NRAO Electronics Division Technical Note No. 101

COMPARISON OF THREE LIQUID NITROGEN NOISE STANDARDS AT 1.5 AND 4.75 GHz

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I. Noise Standard Description

The noise standards, denoted as LN1, MM1, MM2 and two APC7 to SMA male adaptors A1 and A2, are described as follows:

LN1 - This is a newly developed NRAO noise standard with an APC 3.5 male output connector; it will be described in a future report. Loss within the standard is small and has been measured giving noise temperature of 78.9K ± 0.3K at 1.5 GHz and 79.8K ± 0.6K at 4.75 GHz. These values were assumed correct and the other sources were measured relative to LN1.

MM1 - This is a Maury Microwave MT7118A, serial number 113, noise standard purchased by NRAO in April 1980. The unit developed a bad internal connection in December 1980 and in the process of repair the internal 50 ohm load resistor was broken and replaced by a KDI Pyrofilm 125R500S. Thus the original loss calibration may not be valid.

MM2 - This is another Maury Microwave MT7118A, serial number 97, purchased by NASA Goddard Institute in March 1979 and on loan to NRAO. Its original calibration at 3.95, 7.5, 12.4, and 18 GHz should be valid but is referred to an APC7 output connector, necessitating an adaptor to SMA male for comparison with LN1. Two adaptors used in the comparisons are described below:

A1 - This is a Maury Microwave 2625B, serial number 740393, APC7 to SMA male adaptor, purchased by NRAO with loss calibration as follows:

Frequency	Loss, dB	ΔT
1.50	.036	1.8
3.95	.058	2.9
7.50	.060	3.0
12.40	.111	5.5
18.00	.149	7.4

where ΔT is the noise increase of a 300K adaptor to an 84K load.

A2 - This is an Amphenol (?) adaptor, serial number 404613, uncalibrated, purchased by NASA and with physical length of 3 cm which is 0.6 times the length of A1. Noise calibrations of the same load at 1.5 GHz with A1 and A2 gave 0.9K less noise with A2. Thus a first approximation of the loss of A2 is 0.5 that of A1.

II. Measurement Setup

The noise output was measured with both uncooled and cooled receivers at each frequency. The uncooled receivers, at 1.5 GHz and 4.75 GHz, were gain stabilized radiometers with room temperature FET amplifiers in a mixer test set developed by J. Archer. The cooled receivers were FET amplifiers having noise temperatures of 7.5K and 23K at 1.4 GHz and 4.75 GHz. The outgoing noise from the input of the uncooled receivers was 300K (input isolator) and was 30K and 14K for the cooled 4.75 GHz and 1.5 GHz receivers.

The uncooled receivers had built-in reflectometers to measure reflected noise from the noise source/receiver interface but, unfortunately, this data was not recorded for the 1.5 GHz measurements. The 1.5 GHz uncooled receiver measurements gave noise source temperatures 0.7K to 2.2K higher than the cooled receiver results and have been omitted from the results given below because of the unknown reflected noise. At 4.75 GHz the uncooled receiver results, corrected for reflected noise, are in good agreement with cooled receiver results.

The cooled receivers did not have built-in reflectometers but separate reflectometer measurements were made for each noise source and a small correction was made for reflected noise assuming the receiver was matched to 50 ohms. The error in this assumption is small because the outgoing noise is close to the noise source temperature, the receiver return loss was approximately 20 dB, and the noise sources were fairly well matched; all had return loss > 30 dB except LN1, 22 dB at 4.75 GHz and MM1 with A1 adaptor, 28 dB at 4.75 GHz.

The cooled receiver setups utilized an Apple II on-line computer for scanning of the local oscillator, receiver calibration, and graphical display of results.

III. Results

The measured noise temperatures, assuming source LN1 is correct, are summarized below:

TABLE I - Noise Source Temperatures

Frequency GHz	Noise Source And Adaptor MM1 A1	MM2 A2	Comment
1.4	82.3K	81.9K	Cooled receiver
1.5	82.5K	81.5K	Results repeated within 0.1K
1.6	82.8K	81.3K	One hour later
1.5	82.2K	-	Maury initial calibration
4.75	86.0K	86.3K	Cooled receiver
4.75	86.3K	85.5K	Uncooled receiver
4.75	85.7K	-	Maury initial calibration

These temperatures are believed to be correct within ± 0.4K at ∿ 1.5 GHz and + 0.7K at 4.75 GHz.

Thermal Resistance Measurements

The thermal resistance of the 50 ohm RF load to the liquid nitrogen bath can be determined by measuring the RF noise source temperature as a function of DC power applied thru a DC tee in the source output line. This quantity is important because approximately 100 mW of heat flows down the coaxial line inner conductor and may heat the load resistor.

The measurement results, expressed in °K per 100 mW of heat, are as follows:

Noise Source	Thermal Resistance °K per 100 mW
LN1	1.4
MM1	5.3
MM2	2.1