective

DeviceNet™ is a trademark of Open DeviceNet Vendors Association.

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## IEEE 1451.4: Standard for Plug and Play Sensors

IEEE 1451.4 is a standard that defines the parameters for plug and play analog sensors, their interface to existing instrumentation plus the addition of an embedded Transducer Electronic Data Sheet (TEDS). TEDS resides in an EEPROM that is integral to the sensor assembly and contains technical information regarding the sensor.

Watlow's new class of Smart Temperature Sensors (INFOSENSE™-P and WATCOUPLE™) are designed to IEEE 1451.4 guidelines and save operating and maintenance costs by reducing the variation in your process and providing valuable information about the sensor and process performance. Improving sensor accuracy directly reduces uncertainty in the application, improving product quality and yield. Easier communication of sensor information saves money due to reducing installation time.



## INFOSENSE™-P

INFOSENSE™-P is the marriage of thermocouple or RTD sensor information with an integral EEPROM and Tagged Electronic Datasheet (TEDS). This sensor information can reduce process variation by improving sensor accuracy by three to 10 times. INFOSENSE-P utilizes IEEE 1451.4 technology to store sensor and calibration data. Any IEEE 1451.4 compatible controller or data acquisition system can take the calibration information and achieve accuracy of an NIST reference standard.

### Features and Benefits

#### IEEE 1451.4 standard for plug and play sensors

- Open international standard allows sensor information retrieval from all compatible IEEE 1451.4 devices

#### RTD and thermocouple accuracy

- Improves RTD accuracy by 10 times at 600°C (1112°F)
- Improves thermocouple initial accuracy by three times

#### Asset management

- Critical sensor information allows engineers to reduce process variation and increase yields



## WATCOUPLE™

The marriage of material science with IEEE 1451.4 and TEDS creates new thermocouple types that are up to four times more accurate, last three times longer and have three times less drift than traditional thermocouple types. WATCOUPLE™ is an alloy 600 and nickel-silicon thermocouple designed specifically to address the shortcomings across the operating range of a Type K thermocouple. A WATCOUPLE is more accurate than a class A RTD above 100°C (212°F), and being a thermocouple

has natural advantages, such as having very high temperature limits in small sizes.

### Features and Benefits

#### Reduce process variation

- Improves accuracy by four times that of Type K thermocouples

#### Reduce process drift

- Eliminates aging effects and provides three times less drift than Type K thermocouples

#### Reduce ownership costs

- Lasts three times longer than standard thermocouples to reduce preventative maintenance costs

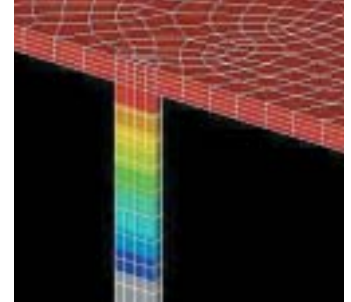
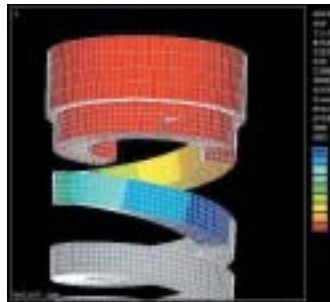
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## MICROCOIL

MICROCOIL surface sensors are ideal for measuring chuck, internal wall, chip, heat sinks and circuit temperatures. The flexible probe design positions the sensor tip for optimal surface contact and isothermal response and accuracy. MICROCOIL can be designed as a single or dual probe and with metal or ceramic tips for maximum isothermal accuracy and process material compatibility.

U.S. Patent #6,257,758  
European Patent #1,119,749



## Features and Benefits

### Miniature size

- Allows for precision measurement in tight spaces

### XACTPAK® mineral insulated thermocouple cable

- Electronically isolated and shielded

### Self leveling and loading

- Provides superior repeatability of measurement for a wide variety of surfaces and isothermal measurement accuracy

## RADIO FREQUENCY Thermocouple Probe (RF)

RF immersion sensors are designed to reduce transient 13.56 MHz signals from being transmitted on the sensor leads in plasma environments. This results in a more stable and accurate measurement of chuck temperature.

## Features and Benefits

### 3000V $\pm$ (dc) dielectric rating

- Allows thermocouple to be used in platens with dc bias

### High thermal conductivity design

- For accurate, repeatable measurements

### High CMRR lead wire design

- Reduces induced error from EMI variety of surfaces



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## TRUE SURFACE Thermocouple (TST)

TST is a surface sensor designed to reduce error in atmospheric applications where air currents can cause instability in temperature accuracy. A winner of *Control Engineering's* 2000 Editor's Choice Award, the TST achieves superior accuracy through a combination of isothermal design and shielding.

### Features and Benefits

#### Isothermal measuring junction

- Offers excellent thermal conductivity for the measuring junction

#### Molded insulator

- Isolates the isothermal measuring junction from ambient airflow

#### Compact, universal package

- Fits into corners and other tight locations easily (11.2 mm (0.44 in.) wide by 6.1 mm (0.24 in.) high) and the molded insulator is removable for applications where an even smaller package is needed

#### Temperature rating of 200°C (400°F)

- Offers superior application flexibility for a wide variety of surfaces



## Tapered Thermocouple Probe

The Tapered Thermocouple Probe is designed to provide rapid temperature response in applications where the sensor is inserted in an electrostatic chuck, gas line or wherever a fast accurate temperature measurement needs to take place in a small area. Tool design using the Tapered Thermocouple Probe is miniaturized by the combination of tapered tip construction and a new mini-bayonet style fitting.

### Features and Benefits

#### NIST traceable cable calibration certification

- Calibration offset information allows the controller to compensate for known error
- INFOSENSE™ calibration code can be used with compatible Watlow controller to double sensor accuracy ( $\pm 0.5^{\circ}\text{C}$  ( $\pm 0.9^{\circ}\text{F}$ ) or  $\pm 0.2$  percent)

#### Tapered tip option

- Faster response time in more rigid sheath designs



### Applications

Electrostatic chucks

Gas lines

Chambers