Dual and Multi-Wavelength Industrial Infrared Thermometers

Pro Series

Williamson

Innovators in Noncontact Temperature Measurement

Improving Quality and Productivity with Non-Contact Temperature

INFRARED THERMOMETERS

Temperature is commonly measured in manufacturing operations to monitor and control product quality and process productivity. For many applications, contact devices like thermocouples and RTDs are used, but for applications where these devices are inaccurate, too slow, or difficult to use, infrared thermometers are the perfect solution because they measure a target's temperature without contact.

This capability is ideal for applications involving:

- High temperatures
- Moving targets
- Hostile or hazardous environments
- Fast response times

With a complete range of infrared thermometers, Williamson can offer the optimal sensor for virtually any application.

STANDARD DUAL AND MULTI-WAVELENGTH SENSOR FEATURES

- Temperature limits 200 to 4500°F / 95 to 2500°C
- Line of sight, visual aiming, laser aiming, and fiber optic aim light alignment options
- A selection of narrow band wavelengths for precise measurement on demanding applications
- A selection of wide angle and high resolution optics
- Each model can be used as a stand alone transmitter or connected to a panel meter, recorder, PID Controller or PLC.
- Programmable 4-20mA and voltage outputs, as well as RS232 and RS485 communications
- Built-in human interface with an intuitive text-based menu for sensor adjustments
- Rugged NEMA4X (IP65), NEMA7, and CENELEC enclosures
- An optional Interface Module and ProView PC Software are available for remote display and data logging capabilities
- To simplify sensor installation and provide added protection in severe environments, Williamson also offers a wide selection of innovative options and accessories including mounting brackets, flanges, water cooling and air purge
- 2 year warranty

ADVANCED DUAL AND MULTI-WAVELENGTH TEMPERATURE MEASUREMENT CAPABILITIES

Williamson's Pro Series dual and multi-wavelength infrared thermometers feature state-of-the-art technology to provide accurate and reliable measurements for traditional and challenging applications including heavy-industrial environments. As the table below illustrates, these sensors feature many advanced measurement capabilities to outperform all others.

Advanced Capabilities of Dual and Multi-Wavelength Sensors
Greater Accuracy
• The Pro body materials and difficult applications.
Greater Reliability
• Industry-leading signal dilution capability eliminates the need for precise alignment and improves the accuracy in hostile environments where the target energy is diluted by intervening media. • Williamson's patented ESP Filters (1) enable dual and multi-wavelength sensors to recognize extreme intermittent measurement conditions and only report valid temperature values.
Simple Installation and Operation
• Text-based menu system assures easy setup and operation. • A complete selection of wavelengths, optics, sensor configurations, and accessories enables each sensor to be optimized for the requirements of each application. • Built-in signal strength/emissivity and signal dilution measurements continuously verify process conditions. For example, these parameters validate sensor alignment and surface properties of metals.

(1) Pat. No. 6,840,671 B2

Measurement

UNEQUALLED PERFORMANCE FOR DIFFICULT APPLICATIONS

The Pro Series dual and multi-wavelength sensors accurately measure temperatures of complex materials under diverse operating conditions. Sample applications are highlighted below.

Iron and Steel

- Ironmaking: Iron Stream, Stove, Coke Guide, Sinter
- Steelmaking & Caster: Vacuum Melting, Molten Metal Pour, Caster Containment Zone
- Hot Strip & Plate Mill: Furnace Soak Zone, Rolling Stands, Coiler
- Wire, Rod, Bar & Structural Mill: Furnace Soak Zone, Rolling Stands, Cooling Bed
- Finishing: Welding, Annealing, Hot Dip Coating, Heat Treating
- Tube & Pipe: Centrifugal Casting, Welding, Annealing, Coating, Forming, Heat Treating
- Foundry: Auto Pour Systems, Investment Die Preheat

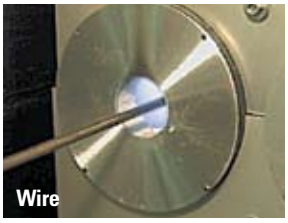
Nonferrous Metals

- Aluminum & Copper Extrusion: Billet, Profile
- Aluminum & Copper Forging: Billet, Die
- Aluminum & Copper Rod Mills: Cast Strand, Rolling Stands
- Aluminum & Copper Strip Mills: Ingot, Breakdown Mill, Finishing Mill, Coiler
- Nonferrous Drawing, Rolling, Forming and Heat Treating

