R10 Compact Fixed Infrared Sensor
User Manual

Palmer Wahl Instruments, Inc.
234 Old Weaverville Road
Asheville, NC 28804
Phone: 800-421-2863 • 828-658-3131
Fax: 828-658-0728
Email: info@palmerwahl.com
www.palmerwahl.com

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Heat Spy Warranty

Manufacturer warrants all Wahl Heat Spy Fixed Infrareds manufactured by us to be free from defects in material or workmanship under normal use and service. The Manufacturer agrees to repair or replace any product listed above which upon examination is revealed to have been defective due to faulty workmanship or material if returned to our factory, transportation charges prepaid, within the product specific warranty period of two (2) years from date of purchase. This warranty is in lieu of all other warranties, expressed or implied and of all obligations or liabilities on its part for damages including but not limited to normal wear and tear or consequential damages following the use or misuse of this or any instrument sold by the Manufacturer. In addition, if the product is tampered with in any way or calibrated in any way other than by the instructions supplied by Palmer Wahl, it will immediately void the warranty. No agent is authorized to assume, for the manufacturer, any liability except as set forth above. Freight cost to return item(s) for evaluation, duties and other fees are not covered by the manufacturer. Product is automatically registered for warranty by serial number at time of purchase. Serial number must remain attached to product upon return.

1. Introduction

The Wahl R10 compact infrared sensors are non-contact infrared temperature measurement sensors. They are designed to measure the infrared radiation emitted from an object, and convert it to an electrical signal. This signal can then be processed to determine the surface temperature of the measured object. The R10 series are all fixed emissivity at 0.95 ±0.2. All models require a 7-24V DC power supply @ 25mA current.

Standard supply includes a 5’ (1.5m) shielded cable with an option for 10’ (3m) cable. Two M18x1mm mounting nuts are also provided. The 4-20mA output model requires only 2 wire connections while the mV and t/c output models use 4 wire connections, 2 for power and 2 for output signal.

2. Model Definition

Model	Output	Temperature Range	Cable length	Accuracy[1]
R10A	4-20mA	0° to 500°C 32° to 932°F	5 feet (1.5m)	±1%r or 2°C
R10A10			10 feet (3.0m)	
R10J	Type J equivalent		5 feet (1.5m)	*Coming Soon*
R10J10			10 feet (3.0m)	
R10K	Type K equivalent		5 feet (1.5m)	
R10K10			10 feet (3.0m)	
R10V	mV output		5 feet (1.5m)	
R10V10			10 feet (3.0m)	

[1]Note: r = “of reading”

3. Available Accessories

16151 - Surface Mount Bracket, 1 Axis, 18.25mm (0.7") Dia.
16153 – Surface Mount Bracket, 2 Axis, , 18.25mm (0.7") Dia.
16171 - Compact Air Purge Collar, M18x1 Threads, Outside Diameter 30mm (1.18")
16180 - Air/Water Cooling Jacket, 31.75mm (1.25") Diameter, 114.3mm (4.50") Long, with 2, 1/8" FNPT Fittings.

4. Full Specifications

4.1. Measuring Specification – R10A, R10A10

Spectrum	Temperature	Accuracy
8 – 14 µm	> 50° to 500°C	±1% of reading or ±2°C, whichever is greater

Optical	20 : 1
Accuracy	± 1% of reading or ±2°C, whichever is greater
Repeatability	± 1.0% of reading or ±1°C, whichever is greater
Response Time	500 mS
Emissivity	0.95

4.2. Electronic Specification

Analog	4 – 20 mA
Cable	2 cond. shielded, PVC, R10A = 5 feet, R10A10 = 10 feet
Power Supply	24 VDC

