Memorandum

To:	W. Crady G. Ediss A.R. Kerr	D. Koller G. Lauria S.-K. Pan
cc:	J. Webber	
From:	J. Effland R. Groves	
Date:	2 November 2001	
Subject:	NRAO HFET Amplifier Gain Compression Measured with Noise	

Uncertainty about the dynamic range of NRAO's HFET amplifiers, which are used in the CDL's mixer/preamps and as general gain blocks in the mixer measurement system, motivated us to measure the gain compression of several amplifiers using noise as the input signal. The NRAO amplifier that is integrally connected to the SIS mixer contains HFET devices manufactured by TRW. We also measured results for similar NRAO amplifiers that use traditional Hughes Research Labs (HRL) HFET devices.

The setup, shown in Figure 1, was comprised of a noise source, and attenuator, and two power meters. The noise source was created with an HP noise diode and two Miteq amplifiers. Using two power meters obviated the need for an accurately calibrated attenuator. An Agilent E4412 power head measured output power directly at the device under test. Input power was measured by an HP 8484A power head that was connected to the coupler through a length of SemiFlex cable. Path loss differences between the two paths connected to the power heads, which results from coupler differences, the SemiFlex cable, and power meter discrepancies, were determined by substituting a SMA bullet for the device under test and measuring the residual power difference. The data were corrected for the measured 0.6 dB path loss difference. Bias points for the amplifiers, which were measured at room temperature, are given in Table 1.

Stage	HRL HFETs		TRW HFETs	
	V_d	I_d	V_d	I_d
	Volts	mA	Volts	mA
1	1.50	15.00	1.75	17.50
2	1.70	12.00	1.75	17.00
3	1.70	12.00	1.50	12.00

Table 1 : Amplifier Bias Points

The excitation noise spectrum initially was unfiltered, and because the Miteq amplifiers exhibit about 20 dB of gain from 100 MHz to 12 GHz, significant noise power was present in the frequency band below the operational band of the amplifiers. The unfiltered frequency response of the noise power that was input to the amplifier is shown in Figure 2.

Output power as a function of input power using unfiltered input noise is shown in Figure 3. The 1-dB compression points, where the real power deviates from the ideal linear curve by 1 dB, are shown as single points on the linear curves. The gain difference between the two amplifiers can be read directly from Figure 3 and is about 5 dB, which is the average gain difference over the entire passband of the amplifiers. It differs from the traditional measured gain using a network analyzer because that is a narrow-band measurement. The gain difference between the two amplifiers using a network analyzer is nearly 10 dB.

Gain compression was also measured with filtered noise, using a 4 GHz high-pass filter, which behaved essentially as a bandpass filter. The noise spectrum using that filter is also shown in Figure 2 and the measured results are shown in Figure 4. The measured gain of the amplifier with HRL devices is essentially unchanged from the unfiltered noise measurement. The gain of the amplifier with TRW devices has increased, and the gain difference between the two amplifiers is about 8 dB, which is approaching the gain difference from network analyzer measurements.

The 1-dB compression point for amplifiers with both HRL and TRW HFETs is about 0 dBm when the input noise spectrum was unfiltered. Filtering the noise to a band between about 4 GHz and 8 GHz resulted in essentially the same gain compression curve for the amplifier with the HRL devices, and the amplifier with TRW devices showed a very slight reduction of 1 dB in dynamic range.

