Single-Wavelength Infrared Temperature Sensors

Silver, Gold and Pro Series

Williamson

Innovators in Noncontact Temperature Measurement

Innovative Technology for Traditional and Challenging Applications

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 the Silver, Gold, and Pro Series sensors, Williamson offers the optimal sensor for a wide range of applications. Each sensor can be used as a stand alone transmitter with a choice of inputs, outputs, and alarms. For more advanced capabilities, an interface module, PID Controller, or PC software program are available.

To help simplify the installation of the sensor and to provide added protection for severe environments, Williamson also offers a wide selection of accessories including mounting brackets, flanges, water cooling, air purges, and hazardous area enclosures.

SAMPLE APPLICATIONS

- Ferrous and Nonferrous Metals
- Induction Heat Treating
- Boilers, Incinerators, Kilns, Flares, and Thermal Reactors
- Ceramics including Bricks, Cement, Glass, and Refractory
- Semiconductor and Engineered Materials
- Aggregate, Ores, Soil and Asphalt
- Pharmaceutical
- Food
- Paper and Paperboard
- Plastics and Rubber
- Painted Surfaces
- Liquids and Pastes

A COMPLETE RANGE OF TEMPERATURE SENSORS

With the Silver, Gold, and Pro Series sensors, Williamson offers a complete range of single-wavelength infrared thermometers featuring state-of-the-art technology to provide accurate and reliable measurements for virtually any application.

The miniature, low cost Silver Series sensors can be easily integrated into a 4-20mA loop or used to replace thermocouples for most general purpose applications in light industrial environments. These sensors are ideal for measurement of most non-reflective materials where precise alignment is not required.

The Gold and Pro Series sensors include a complete selection of wavelengths, optics, and configurations to enable measurements of both traditional and challenging applications in heavy-industrial environments. With advanced capabilities, Gold and Pro Series sensors provide highly accurate measurements involving:

- general purpose applications
- unique materials such as thin film plastics, glass, or painted/coated surfaces
- intervening media, such as steam, water vapor, flames, or combustion gases that have the potential to interfere with a sensor's measurement accuracy

SILVER SERIES FEATURES

- Temperature limits of -40 to 1832°F / -40 to 1000°C with 1% measurement accuracy
- Miniature sensors for easy installation.
- Emissivity settings are fixed or adjustable with a 4-20mA input or a USB connection
- 4-20mA and voltage outputs which are linear with temperature
- Thermocouple or USB temperature outputs
- Internal sensor and process ambient temperature output
- 8-14um wavelength
- A choice of D/2, D/15, and D/30 resolution optics
- 2-wire or 4-wire configurations
- Stainless steel NEMA 4X (IP65) enclosures

Silver U Class sensors feature an innovative design with adjustable settings using a USB port and **SilverView** PC software which is included with each sensor.

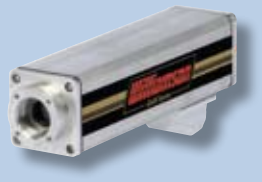
Silver C Class sensors feature fixed sensor settings including an emissivity of 0.95 or a configuration with a 4-20mA input for remote emissivity adjustment (optional emissivity adjuster module is available).

Silver M Class sensors feature a two piece design and miniature sensing head with up to D/30 optical resolution. Fixed sensor settings include an emissivity of 0.95.

THE GOLD AND PRO SERIES

The Gold and Pro Series sensors share a common architecture featuring state-of-the-art infrared technology. Standard sensor features include:

- Temperature limits -40 to 4500°F / -40 to 2500°C
- Line of sight, visual aiming, laser aiming, and fiber optic aim light alignment options
- A complete range of precisely selected short, long, and specialty wavelengths
- A choice of low and high resolution optics
- 4-20mA and voltage sensor outputs which may be programmed with a choice of up to 5 different measured parameters
- Bi-directional RS232 and RS485 communications
- Built-in human interface with an intuitive text-based menu for sensor adjustments
- Stand alone sensors feature a menu selectable alarm relay or an analog input for remote emissivity and alarm set point adjustments
- Optional remote interface module with a built in AC power supply and a wide selection of output and alarm options.
- Rugged NEMA 4X (IP65) and NEMA 7X (Ex II 2G) enclosures



Gold 20 Class sensors feature standard resolution optics and optional integrated laser aiming for precise verification of alignment.

