Rs-5900 Electrically Calibrated Pyroelectric Radiometer

- **± 1% Absolute Accuracy**
- **Spectrally Flat, UV to far-IR**
- **Radiometric Transfer Standard**
- **Traceable to NIST Electrical Standards**

The Rs-5900 Electrically Calibrated Pyroelectric Radiometer (ECPR) System is a ±1% absolute accuracy radiometer, developed in conjunction with NIST to be a transfer standard for the visible to mid-IR range. It can measure the total power and irradiance of free-space sources, or the total power exiting an optical fiber.

The standard ECPR System measures total power and irradiance of cw sources, from 5 μW to 100 mW, 0.25-3.0 μm, with ±1% absolute accuracy. Option RsIR expands the wavelength range to beyond 20 μm, and with the RsFO optical fiber option the ECPR becomes the definitive transfer standard for fiber optic power meters.

The most common application for the ECPR is to transfer an absolute radiometric calibration to another detector or light source with a high degree of accuracy. This is accomplished by measuring either the total power (Watts) of collimated sources that underfill the detector aperture or the irradiance (W/cm^2) of extended sources that overfill the precision 0.5 cm^2 detector aperture. The exceptionally flat spectral response insures broadband sources are measured with the same accuracy as monochromatic light, allowing the ECPR to calibrate visible and IR detectors, standard lamps, blackbody emitters, laser power meters, UV exposure meters, etc.

The ECPR System is composed of the Rs-5900 Readout, RsP-590 Pyroelectric Probe, and CTX-515 Optical Chopper. It operates as a fixed-frequency lock-in amplifier system, where the CTX-515 Chopper both modulates the optical signal impinging on the RsP-590 Probe and provides the reference signal to the lock-in circuitry in the Rs-5900 Readout. Further, the ECPR employs a unique auto-nulling electrical substitution technique that precisely generates and measures an electrical signal equivalent to the optical signal incident on the RsP-590 Probe, thereby allowing direct traceability to NIST electrical standards.

The Rs-5900 Readout displays the optical power in a 4½ digit scientific notation format. LED enunciators indicate the active measurement status (Watts or W/cm^2), the active probe (RsP-590 Pyroelectric or RsP-595 Silicon), the selected averaging time (Fast or Slow), and if the Autorange function is engaged. The Mode enunciator indicates whether the ECPR is in

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power measurement or system test mode. A 12-button keypad allows for numeric entry and selection of system functions such as Units (Watts and dBm), Range select, Autoranging, Calibration Factor Recall/Store, and the various Test Modes.

The ECPR provides access to various signal test points for system test and calibration, including the Preamp Out, Direct Out (0-10VDC analog out corresponding to the mantissa) and Mixer Out (synchronous rectifier output), along with a 0-10VDC input for direct testing of the A/D.

The rear-panel BCD connector is a bit-parallel, digit-serial computer interface that outputs a digital representation of the mantissa and exponent for remote data collection.

The optional RsP-595 Silicon Probe is used to verify the calibration of the RsP-590 Pyroelectric Probe. The RsP-595 is calibrated to better than ±1% accuracy at the HeNe laser wavelength (632.8 nm). When the RsP-590 and RsP-595 are compared at that wavelength they should agree to better than 1%.

The RsP-590 Probe consists of a Pyroelectric detector assembly and preamplifier in a common housing. The gold-black coating on the detector surface functions as both a spectrally flat absorber for the incident optical radiation and the heating resistor for the auto-nulling electrical substitution servo-loop circuit. A precision-etched 0.5 cm^2 detector aperture allows for easy irradiance measurements. The front of the Probe housing is threaded to accept windows and other accessories.

Available window materials include Suprasil and KRS-5, blank window holders are available as well. The RsIR Option provides spectral correction factors to extend the ±1% system accuracy to >20 μm. Option RsFO consists of a fiber adapter that mounts on the front of the RsP-590 Probe and a 15 Hz signal generator circuit in the Rs-5900 Readout that can be used to modulate the light source (LED, laser diode, etc.). The RsFO fiber adapter can accept up to 500 μm diameter fiber, with a maximum numerical aperture of 0.98.

The CTX-515 is a 15 Hz, 50% duty cycle optical chopper. The 1 inch diameter aperture can be rotated to adjust the phase relationship between the optical signal and the electrical reference signal. The chopper can be set for normal operation or test mode. In normal operation the chopper blade spins, in test mode the blade does not spin but the TTL sync signal is active.

What sets the ECPR apart from other radiometers is the electrical substitution technique it employs. This is composed of two primary subsystems, the analog servo-loop and the digital measurement/control system. When the chopper is open the pyroelectric detector produces a thermal signal proportional to the optical power incident on the gold-black absorber material. When the chopper shuts the servo-loop generates electrical current pulses that pass through the gold-black, which now functions as a precision heating resistor. This electrical power (I^2xR) causes the pyroelectric detector to produce a thermal signal proportional to the electrical power. The servo-loop increases the magnitude of the current pulses until the null condition is reached at the output of the synchronous rectifier circuit. At this point the optical power is equal to the electrical power, and the electrical power is digitized and displayed. This makes the ECPR virtually immune to ambient fluctuations, as the auto-nulling occurs at every chopper cycle.

