The increased complexity and decreasing feature size of integrated circuits bring to the forefront the issues of non-destructive comprehensive and ubiquitous testing. Terahertz (THz) imaging has been used for testing VLSI [1] but the image quality is limited by the diffraction limit on the order of tens or even hundreds of microns because of a relatively long wavelength of the sub-THz and THz radiation. Using the laser terahertz emission microscopy for testing VLSI, the resolution could be improved to approximately 3 microns, which still might not be good enough for modern Very Large Scale Integration (VLSI) with feature sizes as small as 7 nm. As was first proposed in 1996 [2], field effect transistors (FETs) can be used as efficient detectors of the THz radiation using the excitation of propagating or overdamped plasma waves in the two-dimensional electronic fluid in the FET, even at zero bias. We have demonstrated that measuring the response between the pins of Monolithic Microwave Integrated Circuit (MMIC) allows for testing MMIC and even identifying the type of a fault. We showed that the measured MMIC response to the sub-terahertz (300 GHz) radiation is in qualitative agreement with the analytical theory of the overdamped plasmonic detection and used this response to establish and identify the MMIC faults. The bias and polarization dependences of the response measured between the different pins provide additional information about the faults location. In contrast to a more conventional terahertz imaging and testing techniques, this method does not have any resolution limitations, since it relies on the electronic response and not on imaging. The advantage of this non-destructive testing approach is also that the MMICs can be tested unbiased and several transistors within the circuit or the entire circuit can be tested fast. In contrast to other THz VLSI testing techniques, this method is capable of identifying individual transistor defects.

Fig. 1. Response to sub terahertz radiation on dc terminals for separate transistors in the virgin (a) and damaged (b) TGA4706-FC MMIC.