Pro 40 Class sensors feature high resolution optics, through the lens aiming, and optional integrated laser aiming for precise verification of alignment.

Gold 30 Class sensors feature a fiber optic configuration with a rugged, compact design and an optional built-in aim light.

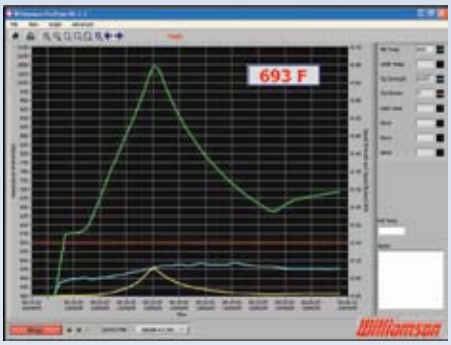
Pro 50 Class sensors feature a fiber optic configuration with a heavy duty design and an optional built-in aim light while offering high resolution optics.

EASY TO INSTALL, OPERATE, AND MAINTAIN

Gold and 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. They also include an optional analog input for remote emissivity and alarm adjustments.

The optional **interface module** is ideal for installations requiring remote temperature display and/or multiple programmable outputs and alarms.



ProView PC software is compatible with the Gold and PRO Series sensors. It may be used to log and analyze data and to make remote sensor adjustments.

Greater Accuracy, Reliability, and Repeatability

MEASURING INFRARED ENERGY

Infrared thermometers collect the infrared energy emitted by an object and convert it into a temperature value. The amount of energy collected by a sensor is a function of the emissivity characteristics of the target and the transmission characteristics of any intervening media between the sensor and the target.

- **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 the 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.
- **Intervening media** such as steam, water vapor, flames, or combustion gases have the potential to interfere with the amount of energy that is measured by the sensor.

WHY WAVELENGTH MATTERS

The emissivity characteristics of a target and the transmission characteristics of any intervening media can vary by infrared wavelength. Williamson's single-wavelength sensors optimize performance by offering the most appropriate wavelength for each application.

- **Short-wavelengths of 1µm, 1.6µm, and 2.2µm** are preferred for most applications because they are less sensitive to variations in surface emissivity, optical obstruction, and misalignment.
- **Long-wavelengths between 8-14µm** are preferred for measurements near or below ambient temperatures, measurements of non-reflective, high emissivity materials, or for applications where accuracy is less critical.
- **Specialty-wavelengths** are required to measure selective emitters like plastics, coatings, and glass or to measure through different types of intervening media.

FIELD OF VIEW (FOV)

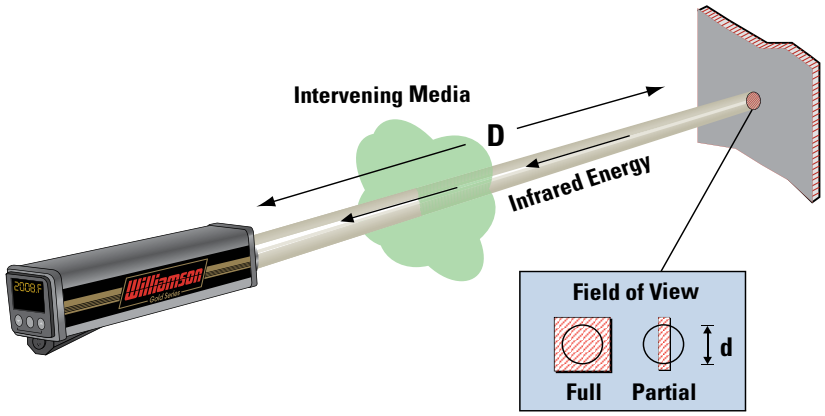
The field-of-view determines a sensor's viewing area for measuring the energy emitted from a target. All Williamson single-wavelength sensors may be used at any distance as long as the measured target is larger than the area viewed by the sensor (i.e a full FOV).

