A Microwave-Operated Hot-Electron-Bolometric Power Detector for Terahertz Radiation

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Abstract — A new class of microwave-operated THz power detectors based on the NbN hot-electron-bolometer (HEB) mixer is proposed. The injected microwave signal (~1 GHz) serves the dual purpose of pumping the HEB element and enabling the read-out of the internal state of the device. A cryogenic amplifier amplifies the reflected microwave signal from the device and a homodyne scheme recovers the effects of the incident THz radiation. Two modes of operation have been identified, depending on the level of incident radiation. For weak signals, we use a chopper to chop the incident radiation against a black body reference and a lock-in amplifier to perform synchronous detection of the homodyne readout. The voltage measured is proportional to the incident power, and we estimate an optical noise equivalent power of ~5pW/√Hz at 0.83 THz. At higher signal levels the homodyne circuit recovers the stream of steady relaxation oscillation pulses from the HEB device. The frequency of these pulses is in the MHz frequency range and bears a linear relationship with the incident THz radiation over an input power range of ~15 dB. A digital frequency counter is used to measure THz power. The applicable power range is between 1 nW and 1 μW.

Keywords (Index Terms) — hot-electron-bolometer mixer, power measurement, THz radiation, direct detector, relaxation oscillations.