

REPORT OF CALIBRATION

for

**One Cooled Lead Sulfide (PbS) Detector
OL 730-PbS-C, S/N: 15100021**

**Calibration Date: April 28, 2015
Certification Date: April 30, 2015
Project No: 917-154**



Gooch & Housego

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for

One Cooled Lead Sulfide (PbS) Detector

Customer: Rochester Institute of Technology
Rochester, NY 14623

Purchase Order No: 165044

1. Material.

One Gooch & Housego OL 730-PbS-C Cooled PbS Detector (S/N: 15100021), consisting of a 3 mm x 3 mm detector and an OL 730-TE Cooler Controller (S/N: 15100092)^{1/}, was calibrated for spectral irradiance response in $[V_{SQP \cdot P} / (W/cm^2)]$ ^{1/} when modulated at a frequency of 167 Hz.

2. Method of Calibration and Standards.

Calibration of the OL 730-PbS-C PbS Detector for spectral irradiance response involves the following two step procedure:

- 1) An absolute spectral response calibration (167 Hz) is performed at a wavelength of 1400 nm relative to a NIST traceable OL 740-16C Standard Detector 93101092. For these measurements, an OL 750D Automated Spectroradiometric Measurement System configured for measuring detector spectral response is used in the transfer calibration (see Figure 1).

GOOCH & HOUSEGO'S GENERAL SETUP FOR DETECTOR RESPONSE MEASUREMENTS

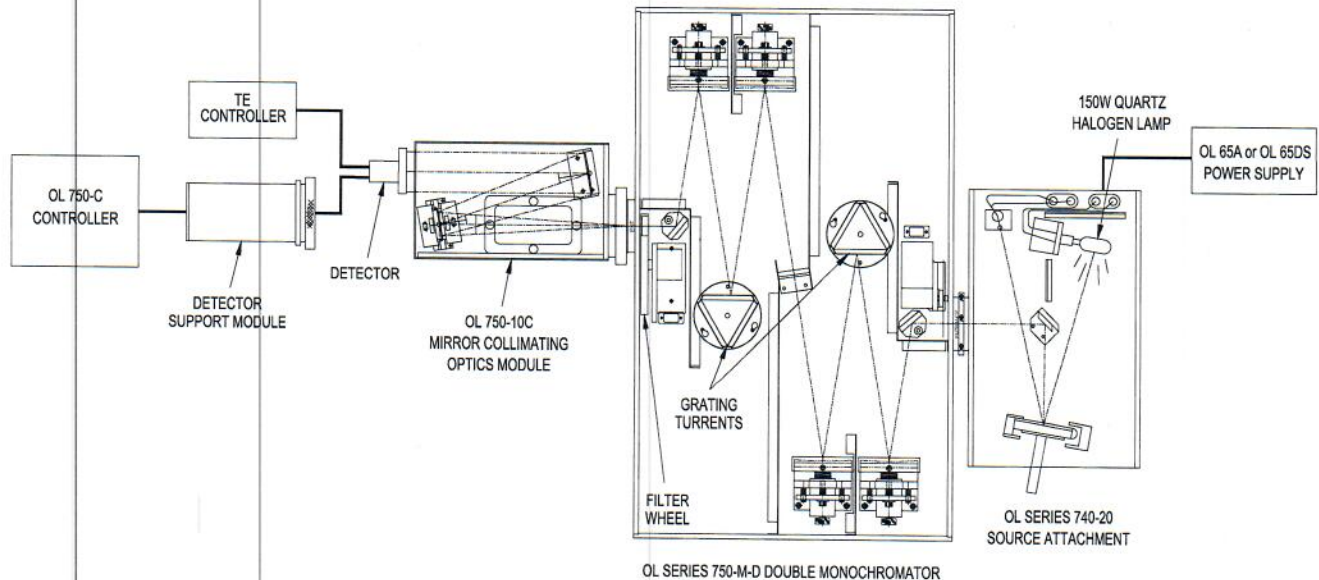


Figure 1

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^{1/} The units $[V_{SQUARE\ PEAK-PEAK} / (W/cm^2)]$ will be referred to as $[V_{SQP \cdot P} / (W/cm^2)]$.

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ORIGINAL: HOST\REPORTS(R)\LAMPTEMPLATES\730PbS POWER.E.G&H.DOT
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The entire sensitive area of the test detector is irradiated with monochromatic irradiance. The half-bandwidth of the monochromator is set to 8 nm. The uncertainty in the calibration of the test detector relative to the NIST detector scale is estimated to be $\pm 1.0\%$. General Information on the calibration procedure along with the NIST traceable standards and estimated uncertainties are described in the attached Information Sheet, "The Gooch & Housego Calibration of Photodetectors."

The calibration of Standard Detector 93101092 is directly traceable to Gooch & Housego's NIST calibrated Standard Germanium Detector 07200011 (NIST Test No. 685/282174).

The ambient temperature was 22.5 °C and the relative humidity was less than 60 %.

