Quasi optical Schottky Diode Detectors for fast Ultra-Wideband Detection

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***Abstract*— We present ultra-wideband zero-bias Schottky diode detector modules with monolithically integrated log-spiral antenna. Detectors exhibit a broad-band response with a stronger roll-off above 800 GHz and the minimum noise-equivalent power of 10 pW/√Hz. The intrinsic diode response time to a short THz radiation has been measured to be less than 25ps.**

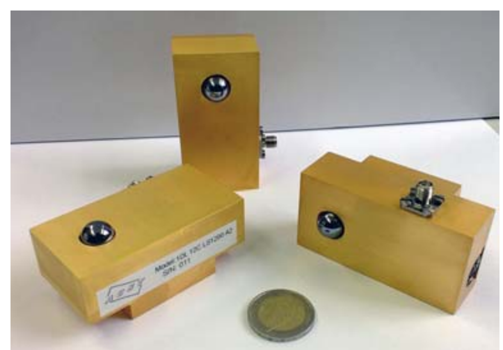
I. Introduction And Background

SCHOTTKY barrier diodes record a long history of being employed for detection of radiation at millimeter and sub-millimeter (nowadays called as Terahertz) wavelengths [1]. Compared with other room temperature detectors, such as pyroelectric detectors, Golay cells, thermocouples or bolometers, diodes offer a set of advantages because of their high sensitivity, ability to operate at an ambient or cryogenic temperature and short response time. Typically, the best performance at room-temperature conditions can be achieved for waveguide-coupled Schottky diode detectors with typical responsivities ranging from 4000 V/W at 100 GHz to about 400 V/W at 900 GHz and the minimum noise-equivalent powers of 1.5 pW/√Hz. However, the frequency bandwidth of waveguide-based detectors is limited, whereas for many applications such as terahertz (THz) spectroscopy, it is highly desirable to achieve wider operating bandwidths going to more broadband radiation coupling schemes [3,4]. This contribution presents a quasi-optical detector using a zero bias Schottky diode (ZBD) with a monolithically-integrated - broadband log-spiral antenna mounted on a silicon substrate lens.

II. Results

The ZBD with monolithically-integrated antenna has been fabricated using thin-film process [5] mounted on high-resistivity silicon substrate lens with a 6-mm radius and packaged into the detector modules. Modules are supplemented with either low-noise amplifiers for moderate signal modulations (from DC to 2 MHz) or a wide video-bandwidth (up to 6 GHz) amplifiers. The photograph with of three modules is presented in the top panel of Figure 1.

The frequency response spectra of the detectors have been characterized using a CW THz set-up which was based on a 850-nm TOPTICA photomixer source. Detector has been placed at the 13 cm distance from the CW source. Since no other beam-forming components have been used, the source produced at the position of the diode a slightly divergent radiation beam [6]. Because the source couples radiation out via a silicon lens similar to the lens in the diode module, the optical coupling between the source and the diode varied slightly with frequency. For referencing purposes, the frequency dependent power (resulting intensity) of the CW THz signal has been controlled with a Golay cell placed to the same position as the diode.



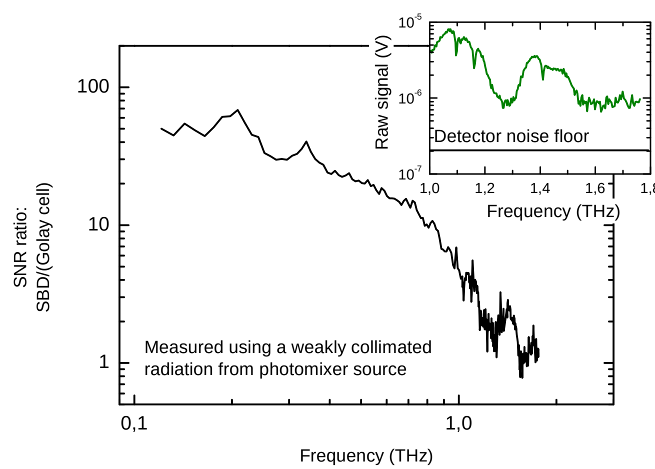


Fig. 1. Top: A photograph with three detector modules.
Bottom: Frequency response of a quasi-optical ZBD detector. The inset presents raw (not normalized) signal close to the maximally available 1.75-THz limit.