Industrial Heating

- Casting, Forming, Joining & Heat Treating of Metals
- Induction, Resistance, Friction, Flame and Laser Heating
- Forging: Billet, Die, Heat Treat
- Wire Drawing: Annealing, Drawing, Coating
- Rotary Kilns: Product, Flame
- Thermal Reactors: Reactor Wall, Fly Ash
- Solid Fuel Power Boilers: Flame, Fly Ash
- Glass Forming: Mold
- Engineered Materials: Carbon Densification, High Temperature Ceramics, Crystal Growing, Plasma Vapor Deposition, Plasma Ion Nitriding

Other Industrial Applications

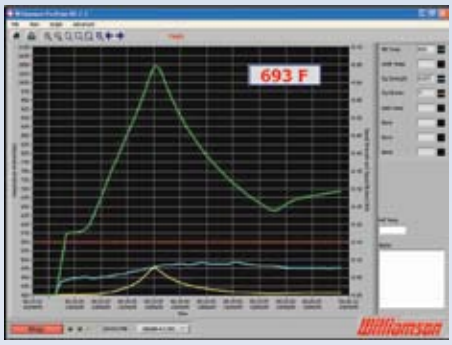


EASY TO INSTALL, OPERATE, AND MAINTAIN

Pro Series sensors are configured using an intuitive text based menu accessed from the sensor, an optional Interface Module, or via a computer with ProView software.

When in the stand-alone mode, the local user interface is used to display the temperature and adjust sensor settings including a programmable output and alarm.

The optional Interface Module is ideal for installations requiring remote temperature display and/or multiple programmable outputs and alarms.

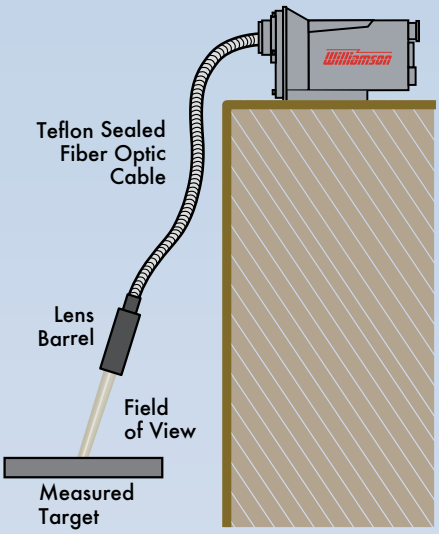


ProView PC software can be used to log and analyze data and to make remote sensor adjustments.

Innovative Technology for Traditional and Challenging Applications

FIBER OPTIC SENSORS

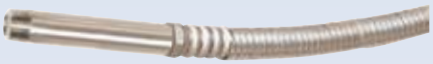
The Pro 90 and Pro 200 Class sensors utilize innovative fiber optic features for greater durability and flexibility when installations involve confined spaces or severe environments. These sensors use a small, Teflon-sealed fiber optic cable to view the target while the sensor is mounted in a remote or more convenient location. While the sensor ambient limit is typically 140°F / 60°C, the fiber cables can withstand ambient temperatures as high as 400°F / 200°C or higher with optional accessories.



The fiber optic sensors feature cable lengths ranging from 3 to 30 feet (1 to 9 meters) as well as a variety of unique mounting and protective accessories for hostile operating conditions. This includes a choice of:

Standard glass (G) and quartz (Q) fiber optic cables or optional 0.05in/1.3mm diameter monofilament (M) cables are available

Flexible, lightweight Stainless Steel Braid (SSB) with built in Air Purge for extra mechanical protection



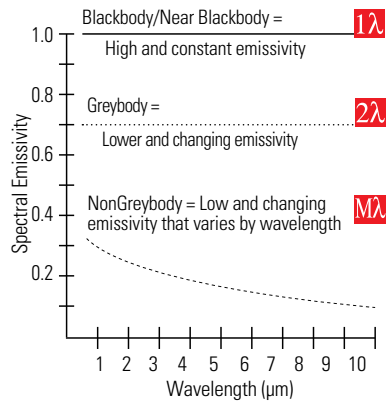
Heavy Duty ArmorGurard (AG) with built in Air Purge for the ultimate mechanical protection

ACCURATELY COMPENSATE FOR SURFACE EMISSIVITY CHARACTERISTICS

Infrared thermometers collect the infrared energy emitted by an object and convert it into a temperature value. While many factors affect a sensor's measurement accuracy, the most important consideration is the selection of the sensor technology that most effectively compensates for the emissivity characteristics of the measured surface.