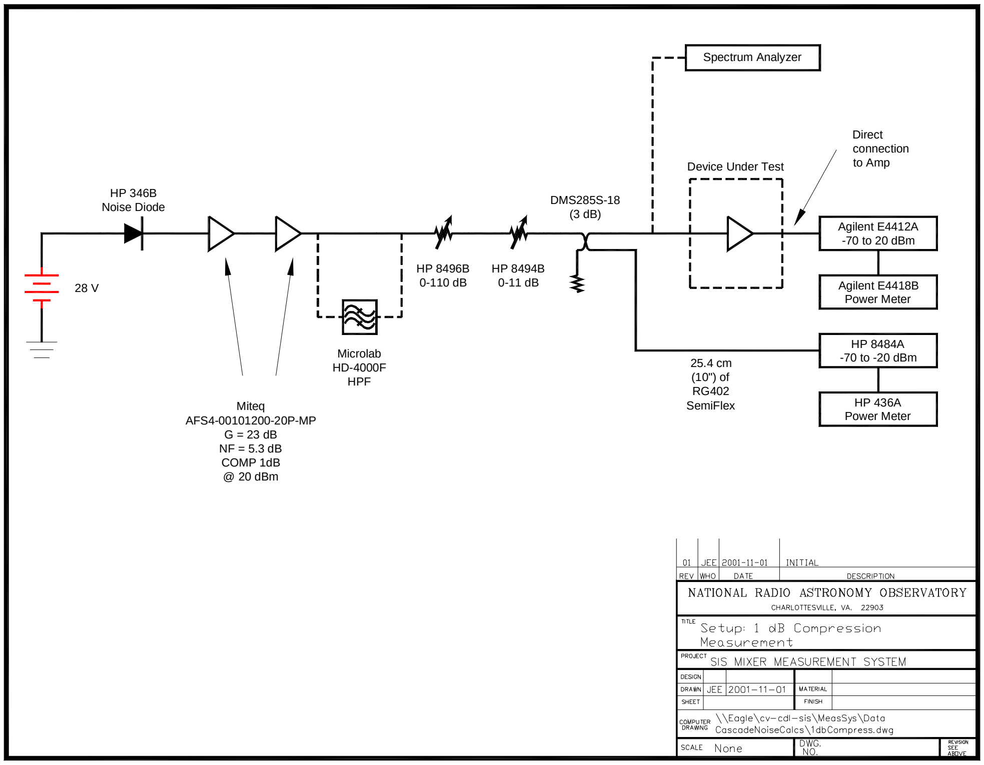

Figure 1: Test Setup

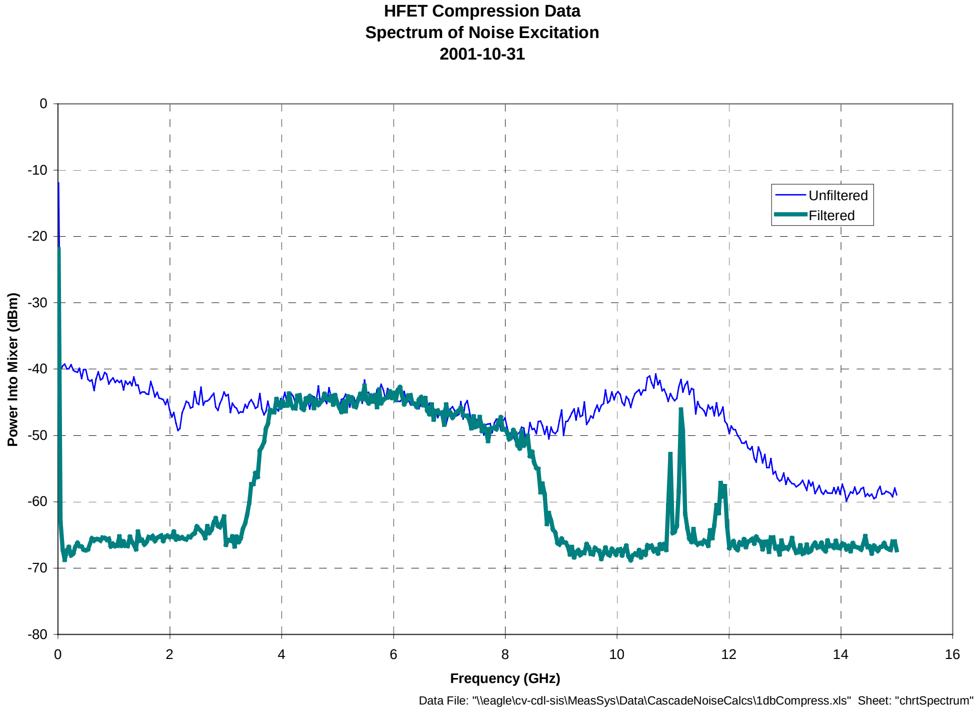

Figure 2 Excitation Noise Spectra