- 2) The relative spectral response of the test detector is determined relative to Standard OL 740-16C Germanium Detector 93101092 (1.0 μm to 1.4 μm) and OL 740-6C High Sensitivity PbSe Module 95101037 (1.4 μm to 3.2 μm). The measurements are performed using an OL 750D Automated Spectroradiometric Measurement System configured for operation over the entire 1.0 μm to 3.2 μm wavelength range. The estimated uncertainty in the transfer calibration from the OL 740-16C Germanium and OL 740-6C PbSe detectors to the OL 730-PbS-C Detector varies with wavelength as follows:

Wavelength (μm)	Uncertainty ($k=2$) (%)
1.0 to 2.5	2.0
2.5 to 3.2	2.5


The relative response of the OL 740-6C PbSe detector is based on the OL 740-17 Thermal Detector 90101055 (1.0 μm to 5.5 μm). The relative spectral response calibration for OL 740-17 Thermal Detector 90101055 was performed by the National Physical Laboratory (Reference: 2011090249).

3. Results.


Spectral irradiance response values (167 Hz) in $[\text{V}_{\text{SQP}} \cdot \text{p}/(\text{W}/\text{cm}^2)]$ are given in Table 1 (a graphical representation is provided). A compact disc containing the spectral values is also provided. The bias voltage from the OL 730-TE Cooler Controller was recorded at 0.5666 Volts (-12.2 °C).

This report of calibration shall not be reproduced, except in full, without written approval of Gooch & Housego, Orlando, Florida.

Calibration Certified By:
GOOCH & HOUSEGO


Deborah Griffith
Calibration Lab Manager

Reviewed By:


Bart Lovell
Optical Technician

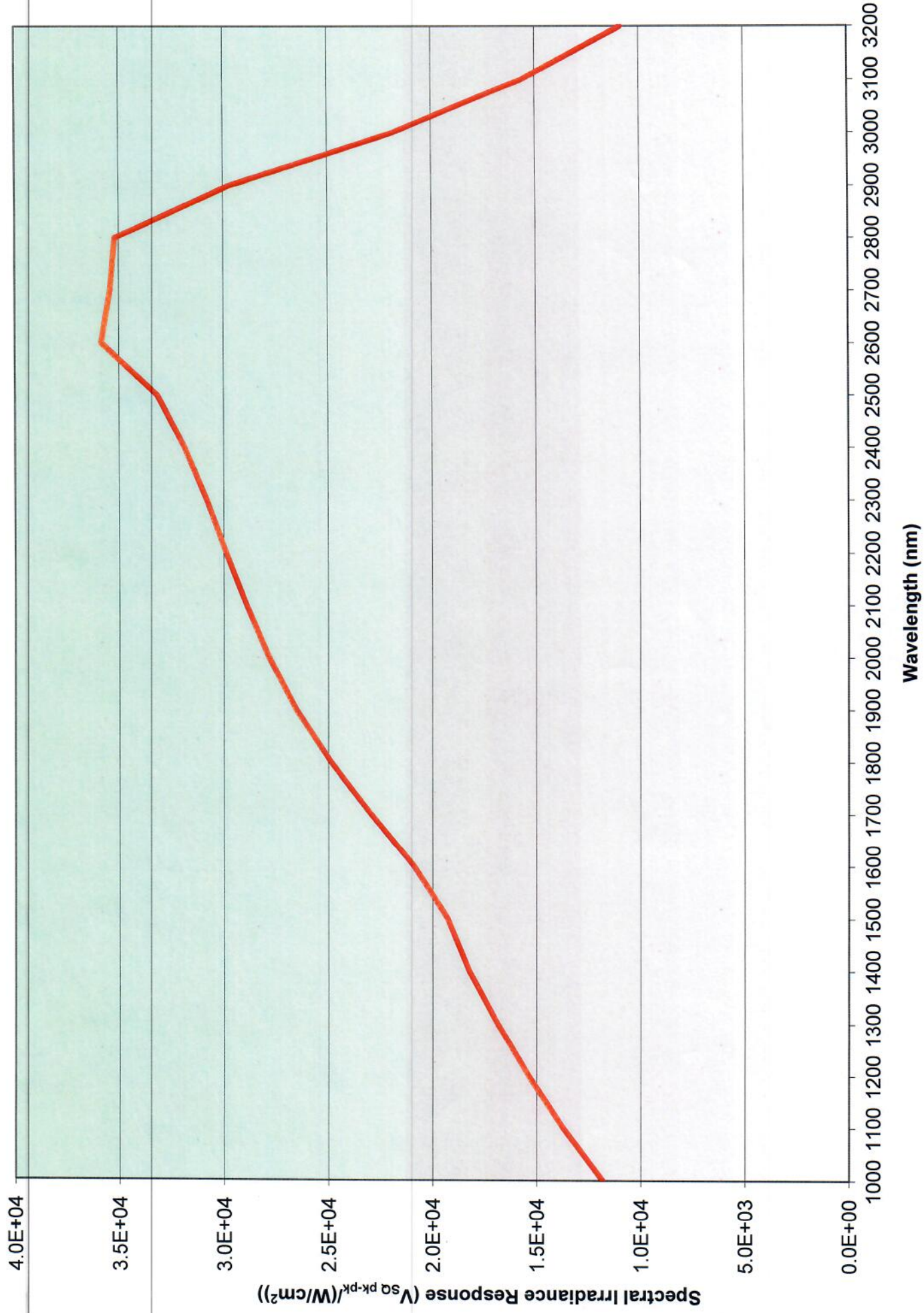
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TABLE 1