Emissivity is a term used to quantify a material's tendency to emit infrared energy. It is measured on a scale of 0 to 1.0, and it is related to the reflective and transmission characteristics of a material. For example, a highly reflective surface like aluminum has a low emissivity of 0.1, while a dull surface like refractory brick has a higher emissivity of 0.9. As the figure to the right illustrates, emissivity characteristics can vary with the type of material and the measured wavelength. Consequently, it is important to select the sensor technology and wavelength that most accurately compensates for the emissivity characteristics of the material. The table below provides some guidelines to help select the most appropriate sensor technology for each application.

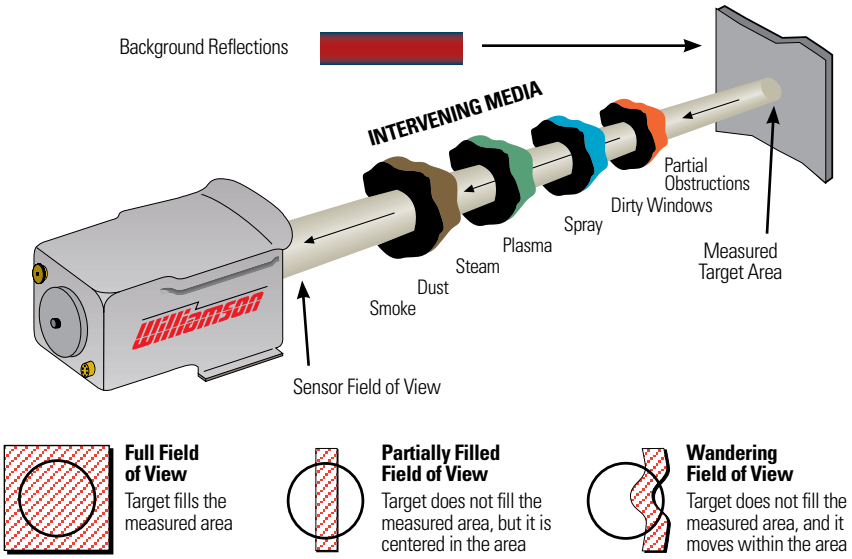
Surface Emissivity Characteristics



Williamson Sensor Selection Guide	
Sensor	**Application Characteristics**
Single Wavelength T° > -40°F / -40°C	
Silver C,M,U (line of sight) **Gold 20 (Laser)** **Gold 30 (Fiber optic)** **PRO 40 (Visual)** **PRO 50 (Fiber optic)**	Single-wavelength sensors tend to measure an average temperature value of the measured target area. Short wavelengths are recommended to reduce errors due to optical obstructions and emissivity variation. Advanced signal processing techniques enable broad temperature ranges, measurement of low temperatures with short wavelengths (auto null sensors), and long term calibration stability. Recommended applications involve: • Most materials possessing a high and constant emissivity • An unobstructed view of the target with a full field of view • Low temperature measurements of low emissivity materials
Dual Wavelength T° > 200°F / 95°C	
PRO 80 (Visual) **PRO 90 (Fiber optic)**	Dual-wavelength sensors tend to measure the hottest temperature viewed in the target area. They provide automatic compensation for emissivity variations of greybody materials. With a unique single-detector design and the industry's highest signal dilution factor, Williamson's dual-wavelength sensors outperform all other ratio sensors. Recommended applications involve: • Materials such as ferrous metals which have low and varying emissivity values • Intervening media such as dirty optics, scale, steam, dust, or water spray • A partially filled field-of-view caused by a mechanical obstruction or a small or wandering target
Multi Wavelength T° > 200°F / 95°C	
PRO 100 (Visual) **PRO 200 (Fiber optic)**	Multi-wavelength sensors utilize ESP algorithms to provide 'aim-and-read' capabilities for non-greybody materials that are not accurately measured by single and dual-wavelength sensors. Recommended applications involve: • Non-greybody materials such as annealed, galvannealed, and stainless steels as well as aluminum, brass, copper, and zinc • Intervening media such as dirty optics, scale, steam, dust, or water spray • A partially filled field-of-view caused by a mechanical obstruction or a small or wandering target. Some applications do require a full field-of-view with multi-wavelength sensors.

