SOLAR SPECTRUM REFLECTOMETER
Model SSR version 6

The SSR version 6 Electronics Package and Measurement Head

AEROSPACE
Thermal control surfaces

CONTROL & CONSERVATION
Films
Coatings

SOLAR ENERGY
Absorber coatings
Reflective coatings
Mirrors and reflectors

Introduction

The Solar Spectrum Reflectometer, Model SSR-ER features a selectable solar measurement spectrum that matches a variety of global and beam normal solar irradiances. The SSR provides accurate measurements on both diffuse and specular materials, even second surface reflectors up to 0.25 inches (6.4 mm) thick. Solar reflectance or absorptance is displayed to 0.001 units, with a repeatability of 0.003 units.

The Measurement

A tungsten filament source provides diffuse illumination at the sample port. Radiation reflected by the sample is measured at an angle of 20 degrees from normal, with four filtered detectors. The detectors are designated UV, Blue, Red and IR indicating the primary wavelength range each covers. The relative response of each detector in combination with the light source has been designed to approximate the solar spectrum in its wavelength range. Two additional virtual detectors are added by re-sampling the Red and IR detectors at a lower color temperature. By summing the six outputs in the appropriate weightings, a solar measurement spectrum is obtained. Each instrument is spectrally calibrated against a set of reference tiles to determine the optimum weightings. SSR solar reflectance readings for a typical solar irradiance model match spectrophotometer measurements with a bias of 0.002 or less and a standard deviation of about 0.005.

Diffuse and specular secondary standards are provided with the instrument for routine calibration. These materials are calibrated against National Bureau of Standards Materials that are maintained at D&S. Once the instrument is calibrated against one of these standards, reflectance is measured by placing the sample over the measurement port or by holding the measurement head against the surface.

In the default operating mode, the instrument cycles through a measurement once every eight seconds. The tungsten lamp remains off for six seconds while detector offset values are stored. The lamp comes on for two seconds and the reflectance readings for the six detectors are sampled and stored. A new solar reflectance value is calculated and displayed as the lamp is turned off.

Instrument Features

Using the keypad on the front of the electronics package, the operator can elect to display reflectance or absorptance for the selected solar spectrum. Reflectance or absorptance for one of the six individual detectors can also be displayed.

Calibration and adjustment of the measurement spectrum against one of the supplied standards is accomplished with a single key stroke. Calibration data for up to five additional standards can be saved in memory, permitting the use of working standards other than those supplied.

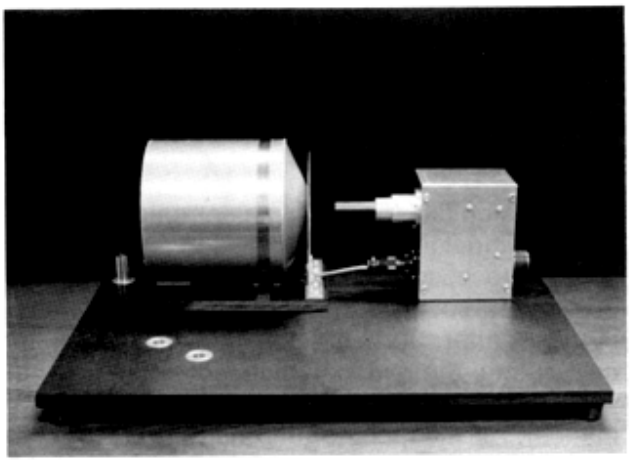
Options

Custom Adapters: Adapters can be designed to measure reflectance for non-flat surfaces. Adapters for cylindrical surfaces with diameters as small as 0.50 inch (13 mm) have been made. A collar is attached to the measurement head that allows different adapters to be attached and does not interfere with normal operation of the instrument. The adapter is machined to fit the specified surface and allows the surface to be positioned repeatably over the measurement port. Calibration standards and special instructions are supplied with the adapter. Operation of the instrument for non-flat surfaces is identical to that for flat surfaces.

Handle: For ease of use when the measurement head must be held in place against the sample.

