

| То: | K. Crady R. Groves D. Koller SK. Pan | G. Ediss A. R. Kerr G. Lauria |
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| From: | J. Effland | |
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| Subject: | Frequency Response of Type II Mixer Bias Supply | |

The frequency response of a Type II Mixer Bias Supply was measured by injecting a time varying voltage into the bias tee in the Mixer 1 Dewar. The 3 dB frequency when operating in closed loop mode is 200 Hz but increases to about 800 Hz when operating open loop.

The bias supply frequency response is important when measuring mixer frequency characteristics with a Fourier Transform Spectrum (FTS) analyzer, because the RF signal is chopped in the FTS at a minimum rate of a few kHz. Such chopping modulates the mixer current at the same rate, so the frequency response of the bias supply determines measurement sensitivity given a fixed number of averages.

Measurement Setup

The equipment configuration to measure the bias supply frequency response is shown in Figure 1. The mixer's DC resistance is simulated by R2, a 100 Ω resistor. A function generator provides the time-varying voltage across the 100 Ω resistor to simulate mixer current changes. Resistor R1 isolates the low impedance generator output from the bias circuit.

To provide sufficient offset range on the oscilloscope when measuring low amplitude signals, the mixer bias supply was adjusted for 0 V nominal bias for these measurements. To confirm that the bias supply frequency response doesn't vary with nominal bias, the bias was temporarily adjusted to 9 mV. The data obtained at a few spot frequencies is identical to the results with 0 V bias.

The relative gain is calculated by determining the ratio of voltage representing the output current (V_{out}), available on the bias supply as 10 mV/µA, to the input voltage measured at the function generator output. Using voltages to represent currents works because the ratios of voltages are used in the analysis, and Ohm's Law shows that the common conductance factor (1/R) mapping voltages to currents cancels. The gain relative to DC was obtained by subtracting from the measurement the lowest frequency gain ratio (V_{out}^0/V_{gen}^0) in dB.

$$G = 20\log_{10}\left(\frac{V_{out}}{V_{gen}}\right) - 20\log_{10}\left(\frac{V_{out}^0}{V_{gen}^0}\right)$$

Results

The frequency response of the bias supply by itself was measured by injecting the function generator voltage across a resistor connected to the dummy mixer test box. That test box connects directly to the bias supply without any EMC filters and hence this should yield the highest frequency response. The results are labeled "Open Loop, No Filter" and "Closed Loop, No Filter" in Figure 2.

Next, the frequency response of the bias supply was measured using EMC filters from the dip tester bias tee. The data labeled "Closed Loop, With Bias Filters" shows this case in Figure 2.

The frequency response of the bias supply, bias tee, and EMC filters from the Mixer 1 Dewar is shown in Figure 3 for both open and closed loop bias supply modes. The 3 dB frequency when operating in closed loop mode is 200 Hz and increases to about 800 Hz when operating open loop. The peaking phenomenon around 10 kHz is generated in the bias supplies, since similar peaks occurred when the bias supplies where measured with the bias tees used in the dip test setup.



Figure 1: Measurement Setup



Frequency Response of SIS Bias Supply (Model II, Mixer 1 Rack)

Figure 2: Frequency response using Dummy Mixer Tester and Dip Test Apparatus





Frequency Response of SIS Bias Supply (Model II, Mixer 1 Rack)

Figure 3: Measured results using old type Bias Tee in Mixer 1 Dewar