A sample calculation of the FOV is as follows, if a sensor is mounted with a focal distance (D) of 50 inches from the target and it has an optical resolution factor (F) of 100, then the viewed target diameter (d) is 0.5 inches (d=D/F).

SELECTING THE OPTIMAL SENSOR FOR AN APPLICATION

To ensure accurate and reliable temperature measurements, it is important to select the sensor features which optimize the collection of infrared energy. This includes

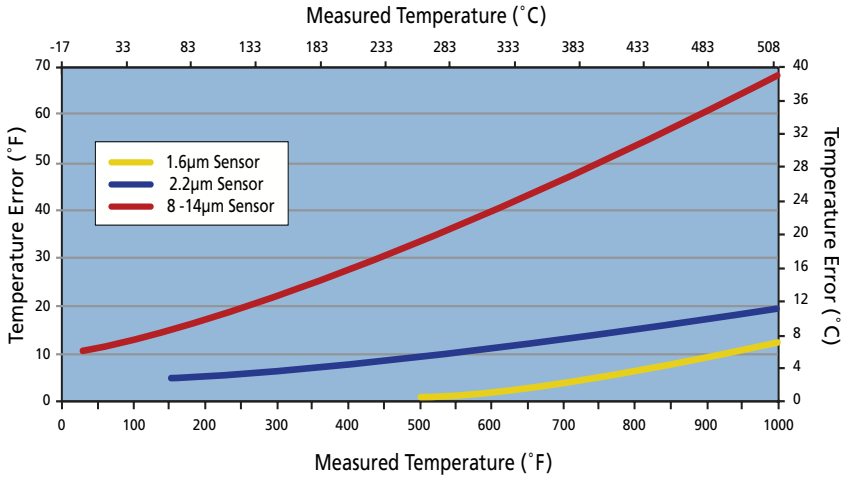
- A **wavelength** where the emissivity of the target is high and constant and any intervening media between the sensor and the target is highly transparent. Sensor wavelengths vary by model and temperature range.
- A **field-of-view (FOV)** where the target is larger than the area viewed by the sensor (i.e. a full FOV). Sensor optics vary from low resolution optics for large targets to high resolution optics for precise alignment on small targets or to view through sight tubes and narrow gaps within the sight path.
- A **sensor configuration** which enables verification of alignment to the target. Options include line-of-sight alignment, through-the-lens aiming, integrated laser aiming, and fiber optic alignment with an optional built in aim light.



LOW TEMPERATURE MEASUREMENTS OF METAL TARGETS

For applications like cold rolled steel, low temperature induction heating, or calendering rolls, short-wavelength sensors are required to compensate for the low and varying emissivity of the target. As the figure below illustrates, if there is a 10% change in the energy measured by the sensor, the measurement error of a long-wavelength sensor can be 5 times greater than a short wavelength sensor. Williamson's innovative Auto Null Technology, only available in Pro 42 and 52 sensors, is ideal for these applications as they feature short 2.2µm and 2.8µm wavelengths and measurement capabilities down to 75°F / 25°C.

