

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886**

April 14, 2015

*Telephone: 781-981-5400
Fax: 781-981-0590*

To: EDGES Group
From: Alan E.E. Rogers
Subject: Improving the LNA performance

The ideal LNA would have a zero noise waves and a perfect match. In practice the EDGES LNA has an outgoing uncorrelated noise of about 70 K and outgoing correlated noise of about 10 K below 100 MHz rising to 30 K at 200 MHz. The input S11 is about -26 dB below 100 MHz rising to -20 dB at 200 MHz. If we consider the effect of adding a 3 dB attenuator on the input of the LNA. This has the following effects.

- 1] The correlated noise waves are reduced by 3 dB but so is the sky signal so nothing is gained.
- 2] The uncorrelated noise from the LNA is reduced by 6 dB so there could be a gain if the added noise from the attenuator is much smaller than the sky noise. The noise launched from each end of a 3 dB attenuator is half the ambient or about 150 K which is much smaller than the sky noise in the low band.
- 3] The S11 is improved by 6 dB which reduces the variation of the “F” factor with phase by a factor of 4.

The potential advantage of adding attenuation for the low band has been discussed in memo 136 – see the number in parentheses in table 1. Further study shows that is better to add the attenuation after the 3-position switch.

In addition improvements to the LNA are under study. Fine adjustments to the feedback resistor value, the input inductors and the input capacitance can be made to improve the S11. Simulations using the circuit model of memo show that it should be possible to obtain an S11 below -26 dB in the 50 to 100 MHz range. New values obtained from simulations are 1000 Ω , 1 μ H and 680 pf. The feedback resistor value depends on the transconductance and may need adjustment to the individual PHEMT transistor.