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EXCESS NOISE TEMPERATURE MEASUREMENTS OF CALIBRATION SYSTEM FOR 609 MHz VLB RECEIVER, USING AN INTERNATIONAL MICROWAVE CORPORATION NOISE DIODE (NCM-0110-33386)

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ABSTRACT

This is a summary of excess noise temperature measurements performed at 609 MHz on a system consisting of a noise source, 6 dB attenuator, PIN diode switch and directional coupler, provided by George Purcell. The series of tests (arbitrarily called "F" series) are considered to be the most accurate. With the average excess noise temperature calculated at 277.41 °K (for tests 1-10) and 274.74 °K (for tests 11-20),

INTRODUCTION

Our experiments were aimed at determining the excess noise of the system provided by George Purcell. This system consisted of

a) A noise diode of unknown noise temperature.
b) A PIN diode switch.
c) A directional coupler.
d) A 6 dB coaxial attenuator.

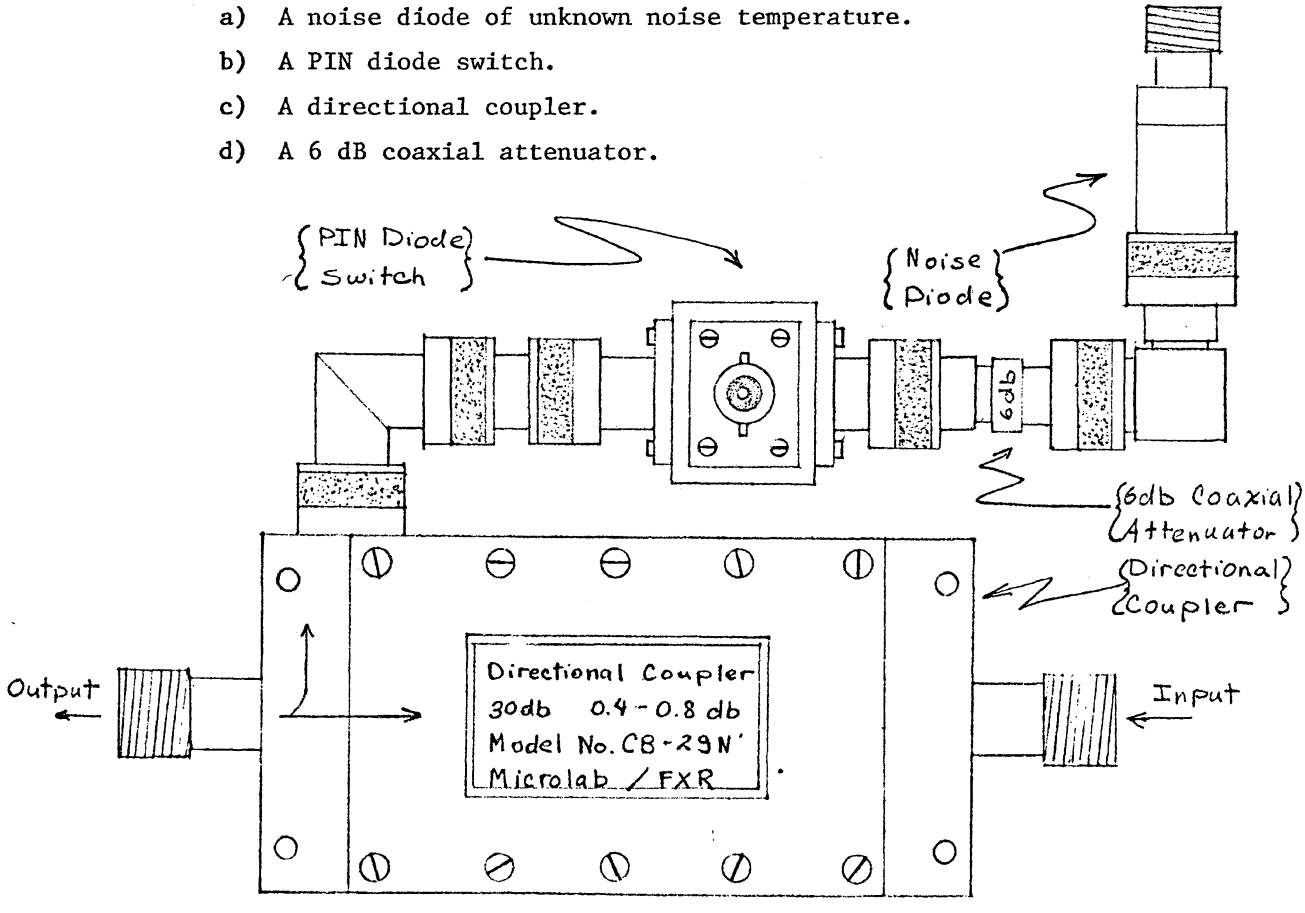

Figure 1

SET-UP

The output of the directional coupler was connected to a 609 MHz receiver (followed by NRAO standard receiver) with well monitored output. The input of the directional coupler was switched between a cold (liquid nitrogen 77.38 °K) and hot (298 °K) load in order to calibrate the scale on the chart recorder.