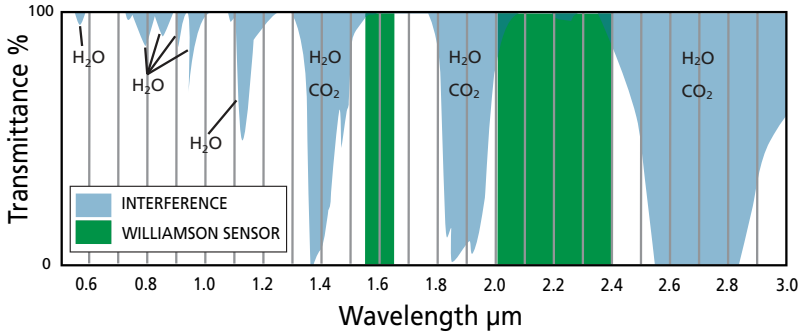
ERROR FROM A 10% CHANGE IN EMISSIVITY OR OPTICAL OBSTRUCTION



MEASUREMENTS THROUGH STEAM, FLAMES AND COMBUSTION GASES

The need to view a target inside a flame-fired heating chamber or to view a target through steam, flames, or combustion gasses is common. As the figure below illustrates, despite being highly transparent in the visible spectrum, carbon dioxide, and other gases that are naturally found in air are significantly opaque over a wide range of the infrared spectrum. For these measurements, Williamson's 1.6µm and 2.2µm sensors use unique narrow band filters that avoid interference from steam, flames, and combustion gases. Competitive sensors which use much wider infrared filters (1.0-1.75µm and 2.0-2.8µm respectively) cannot view clearly through these common gasses.

TRANSMISSION THROUGH AIR AND COMBUSTION GASES

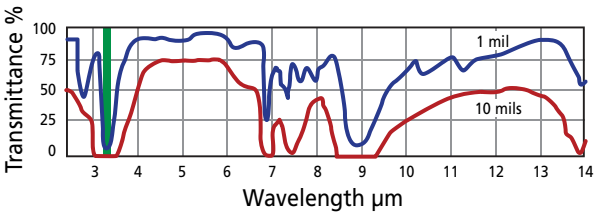


MEASUREMENT OF SELECTIVE EMITTERS

Materials such as thin film plastics and glass require precise sensor wavelength selection because these special materials, known as selective emitters, are highly opaque and non-reflective only at specific wavelengths. the figures below illustrate the different transmission characteristics of some materials where Williamson offers unique measurement capabilities.

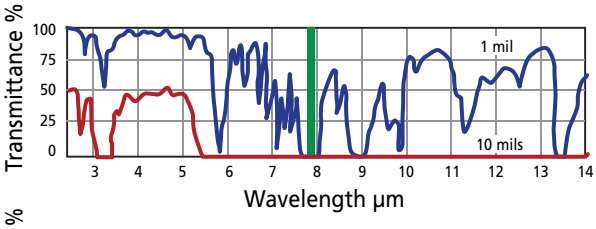
POLYETHYLENE FILM

Williamson's 3.43µm narrow band wavelength enables measurements on polyethylene films as thin as 0.25 mil.



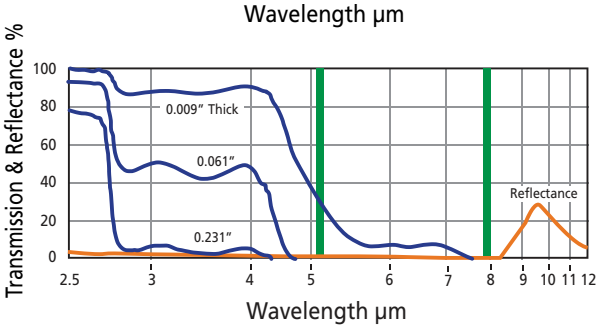
POLYESTER FILM

Williamson's 7.9µm narrow band wavelength enables measurements on polyester films as thin as 1 mil.



GLASS

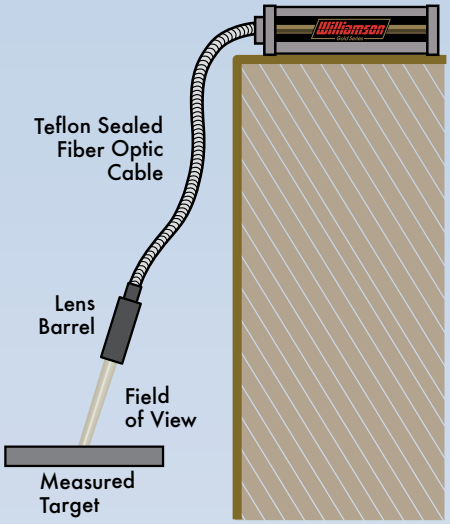
Williamson offers a narrow band 7.9µm wavelength to measure the real surface temperature of the glass as well as a 5µm wavelength which can measure just below the surface of the glass.



