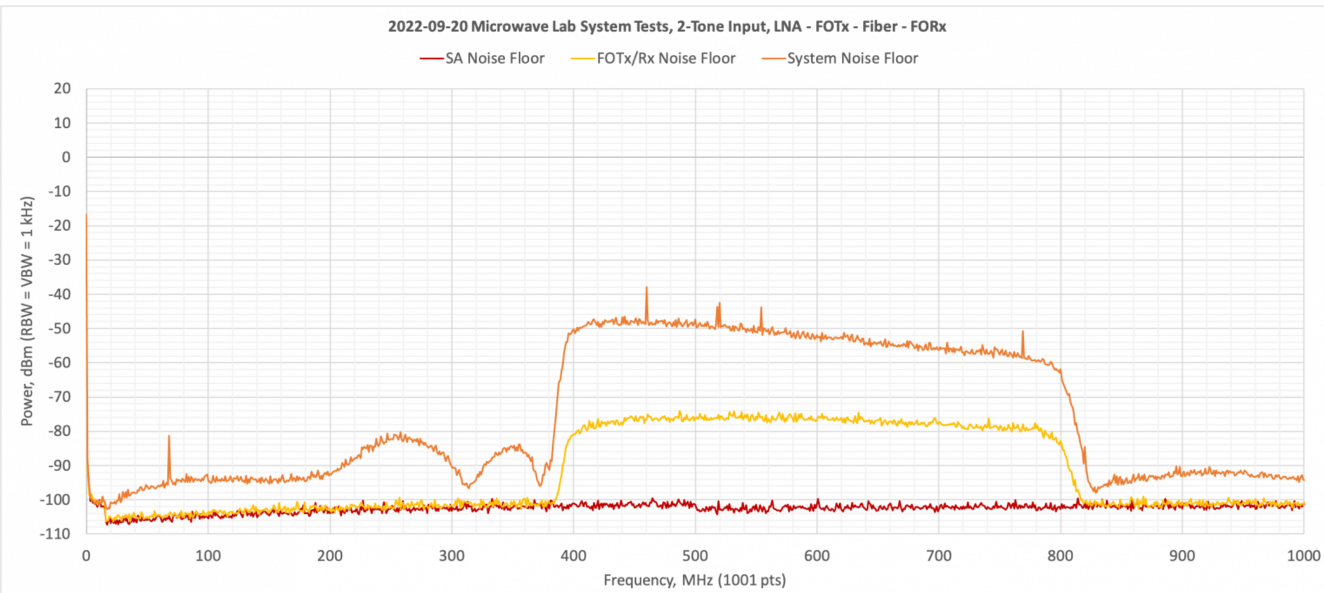
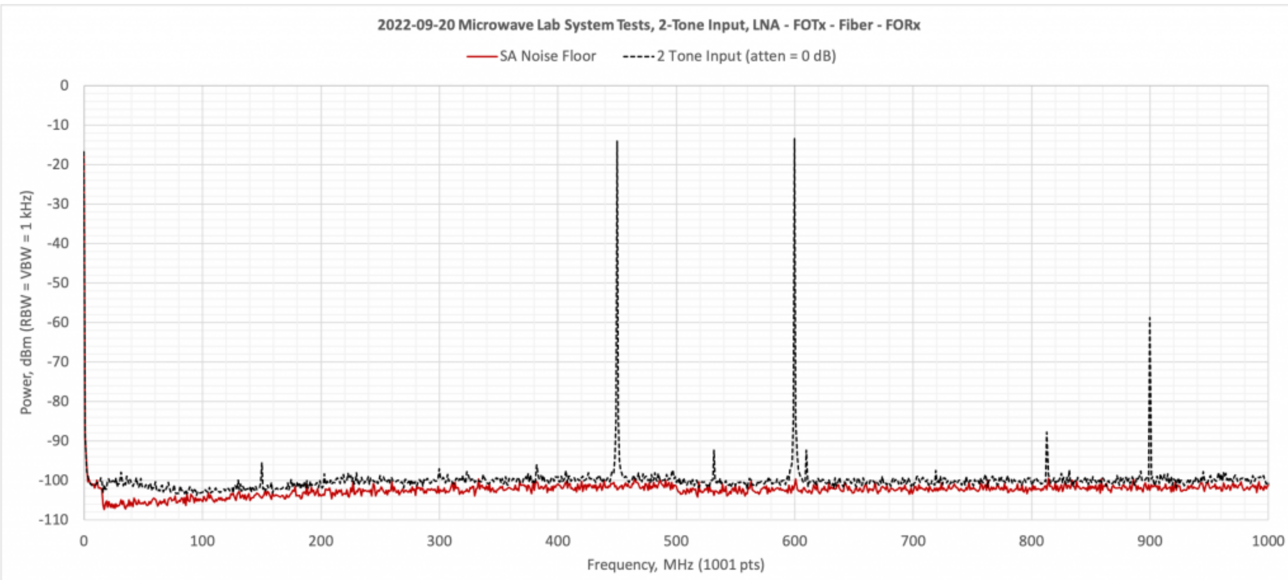
FRB Blog