Our method was aimed at simulating the condition that the system would experience in actual use. Because we were interested in the system as a whole, we did not invest any time into measuring the amount of coupling of the directional coupler nor the actual attenuation of the 6 dB pad, etc.

PROCEDURE

Our basic procedure was to use the known temperature output from our known sources to scale the output from our receiver. Then the PIN diode switch was turned ON (+10 V at negligible current), allowing the noise energy to enter the directional coupler with the cold load (77.38 °K). The corresponding receiver output was multiplied by our scaling factor (arrived at with the cold and hot load) to obtain the excess noise temperature of the system under test.

Figure 2 shows a block diagram of our test set up. This test set up was used for all F series tests.

A typical set of measurements included recording the output from the receiver when both of our known loads were connected and then turning on the noise source when switched to the cold load. All equipment was turned on and allowed to warm up for several hours. Liquid nitrogen was then poured into the cold load and approximately another hour passed before our measurements began.

DATA RESULTS

The data from our tests are shown in table 1. In tests 1-10 we left the PIN diode switch normally off (-1.7 V at 75 mA) except for approximately 15-30 seconds each test to record the output of the square law detector for the noise diode. Now in tests 11-20 we left the PIN diode switch ON except for a short period of time ($\sim$30 seconds) to record the output of the square law detector for the cold and hot load. For reasons that are not yet clear, our measurements indicated an average noise temperature difference of $\sim$2.7 degrees lower than for the latter tests (11-20).

CONCLUSION

In making these measurements we have put forth a conscientious effort to be complete and accurate. Additional information and results of our other tests are available upon request.