WILLIAMSON SENSOR WAVELENGTHS

FIBER OPTIC SENSORS

The Gold 30 and Pro 50 Class utilize innovative fiber optic features for greater durability and flexibility when sensor 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.



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

Rugged glass (G) and quartz (Q) fiber optic cables

Heavy Duty ArmorGurard (AG) with built in Air Purge

Flexible, light weight Stainless Steel Braid (SSB) with built in Air Purge

ADVANCED CAPABILITIES THAT ARE EASY TO USE

With integrated processing electronics and an easy to use text based menu system, the Gold and Pro Series sensors can be configured for a variety of process monitoring and control capabilities.

The Gold and Pro menu system can be accessed from the sensor, an optional interface module, or via ProView PC software. Programmable output and alarm parameters include: Filtered Temperature, Unfiltered Temperature, Ambient Temperature, Rate of Change, Cell Strength (Auto Null).

GOLD AND PRO MENU SYSTEM

Signal Conditioning

- Average Time
- Peak/Valley Hold
- Temperature Scale (°F/°C)
- Emissivity
- 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 Emissivity or Alarm Set Point

Configure Alarms

- Select Measured Parameter
- Select Set Point Value

Diagnostics

- System Test
- Analog Output Test
- Alarm Test
- Menu Lockout

Status Messages

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

INTERFACE MODULE SPECIFICATIONS

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

- 2 programmable analog outputs
- 1 programmable analog input
- 2 programmable relay alarms
- Bi-directional digital communications (RS485/RS232)
- Built-in power supply with 90 - 260Vac input

SENSORS DESIGNED FOR ANY REQUIREMENTS

To help select the optimal sensor for an application, this table highlights the unique features of each series.

	Silver Series			Gold Series		Pro Series	
	C	M	U	20	30	40	50
Sensor Alignment							
Line of Sight	✓	✓	✓	✓			
Integrated Laser Aiming				✓		✓	
Through the Lens Visual Aiming						✓	
Fiber Optic with optional integrated Aim Light					✓		✓
Spectral Response							
Short Wavelengths (1, 1.6, and 2.2µm)				✓	✓	✓	✓
Long Wavelength (8-14µm)	✓	✓	✓	✓		✓	
Application Specific Wavelengths				✓		✓	
Field of View (FOV)							
Low Resolution Optics (D/2 to D/30)	✓	✓	✓		✓		✓
Standard Resolution Optics (D/15 to D/100)				✓	✓	✓	✓
High Resolution Optics (D/100 to D/150)						✓	✓
Human Interface and Signal Processing							
Integrated Sensor Menu System and Display				✓	✓	✓	✓
Adjustable Sensor Settings via PC Application			✓	✓	✓	✓	✓
mA & Voltage Outputs	✓	✓	✓	✓	✓	✓	✓
J, K and T Thermocouple Outputs	✓	✓					
Sensor Based Relay Alarm or Analog Input	✓			✓	✓	✓	✓

SENSOR SPECIFICATIONS

This table is an overview of sensor specifications. All Williamson sensors include a 2 year warranty and CE Certification. See individual data sheets for complete details.

