Investigation of the Interdependency of Intrinsic Characteristics in a Single-Photon Counting Module via Electronic and Temperature Variation of Core Parameters

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Single Photon Avalanche Diode (SPAD) characteristics are substantially conditioned by the Silicon chip structure but are only brought to their limits by a sophisticated circuit. This study focuses on SPCM-COUNT®. It utilizes an ultra-low-noise silicon SPAD. COUNT® is completed by an active quenching circuit (AQC). In this context, the temperature and its management, as well as the overvoltage, are assumed to have the greatest impact on the SPCM performance.

The intrinsic SPAD characteristics, such as time dependent response and afterpulse probability (AP), were examined and discussed using a conventional active quenching circuit at the SPAD level. Subsequently, the influence of temperature and excess voltage was investigated.

A recently developed AQC establishes the Geiger-mode function of SPAD with short time-dependent values, provides suitable thermal management, appropriate overvoltage, and maximizes the essential characteristics. In this context, the quenching pulse width (QPW) is essential for optimizing the electrical parameters of a module. We examined the influence of QPW on dead time and timing jitter, and on the AP, indirectly varied through the dead time changes.

Our experiments led to QPWs corresponding to dead time values ranging from 25ns to 60ns, which are useful in the most applications. In the chip structure of the APD intrinsically anchored very low AP could rise over 1% for the shortest dead time of 25ns, but suppressed to even lower than 0.1% on the other scale end 60ns dead time. Other parameters remain stable through to the investigated dead time range, provided that a constant temperature is maintained.