RF Front-end Characterization with 2-Tone Injection

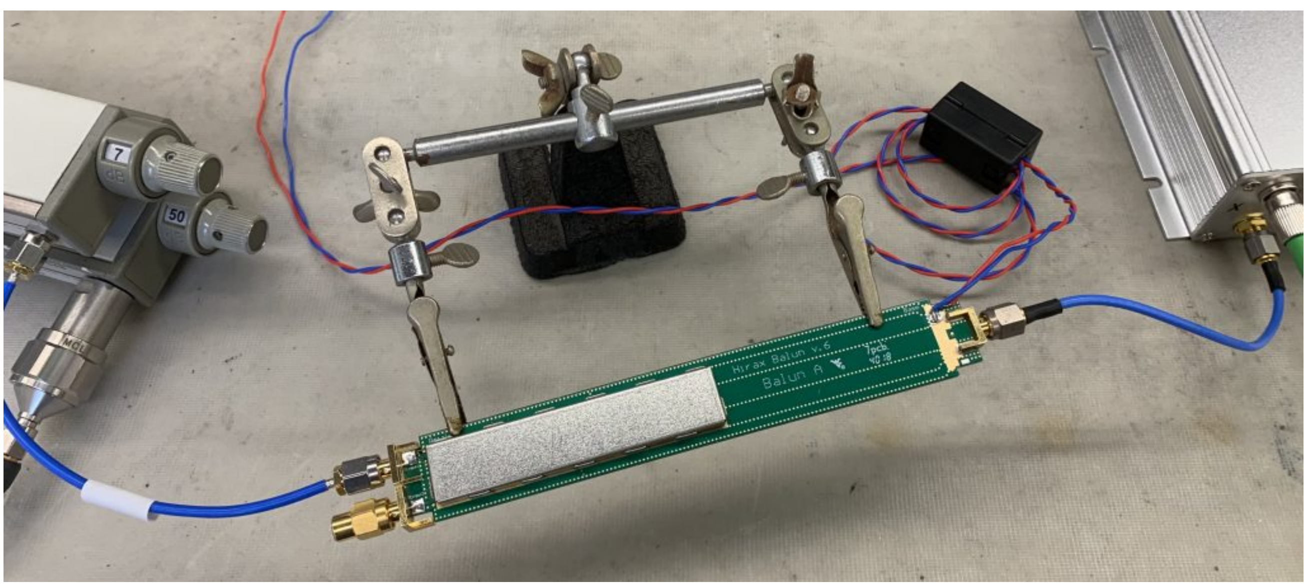


Test setup – left to right, step attenuator, LNA, FOTx, FORx, and spectrum analyzer.