4.3. Environmental & Housing Specification

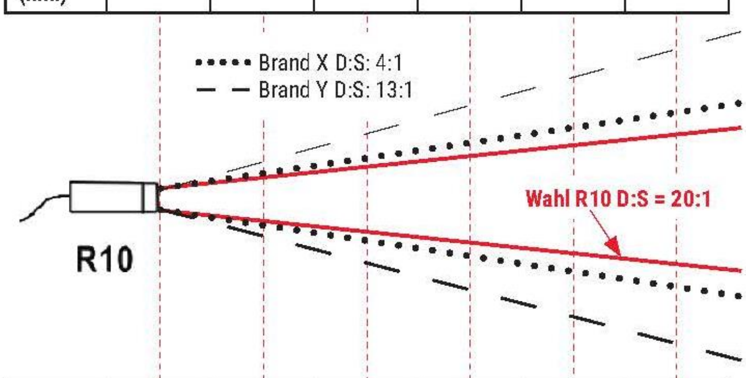
Ambient	0° – 70°C (32° – 158°F)
w/ Air Cooling	0° – 90°C (32° – 194°F)
w/ Water Cooling	0° – 200°C (32° – 392°F)
Storage	-20° – 70°C (-4° – 158°F)
Relative Humidity	10% - 95% non-condensing
Protection Class	IP65 (NEMA 4)
Shock	MIL-STD-810D
Vibration	MIL-STD-810D
Housing Material	304 Stainless Steel
Dimensions	18 x 120 mm (0.7 x 4.75 in) / Thread: M18 x 1
Weight	270g (9.52 oz)

5. Optical Chart

The R10 optical field of view is nominally 20:1 D:S ratio. D:S ratio is an abbreviation for Distance to Spot ratio. For the R10, for every 20 units of measure distance, the target diameter that the R10 is measuring will be 1 unit. For example at a distance of 20 inches the unit will be measuring a 1” diameter target and at 60 inches it will be measuring a 3” diameter target. The minimum diameter is approximately .35 inches (8.9mm).

R10 Optics

Distance (mm)	0	200	400	600	800	1000
Target (mm)	8.9	10	20	30	40	50



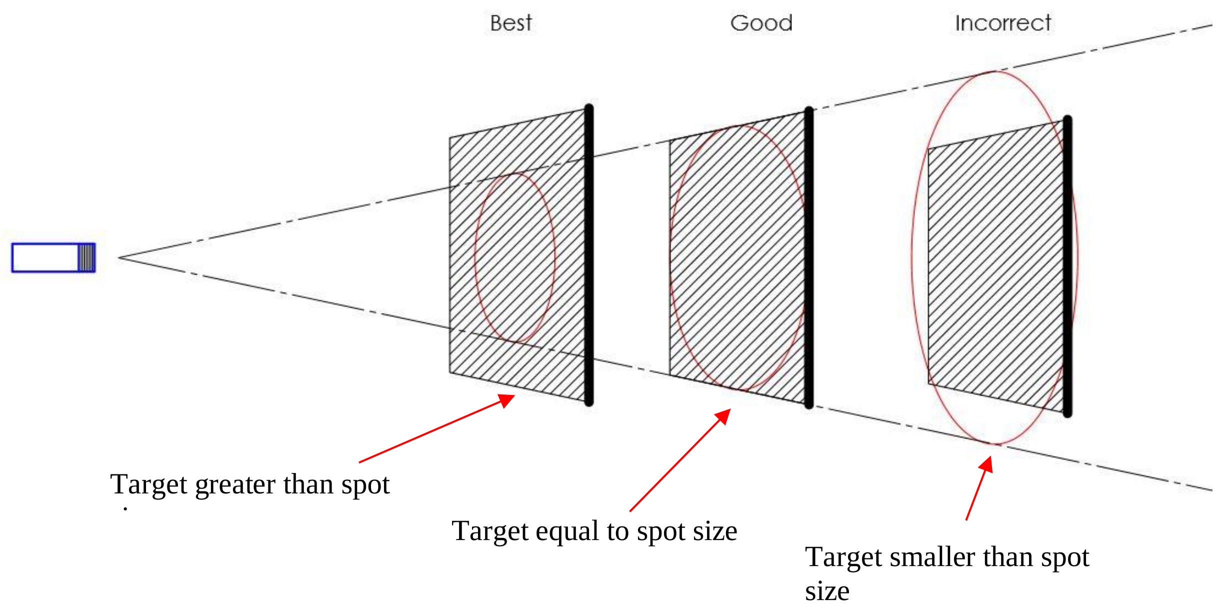
Distance (in)	0	8	16	24	32	40
Target (in)	0.35	0.4	0.8	1.2	1.6	2

6. Installation

Installation consists of 4 primary steps: Mechanical, Environmental, Wiring Installation and Validation/Operation

6.1. Mechanical

Pyrometer placement - The mechanical process starts with determining the proper mounting location. One key factor of this is the D:S ratio of the instrument used. The placement has to allow for proper filling of the field of view. The below diagram demonstrates proper target filling. Failure to completely fill the target area of the pyrometer will result in increased error of the measurement. The dotted circle indicates the field of view.



