410-VIS-IR REFLECTOMETER

Solar reflectance and thermal emittance measurements

The 410-Vis-IR joins the ET100 and 410-Solar or 410 Solar-i measurement heads in a single package for measuring solar reflectance/absorptance and thermal emittance. The ET100 measurement head collects directional reflectance from 1.5 to 21 µm to determine directional and total hemispherical emissivity. The 410-Solar models measure reflectance at near-normal incidence from 335-2500 nm. Easily switch between reflectance and emittance data collection with a single handle for data display and measurement controls.

BENEFITS

- **Complete spectral range**
  Reflectance, absorptance and emittance from 350 nm – 21 µm.
- **ASTM compliant**
  Compliant with ASTM E903, E408, C1549 & E1980.
- **No waiting**
  90 sec warm up, no equilibration between measurements.
- **Easy to use**
  Simply press port against sample and pull trigger.
- **Fast calibration**
  One minute calibration at start of measurement session.
- **Room temperature samples**
  Calculate emissivity without heating sample.

APPLICATIONS

- **Space Coatings**
  Thermal control | α/ε | Thermo-optical properties
- **Defense | Aerospace**
  IR Signature | Low observable paint & coatings
- **Cool Building Materials**
  TSR | SRI | ASTM | LEED | CRRC
- **Concentrated Solar**
  Mirror evaluation | Selective absorber coatings
- **Radiative Heat Transfer**
  Absorptance for thermal modeling
- **Semiconductors**
  Wafer fab hardware emissivity
- **Astronomy**
  Mirror evaluation

ORDERING

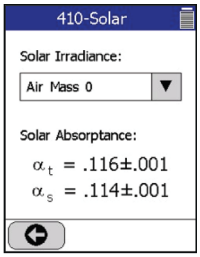
Standard components 410-Solar	0410-0011	410-Vis-IR Measurement Heads
	0410-0001	Handheld Command Module - 120VAC
	0410-0100	Specular Gold Calibration Coupon (Non-NIST Traceable)
	0410-0102	Diffuse Calibration Coupon (Non-NIST Traceable)
	0410-0103	Specular Calibration Coupon (Non-NIST Traceable)
Standard components 410-Solar-i	0410-0013	410-Vis-IR (Model i) Measurement Heads
	0410-0001	Handheld Command Module - 120VAC
	0410-0100	Specular Gold Calibration Coupon (Non-NIST Traceable)
	0410-0107	Glazed Ceramic Calibration Coupon (Non-NIST Traceable)
Options	0410-0002	Benchtop Remote Control Unit - 120VAC
	0410-0101	Specular Gold Calibration Coupon (NIST Traceable)
	0410-0106	Diffuse Calibration Coupon (NIST Traceable)
	0410-0104	Specular Calibration Coupon (NIST Traceable)
	0410-0123	Glazed Ceramic Calibration Coupon (NIST Traceable)
	0410-1015	410-Vis-IR Reflectometer Maintenance and Calibration Plan (Non-NIST)
	0410-1014	410-Vis-IR Reflectometer Maintenance and Calibration Plan (NIST)
	0410-1007	410-Vis-IR Extended Warranty
	0410-1012	410-Vis-IR (Model i) Extended Warranty
	0410-0200	Handheld Command Module - 220VAC
	0410-0019	Benchtop Remote Control Unit - 220VAC

CE Equipment described herein is subject to US export regulations and may require a license prior to export. Diversion contrary to US law is prohibited.

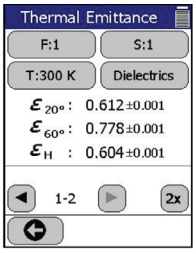
EXAMPLE MENU SCREENS

Measurement screen. Results are displayed on the liquid crystal display touchscreen, and stored on a SecureDigital (SD) card.

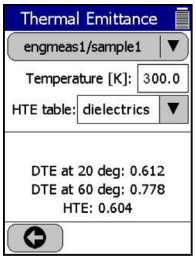
Solar absorptance calculation for the selected solar irradiance function.



Directional and hemispherical emittance measurement data screen.



Set temperature and material type for Hemispherical Thermal Emittance calculation.



