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RECEIVER NO= TEMPERATURE MEASUREMENTS USING THE STANDARD RECEIVER

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RECEIVER NOISE TEMPERATURE MEASUREMENTS USING THE STANDARD RECEIVER

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The main idea of the present work is to develop a method of optimizing the noise temperature of front ends using the standard receiver.

From the general instability equation for the standard radiometer ( ), the term for variations in T is

$$AT.= \qquad (34$$

If the cable between. the signal source and the front end is short

$$= 1 \; T_1 = T_A$$

and if the receiver is balanced

$$K = \frac{T_A + T_R}{T_C + T_R}$$

If both conditions are achieved, the equation (1) becomes

$$A\ (1 - K) Aa_R$$

Equation (2) shows that any variation in the front end noise temperature appears in the output of the receiver as an equivalent signal $\%ST_A$, which is related to AT_R by the factor (1 K). Therefore, any variation in the noise temperature of the front end due to changes in the parameters of the mixer or preamplifier (crystal current, impedance adjustments, etc.) can be measured by a calibrated standard receiver. In order to obtain good sensitivity in this measurement K 7^i I.

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* T. Orhaug and W. Waltman, "A Switched Load Radiometer " Pub. of Vol. 1, No. 12, p 183, February: 1962.

MEASUREMENTS

All measurements described here were made on the mixer-ceramic tube IF pre-amplifier at 1400 mc. The noise temperature as a function of mixer-erystal current was first measured by using the Y factor method, and the result is shown in Table 1 and Figure 4.

TABLE 1

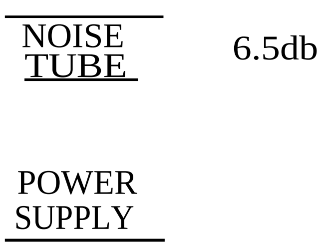

Figure 1. -- Test set-up for receiver noise temperature measurements

Errors in reading the detector current meter affected the measurements. The magnitude of error was in the order of 0. 1 db in terms of Y factor, which means 20^0 in noise temperature. The above results (table 1) are the average of ascending and descending readings.

MEASUREMENTS WITH THE STANDARD RECEIVER

In order to get an unbalance between signal and comparison channel (K 1), two approaches were used: (a) An AIL cold load in liquid nitrogen (77 'X), and (b) a calibrated noise tube with a 10 28 db pad. In both cases a 50 ohm load at room temperature was used in the comparison channel.

Two series of measurements were made with the cold load — one with the standard receiver initially balanced at 1.4 MA crystal mixer current and one with the receiver initially balanced at 1 mA.

Variations in the output were measured in terms of the 10 °K calibration from the noise tube. Steps of 0. 1 mA were made in the crystal current, and for each value of the current the 10 °K calibration was used to check any variations in the conversion loss of the mixer (and so overall gain in the receiver). No changes were observed. In both cases the results given are averages of ascending and descending readings.

Figure 2. — Block diagram of radiometer terminated in cold (liquid nitrogen (77 °K)) load

1) Receiver balanced at 1.4 mA

From these results with the Y factor method and with

$$T_c = 77\ °K$$

then

$$K = \frac{T \quad T}{T_C \quad T_R} \qquad 0.68$$

from equation (2)

$$\Delta T_R \quad \frac{\Delta T}{1 - K} \qquad 3.1\ \Delta T$$

Results are given in figure 5.

.a_Itesej!ver bg....anced at 1mA

From the results with the Y factor method

$$T = 370°K$$

then

$$\Delta T_R = 3.1 \Delta T_A$$

Results are given in figure 6.

(b) Hot Load

L O

MiXER
PREAMP.

'RECORDER

CALIBRATION
swITcH

PowER
SUPPLY

Figure 3. -- Block diagram of radiometer terminated in hot load.

The argon gas tube and the 10. 28 db pad (measured with the Weinschel system) gave a signal temperature

$$\underline{10.100\ °K} \quad 290\ °K \quad L \quad 10.6\ (10.\ 28\ db)$$

$$1224\ °K$$

The standard receiver was balanced at O. 5 mA, crystal current. From the results with the Y factor method at O 5 mA

$$= 470\ °K$$

therefore

$$K = 2.23$$

and

$$AT = -0.81AT_A$$

The results are given in figure 7.

This method provides only a way to measure incremental variations AT_R, and the accuracy depends on how precisely the value K is obtained which in turn depends on how accurately T_R is known.

However, the method is useful for optimizing the receiver noise temperature when the receiver is operating on a telescope. In this case the antenna, when pointed at the cold sky, provides the cold termination, and usually $K < 1$. In order to minimize the system noise temperature, the input circuits should now be adjusted for minimum apparent antenna temperature as read on the recorder.