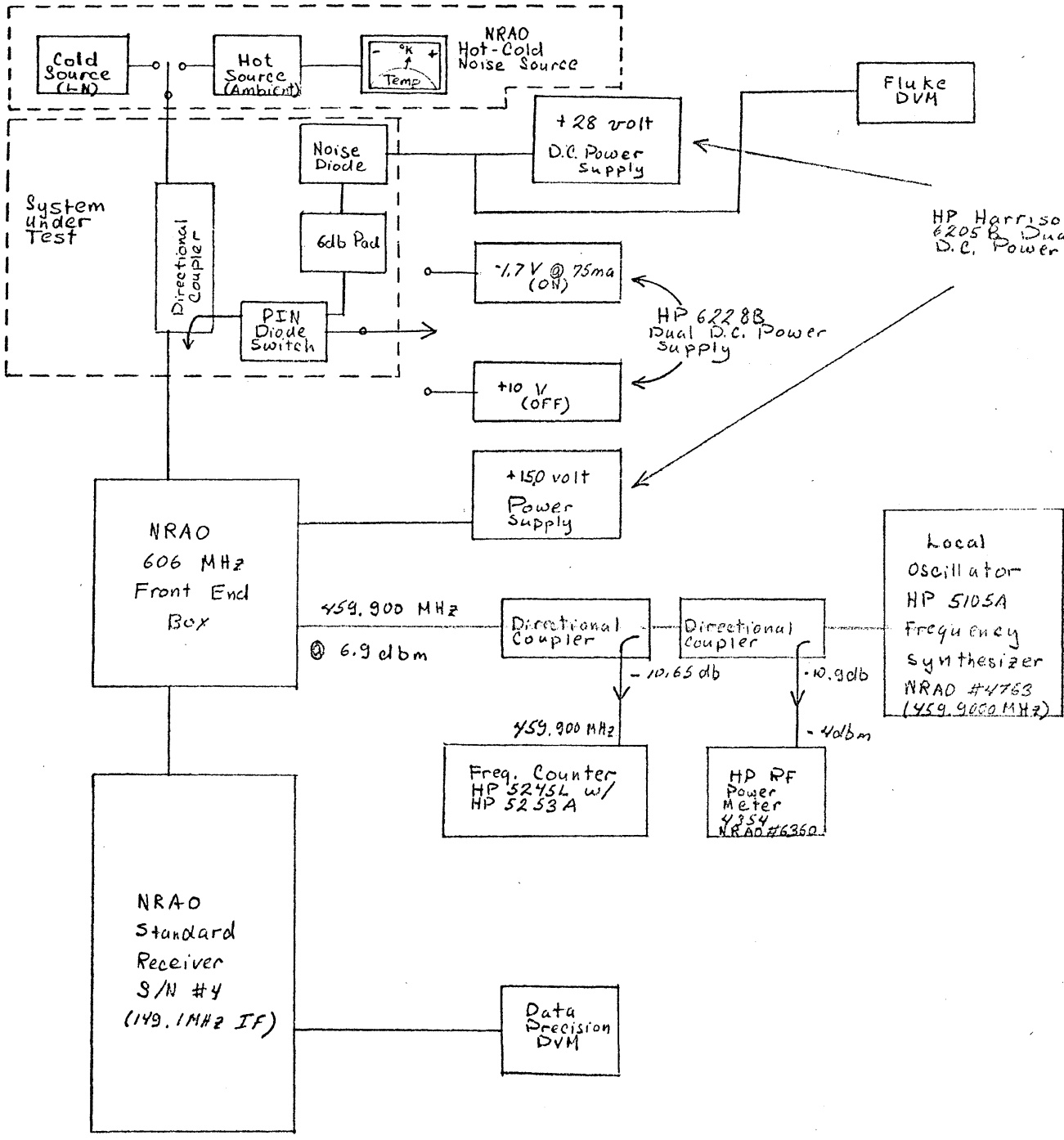

Figure 2

Test Set-up For Series "F"
Diode Noise Measurements.

TABL

Test Number	A Test Time	B T_{Hot} (°K)	D.V.M. Readings C Cold Load (V)	D Hot Load (V)	E Noise Diode (V)	Comments	F Noise Source Temperature (°K)
Date: 7/14/75							
1 F	0922	297.94	2.226	3.945	4.391		277.533
2 F	0931	297.94	2.226	3.946	4.392		277.752
3 F	0932	297.94	2.226	3.946	4.392		277.752
4 F	0934	397.94	2.225	3.945	4.390		277.785
5 F	0936	297.94	2.225	3.943	4.389	PIN diode switch on = +10 V for ∿ 30 sec each measure-ment.	277.818
6 F	0937	297.94	2.223	3.945	4.389		277.429
7 F	0939	297.94	2.223	3.945	4.388		277.301
8 F	0940	297.94	2.224	3.944	4.388		277.495
9 F	0942	297.96	2.223	3.949	4.387		276.556
10 F	0944	297.96	2.225	3.952	4.391		276.651
% Error	± 1 min	± .02°	± .002 V	± .002 V	± .002 V		
						Average	274.7356 °K

1. PIN diode switch ON → 10 V.
2. PIN diode switch OFF → -1.7 V at 75 mA.
3. Noise diode voltage = +28.0 V.
4. Formula:

$$\text{Noise source excess temperature} = F = \frac{(B - 77.38\ ^\circ K)}{(D - C)} * (E - C)$$

5. Noise diode on for > 9 hours (i.e., assumed completely warmed up).

Average (rounded off) = 477.41 °K

TABLE 1 tinued)

Test Number	A Test Time	B T_{Hot} (°K)	D.V.M. Readings C Cold Load (V)	D Hot Load (V)	E Noise Diode (V)	Comments	F Noise Source Temperature (°K)
Date: 7/14/75							
11 F	1430	298.14	2.221	3.953	4.383		257.568
12 F	1453	298.12	2.216	3.945	4.370		274.999
13 F	1455	298.12	2.215	3.947	4.368		274.396
14 F	1457	298.11	2.216	3.948	4.369		374.383
15 F	1459	298.10	2.218	3.950	4.373	PIN diode switch off (= -1.7 V at 75 mA) for only ∿ 30 sec.	274.656
16 F	1501	298.10	2.220	3.954	4.377		274.563
17 F	1503	298.10	2.220	3.952	4.377		274.880
18 F	1505	298.10	2.219	3.953	4.375		274.436
19 F	1506	298.10	2.220	3.952	4.376		374.753
20 F	1508	298.10	2.220	3.953	4.377		274.722
% Error	± 1 min	± .02°	± .002 V	± .002 V	± .002 V		
						Average	274.7356 °K

1. PIN diode switch ON → +10 V.
2. PIN diode switch OFF → -1.7 V at 75 mA.
3. Noise diode voltage = +28.0 V.
4. Formula:

$$\text{Excess noise temperature} = F = \frac{(B - 77.38\ ^\circ K)}{(D - C)} * (E - C)$$

5. Noise diode on for > 12 hours (i.e., assumed completely warmed up).

Average (rounded off) = 274.74 °K