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Quad-Detector for Simultaneous Beam Tracking and Communication in Long and Ultra-long Distance Wireless Optical Links

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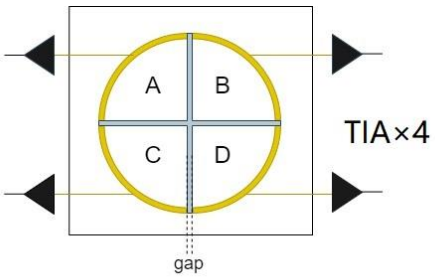
Abstract: We present in this paper Quad Detectors that are suitable for beam steering and high-speed data communication. The quad detector with the smallest active area shows the dark current of 4.3 nA with the junction capacitance of 123.5 fF, this indicates that the device would have a bandwidth that is suitable for 25Gb/s data rate communication. The responsivity is >0.9 A/W over O-band to C-band.

1. Introduction

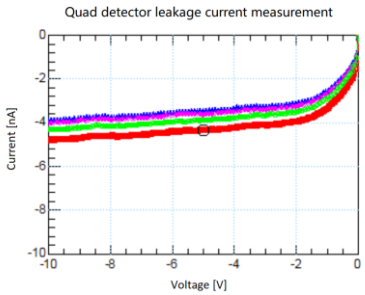
In long and ultra-long distance wireless optical links, photodetectors are used for beam tracking, data communication, wavefront detection and laser interferometry space antenna [5]. Quad detectors have been used as a position-sensitive detector for beam tracking in different free space optical communication systems [1,2]. A separate detector would be used for data communication. In recent years, there are publications that demonstrate the simultaneous beam steering and data communication with the same quad-detector [3,4]. In this work, we describe the combination of beam steering and data communication on one device with the use of heterostructure PIN photodiode.

2. Quad Detector Design and Characterization

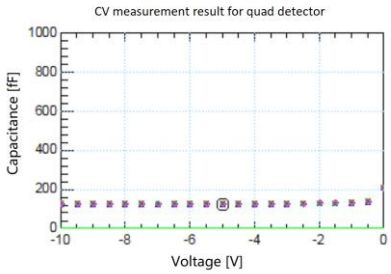
Detectors with various active area size and quadrant gap are designed and fabricated to investigate the trade-off between the requirement of large detector size for the easiness of beam steering and the requirement of a small detector size to achieve high bandwidth and sensitivity. Fig. 1 (a), shows a schematic of the quad-photodiode, the quadrants are separated with different gap size which is indicated by the cross in the middle. Each quadrant is connected to a TIA (transimpedance amplifier) for current readout. Fig. 1 (b) shows the measured leakage current of the smallest design till reverse bias 10V. The quadrant in this run indicates a leakage current of 4.3 nA at a reverse bias 5V. Fig. 3 shows the result of CV (capacitance-voltage) measurements. Each quadrant has the capacitance around 125 fF.



(a)



(b)



(c)

Fig. 1 (a), Top, Schematic of a large-area quad photoreceiver. (b), bottom left, leakage current measurement result of 4 quadrants under different reverse bias voltage (c), bottom right, CV measurement shows capacitance of each quadrant around 123.5 fF

3. Conclusions and Future Work

We demonstrate the results of quad-detector designs. The design variations we have covered both the need for beam steering and the need for data communication. The design space should cover the device that has the potential for simultaneous beam steering and data communication. Further evaluation and development will be required for device packaging and module integration. The system-level testing will be performed to find an optimum design for the dual function quad detector. Devices will be packaged in the future and assembled with receiver electronics to measure RF response and noise bandwidth performance.

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