AFBR-S4NxxPyy4M

NUV-MT SiPM Performance Correlation

The Broadcom® AFBR-S4NxxPyy4M is a silicon photomultiplier (SiPM) series that is used for ultra-sensitive precision measurements of single photons. These SiPMs are based on NUV-MT technology with a single photon avalanche diode (SPAD) pitch of 40 µm.

The SiPM performance in application systems depends on various performance parameters, such as the photon detection efficiency (PDE), noise characteristics (crosstalk, afterpulsing, and dark count rate), and gain. All of these parameters are a function of the applied overvoltage and must be tuned such that the overall performance at the system level is optimized in this multidimensional performance parameter space.

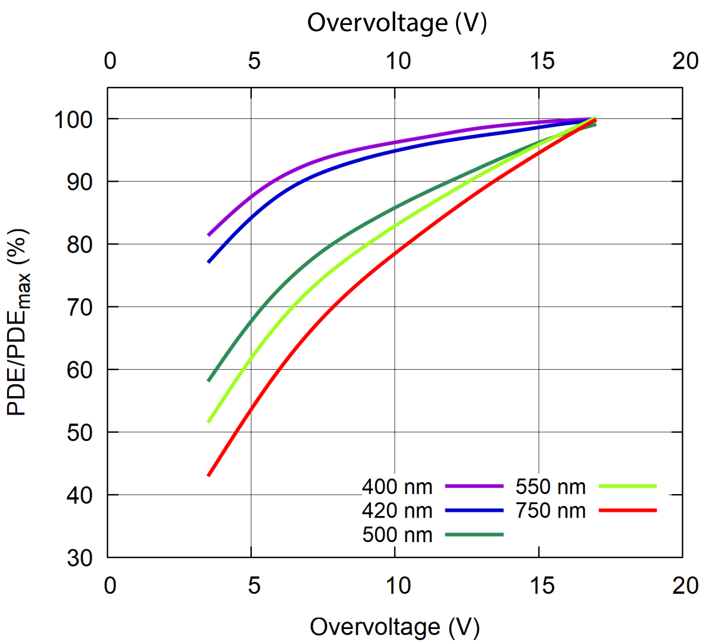
As a guideline, this application note provides correlation plots for different performance parameters. The typical operation point (12V overvoltage) as stated in the Broadcom NUV-MT SiPM data sheet is indicated by a red data point. The parameter that must be varied to obtain the performance parameter as shown in the following plots is the *applied bias voltage*.

PDE Saturation Point

The avalanche trigger probability in a SiPM increases with higher overvoltages until a specific maximum (saturation) is reached. From this overvoltage on, the PDE does not increase significantly anymore. The overvoltage at which trigger probability saturation occurs is wavelength dependent and tends to shift toward higher overvoltages for longer wavelengths. The following figure plots the PDE relative to the maximum reachable PDE at the given wavelengths as a function of the overvoltage. The increase of the PDE relative to the maximum is steeper for longer wavelengths, whereas for shorter wavelengths, PDE saturation is already reached for rather low overvoltages.

Consequently, for NUV and blue light, the overvoltage can be decreased to reduce SiPM noise, such as crosstalk and dark count rate, while still maintaining a high PDE.