To achieve the best results, the spot size of the infrared thermometer should be smaller than the object being measured.

Before installation, review the target to ratio tables on the previous page for the appropriate Optics image for your model to determine the correct distance and visual field.

Palmer Wahl offers various mounting brackets as listed in Section 3, which offer various adjustment methods. Additionally, the unit can be mounted in an 18.2mm diameter hole with the included mounting nuts.

6.2. Environmental Considerations

Conditions such as ambient temperature, atmospheric particulates and electrical interference should be considered.

6.2.1. Ambient Temperature

The unit is designed for operation in ambient temperatures from 0° to 70°C (32° to 158°F). Temperatures above 50°C will require a cooling jacket, which can extend the temperature range as high as 200°C (392°F) with water cooling.

6.2.2. Atmospheric conditions

Atmospheric conditions fall into two main categories. The first is for particulates or materials in the optical path that may interfere with the measurement. This can be things such as trying to measure through a window or screen or an excessive amount of particulates such as dust, fibers, fumes or smoke particles in the air. These all have the potential to induce error in the measurement. The second category is for these airborne contaminants to settle on the lens and coat the lens which will reduce the IR energy getting to the detector. These type of contaminants may be controlled by using the air purge collar which creates a positive flow of clean, dry air out through the front opening to prevent contaminants from entering the housing and adhering to the lens.

6.2.3. Electrical Interference

Excessive electromagnetic interference may induce error into the measurement. To reduce the possibility of this happening, do not place the unit near electrical equipment that generates large amounts of EMI. These are usually apparatus such as motors, switches, controllers and RF transmitters/antennas.
Connecting the shield of the cable to an earth ground may also help reduce any effects from EMI.

6.3. Wiring Installation

Connect the wiring per the following table. The wiring color code is also printed on the unit's label. Wiring should be in accordance with any applicable Federal, State and Local codes.

There are additional wires that are enclosed in heat shrink which should not be connected as these are for factory calibration only. Standard delivery includes a 5 foot cable with an option for a 10 foot cable. In most cases the wiring can be extended by the user, by a skilled electronic/electrical technician using proper connection and grounding techniques.

The power supply requirements are 7-24V DC power. The R10A with 4-20mA output requires a 25mA power supply, while the R10J, K, V models require a10mA power supply.

Model	Wire Color	Signal
R10A, R10A10	Black	Volts DC common (return)
	Red	+ Volts DC

7. Validation/Operation

After installation the measurements should be validated. This will verify that the optical path and materials are compatible with this instrument. To validate the system requires a target of a known temperature. This can be from the temperature controls, an independent mechanical/electronic thermometer, or another infrared thermometer, such as a handheld infrared thermometer. This measurement should be compared to the R10 measurement and should be within the specified tolerances of both temperature measurement systems.

In the event that there are inaccuracies due to differences in emissivity of the target, you may be able to apply a correction factor as compensation.

The output for the R10A is a 4-20mA output scaled over the 0 to 500°C range. This equates to 32µA per °C or 17.78 µA per °F.

There are no under/over range indicators so at temperatures below 0°C the unit will always output approximately 4mA and temperatures above 500°C it will always output approximately 20mA.

8. Important Notes:

When a sensor is first powered up it may take 10-20 minutes for the reading to stabilize.

If the sensor is subjected to rapid changes in ambient temperature, such as going from a cold to hot or hot to cold area, it may require a 20 to 30 minute stabilization time.

Measurements made at high target temperatures for a 20 minute or greater time, and then rapidly reduced may require a 2-10 minute settling time for the measurement to be within the specified accuracy.

Incorrect wiring may result in permanent damage to the sensor and void the warranty.