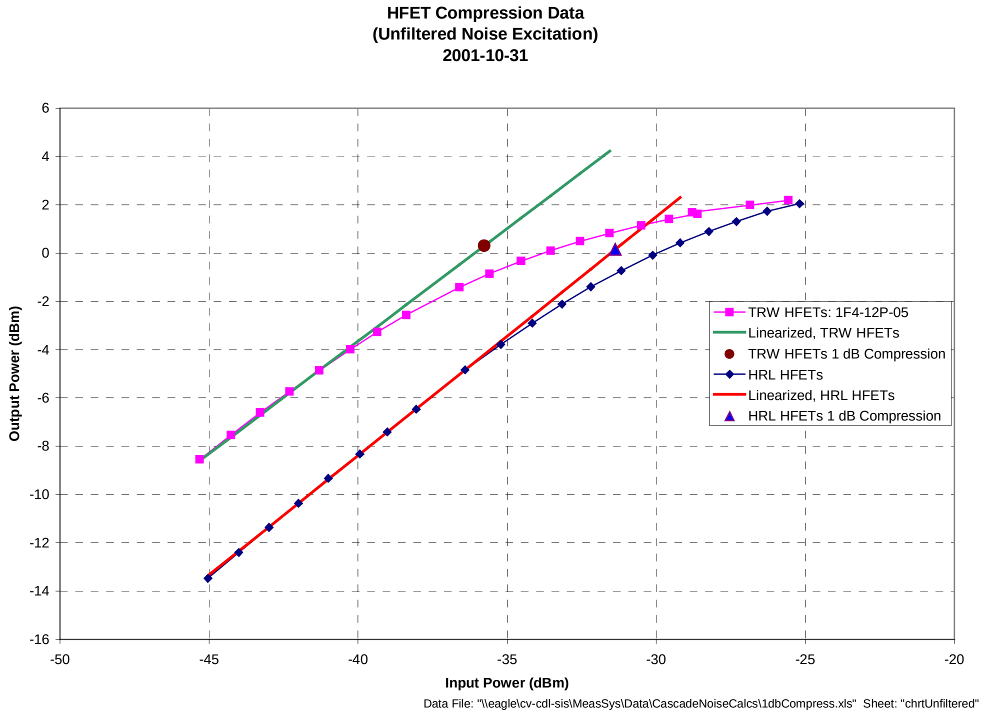

Figure 3 Compression Data -- Unfiltered Noise Data

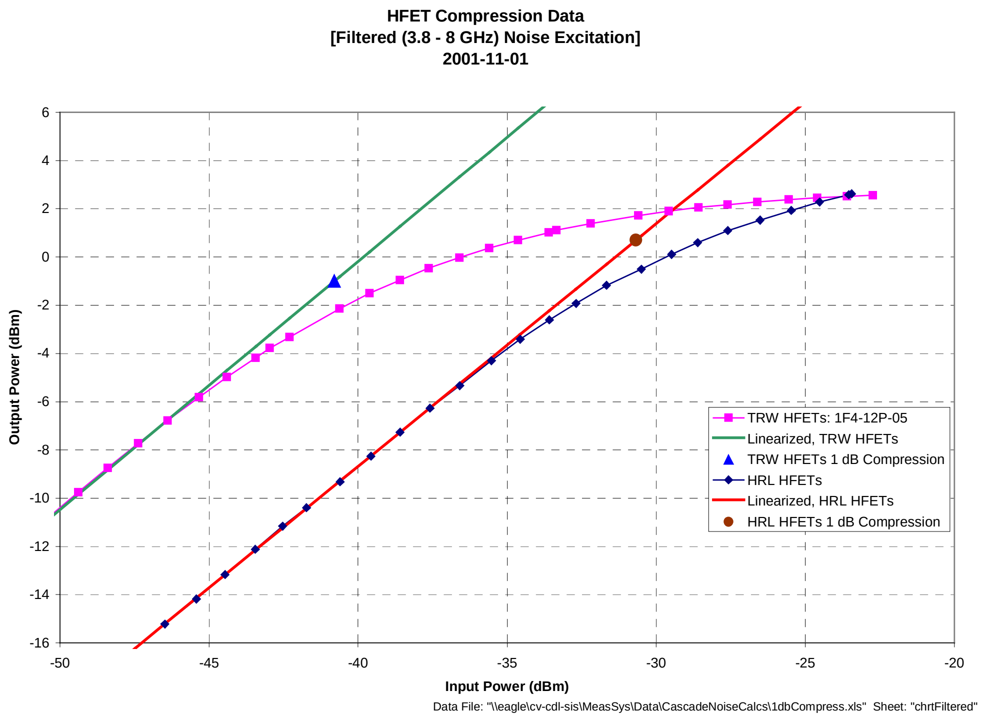

Figure 4 Compression Data --Filtered Noise Data