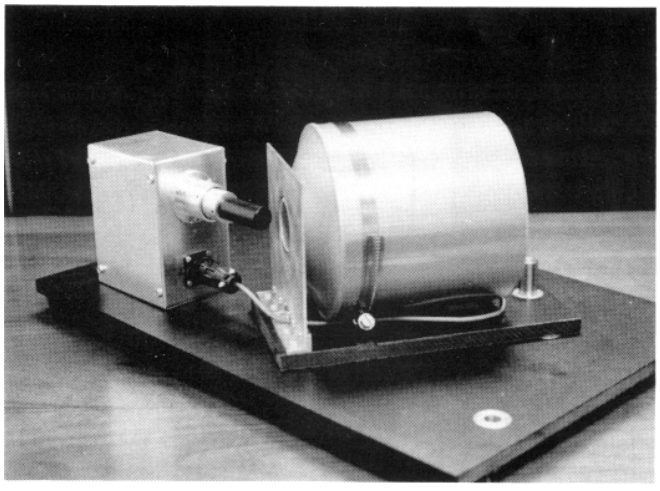
12V Portable Power System Option: To make the D&S Solar Spectrum Reflectometer Model SSR-ER portable, an optional battery pack can be attached. The battery pack comes with its own rechargeable battery, charging system, and carrying case. The SSR-ER will operate for up to 5 continuous hours when connected to the 12V Battery Pack.

Transmittance Attachment: The D&S Transmittance Attachment, Model SSR-T, is plug compatible with the SSR-R reflectance head and enables the instrument to be used for total solar transmittance measurements.



Transmittance Attachment: light source and sample stage to the left; detector to the right.

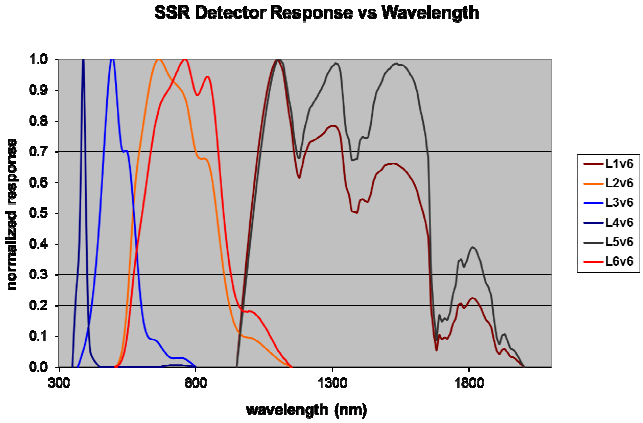
Transmittance can be measured at angles from normal to 60 degrees off normal. A diffuse radiation source illuminates a one and a half inch diameter sample port and transmitted energy is measured with six detectors.



Light source and sample stage rotated to measure transmittance at 60 degrees.

Specifications

Measurement Spectrum: To match the various solar spectra, the weightings for the six detectors are determined by spectral calibration with a set of reference reflectance tiles. By creating a custom set of weightings for each instrument, the matches to the solar spectra are optimized and instrument to instrument variation is minimized.



The selection of solar irradiance matches is listed below.

ASTM G173 air mass 1.5 global irradiance
ASTM G173 air mass 1.5 beam normal component
Air mass 1 global irradiance on a horizontal surface
Air mass 1 beam normal component
Air mass 1 diffuse component
Air mass 0 beam normal
ASTM E891-87 air mass 1.5 beam normal
Emulation of version 5 air mass 2 beam normal
Emulation of version 5 air mass 1.5 beam normal
Emulation of version 5 air mass 0 beam normal
IR, Red, Blue and UV detector readings at ~3125K lamp
IR and Red detector readings at ~ 2300K lamp

Matches to irradiance models that may be adopted as standards in the future can be substituted by uploading to RAM or installing a firmware upgrade.

Resolution: Four (4) digit liquid crystal digital display indicates reflectance, absorptance and transmittance to 0.001 units.

Repeatability: +/- 0.003 units.

Accuracy: As calibrated, for a typical solar irradiance match, a bias of +/- 0.002 and a standard deviation of 0.005 for the spectral calibration tile set.

Drift: After 5 minutes warm-up, drift is less than +/- (1% of reading + 0.003)/hour.

Temperature: Max. operating temperature, Electronics package 140 F (60 C). Measurement Head and Transmittance Attachment 120 F (50 C).

Humidity: 80% maximum for operation or storage.

Calibration Standards: Diffuse and Specular Standards are provided. These are secondary standards that are calibrated against NBS standards, numbers 2019 and 2023. Calibration data for the standards is programmed in read only memory in the electronics package, and is provided on a calibration record.