9. Maintenance and Troubleshooting

9.1. Maintenance

Housing – The housing is constructed of AISI 304 Stainless Steel and should not require any cleaning. If it does get dirty, cleaning should be with a damp cloth and mild detergent.

Lens – The lens must be kept clean at all times. If the air purge collar is not used the lens may need to cleaned with clean compressed air or a moist cotton swab to gently wipe off the lens. A dry cotton swab may be used to remove any moisture left on the lens. **DO NOT** use solvents on the lens!

Wiring – make sure the wiring is protected and not subject to crushing, cutting or extremely tight bending.

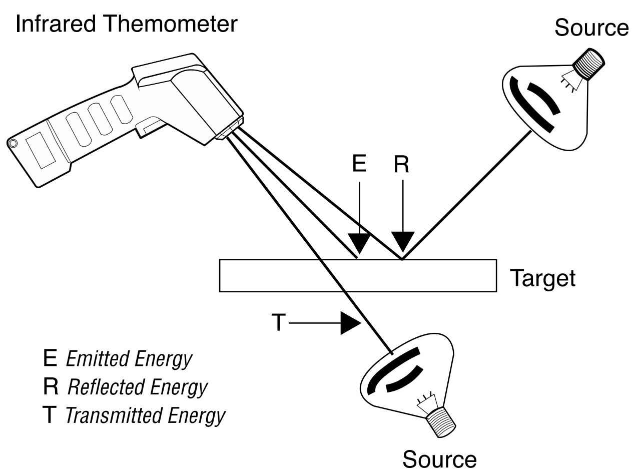
9.2. Trouble shooting

See the below chart for troubleshooting tips. If the problem is not remedied, call Palmer Wahl customer service at the number provided at the end of this manual for a Return Material Authorization (RMA) number prior to returning any goods.

Symptom	Probable Cause	Possible Solution
No Output	No power to the sensor	Check power supply for proper operation and wiring connections and continuity
Inaccurate Measurement	Incorrect target size or obstruction in the field of view.	Verify optical requirements are met per paragraphs 5 and 6.1. Clear optical path of obstructions.
Inaccurate Measurement	Particulates, vapors, gases settling on lens	Clean per paragraph 9. Add air purge collar.

10. Emissivity

Emissivity in infrared (IR) measurement refers to the ability of the surface being measured to emit radiation. Surfaces vary in emissivity and this must be taken into account before accurate readings can be obtained. The emissivity ratio represents the amount of radiated energy that the measured surface returns to the instrument. A return of 100% of the energy is measured as 1.0 emissivity. If all the radiated energy is reflected and/or transmitted and none emitted, the emissivity ratio is 0.0. A perfect radiator such as a black body, has a 1.0 emissivity ratio and a very shiny or highly-polished surface has a ratio of 0.2 or lower. Most textured or painted surfaces have an emissivity ratio of around 0.95. DHS40 Series Wahl Heat Spy thermometers feature adjustable emissivity from 0.10 to 1.00.



One of three things will happen to the energy as it reaches the sensor:

- **E - Emitted Energy** - Some energy will be absorbed and converted into heat.
- **R - Reflected Energy** - Some energy will be reflected from the surface of the material.
- **T - Transmitted Energy** - Some energy will be transmitted completely through the material.

As one or more of these three things must happen to the energy, the amount of energy absorbed, reflected and transmitted must add up to 100%. Therefore, the coefficients of absorption, reflection and transmission (E, R, and T) must equal 1.

The ideal material in non-contact temperature measurement and, in fact, the source against which instruments are calibrated is the black body. This is defined as a surface which emits the maximum amount of radiation at a given temperature. The name "black body" is misleading because it implies color - the color of the material is not as important as the surface finish. Materials which are good radiators (absorbers) and approximate black body conditions are carbon, asbestos, and rubber. Highly polished metals are poor black bodies and therefore good reflectors.

As long as the emissivity setting on the instrument is properly set with respect to the material being measured, all measurements with the infrared thermometer will be precise.

The emissivity can be determined by one of the following methods, in order of preference:

1. Determine the actual temperature of the material using a sensor such as a RTD, thermocouple or another suitable method. Next, measure the object temperature and adjust the emissivity setting until the correct value is reached. This is the correct emissivity for the measured material.

