Alternative Calibration methods of radiometric detectors

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Abstract

The usual way of calibrating detectors or devices is to treat them as black boxes. We measure the response when the device is excited with a well known signal. With this approach we throw away a lot of information that can be used to develop new calibration techniques. In the common European project *chip*S·CAL*e* (running from June 2019 – May 2022) we aim to develop self-induced silicon photodiodes capable of calibrating themselves in possibly remote operation. The trick is to exploit the intrinsic quantum properties of photodiodes that each photon generates exactly one electron – hole pair. This is a valid assumption to about 99.9% of common calibration standard photodiodes used in laboratories today when correcting for reflectance.

Two fundamentally different approaches are explored in the *chip*S·CAL*e* project. We are developing new simple structure photodiodes with improved quantum efficiency beyond the usual 99.9 % photon to electron conversion efficiency. Because the photodiodes has a simplified structure, their losses can be simulated with 3D simulation models. With simple I-V measurements at one wavelength only, a 3D model fit can be applied, and the responsivity from 400 nm to 850 nm can be predicted.

The second method is based on exploiting the photodiode as an electrical substitution radiometer in addition to its usual quantum mode. The incoming radiation is converted either to a photocurrent, as in a traditional photodiode, or to heat, using electrical substitution to determine the power of the absorbed radiation. The true internal quantum deficiency is measured by this method as it is the same absorber used in both application modes and heat is generated by forward bias of the photodiode using the same ammeter. Special type of packaging is required to operate the photodiode in dual mode and the technique is not in general limited to the use of self-induced photodiodes. However, if using a self-induced photodiode both approaches can be applied independently on the same device and the radiometric measurement of fundamental constants can be measured as a validation of the equivalence between the two independent methods.

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