GREATER ACCURACY, RELIABILITY, AND REPEATABILITY

As the figure and table below illustrate, accurate temperature measurements require careful consideration of many application issues, and with the advanced capabilities of the Pro Series, Williamson simplifies these issues to out perform all others.



Williamson's Advanced Design vs Traditional Technology

	Williamson Dual-Wavelength	Traditional Two-Color / Ratio
General Features and Benefits	With a unique single detector design, these sensors offer long-term calibration stability, flexibility to select the optimal wavelengths for advanced measurement requirements, and an industry leading signal dilution capability for measurements with low energy conditions.	With a two detector design that mounts one detector on top of the other, these sensors are susceptible to long-term drift, a limited choice of wavelengths, and a reduced signal dilution capability that limits their performance on many applications.
Misalignment and Opaque Optical Obstructions	Signal dilution capability is 20 to 100 times greater than two-color models, producing stable temperature readings were two-color sensors falter or fail.	Signal dilution capability limited by top detector obstructing bottom detector's view and inability to select operating wavelength.
Small or wandering Targets	By measuring the hottest spot within a relatively large optical area, the sensor maintains alignment to the target.	High resolution optics with small spot sizes require precise alignment to the moving target.
Water, Steam, Clean Flames, Combustion Gasses, Plasma, Diode & YAG lasers	The optimal wavelengths are selected to view through each of these common optical obstructions without error.	Each of these common optical obstructions creates an error due to restricted wavelength options.
Temperature Gradients or Surface Scale	Produces a 20-times-greater heavily-weighted average towards the hottest temperature viewed (1) due to a greater separation between wavelengths.	Cooler temperatures are averaged into the temperature reading causing a less accurate measurement.
Low-Temperature Measurements	Able to measure temperatures 200°F / 95°C and above.	Most brands are limited to high temperatures only.
Emissivity and Signal Dilution Measurements	Included in all models and useful for sensor and process diagnostics.	Not available.
Advanced ESP Filtering	Included in all models to eliminate intermittent interferences.	Not available

(1) A temperature gradient or surface scale that produces a 60 degree error for a two-color sensor will produce an error of only 3 degrees for select dual-wavelength models.

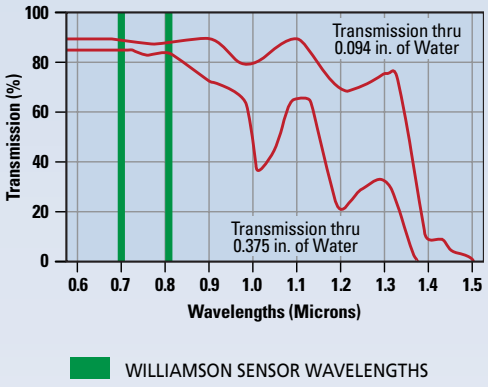
ACCURATE MEASUREMENTS UNDER ADVERSE CONDITIONS

The Pro Series dual and multi-wavelength sensors use state-of-the art technology to provide superior accuracy, reliability, and repeatability to satisfy virtually any application requirement. This includes measurements with:

- **Emissivity Variation:** Dual-wavelength sensors are appropriate when emissivity varies equally across wavelengths (greybody materials). A multi-wavelength sensor is recommended when emissivity change varies by wavelength (non-greybody materials).
- **Optical Obstruction:** The ability to tolerate optical obstruction is measured by the sensor's signal dilution capability. Williamson sensors offer the highest signal dilution capability in the industry with typical values 20 to 100 times greater than two-color sensors.
- **Optical Interference from Intervening Media:** Water, steam, combustion gas, plasma and laser energy possess different transmission properties at different wavelengths. Thoughtful wavelength selection is essential to assure that the sensor is able to view through these interference sources without error.
- **Scale and Temperature Gradients:** The greater the wavelength separation the greater is the tendency to measure only the hottest temperature viewed. Select Williamson sensors tolerate surface scale and temperature gradients 20 times better than two-color sensors.

OPTIMAL WAVELENGTHS

Williamson's innovative technology permits the selection of the optimal wavelengths for a wide range of application requirements. This includes unique capabilities such as measurement through steam, water (see figure), and plasma coatings as well as low temperature dual-wavelength measurements. With a two detector design, the traditional two color/ratio sensors are restricted to use 0.7-1.1µm and 1.0-1.1µm wavelengths.



