Abstracts

Suggestions for revised definitions of noise quantities, including quantum effects

A.R. Kerr. "Suggestions for revised definitions of noise quantities, including quantum effects." 1999 Transactions on Microwave Theory and Techniques 47.3 (Mar. 1999 [T-MTT]): 325-329.

Recent advances in millimeter- and submillimeter-wavelength receivers and the development of low-noise optical amplifiers focus attention on inconsistencies and ambiguities in the standard definitions of noise quantities and the procedures for measuring them. The difficulty is caused by the zero-point (quantum) noise hf/2 W/Hz, which is present even at absolute zero temperature, and also by the nonlinear dependence at low temperature of the thermal noise power of a resistor on its physical temperature, as given by the Planck law. Until recently, these effects were insignificant in all but the most exotic experiments, and the familiar Rayleigh-Jeans noise formula P=kT W/Hz could safely be used in most situations, Now, particularly in low-noise millimeter-wave and photonic devices, the quantum noise is prominent and the nonlinearity of the Planck law can no longer be neglected. The IEEE Standard Dictionary of Electrical and Electronics Terms gives several definitions of the noise temperature of a resistor or a port, which include: 1) the physical temperature of the resistor and 2) its available noise power density divided by Boltzmann's constant-definitions which are incompatible because of the nature of the Planck radiation law. In addition, there is no indication of whether the zero-point noise should be included as part of the noise temperature. Revised definitions of the common noise quantities are suggested, which resolve the shortcomings of the present definitions. The revised definitions have only a small effect on most RF and microwave measurements, but they provide a common consistent noise terminology from dc to light frequencies.

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