

## NOISE-INJECTION

## RADIOMETERS

The radiometer is a sensitive, accurate, calibrated receiver that is used for remote measurement of temperature. An object emits white noise in an amount proportional to its temperature. If noise power from the emitting object is applied to the input of a radiometer, it can be compared to the noise power of an internal white noise reference.

The noise-injection radiometer has significant advantages over other common radiometers, as it eliminates a majority of the measurement errors due to gain variation, radiometer noise figure, and impedance mismatching. A block diagram of the noise-injection radiometer concept is shown in Figure 1.

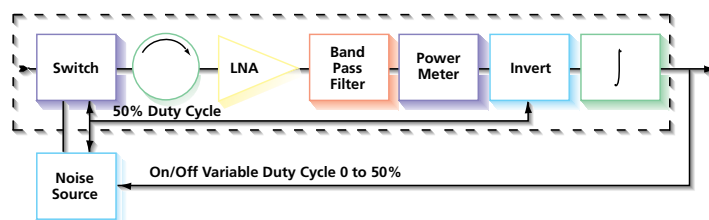


Figure 1. Noise-injection radiometer.

The noise temperature of interest is the effective noise temperature at the radiometer input, which is:

$$T_{in} = T_a(1 - |\Gamma_s|^2)$$

where:

$T_a$  = the available noise temperature

$\Gamma_s$  = the source reflection coefficient

The effective noise temperature is compared to two internal reference temperatures in the noise-injection radiometer. Gain variations and the noise figure of the radiometer can thereby be estimated and deducted.

If one of these reference noise temperatures is equal to the physical temperature of the receiver front end, the reflection coefficient term for this reference temperature becomes negligible. The reflection term can be neglected because the noise power reflected from the reference source is equal to that reflected from the front end if both have the same temperature. A good solid-state white noise source with high efficiency, such as from Noise Com's NC346 or NC5000 Series, has these properties when it is in the "Off" condition.

The second internal reference temperature is obtained when the noise source is in the "On" condition. This noise temperature can be determined from the ENR of the noise source as follows:

$$ENR = 10 \log \left( \frac{T_a (1 - |\Gamma_s|^2) - 290}{290} \right)$$

In the noise-injection radiometer, the noise power of the white noise source in the "Off" condition is measured during one-half period. The input noise power plus the noise power of the white noise source in the "On" condition is measured during the other half period.

The duty cycle of alteration between the input noise power and the noise power of the white noise source in the "On" condition is controlled by a feedback loop. The loop keeps the average noise power equal to the noise power measured during the first half period. The measurement of input noise power therefore becomes a measurement of time (duty cycle) rather than power (see Figure 2).

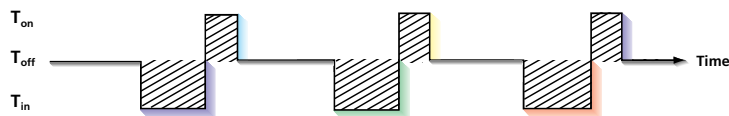


Figure 2. Noise-injection radiometer duty cycle.

The sensitivity of the noise-injection radiometer is close to that of the Dicke radiometer:

$$T = 2 \frac{T_{off} + T_n}{\sqrt{B \times t}}$$

where:

$T$  = sensitivity (resolution)

$T_{off}$  = first reference noise temperature

$T_n$  = radiometer noise temperature

$B$  = radiometer noise bandwidth

$t$  = integration time

Noise Com's NC346 Series coaxial and NC5000 Series waveguide white noise sources are available with optional built-in regulators for stable noise-injection radiometer applications.

For more information on the NC346 Series, see pages 2-3; on the NC5000 Series, see pages 4-5.