ESP Technology Provides Greater Accuracy, Reliability, and

ADVANCED CAPABILITIES THAT ARE EASY TO USE

With an easy-to-use text-based menu system, the Pro Series sensors can be configured for a variety of process monitoring and control applications. The menu system can be accessed from the sensor, an Interface Module, or via ProView PC software. The menu is organized as follows:

Signal Conditioning

- Average Time
- Peak/Valley Hold
- Temperature Scale (°F/°C)
- E-Slope Offset
- Rate of Change Multiplier

Configure Inputs and Outputs

- Select Measured Parameter
- Select Scale (4-20mA, 0-20mA)
- Configure the Output Range
- Configure Remote Input for E-Slope or Alarm Set Point

Configure Alarms

- Select Measured Parameter
- Select Set Point Value

Configure ESP

- Select Application Algorithm (only available with multi-wavelength sensors)
- Enable ESP Filter
- Select Range for ESP Filter
- Average Time for Signal Strength and Signal Dilution

Diagnostics

- Analog Output Test
- Alarm Test
- Menu Lockout

Status Messages

- Out of Temperature Range
- ESP Filter Status
- High Ambient Warning
- Aiming System Status
- Status of Digital Communications

SIMPLIFY SENSOR INSTALLATION, OPERATION AND MAINTENANCE

The Pro Series dual- and multi-wavelength sensors are able to characterize and compensate for a wide range of application conditions because they continuously measure five unique parameters. Each parameter can be viewed on the sensor's displays or sent elsewhere via programmable outputs and alarms. To verify the accuracy of a sensor's temperature measurement, simply check the measured signal strength and/or signal dilution to confirm they are in a normal range for the application. For example,

- abnormally low values can indicate misalignment, an optical obstruction, or a dirty lens/window
- abnormally high values can indicate a high temperature interference or background reflections

Pro Series Measured Parameters
Filtered Temperature: The measured target temperature with signal conditioning filters applied. Adjust the signal conditioning settings as required to achieve the desired readings.
Unfiltered Temperature: The measured target temperature with no signal conditioning filters applied. It can be viewed simultaneously with the filtered temperature to better understand the measurement conditions.
Signal Strength/Emissivity: The signal strength value is a measure of the effective emissivity. When the sensor's field-of-view is filled. With no sight path interference or background reflections, this value represents the emissivity of the measured surface.
Signal Dilution: Signal dilution is a relative measure of the infrared energy received from the target. A signal dilution value of 500:1 indicates the sensor is collecting 500 times more infrared energy than is required to make a reading.
Ambient Temperature: The ambient temperature inside the sensor is measured to verify that the sensor is within its ambient operating limits. A status message is displayed when the limits are exceeded.

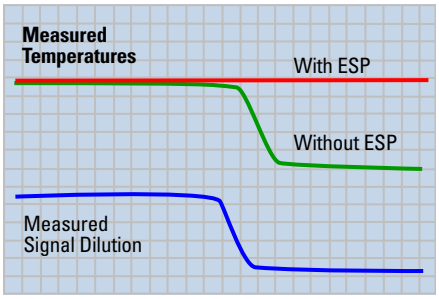
ESP FILTERS ASSURE VALID MEASUREMENTS WITH APPLICATIONS INVOLVING AN EXTREME INTERMITTENT INTERFERENCE

While Williamson's dual- and multi-wavelength sensors outperform all others with application issues such as flames, hot background reflections, steam, and smoke, there are applications where extreme, intermittent conditions make it difficult to maintain an accurate temperature measurement. With these applications, Williamson's patented ESP Filters can enable the sensor to recognize and ignore these troublesome intermittent error sources. This advanced feature is easy to use and is popular for measurement of molten metal streams, forging dies, and any measurement with extreme intermittent interferences.

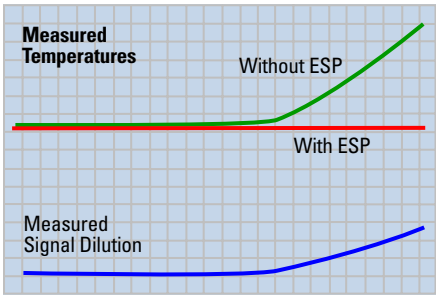
With the ESP Filters, the sensor is programmed to read a real-time temperature value only when the measured signal strength and/or signal dilution values are within their normal range. If an interference causes these values go out of range, then the sensor can be configured to:

- hold the last valid reading until the valid measurement conditions resume
- display no reading at all and a status that the ESP filters are out of range

In either case, the reported sensor reading is unaffected by the interference. The two figures below compare the measurements of a sensor without ESP to a sensor with ESP and the hold feature enabled.



