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**I R E STANDARDS ON ELECTRON TUBES:
DEFINITIONS OF TERMS, 1962 (62 I R E 7. S 2)**

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IRE Standards on Electron Tubes: Definitions of Terms, 1962* (62 IRE 7. S2)

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Effective Input Noise Temperature T_e (of a multiport transducer with one port designated as the output port). The *noise temperature* in degrees Kelvin which, assigned simultaneously to the specified impedance terminations at the set of frequencies contributing to the output, at all accessible ports except the designated output port of a noise-free equivalent of the transducer, would yield the same available power per unit bandwidth at a specified output frequency at the output port as that of the actual transducer connected to noise-free equivalents of the terminations at all ports except the output port.

Note 1: A noise-free equivalent of the transducer is one for which all internal (inaccessible) noise sources are removed, and for which the termination at the output port is noise-free.

Note 2: The effective input noise temperature may depend significantly on the impedance and the *noise temperature* of the termination at the output port at frequencies other than the specified output frequency.

Note 3: For a two-port transducer with a single input and a single output frequency the effective input noise temperature T_e is related to the *noise factor* F by the equation

$$T_e = 290(F - 1).$$

Effective Input Noise Temperature, Average $\bar{T}_e$ (of a multiport transducer with one port designated as the output port). The *noise temperature* in degrees Kelvin which, assigned simultaneously to the specified impedance terminations at all frequencies at all accessible ports except the designated output port of a noise-free equivalent of the transducer, would yield the same total noise power in a specified output band delivered to the output termination as that of the actual transducer connected to noise-free equivalents of the terminations at all ports except the output port.

Note 1: A noise-free equivalent of the transducer is one for which all internal (inaccessible) noise sources are removed and for which the termination at the output port is noise-free.

Note 2: The load is to be taken as noise-free over the output frequency band when determining the delivered output power.

Note 3: $\bar{T}_e$ may depend significantly on the impedances and averaged *noise temperatures* of the termination at the output port within frequency bands other than the specified output frequency band.

Note 4: For a two-port transducer with a single input and a single output frequency band, the average effective input noise temperature $\bar{T}_e$ is related to the *average noise factor* $\bar{F}$ by the equation

$$\bar{T}_e = 290(\bar{F} - 1).$$

Operating Noise Temperature T_{op} (of a system under operating conditions). The temperature in degrees Kelvin given by

$$T_{op} = \frac{N_0}{kG_s}$$

where N_0 is the output noise power per unit bandwidth at a specified output frequency flowing into the output circuit (under operating conditions), k is Boltzmann's constant, and G_s is the ratio of

- 1) the signal power delivered at the specified output frequency into the output circuit (under operating conditions) to
- 2) the signal power available at the corresponding input frequency or frequencies to the system (under operating conditions) at its accessible input terminations.

Note 1: In a nonlinear system T_{op} may be a function of the signal level.

Note 2: In a linear two-port transducer with a single input and a single output frequency, if the noise power originating in the output termination and reflected at the output port can be neglected, T_{op} is related to the *noise temperature* of the input termination T_i , and the *effective input noise temperature* T_e , by the equation

$$T_{op} = T_i + T_e.$$

Operating Noise Temperature, Average $\bar{T}_{op}$ (of a system under operating conditions). The temperature in degrees Kelvin given by

$$\bar{T}_{op} = \frac{N_{T_0}}{k\bar{G}_s B}$$

where N_{T_0} is the output noise power within a specified output frequency band flowing into the output circuit (under operating conditions), k is Boltzmann's constant.

$$\bar{G}_s B = \int_{f_1}^{f_2} G_s(f) df, \text{ and } G_s(f) \text{ is the ratio of}$$

- 1) the signal power delivered at output frequency into the output circuit (under operating conditions) to
- 2) the signal power available at the corresponding input frequency or frequencies to the system (under operating conditions) at its accessible input terminations and where the integration is performed over the specified output frequency band $B = f_2 - f_1$.

Note 1: In a nonlinear system $\bar{T}_{op}$ may be a function of the signal level.

Note 2: In a linear two-port transducer with single input and output frequency bands, if the noise power originating in the output termination and reflected at the output port can be neglected, $\bar{T}_{op}$ is related to the average of the *noise temperature* of the input termination $\bar{T}_i$, and the *average effective input noise temperature* $\bar{T}_e$ by the equation

$$\bar{T}_{op} = \bar{T}_i + \bar{T}_e.$$