	Silver Series	Gold and Pro Series
Measured Temperature Limits	-40 to 1832°F / -40 to 1000°C	-40 to 4500°F / -40 to 2500°C
Nominal Accuracy	1% of reading	0.25% to 0.5% of reading
Repeatability	0.5% of reading or +/-0.5°C whichever greater	Better than 1°C
Response Time	240ms (90% of Response)	5 to 100ms (95% of Response) update time is 5 to 50ms
Emissivity	C Series: Fixed at 0.95 or Adjustable 0.20 to 1.00 M Series: Fixed at 0.95 U Series: Adjustable 0.10 to 1.00	Adjustable 0.010 to 1.500
Input Power	6 to 28Vdc (20mA)	24Vdc (300mA)
Analog Inputs / Outputs	4-20mA, Linear Voltage or Thermocouple Outputs C Series: Optional 4-20mA Input to Adjust Emissivity	4-20mA, 0-20mA, or voltage outputs, alarm, and analog input to adjust emissivity or alarm set point
Digital Communications	U Series – USB	RS485 or RS232
Ambient Temperature Limits	32-158°F / 0-70°C w/ Water Cooling Limit is 482°F / 250°C	0 to 140°F / -17 to 60°C 0 to 120°F / -17 to 50°C (Auto Null models only) w/ Water Cooling limit is 350°F / 175°C Fiber Optic Assembly limit is 400°F / 200°C
Enclosure	Stainless Steel Enclosures with NEMA 4X (IP65) Rating	Stainless Steel and Aluminum Cast Enclosures with NEMA 4X (IP65) Ratings, optional NEMA 7X (Ex II 2G) are available

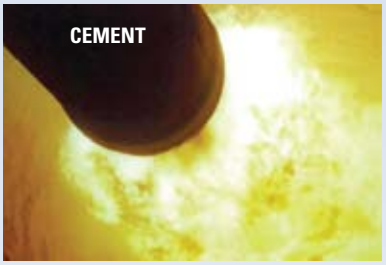
SENSOR WAVELENGTH SELECTION GUIDE

Williamson's single-wavelength sensors optimize performance by offering the most appropriate wavelength for each application. The table below summarizes the options available.

Typical Application	Temperature Limits	Sensor Model	Nominal Wavelength
Short - Wavelength Sensors - *Best for Tolerating Emissivity Variation, Misalignment & Optical Obstruction*			
• Metals, Refractory, and Other High Temperature Applications • Silicon Processing • View through Water	1000 - 4500°F 540 - 2475°C	21, 31 41, 51	1µm
• Metals and General Purpose Applications • Flame-Fired Processes • Bulk Glass Temperatures • View through Steam, Water Vapor, Flames, and Combustion Gasses	500 - 3200°F 260 - 1750°C	21, 31 41, 51	1.6µm
• General Purpose Applications • Low-Temperature, Low-Emissivity Metals • Flame-Fired Processes • View through Steam, Water Vapor, Flames, Combustion Gasses, Plasma, Thin Plastics and Oil	150 - 2500°F 65 - 1375°C	22, 32 42, 52	2.2µm
Specialty - Wavelength Sensors - *Selected to Measure or View Through Specific Materials*			
• General Purpose Applications • Chromate and Zinc-Coated Strip, • Safety Glass Lamination • Low-Emissivity Materials	75 - 800°F 25 - 800°C	42	2.8µm
• Thin Films of H-C-Based Plastics (e.g. Polyethylene and Polypropylene)	125 - 700°F 50 - 175°C	43	3.43µm
• Boiler Tubes • Refractory Walls • Glass Subsurface • Views through Flames and Combustion Gasses	400 - 4000°F 200 - 2200°C	24, 44	3.8µm
• Hot Combustion Gas • CO or CO2 Producing Flames	600 - 4000°F 300 - 2200°C	25, 45	4.65µm
• Glass Surfaces - Especially Inside Furnaces, Ovens and IR Heaters	200 - 4000°F 100 - 2200°C	25, 45	5µm
• General Purpose Applications using Quartz Infrared Heaters • Glass Surfaces • Thin Plastics such as Polyester, Acrylic, and Teflon • Epoxy and Painted Surfaces	85 - 2500°F 30 - 1375°C	28, 48	7.9µm
• Semiconductor, Superconducting, Crystalline Materials, Zirconium and Alumina all Require Specific Wavelengths for Measurement	Per customer requirements	Various	Various
• Hot Slug Detector for Fiberglass Batting • Hot Spot Detector for Rubber Conveyor Belt Protection • Hot Metal Detector for Forging Plant, Rolling Mill and Caster operations	Per customer requirements	Various	Various
Long - Wavelength Sensors - *Best for Measurement of Near-Ambient Targets and Non-Reflective Targets*			
• General Purpose Applications below 500°F / 250° C with Non-Reflective, High Emissivity Materials	-40 - 2000°F -40 - 1100°C	C9, M9, U9 29, 49	8-14µm