SPECIFICATIONS 410-SOLAR, 410-SOLAR-i

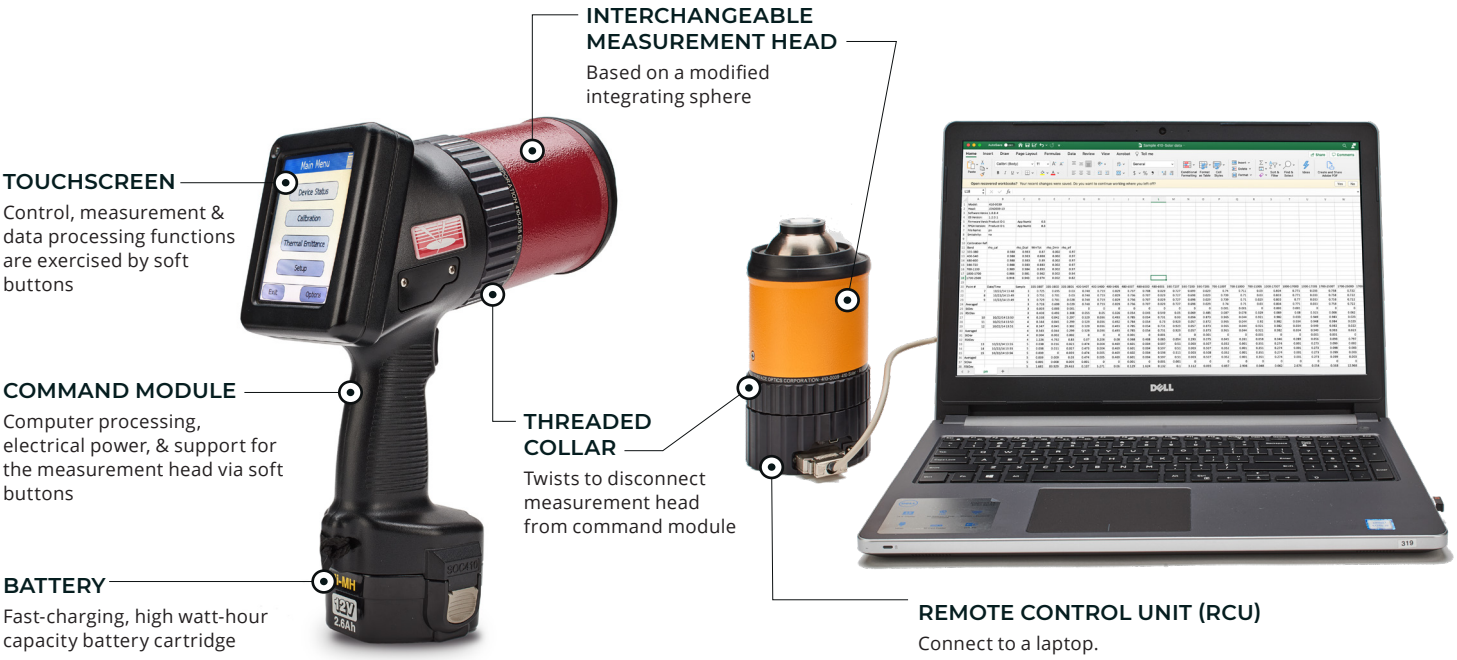
410 Solar or 410 Solar-i included in 410 Vis-IR Package.

