Augustyn & Company
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Measuring the Sun since 1983

Field Reference Irradiance Measurement System (FRIMS)

The FRIMS is a light-weight, easily transportable solar radiation measurement system providing the lowest practically attainable field irradiance measurement uncertainties of direct beam and horizontal diffuse for in-situ, field validation and calibration of operating solar measurement stations. It measures the two basic components of broadband solar radiation: direct beam and diffuse on a horizontal surface, from which total horizontal irradiance can be readily and most accurately derived.

The FRIMS was developed in the process of validating and calibrating measurements from over 135 solar measurement stations installed by Augustyn & Company world-wide since 2007. NREL recommended its use to validate the measurement accuracy of the 70+ stations of Saudi Arabia's RRMM solar measurement network developed and operated by King Adbullah City for Atomic and Renewable Energy.

The system comes in two rugged carrying cases weighing under 7 and 12 kg respectively. The larger case measures 54 x 40 x 22 cm externally, and contains the reference irradiance sensors, mounts and tracking components. The smaller case measures 42 x 32 x 17 cm and contains the pre-programmed measurement and control unit with attached cabling and mounted GPS communication, meteorological sensors and control components. It can be unpacked and placed in operation in less than 30 minutes by a practiced technician.

FRIMS set up for first KA-CARE site validation near Riyadh

Cases w/ layered, custom-formed foam inserts

KACARE, Battelle, and NREL Marveling at FRIMS

The system provides measurements of direct beam irradiance using an ISO first class (secondary standard) pyrheliometer mounted on a compact two axis astronomical tracker with internal GPS along with a disk-shaded horizontally constructed thermopile pyranometer for diffuse measurement. Traceability to WRR is through manufacturer's sensor and data logger calibrations and/or through additional calibrations such as NREL's BORCAL service if available. As with any measurement system of this kind, even with use of the highest quality components available, its end-use accuracy or measurement uncertainty is strongly a function of operator technique and attention to detail during setup and operation of each validation or calibration event.

The Standard FRIMS Configuration includes:

1. Sensors: one secondary standard first class pyrheliometer (EKO MS56, or Kipp & Zonen CHP1/CH1, one pyranometer for diffuse horizontal measurements (Eppley 8-48 or Kipp & Zonen CMP-22, one Campbell Scientific HC2S3 sensor for air temperature and relative humidity, and one Campbell Scientific CS106 barometric pressure sensor.
2. Mounting apparatus: Consisting of a light weight, high quality carbon-fiber tripod, 12V DC powered automatic astronomical tracker and custom assembly of mounting fixtures, fasteners, and machined parts providing the necessary geometric arrangement and adjustment control to accurately align the pryheliometer and continuously shade the (diffuse) pyranometer.
3. A pre-programmed Campbell Scientific CR1000 data logger for data acquisition is mounted within its own separate padded water proof carrying case. This data logger is pre-wired, requiring field connection to only the reference irradiance sensors and an earth ground.
4. Power supply consisting of a small 12VDC rechargeable battery capable of running the FRIMIS system for up to 13 hours.
5. GPS Receiver to provide accurate automatic data logger clock time synchronization and location coordinates for solar geometry calculations.
6. A panel mounted push button switch and alarm buzzer are provided to initiate and indicate the start and progress of "Cleaning" events during which the operator checks and if necessary adjusts the alignment of the sensors. Measurements are paused during these events which typically occur every 30 to 60 minutes throughout the test period to make certain the most accurate reference measurements are being made..
7. A pre programmed and wired wireless access point mounted within the data logger case to allow connection to the FRIMS data logger during operation using either a Windows PC running Campbell Scientific LoggerNet Data logger communication Software, or using an Apple iPhone or iPad running Campbell Scientific's LoggerLink application.
8. A Campbell CR1000KB keyboard display to provide the easiest direct-connection to system control.
9. A Campbell CS I/O-to-USB Flash Memory Drive to allow continuous output data record capture from the FRIMS.

Options:

A. Calibration documentation can be provided for the sensors and data logger at additional charge.
B. Foldable PV module to extend the operating time of the standard power supply.
C. A second CS I/O-to-USB Flash Memory Drive can be included and used to retrieve and store data records generated by the system under test.
D. A limited number of additional Campbell Scientific CR800/1000 compatible sensors may be added.

The FRIMS is intended for use in short term tests and studies, and not designed for long-term unattended operation. It is typically set up and run for a partial or full day of measurements at a site on a day with clear and stable skies. At a minimum it can provide validation of the accuracy of measurements of an operating solar measurement system, but can also be used to develop a more comprehensive analyses and of calibration correction functions where the highest practically field-achievable accuracy is required.

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