Absolute Photodiode Response in Space Environments

Silicon photodiodes have long been used as absolute radiometric measurement standards in laboratory environments. The aging of photodiodes with time in fixed physical environments has also been well studied, the typical variation in sensitivity being less than 1% per year for all sources of change for select devices.

In a space environment, vacuum and ionizing radiation alter the reflectance, bulk silicon and junction properties. This and the inability to make complex measurements of the detector properties once in orbit complicate the possibility of using photodiodes in this environment.

We propose to study the suitability of silicon photodiodes for use as absolute radiometric measurement devices in space. We will perform a detailed literature investigation and other research ideally leading to a model for the behavior of silicon photodiodes as a function of radiation dose. We will also attempt to determine if such a model could be used to predict the change in sensitivity of a silicon photodiode as a function of other measured parameters - e.g. leakage current or forward voltage drop. A report or presentation will be prepared documenting this study.

The report will cover the following subjects:

1. Diodes as Radiometric Measurement Standards
    - 1.1. Solid state physics of photodetection in silicon diodes
    - 1.2. Use of diodes as standard detectors
    - 1.3. Detector types and architecture

2. Effects of the Space Environment
    - 2.1. Damage effects in silicon junctions and bulk
    - 2.2. Alterations in photodetection physics by radiation damage
    - 2.3. Solar Flux
        - 2.3.1. Heavy charged particles
        - 2.3.2. Light charged particles
    - 2.4. Neutrals
    - 2.5. Cosmic ray flux

3. Modeling Diode Photodetection
    - 3.1. Diode photodetection models
    - 3.2. Reverse current, forward voltage drop vs. silicon radiation dose

4. Photodetection modification vs. silicon dose

5. Monitoring Photodiode Performance
    - 5.1. System feasibility
    - 5.2. Self-correcting/monitoring schemes

6. Conclusions