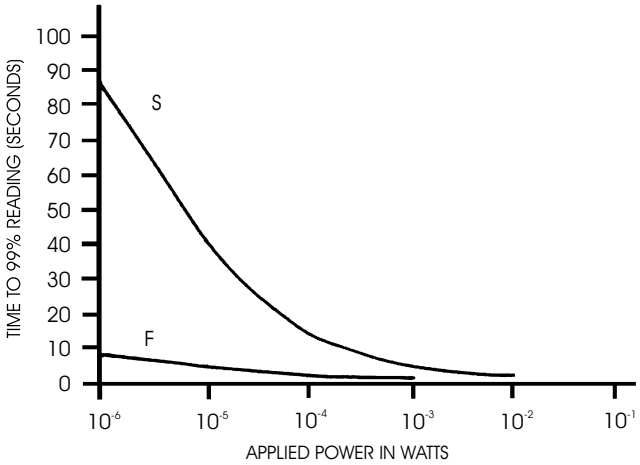
The ECPR also incorporates frequency sensitive AC voltmeter (lock-in amplifier) circuitry that automatically rejects any input optical signal that is not frequency matched to the chopping rate, thereby insuring that any optical radiation that strikes the detector without having passed through the optical chopper is ignored. This further reduces ambient drift and maximizes signal-to-noise ratio.

It is important to note that most electrically calibrated radiometers employ a resistive heating element that is physically independent of the detector's optical absorbing surface, which means that any changes in the detector's absorption characteristics are not accounted for in the electrical calibration. In the ECPR, however, the gold-black optical absorber is also the resistive heating element, so once the differences between optically and electrically heating the gold-black are characterized (the electro-optical equivalence factor) the system is balanced. Thus, a small change to the gold-black absorber will effect the electrical and optical heating equally, and consequently be nulled out.

The Rs-5900 ECPR System is provided with a certificate of calibration showing traceability to the National Institute of Standards and Technology (NIST) and compliance with MIL-45662 and ANSI-Z540 Sections 7-18.

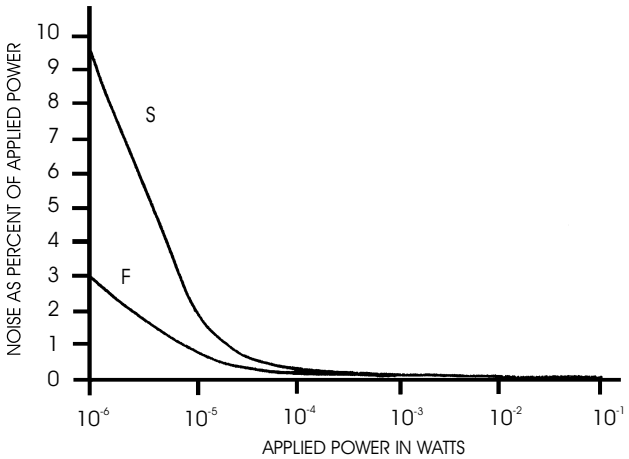
SPECIFICATIONS

System uncertainty	± 1%, 2σ limits (0.25-2.0 μm)
Electrical substitute accuracy	± 0.1%
Scale ratio accuracy	± 0.1%
Full scale ranges	5; 9.999 E-6 W to 9.999 E-2 W
Resolution	0.015% of F.S.
System response time	see curve 1
Spectral response	see curve 3
Maximum total power	100 mW
Maximum power density	200 mW/cm^2
Noise equivalent power	see curve 2
Detector aperture dimensions	7.98 mm (0.5 cm^2)
Det. plane to aperture distance	0.445 cm
Chopping frequency	15 Hz ± 0.1 Hz; 50% duty cycle
Analog output	0-9.99 VDC, voltage = mantissa value
Power supply	120/240 ± 10% VAC; 50-60 Hz
Temperature range	0°C to 40°C operating; -20°C to 70°C storage
Dimensions:	
Rs-5900 (l x w x h)	28.0 cm x 28.5 cm x 9.0 cm (11.0" x 11.2" x 3.5")
RsP-590 (dia x depth)	6.4 cm x 9.6 cm (2.5" x 3.8")
CTX-515 (dia x depth)	15.2 cm x 6.4 cm (6.0" x 2.5")
Weight (system)	7.0 kg (15.0 lb)