2. For relatively low temperature objects (up to 260°C or 500°F), place a piece of tape, such as a masking tape, on the object. Make sure the tape is large enough to cover the field of view. Next, measure the tape temperature using an emissivity setting of 0.95. Finally, measure an adjacent area on the object and adjust the emissivity setting until the same temperature is reached. This is the correct emissivity for the measured material.

3. If a portion of the surface of the object can be coated, use a flat black paint, which will have an emissivity of about 0.98. Next, measure the painted area using an emissivity setting of 0.98. Finally, measure an adjacent area on the object and adjust the emissivity setting until the same temperature is reached. This is the correct emissivity for the measured material.

10.1. **Typical Emissivity Values**

The table in Appendix I provides a brief reference guide to determine emissivity and can be used when one of the above methods is not practical. Emissivity values shown in the table are only approximate, since several parameters may affect the emissivity of an object. These include the following ones:

1. Temperature
2. Angle of Measurement
3. Geometry (plane, concave, convex, etc.)
4. Thickness
5. Surface Quality (polished, rough, oxidized, sandblasted)
6. Spectral region of measurement
7. Transmissivity (e.g., thin film plastics)

To optimize surface temperature measurements, consider the following guidelines

1. Determine the object emissivity using the instrument to be used for the measurement.
2. Avoid reflections by shielding the object from surrounding high temperature sources.
3. For higher temperature objects, use the shortest wavelength instrument for your temperature range.
4. For semi-transparent materials such as plastic films and glasses, ensure that the background is uniform and lower in temperature than the object.
5. Mount or hold the sensor perpendicular to the surface whenever the emissivity is less than 0.90. In any case, do not exceed angles more than 30 degrees from incidence.

Return for Calibration Service

To receive a NIST Traceable Certificate of Conformance or repair service on your product, go to palmerwahl.com and click on: Request an RMA (Return Material Authorization Number) and follow the instructions. You will receive your RMA number via email once your item is received at our facility. If you prefer, call Customer Service at: 1-800-421-2853 for assistance with the RMA process. Material being returned to us should be packed well, preferably in the original shipping container.
Our quality management system is certified to conform to ISO 9001:2015. We maintain a calibration system in conformance with ANSI/NCSL Z-540 and MIL-STD-45662A.

All calibrations are performed against standard instruments, traceable to NIST. Records are stored for a minimum of three years. Standards used have a test ratio of four times greater than the unit being calibrated. We can perform certified, traceable calibrations in support of companies that require meeting FAA and FDA quality standards.

Palmer Wahl BEYOND THE SCALE

Palmer Wahl Instruments, Inc.
234 Old Weaverville Road
Asheville, NC 28804
Phone: 800-421-2853 • 828-658-3131
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Appendix I: Emissivity of Common Materials

Hints for Choosing and Using

Know your target
What is the emissivity? How clear is the optical (IR) path to the target? Are reflections a concern? What is the expected temperature range you will need to measure?

Know your spot size
The target must completely fill the sensitive area in order to get accurate readings.

Have realistic expectations
If you need to know the temperature within 1 degree Fahrenheit, you should use another technology, like a RTD contact probe.

Stabilization
Allow the IR thermometer to stabilize at the temperature where it will be used for at least 30 minutes for an accurate reading.

Keep the lens clean
Also watch out for dusty or vapor-filled optical paths.

Accuracy concerns
If accuracy is a concern, buy a model with adjustable emissivity. If you're just looking for "hot spots" a fixed emissivity model will work well.

Always remember
You are only measuring surface temperature. If you need the temperature of a mixture, use an immersion probe and an electronic thermometer.

How It Works

All solid objects emit infrared energy above absolute zero. The amount of energy emitted is proportional to the body temperature. Wahl's Heat Spy® directs this energy by means of fixed focus optics into a sensitive detector, which is amplified and processed by the computer to temperature readings in °F or °C. It is fast, because IR energy travels at the speed of light, and the detector has a very low mass. The time constant is 0.1 second, about 10 times faster than conventional contact methods. Measurements are displayed in less than one second.