	410-SOLAR	410-SOLAR-i
MEASURED DATA		
Measured Parameter	Directional hemispherical reflectance (DHR)	
Method	Integrated total reflectance in a band for a given angle of incidence	
Measured Value	Absolute reflectance (0-1), Diffuse Reflectance	Absolute reflectance (0-1)
Calculated Value	Total Solar reflectance, Solar absorptance, specular reflectance	Total Solar reflectance, Solar absorptance
Wavelength Bands (nm)	335-380, 400-540, 480-600, 590-720, 700-1100, 1000-1700, 1700-2500	
ASTM Standards	C1549 E1980 E903	
Angle of Incidence	20° from normal incidence	
Calibration Coupon	Specular, Diffuse	Glazed Ceramic
PERFORMANCE		
Accuracy	+/- .02	
Repeatability	±.005 units	
Beam Spot Size	0.25 inches	0.50 inches
Beam Angle	3° half cone angle	N/A
Measurement Time	10 seconds	7 seconds
Solar Irradiance Functions	Air Mass 0 (AM) Extraterrestrial irradiance (ASTM E490-00) Hazy sky AM1.5 beam-normal irradiance (ASTM E891-87) Clear sky AM1 global horizontal irradiance (SMARTS 2.9.5) Clear sky AM1.5 global irradiance surface tilted 37° (ASTM G173-03) Clear sky AM1.5 global irradiance surface tilted 20° (ASTM G197-14) Clear sky AM1.5 global irradiance surface tilted 90° (ASTM G197-14) Clear sky AM1.5 global horizontal irradiance (SMARTS 2.9.5) Clear sky AM2.0 global horizontal irradiance (SMARTS 2.9.5)	
Sample Size and Geometry	Flat: ≥ 0.5 in. diameter Curved: 6 in. convex; 12 in. concave	
Warm Up Time	90 seconds	
Time Between Measurements	2 seconds	
Sample Temperature	Ambient or heated/cooled to 0 - 100° C	
Operating Temperature	0° to 40° C	
POWER		
Run Time	2 hours on one battery. Battery easily replaced with continuous operation after battery replacement.	
Power Source	Rechargeable battery (standard environmentally friendly NiMH)	
Battery Recharge Time	1 hour	
VIS-NIR Source	Tungsten filament, temperature controlled by user	
DIMENSIONS		
Weight	4.7 lbs. (2.13 kg)	
Form Factor/Size	H 11.54 in., L 9.04 in., W 3.27 in. (29.31 cm x 22.96 cm x 9.44 cm)	
INTERFACE		
Operator Interface	LCD graphics screen, 1/4 VGA, touch screen, software buttons; trigger switch in handle	
Diagnostics	On screen status and signals monitor. Signal values stored with data. Raw data collection and display.	
MISCELLANEOUS		
Format	Data files can be opened and post processed with Excel or a text processor	
Storage	Removable SanDisk (SD) card	
Export control	ECCN #3A999.F	

SPECIFICATIONS ET-100

ET-100 included in 410 Vis-IR Package.

	ET-100
MEASURED DATA	
Measured Parameter	Directional hemispherical reflectance (DHR)
Method	Integrated total reflectance in a band for a given angle of incidence
Measured Value	Absolute reflectance (0-1)
Calculated Value	Directional thermal emissivity at 20°, directional thermal emissivity at 60°, hemispherical thermal emissivity
Wavelength Bands (microns)	1.5-2.0, 2.0-3.5, 3.0-4.0, 4.0-5.0, 5.0-10.5, 10.5-21
Angle of Incidence	20° & 60° from normal incidence
ASTM Standards	E903
Calibration Coupon	Specular Gold
PERFORMANCE	
Accuracy	+/- .03
Repeatability	±.005 units
Beam Spot Size	0.50 inches
Measurement Time	10 sec
Sample Size & Geometry	Flat: ≥ 0.5 in. diameter Curved: 6 in. convex; 12 in. concave
Warm Up Time	90 seconds
Time Between Measurements	2 seconds
Sample Temperature	Ambient or heated/cooled to 0 - 100° C
Operating Temp	0° to 40° C
POWER	
Run Time	2 hours on one battery. Battery easily replaced with continuous operation after battery replacement.
Power Source	Rechargeable battery (standard environmentally friendly NiMH)
Battery Recharge Time	1 hour
IR Source	Kanthal filament operated at about 1,000°C
ENVIRONMENT	
Storage	-25° to 70°C
Operating	0° to 40° C
DIMENSIONS	
Weight	4.7 lbs
Form Factor/Size	H 11.54", L 9.04", W 3.27" (29.31 cm x 22.96 cm x 9.44 cm)
INTERFACE	
Operator Interface	LCD graphics screen, 1/4 VGA, touch screen, software buttons; trigger switch in handle
Inspection Applications	Pass/fail can be incorporated, user set values
Diagnostics	On screen status and signals monitor. Signal values stored with data. Raw data collection and display.
MISCELLANEOUS	
Date Format	Data files can be opened and post processed with Excel or a text processor
Data Storage	Removable SanDisk (SD) card
Export control	ECCN #3A999.F