Spectral Irradiance Response of OL 730-PbS-C Cooled Lead Sulfide (PbS) Detector, S/N: 15100021

Wavelength [nm]	Response [V _{SQP} · P / (W / cm ²)]
1000	1.181E+04
1100	1.372E+04
1200	1.536E+04
1300	1.687E+04
1400	1.823E+04
1500	1.927E+04
1600	2.088E+04
1700	2.296E+04
1800	2.487E+04
1900	2.654E+04
2000	2.784E+04
2100	2.891E+04
2200	2.988E+04
2300	3.080E+04
2400	3.186E+04
2500	3.316E+04
2600	3.584E+04
2700	3.541E+04
2800	3.518E+04
2900	2.976E+04
3000	2.184E+04
3100	1.569E+04
3200	1.090E+04

Spectral Irradiance Response for OL 730-PbS-C S/N: 15100021



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Appendix A

OL 730D Programmable DSP Radiometer Configuration for OL 730-PbS-C Lead Sulfide Detector

AC with optical chopper and standard source (Connect the OL 730-PbS-C Output BNC to the 730D Voltage Input BNC) 730D Set-up	
RESPONSE TIME	Set response time for the OL 730-PbS Detector as follows: For the AC voltage square wave peak to peak mode response times are e^0 (0.5 second), e^{-1} (1 second), e^{-2} (2 seconds), and e^{-3} (3 seconds).
INPUT SOURCE	Set to AC VOLTAGE AC CPLG. This AC couples the signal.
SELECT MEASUREMENT	SQUARE INPUT, PK-PK. This will equate the measurement of the standard detector performed in the DC with the AC measurement units of the test detector.
SELECT REFERENCE	Set to CHOPPER REFERENCE
DYNAMIC RESERVE	0 db should be sufficient for these measurements.
SELECT NOTCH FILTERS	1X OUT 2X OUT. Unless calibration is performed in the presence of room light, no notch filtering should be required. If measurements are performed in the room light select 2X IN. Using this option during the calibration can affect the accuracy of the measurement when the reference frequency is in the proximity to the notch frequency (Q=4). Highest accuracy will be achieved without this filter.
REFERENCE FREQUENCY	167 Hz



Gooch & Housego

Introduction

Detector spectral response measurements over the wavelength range of 200 nm to 1800 nm are based directly on standard detectors supplied to Gooch & Housego by NIST (National Institute of Standards and Technology). All measurements made beyond 1800 nm are referenced to a heavily blackened thermal detector, which covers the entire 1.0 μm to 30 μm wavelength range. All primary detectors are calibrated in a uniform, semi-collimated beam, which irradiates the central portion of the detector's active area.

The Gooch & Housego Calibration of Photodetectors

Instrumentation

A typical configuration for spectral response measurements consists of Gooch & Housego's OL 750D Double Monochromator Automated Spectroradiometric Measurement System supplemented with the:

1. OL 740-20D/UV UV-Visible Dual Source Attachment
2. OL 740-20D/IR Visible-IR Dual Source Attachment
3. OL 750-10C Mirror Collimating Optics Module
4. OL 410-200 Precision Lamp Sources
5. OL 46D Deuterium Lamp Precision Current Source
6. OL 750-425 Detector Spectral Response Software Package

Appropriate gratings and blocking filters supplement the above equipment.

Measurement Procedure

Gooch & Housego has set up a series of calibrated UV-enhanced silicon detectors for the 200 nm to 1100 nm wavelength region and TE cooled germanium detectors for use over the range of 800 nm to 1800 nm. These detectors have been compared directly to the NIST calibrated detectors. All IR detector spectral response calibrations (with the exception of the Ge and InGaAs detectors) are based on a standard thermal detector. NPL (National Physical Laboratory) performed the relative spectral response curve for the standard thermal detector from 1.0 μm to 20 μm . The relative spectral response of the thermal detector from 20 μm to 30 μm was determined from a knowledge of the spectral reflectance of the blackened receiver and independently verified by comparison to a blackened, conical-shaped, thermopile detector. The absolute response of the thermal detector was determined by comparison to a NIST-traceable silicon detector at a wavelength of 1.0 μm . Accordingly, the absolute spectral response of the OL thermal detector was determined from a knowledge of the relative spectral response over the wavelength range of 1.0 μm to 30 μm and the absolute response at 1.0 μm .

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As part of our policy of continuous product improvement, we reserve the right to change specifications at any time