When to Use

Temperature at a Distance
You can stand 1 to 40 feet away and conveniently measure temperature of bearings, kilns, and furnace walls. You can locate hot spots in reactor shells, steam piping, and insulation surfaces. Specialty models can be used to up to 300 feet away from your temperature target.

Temperature of Moving Material

Moving materials require two Heat Spy features not available by any other method: non-contact with the process material, and fast-measurement of rapidly moving materials. Measure continuously moving solid materials like plastic film and extrusions, pulp and paper, textiles, rubber, steel sheets, coating, or painting.

Temperature of Small, Low Mass Material

Electronic components or other small or low mass items can be measured with a Wahl Heat Spy, where a contact thermometer would change the measured condition through heat transfer.

Temperature of areas too hot for personnel

In foundries, forging shops, glass factories and power plants, the Wahl Heat Spy allows you to stand away from the heat or high voltage.

Temperature of Rough Surfaces

The Wahl Heat Spy does not require contact with the target. It measures rough and uneven surfaces and averages temperature readings of the observed target area. It affords users an efficient method of measuring the temperature of granular materials, rough castings, and forgings.

Temperature requiring quick measurement

Opening and closing of injection molding dies requires temperature to be measured in less than 2 seconds. The Wahl Heat Spy is ideal for use with rotating machinery, like large motor armatures and drive couplings.

Emissivity Table

Metals

Spectral Range	1.0 µm	1.6 µm	2.3 µm	5.1 µm	8-14 µm
Aluminum					
Non-Oxidized	0.1-0.2	0.02-0.2	0.02-0.2	0.02-0.2	0.02-0.1
Oxidized	0.4	0.4	0.2-0.4	0.2-0.4	0.2-0.4
Alloy A 3003					
Oxidized	--	0.4	0.4	0.4	0.3
Roughened	0.2-0.8	0.2-0.6	0.2-0.6	0.1-0.4	0.1-0.3
Polished	0.1-0.2	0.02-0.1	0.02-0.1	0.02-0.1	0.02-0.1
Brass					
Polished	0.8-0.95	0.01-0.05	0.01-0.05	0.01-0.05	0.01-0.05
Burnished	--	--	0.4	0.3	0.3
Oxidized	0.6	0.6	0.6	0.5	0.5
Carbon					
Non-oxidized	0.8-0.95	0.8-0.9	0.8-0.9	0.8-0.9	0.8-0.9
Graphite	0.8-0.9	0.8-0.9	0.8-0.9	0.7-0.9	0.7-0.8
Chromium	0.4	0.4	0.05-0.3	0.03-0.3	0.02-0.2
Copper					
Polished	0.05	0.03	0.03	0.03	0-03
Roughened	0.05-0.2	0.05-0.2	0.05-0.2	0.05-0.15	0.05-0.1
Oxidized	0.2-0.8	0.2-0.9	0.7-0.9	0.5-0.8	0.4-0.8
Gold	0.3	0.01-0.1	0.01-0.1	0.01-0.1	0.01-0.1
Haynes Alloy	0.5-0.9	0.6-0.9	0.6-0.9	0.3-0.8	0.3-0.8
Inconel					
Oxidized	0.4-0.9	0.6-0.9	0.6-0.9	0.6-0.9	0.7-0.95
Sandblasted	0.3-0.4	0.3-0.6	0.3-0.6	0.3-0.6	0.3-0.6
Electropolished	0.2-0.5	0.25	0.25	0.15	0.15
Iron					
Oxidized	0.4-0.8	0.5-0.9	0.5-0.9	0.6-0.9	0.5-0.9
Non-oxidized	0.35	0.1-0.3	0.1-0.3	0.05-0.25	0.05-0.2
Rusted	--	0.6-0.9	0.6-0.9	0.5-0.8	0.5-0.7
Molten	0.35	0.4-0.6	0.4-0.6	--	--
Iron, Cast					
Oxidized	0.7-0.9	0.7-0.9	0.7-0.9	0.65-0.95	0.6-0.95
Non-oxidized	0.35	0.3	0.1-0.3	0.25	0.2
Molten	0.35	0.3-0.4	0.3-0.4	0.2-0.3	0.2-0.3
Iron Wrought					
Dull	0.9	0.9	0.95	0.9	0.9
Lead					
Polished	0.35	0.05-0.2	0.05-0.2	0.05-0.2	0.05-0.1
Rough	0 65	0.6	0.6	0.4	0-4
Oxidized	--	0.3-0.7	0.3-0.7	0.2-0.6	0.2-0.6
Magnesium	0.3-0.8	0.05-0.3	0.05-0.3	0.03-0.15	0.02-0.1
Mercury	--	0.05-0.15	0.05-0.15	0.05-0.15	0.05-0.15
Molybdenum					
Oxidized	0.5-0.9	0.4-0.9	0.4-0.9	0.3-0.7	0.2-0.6
Non-oxidized	0.25-0.35	0.1-0.3	0.1-0.3	0.1-0.15	0.1
Monel (Ni-Cu)	0.3	0.2-0.6	0.2-0.6	0.1-0.5	0.1-0.14
Nickel					
Oxidized	0.8-0.9	0.4-0.7	0.4-0.7	0.3-0.6	0.2-0.5
Electrolytic	0.2-0.4	0.1-0.3	0.1-0.3	0.1-0.15	0.05-0.15
Platinum					
Black	--	0.95	0.95	0.9	0.9
Silver	0.04	0.02	0.02	0.02	0.02