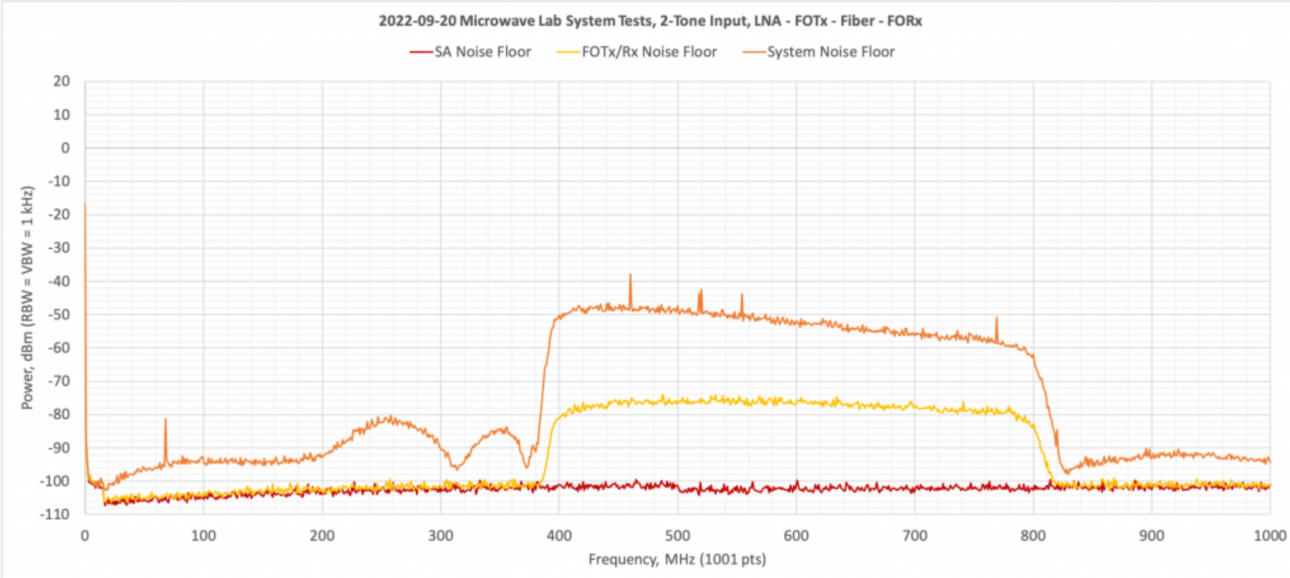
Referring to the above setup, two equal power CW tones were generated using a 8720ET VNA and E8257D synthesizer and summed together using a Mini-Circuits ZFSC-2-11S+ power combiner. The output of the combiner was fed to an HP 8494B/8495B step attenuator to control power injected into the RF1 (non-inverting) input port of the LNA. The purity of the input tones is shown below for -70 dBm. Note the high spectral purity of the 450 MHz and 600 MHz tones. The second harmonic of the 450 MHz @ -14 dBm input tone shows up at 900 MHz @ -58 dBm (-44 dBc).



450 MHz and 600 MHz input tones with step attenuator set to 0 dB. Note the high spectral purity of these two input tones.