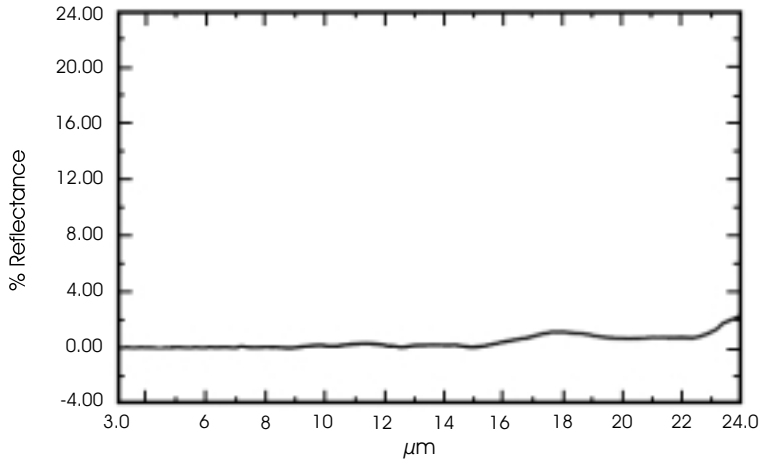
NOTE: FAST RESPONSE NOT USABLE FOR POWER LEVELS GREATER THAN 10 mW.

CURVE 1 SYSTEM REPSONSE TIME (STANDARD SYSTEM)

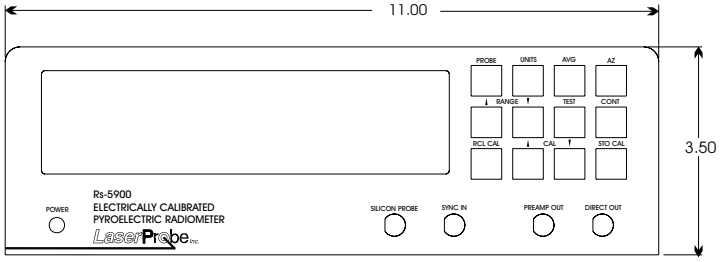


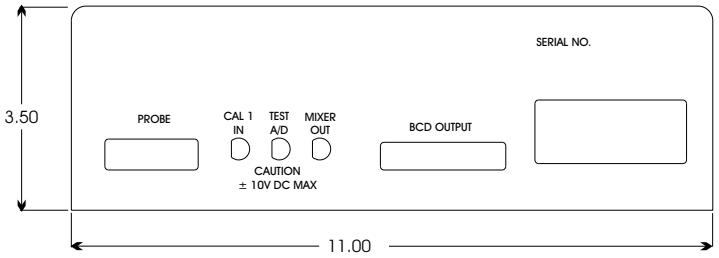
NOTE: FAST RESPONSE NOT USABLE FOR POWER LEVELS GREATER THAN 10 mW.

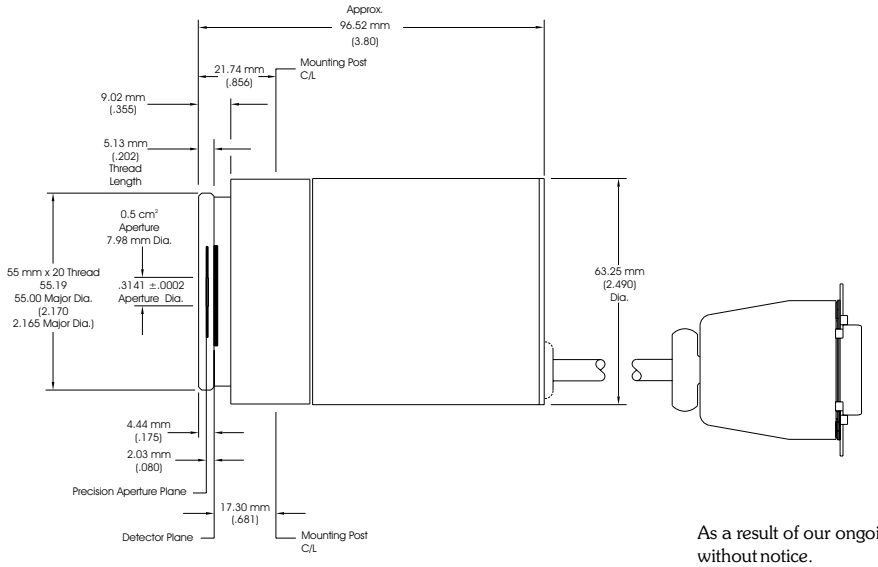
CURVE 2 NOISE EQUIVALENT POWER (STANDARD SYSTEM)

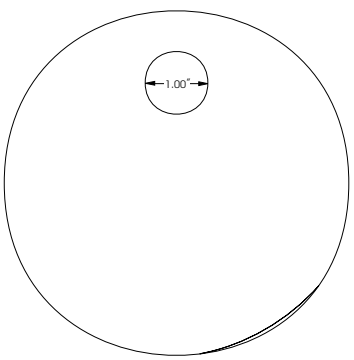


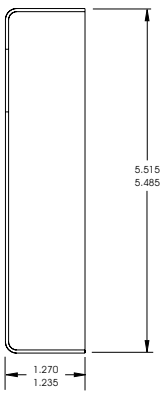
CURVE 3 SPECTRAL RESPONSE











As a result of our ongoing commitment to product improvement specifications are subject to change without notice.

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