Spectral Range	1.0 µm	1.6 µm	2.3 µm	5.1 µm	8-14 µm
Steel					
Cold-Rolled	0.8-0.9	0.8-0.9	0.8-0.9	0.8-0.9	0.7-0.9
Ground Sheet	--	--	--	0.5-0.7	0.4-0.6
Polished Sheet	0.35	0.25	0.25	0.15	0.1
Molten	0.35	0.25-0.4	0.25-0.4	0.1-0.2	--
Oxidized	0.8-0.9	0.8-0.9	0.8-0.9	0.7-0.9	0.7-0.9
Stainless	0.35	0.2-0.9	0.2-0.9	0.15-0.8	0.1-0.8
Tin (Non-oxidized)	0.25	0.1-0.3	0.1-0.3	0.05	0.05
Titanium					
Polished	0.5-0.75	0.3-0.5	0.3-0.5	0.1-0.3	0.05-0.2
Oxidized	--	0.6-0.8	0.6-0.8	0.5-0.7	0.5-0.6
Tungsten		0.1-0.6	0.1-0.6	0.05-0.5	0.03
Polished	0.35-0.4	0.1-0.3	0.1-0.3	0.05-0.25	0.03-0.1
Zinc					
Oxidized	0.60	0.15	0.15	0.1	0.1
Polished	0.5	0.05	0.05	0.03	0.02

Non-Metals

Spectral Range	1.0 µm	1.6 µm	2.3 µm	5.1 µm	8-14 µm
Asbestos					
Asbestos	0.9	0.8	0.8	0.9	0.95
Asphalt	--	--	--	0.95	0.95
Basalt	--	--	--	0.7	0.7
Carborundum	--	0.95	0.95	0.9	0.9
Ceramic	0.4	0.8-0.95	0.8-0.95	0.85-0.95	0.95
Clay	--	0.8-0.95	0.8-0.95	0.85-0.95	0.95
Concrete	0.65	0.9	0.9	0.9	0.95
Cloth	--	--	--	0 95	0.95
Glass					
Plate	--	0.2	0.2	0.98	0.85
"Gob"	--	0.4-0.9	0.4-0.9	0.9	
Gravel	--	--	--	0.95	0.95
Gypsum	--	--	--	0.4-0.97	0.8-0.95
Ice	--	--	--	--	0.98
Limestone	--	--	--	0.4-0.98	0.98
Paint	--	--	--	--	0.9-0.95
Paper (any color)	--	--	--	0.95	0.95
Plastic (opaque, >20	--	--	--	0.95	0.95
Rubber	--	--	--	0.9	0.95
Sand	--	--	--	0.9	0.9
Snow	--	--	--	--	0.9
Soil	--	--	--	--	0.9-0.98
Water	--	--	--	--	0.93
Wood (natural)	--	--	--	0.9-0.95	0.9-0.95