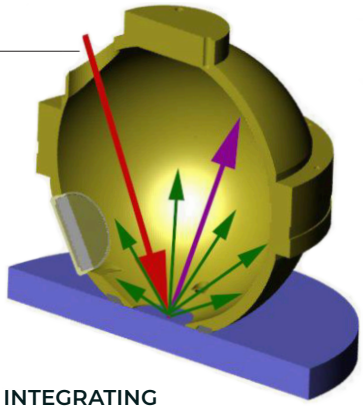
HANDHELD CONFIGURATION **BENCHTOP CONFIGURATION**

METHODOLOGY

The basic structure of a measurement head is an internal source, a modified integrating sphere, and detectors. The reflectance measurement is made by collimating the source beam onto the target, the energy is reflected back into the sphere, and eventually detected or dissipated.

The 410 Series Reflectometers measures the integrated surface reflectance of a surface at a given angle of incidence (20° or 60°). The integrating sphere captures the reflected light from the target material, integrating reflections in all directions. Wavelength-filtered detectors measure the total light reflected in each wavelength band and converts it to an analog electrical signal.

The 410 Series Reflectometer electronics processes the detector signals for initial amplification (fixed), filtering, offset adjustment, secondary amplification (variable), and analog to digital conversion. The digitized signals are read by the on-board processor, stored in memory, and then used to determine the target sample reflectance at each incident angle and wavelength band. Those reflectances are used to calculate additional properties such as directional thermal emittance or total hemispherical emittance. Results are displayed on the liquid crystal display touchscreen, and stored on a SecureDigital (SD) card.



INTEGRATING SPHERE SCHEMATIC

Schematic of the integrating sphere in contact with a sample.

Red arrow – illuminating beam

Purple arrow – reflected beam

Green arrows – scattered light

CALIBRATION COUPON

CALIBRATION

An easy calibration process is required before each measurement session. The software GUI will walk the user through the process. Calibration is performed using calibration coupon(s) with known reflectance values.

410 REFLECTOMETERS MODEL COMPARISON GUIDE

The SOC410 Series Reflectometers are portable contact measurement devices designed to take precise, accurate reflectance and emittance measurements. Made with an ergonomic power-drill design, the SOC410 Series lets you easily take measurements in-the-field or around the lab—no cords or external batteries necessary. The world's largest defense, aerospace, and energy companies rely on SOC410 data.

Model	410-Solar	410-Solar-i	410-VIS-IR	ET-100	ET-10	410-DHR
Spectral Bands	335 - 380 nm 400 - 540 nm 480 - 600 nm 590 - 720 nm 700 - 1100 nm 1000 - 1700 nm 1700 - 2500 nm	335 - 380 nm 400 - 540 nm 480 - 600 nm 590 - 720 nm 700 - 1100 nm 1000 - 1700 nm 1700 - 2500 nm	Dual measurement head package consisting of a 410-Solar model and ET100 measurement heads with a single command module	1.5 - 2.0 µm 2.0 - 3.5 µm 3.0 - 4.0 µm 4.0 - 5.0 µm 5.0 - 10.5 µm 10.5 - 21.0 µm	3.0-5.0 µm 8.0-12.0 µm	0.9 - 1.1 µm 1.9 - 2.4 µm 3.0 - 4.0 µm 3.0 - 5.0 µm 4.0 - 5.0 µm 8.0 - 12.0 µm
Calculated Properties	Total, diffuse & specular reflectance absorptance	Total reflectance/ absorptance		In-band total reflectance Directional thermal emissivity at 20° Directional thermal emissivity at 60° Hemispherical thermal emissivity	Directional thermal emissivity at 20°	In-band total reflectance In-band emissivity
Angle of Incidence	20°	20°		20° and 60°	20°	20° and 60°
Calibration Coupon(s)	Solar Diffuse Solar Specular	Glazed Ceramic		Specular Gold	Specular Gold	Specular Gold
ASTM Compliance	C1549 E903 E1980	C1549 E903 E1980		E408 E1980		N/A

SURFACE OPTICS CORPORATION

11555 Rancho Bernardo Road
San Diego, CA 92127

For Information and Ordering

Email: contact@surfaceoptics.com
Phone: +1 858 675-7404
Website: surfaceoptics.com

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