Deployment of a VNA-based test system for characterization of high-volume TO-housed devices

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There is nowadays a growing interest for high speed photodiodes operating in the mid-infrared (mid-IR) wavelength region [1], because of their potential application in free-space optic communication (FSO) links [2]. Alike fiber optic communication, in order to receive data of GB/s rate via FSO, one requires a specialized receiver optical sub-assembly (ROSA) consisting of a fast photodiode and an electrical preamplifier [3], to receive data at GB/s rate.

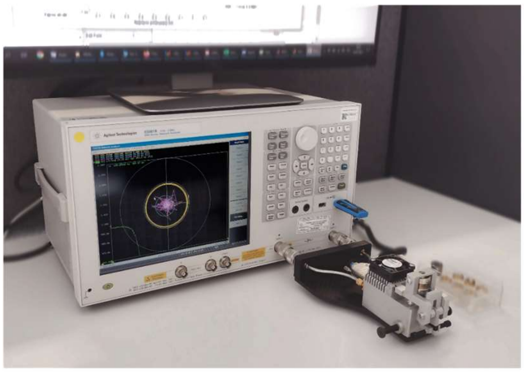

Fig. 1. Measurement system for TO-housed device characterization.

Currently, many customers pursue individual customization of ROSA designs and this may be attributed to a new Industry 4.0 trend - so-called mass-customization [4]. Undoubtedly, such postulates are revolutionizing the way factories manufacture, test and improve each of their product. Measuring and interpreting its results underlies those processes and broadband characterization and modeling of high-speed photodetectors with a vector network analyzer (VNA) is of key importance. Although, the use of an automated measurement probe station for the aforementioned task would provide the most effective way for the high-volume characterization, but such a solution is very expensive. Moreover, due to the design constrains, i.e. thermoelectric cooling [1], photodiodes are typically housed in Transistor Outline (TO) cans. Despite their widespread use, the TO package introduces undesirable shortcomings for radio frequency (RF) applications. Because photodiode structure exhibit large junction capacitance [5], the parasitic inductance of interconnects [6] causes undesirable damped oscillations to occur in ROSA's pulse response. Thus in order to meet individual customer's needs, such parasitic effect must be corrected with a near mass production efficiency.

Computer-aided (CAD) fine tuning of the preamplifier parameters is one the quickest and most efficient solution for the VIGO's manufacturing floor, since it allows for suppressing oscillations and maintaining sensor's nominal response speed. Such a flexible manufacturing solution requires, however, to provide a reliable equivalent circuit models and calibration and de-embedding for characterization of the TO-canned devices.

So far, we developed a low-cost specialized test fixture shown in Fig. 1 and described in [7], which at first allowed us to model interconnects for thermoelectrically cooled devices [6], while in [8] we demonstrated error-corrected measurements of small- and large-signal responses of the mid-IR photodetector, both, in frequency- and time-domain.

In this work we present a complete, vector network analyzer (VNA) based system for high-volume characterization of TO-housed devices. We demonstrate our in-house developed software for automatic extraction of the small-signal photodetectors' models as a function of the applied bias voltage. Moreover, it allows for separating their intrinsic (photodiode junction [9]) parameters from the extrinsic (interconnects [6]) ones. Compared to our previous works [6-9], our versatile turn-key solution provides equivalent circuit models which might be easily imported by industry-standard CAD software, e.g. SPICE and Microwave Office (MO) of Cadence.

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