

Dark Current

Dark current refers to unwanted free electrons generated in the CCD due to thermal energy. The name dark current or dark charge comes from the fact that it has nothing to do with the incident light, and is generated equally well in complete darkness. Depending on where in the silicon these electrons are generated, some of the charge will get collected in the individual CCD pixels and contaminate signal electrons (generated from the image itself). At the CCD output, electrons generated from dark current look identical to signal generated electrons, so dark current appears as a noise source in the image.

At a given temperature, the average dark current in a given pixel is pretty much constant resulting in a fixed offset which is added to each pixel value. However, the dark current generation rate typically varies spatially across the array leading to a fixed background pattern which is superimposed on top of the desired image. Dark current generation is a random process and is actually composed of two components. A fixed average value (offset) which can be mathematically removed, plus a randomly varying part due to shot noise. The random portion of the dark current is given by the square root of the dark current collected in a given pixel and cannot be corrected. This added noise can easily make image data from a 12 bit camera no better than 8 bits.

Since dark current is thermally generated, one of the most common ways of reducing its impact on image quality is by making sure the image sensor stays cool. Camera cooling not only reduces the effects of dark current noise, but helps in providing more stable, repeatable image data.



Figure 1. Image with Dark Current Contamination (*Note white speckled background*)



Figure 2. Image without Dark Current Contamination (*Note clean background*)