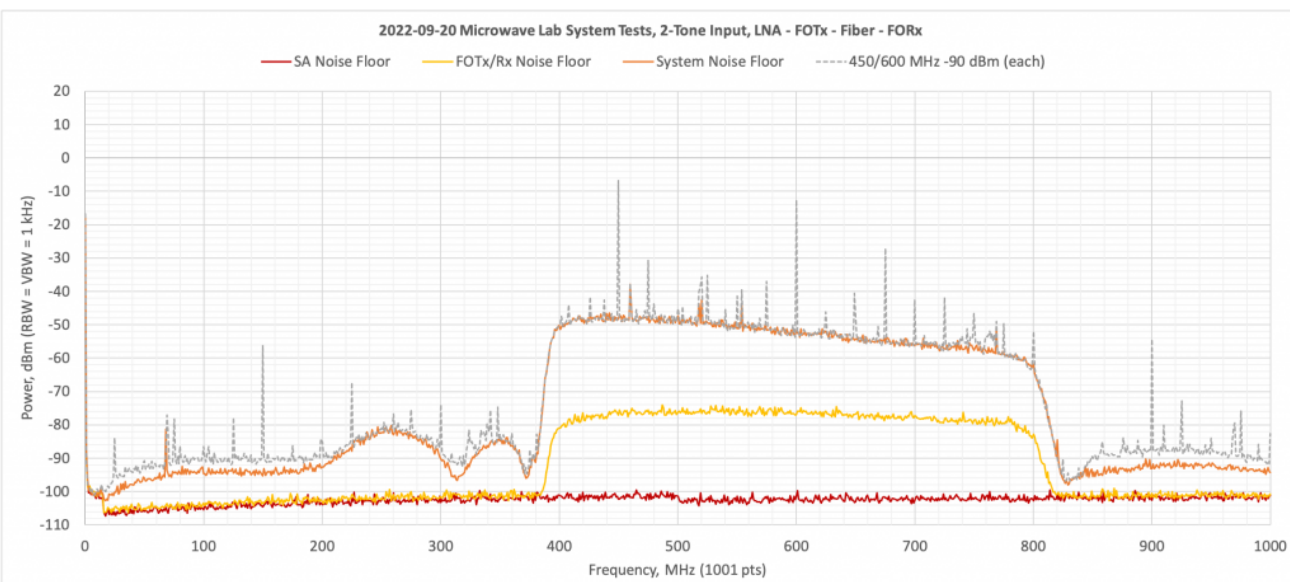


Connectorized LNA with differential inputs on left and single-ended output on right. When integrated with the clover leaf antenna the two inputs solder directly to the two clover leaf petals.



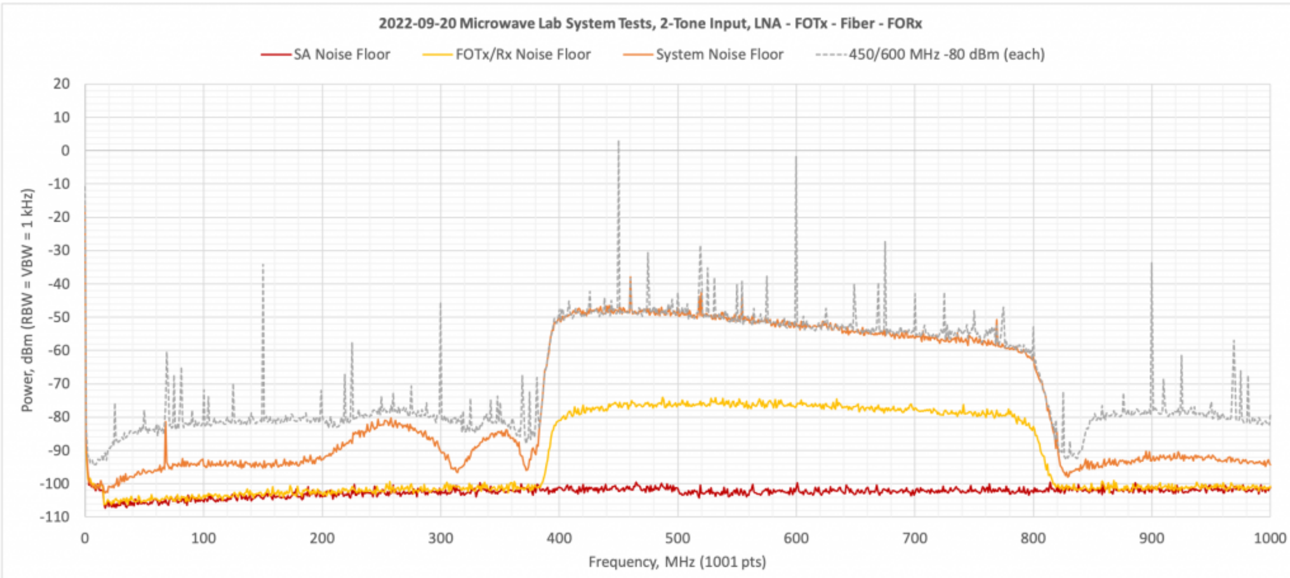
System noise floor characterization: orange – total system noise floor with both LNA input ports terminated to 50 Ohms; yellow – fiber optical system noise floor with input terminated with 50 Ohms. Under these conditions the LNA output dominates the system noise floor by the following margins: 400 MHz – 30 dB; 600 MHz – 26 dB; and 800 MHz – 20 dB.