Intermittent Reduction of Energy Due to Intervening Media



Intermittent Increase in Energy Due to High Temperature Interference / Reflection

Ease of Use

ESP ALGORITHMS CORRECT FOR EMISSIVITY IRREGULARITIES

Single- and dual-wavelength (i.e. ratio or two-color) sensors are unable to provide accurate and reliable temperature measurements on non-greybody materials due to their complex emissivity characteristics. By using application specific ESP algorithms, Williamson's multi-wavelength infrared thermometers outperform all others on these challenging non-greybody materials. With greater temperature measurement accuracy, Williamson's customers are able to achieve new levels of process control for applications previously considered difficult and impossible to measure. Typical non-greybody materials include:

- Aluminum
- Brass
- Bronze
- Chromium
- Copper
- Magnesium
- Manganese
- Molybdenum
- Nickel
- Silicon
- Stainless Steel
- Tin
- Titanium
- Tungsten
- Zinc

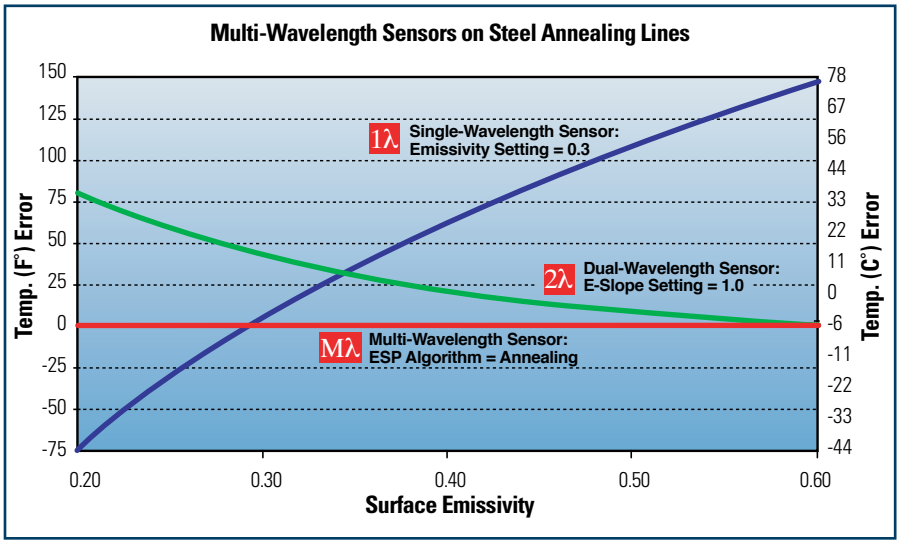
Multi-wavelength sensors use ESP algorithms to characterize infrared energy, emissivity, and the measured wavelengths to accurately calculate the temperature and emissivity of complex non-greybody materials. These algorithms are computer-based empirical models developed from extensive data collected from off-line simulations and on-line trials. Each multi-wavelength sensor can include up to four menu-selectable, factory-programmed ESP algorithms plus a dual/ratio mode for dual-wavelength measurement. ESP algorithms may be combined with ESP filters to enable measurement of non-greybody materials under adverse operating conditions. Popular multi-wavelength applications include:

- Aluminum and Copper Extrusion, Forging, Continuous Casting and Rolling
- Continuous Annealing of Steel and Stainless Steel Strip and Tube
- Zinc-Coated Steel Strip and Tube
- Heating, Forming and Annealing of High-Silicon and High-Nickel Steel Alloys, including high strength steels, rail steel, high-temperature steel, electrical steel and motor rotors
- Chrome, Stainless Steel and Iron Molds for Glass Forming
- Measurement of all non-grey metals listed above

An example of a popular multi-wavelength application is a steel continuous annealing line. As the graph below illustrates, single- and dual-wavelength sensors can produce significant errors as the emissivity and e-slope vary while the Williamson multi-wavelength technology is able to accurately correct for these variations which are due to:

- Changes in alloy, surface texture, surface oxidation, grain growth, elemental migration
- Abnormal operating conditions, such as a furnace leak, a bad roll, or a reheated coil

These results are achieved under a wide range of operating conditions without any adjustments to the multi-wavelength sensor.