Measurement Port: The reflectance measurement port is 1 inch (2.54 cm) in diameter. The sample rests on a thin Teflon gasket that rings the port. This gasket protects the surface of the sample from being marred by the measurement process. Minimum sample size is 1.1 inch (2.8 cm) in diameter. The transmittance measurement port is 1.5 inch (3.8 cm) in diameter. The sample rests against a support plate. Minimum sample size is 1.65 inches (4.2 cm) across.

Lamp: Plug in replaceable tungsten-halogen lamp.

Reflectance Measurement: A single tungsten halogen lamp provides diffuse illumination at the measurement port. The energy reflected from a sample placed over the port is measured at an angle of 20 degrees to the normal to the surface. By a reciprocity relationship, this measurement corresponds to the reflectance of the surface for direct radiation incident at 20 degrees from the normal.

Transmittance Measurement: The sample is illuminated diffusely, and transmitted energy is measured in a small solid angle at 0 to 60 degrees from normal. By reciprocity, this measurement is equivalent to the transmittance of the material for beam radiation incident at the angle of interest.

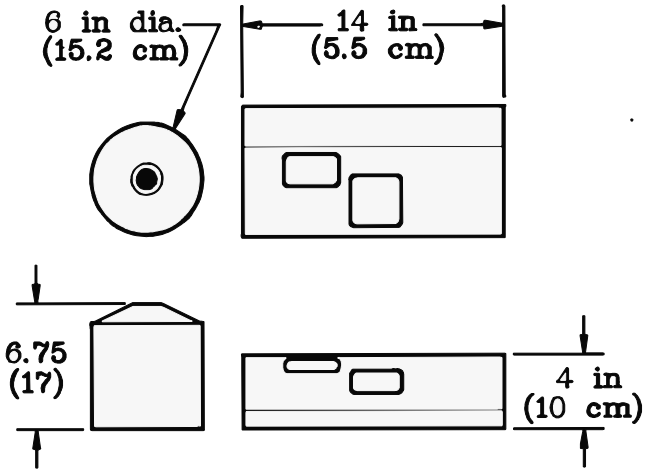
Power Requirement: 100-240 VAC, 50 to 60 Hz, universal power adapter supplied with modular power cord.

Carrying Case: Carrying case with cutouts for the electronics package, measurement head, cable, standards, spare parts and other options (not including Transmittance Attachment).

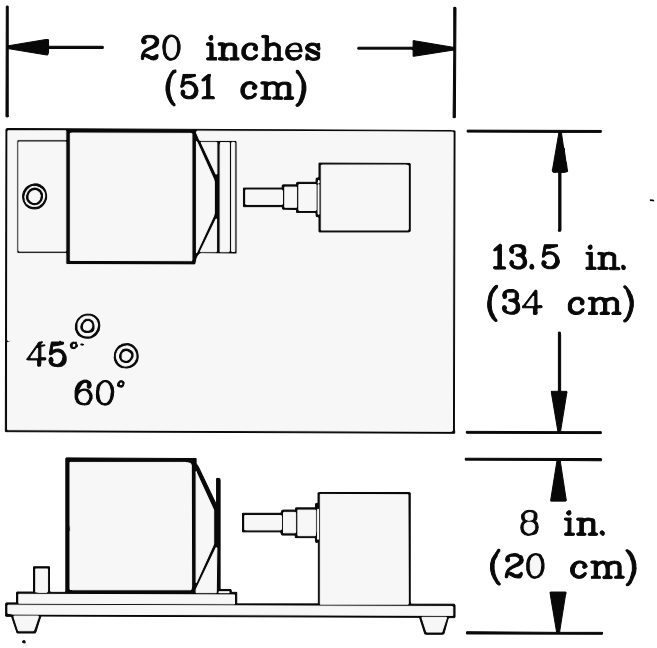
Cable: Flexible cable that connects reflectance or transmittance measurement head to electronics package. Standard cable length is 5 feet (1.5 m). Optional cable length to 32 feet (10 m).

Weights: Measurement Head, 2 lbs. (0.9 kg); Electronics Assembly, 4 lbs. (1.8 kg); Transmittance Attachment, 10 lbs. (4.5 kg).

Physical Dimensions, SSR-ER



Physical Dimensions, SSR-T:



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