VSRT MEMO #017

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To: VSRT Group
From: Alan E.E. Rogers
Subject: Tests and laboratory demonstrations with a single LNB

If a single LNB is connected to the detector (via a single CAE-9220 amplifier) the output from the detector can be observed with a digital multimeter (e.e. Radio Shack model 22-813 $29.99, or a USB data logging meter from Fluke model 189 at $370)

Typical readings (with detector output loaded with frame grabber):

Outside pointed at sky	4 mV
Outside pointed at ground	20 mV
Outside with hand over feed	24 mV
Inside	24 mV
Inside with hand over feed	24 mV
Inside with 27 W fluorescent lamp 1 foot away	50 mV

Explanation

1] Detector Loading

The voltage out of the detector will change dramatically with the load on its output. The detector was designed for the 75 ohm load of the frame grabber. A more ideal load would be about 1000 ohms. If you want more output for tests with a multimeter I suggest loading the detector with 1000Ω. With 1000 ohm the output with typical increase by a factor of about 8.

2] Radiometry Physics

The LNBs are sensitive to radiowaves at 12 GHz or a wavelength of 2.5 cm. The power output, P, can be characterized by the sum of 2 terms.

$$P = g\left(T_R + T_A\right)$$

where
g = amplifier plus detector gain
T_R = receiver noise temperature in Kelvin
T_A = antenna (or feed) noise temperature in Kelvin

The antenna temperature is given by the equation of Radiative transfer

$$T_A = T_I e^{-\tau} + T_p\left(1 - e^{-\tau}\right)$$

where T_I = the input temperature
T_p = the physical temperature of the medium through which the radio waves propagate
τ = medium opacity

When outside pointed at the sky

$$T_A \sim 3 + 5K$$

where 3K is the cosmic background
and 5K is the noise picked up in the propagation through the atmosphere

When pointed at your hand or the ground

$T_I = 0$ but your hand or the ground is an opaque object at bout 300K so in this case: $T_A \sim 300K$

When inside a room the radio waves emitted from the objects in the room all come from opaque objects (or reflective objects) at room temperature.

These "single LNB" measurements can be extended to "single dish" measurements. For example, you can see the large increase power from the detector if you point the dish at the ground. Also you can see the power increase by about 50% when the dish is pointed at the Sun[1].

Ref. Radio Astronomy by J.D. Kraus

[1] If a small flat mirror is stuck to the middle of the dish a reflection of the Sun onto the feed can be used as a pointing guide.