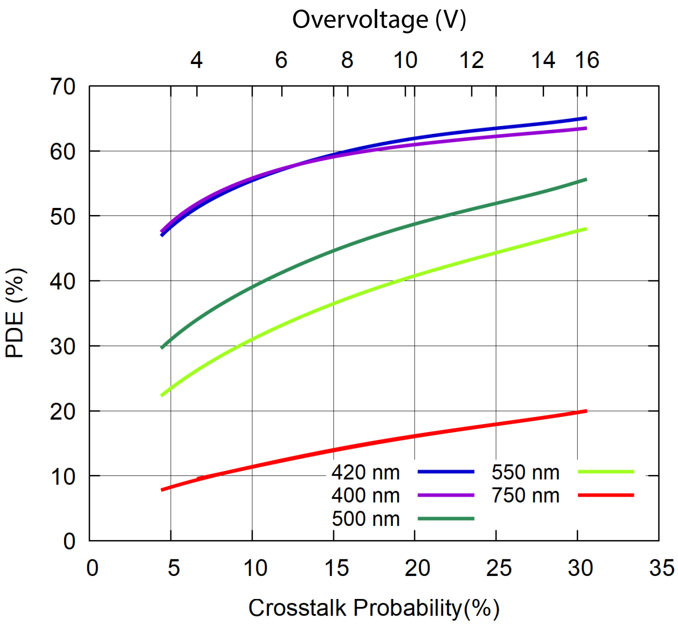
Figure 1: Relative PDE vs. Overvoltage

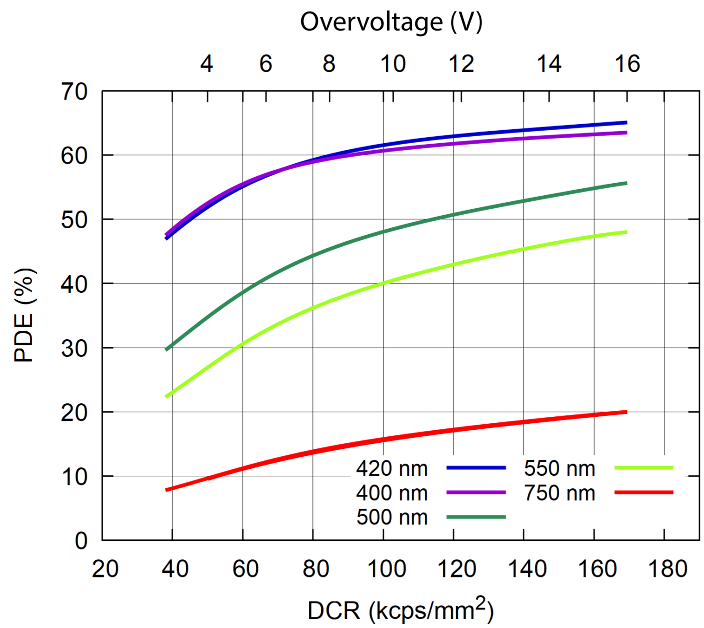


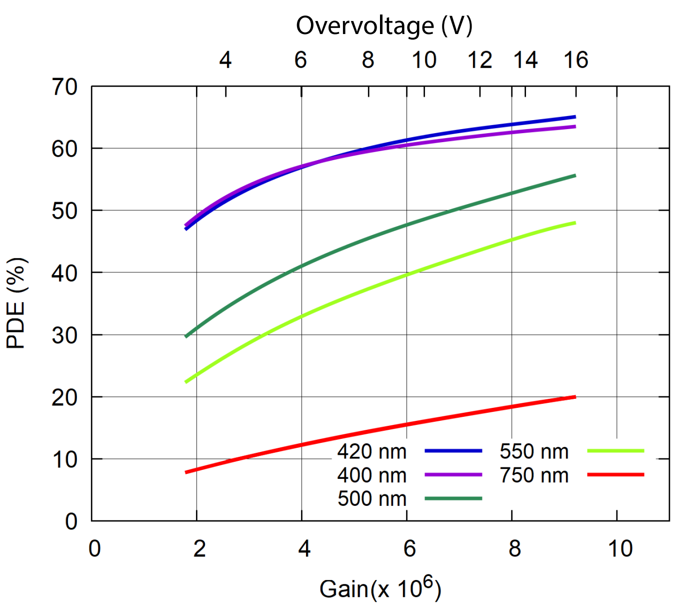
Photon Detection Efficiency

The following plots show the achievable PDE (at 420 nm) as a function of the crosstalk probability, the dark count rate, and the gain. The change in the parameters arises mainly from varying the applied overvoltage. The correlation is shown for 400 nm, 420 nm, 500 nm, 550 nm, and 750 nm.

Figure 2: PDE as a Function of the Crosstalk Probability, DCR, and Gain



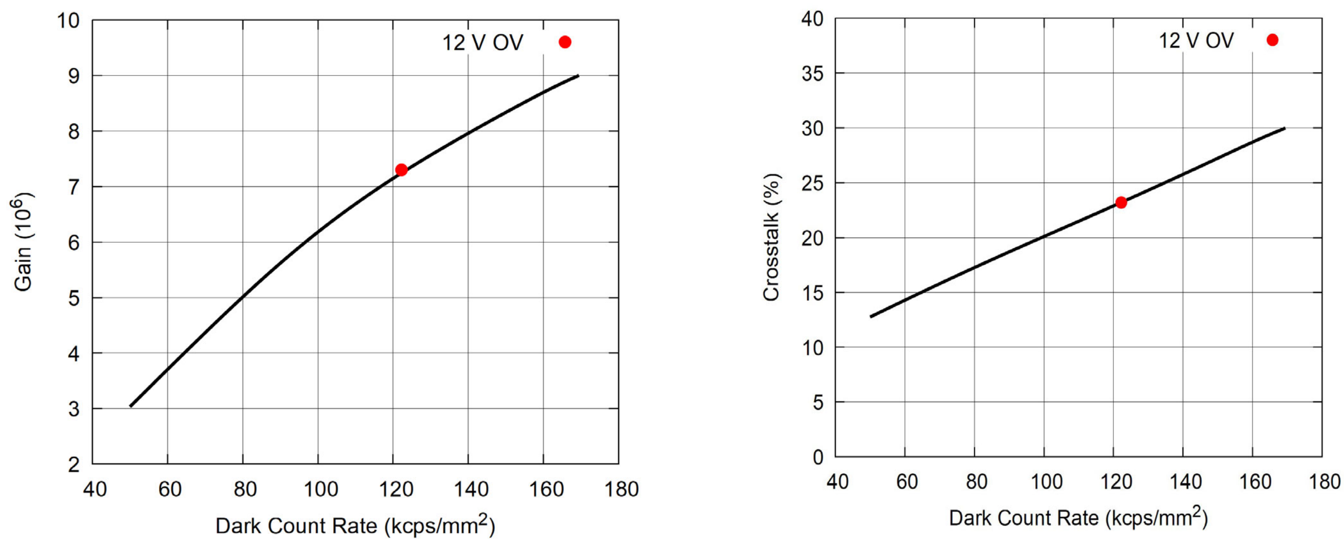




Dark Count Rate

The SiPM gain and the crosstalk probability as a function of the DCR are shown in the following figure.

Figure 3: DCR as a Function of the Gain (Left) and the Crosstalk (Right)



The change in the PDE slope represents the point where the SPAD reaches full depletion and the gain becomes predominantly a function the overvoltage. Contact sipm@broadcom.com for more details on the electrical parameters of the SiPM and their influence on the device performance.

Crosstalk vs. Gain

The following plot shows the SiPM gain as a function of the achievable crosstalk probability.

Figure 4: Gain as a Function of the Crosstalk