Note: Assumes Strip Temperature of 1400˚F (760˚C)

DUAL AND MULTI-WAVLENGTH SENSOR SPECIFICATIONS

Measured Temperature Limits
- 200 to 4500°F / 95 to 2500°C

Accuracy
- 0.25% of Reading or 2°C whichever is greater

Repeatability
- Better than 1°C

Response Time
- 100ms (95% of Response) update time is 50ms

E-Slope (E-Slope Offset)
- 0.000 to 2.000 (+/- 1.000)

Input Power
- 24Vdc (300mA)

Analog Outputs
- 4-20mA, 0-20mA, or voltage outputs and a TTL alarm

Digital Communications
- RS485 or RS232

Ambient Temperature Limits
- 0 to 140°F / -17 to 60°C
- 0 to 120°F / -17 to 50°C (some low temperature models)
- With Water Cooling limit is 350°F / 175°C
- Fiber Optic Assembly limit is 400°F / 200°C

Enclosure
- Corrosion Resistant, Aluminum Cast Enclosure with NEMA 4X (IP65) Rating. Optional NEMA 7 and CENELEC enclosures are available

INTERFACE MODULE SPECIFICATIONS

For installations requiring remote temperature display and advanced programming capabilities, the interface module offers the following:

- 2 programmable 4-20mA, 0-20mA, or voltage outputs
- 1 programmable 4-20mA, 0-20mA, or voltage input
- 2 programmable SPDT relay alarms
- Bi-directional RS485/RS232 communications
- Built-in power supply with 90 - 260Vac input

Unequaled Performance in Temperature Measurement

WILLIAMSON OVERVIEW

With the Silver, Gold, and Pro Series sensors, WIlliamson offers a complete range of infrared thermometers to provide accurate and reliable measurements for traditional and challenging applications.

- The **Silver Series** offers miniature, low cost configurations for many general purpose applications.
- The **Gold Series** offers a complete selection of wavelengths, optics, and configurations for traditional and challenging applications including heavy industrial environments.
- The **Pro Series** offers the most advanced capabilities with a complete selection of wavelengths, optics, and configurations for traditional and challenging applications including heavy industrial environments.

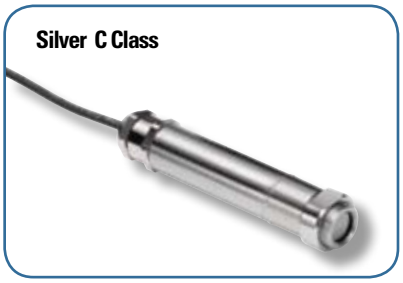
Class	Sighting
Single-Wavelength Sensors	
Silver C, M, & U	Line of Sight
Gold 20	Line of Sight or Laser
Gold 30	Fiber optic w/ Aim Light
Pro 40	Visual or Laser
Pro 50	Fiber optic w/ Aim Light
Dual-Wavelength Sensors	
Pro 80	Visual or Laser
Pro 90	Fiber optic w/ Aim Light
Multi-Wavelength Sensors	
Pro 100	Visual or Laser
Pro 200	Fiber optic w/ Aim Light

For more details on Single-Wavelength models, see Williamson's Single-Wavelength Industrial Infrared Thermometers brochure and data sheets.

SAMPLE INDUSTRIES SERVED

- Iron and Steel
- Nonferrous Metal
- Industrial Heating, Thermal Surface Treatment
- Engineered Materials, Semiconductor
- Glass and Ceramics including Bricks, Cement, Glass, and Refractory
- Incinerators, Boilers, Rotary Kilns, Flares, Thermal Reactors
- Paper, Textile, Plastic, Rubber
- Pharmaceutical
- Food
- Aggregate, Ores, Soil and Asphalt

A COMPLETE RANGE OF INFRARED THERMOMETERS FOR EVERY APPLICATION



WILLIAMSON CORPORATION
70 Domino Drive, Concord, Massachusetts 01742
TEL: (978) 369-9607 • FAX: (978) 369-5485 • (800) 300-8367 (USA)
sales@williamsonir.com • www.williamsonir.com

Williamson
Innovators in Noncontact Temperature Measurement