SYSTEMS FOR INDUSTRIAL APPLICATIONS

Williamson offers a complete range of infrared thermometers for a wide range of traditional and challenging applications. Sample industries include:

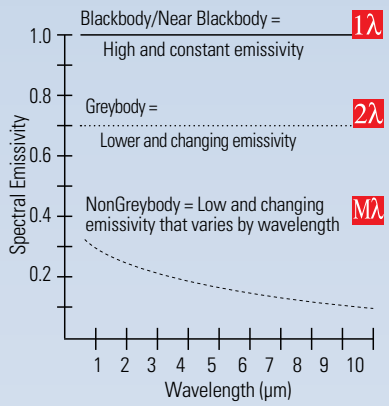


Unequaled Performance in Temperature Measurement

ACCURATE MEASUREMENT OF COMPLEX MATERIALS

Infrared thermometers measure the amount of infrared energy emitted by an object's surface, and then convert this signal into a temperature value. While many factors affect the measurement accuracy, the most important consideration is the selection of the sensor 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 the 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.

Surface Emissivity Characteristics



TYPICAL APPLICATIONS

Single Wavelength

- Food Processing
- Paper, Rubber, Textile, Plastics, and Paint
- Ceramic, Glass, and Aggregate
- Flame Fired Processes
- Low Temperature Metals

Dual Wavelength

- Casting, Forming, and Heat Treating of Metals
- Welding and Brazing
- Crystal Growing and CVD

Multi Wavelength

- Alumininum, Copper, Brass and Other Nonferrous Metals
- Annealed, Galvannealed, and Stainless Steels

VERSATILE SYSTEMS TO MEET ANY REQUIREMENT

Williamson's advanced infrared thermometers feature state-of-the-art technology to provide accurate and reliable measurements for challenging applications in heavy-industrial environments.

Williamson Sensor Selection Guide

Sensor	Application Characteristics
Single Wavelength T° > -40°F / -40°C **Silver C,M,U (line of site)** **Gold 20 (Laser)** **Gold 30 (Fiberoptic)** **PRO 40 (Visual)** **PRO 50 (Fiberoptic)**	Single-wavelength sensors provide an average temperature measurement of the measured target area, and short wavelengths are recommended to reduce or eliminate errors due to emissivity variation. The Patented Auto Null Design eliminates noise and calibration drift often associated with this type of sensor. Advanced signal processing techniques allow for broad temperature ranges, operation at low temperatures, and long term calibration stability. These sensor's are recommended for applications involving: • A constant emissivity with an unobstructed view of the target (all temperatures) • Low temperature measurements of low-emissivity materials
Dual Wavelength T° > 300°F / 150°C **PRO 80 (Visual)** **PRO 90 (Fiberoptic)**	Dual-wavelength sensors tend to measure the hottest temperature viewed in the target area, and 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 when demanding application issues exist. Typically difficult application issues include: • Low or varying emissivity • 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° > 300°F / 150°C **PRO 100 (Visual)** **PRO 200 (Fiberoptic)**	Multi-wavelength sensors utilize programmable ESP algorithms to provide 'aim and read' capabilities for non-greybody materials that are not accurately measured by single and dual wavelength sensors. These sensor's are recommended for applications involving: • Non-Greybody Materials such as aluminum, brass, chrome, copper, molybdenum, stainless steel, tin, titanium, tungsten, 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

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Williamson
Innovators in Noncontact Temperature Measurement

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