The plot shown below represents the output spectra from the FOTx (fiber optic receiver) for the two tone input condition of -90 dBm (power level for each tone). Color legend: maroon – spectrum analyzer noise floor; yellow – fiber link noise floor with input terminated; orange – overall system noise floor with input terminated; and gray – two output response.

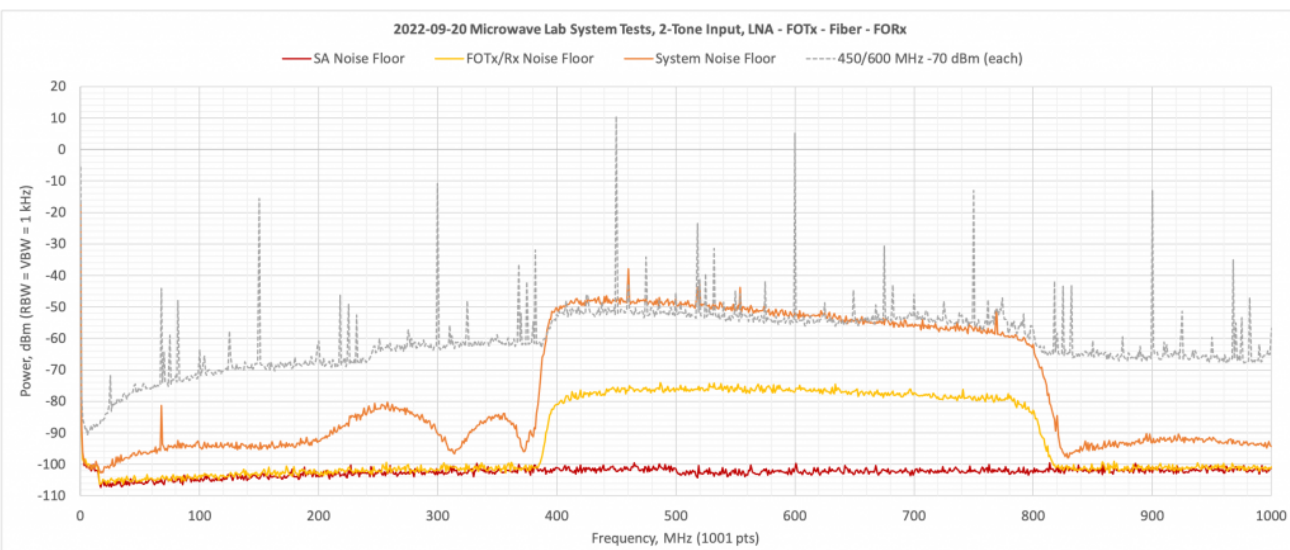


Output spectrum for 2-tone inputs at -90 dBm. The outputs are 450 MHz @ -6 dBm and 600 MHz @ -13 dB and translate to system gains of 84 dB and 77 dB, respectively (nominal gain was estimated to be 80 dB). I suspect the numerous spurs seen on the gray output trace is RFI pickup from the test equipment.

The next two plots below are for input conditions of -80 dBm and -70 dBm. Based on these results, we can tolerate an RFI input signal of approximately -80 dBm corresponding to an output of approximately 0 dBm without any desensitization.



Output spectrum for 2-tone inputs at -80 dBm. The outputs are 450 MHz @ +3 dBm and 600 MHz @ -2 dB and translate to system gains of 83 dB and 78 dB, respectively. Note out-of-band spectral regrowth indicating the beginning of nonlinearity.



Output spectrum for 2-tone inputs at -70 dBm. The outputs are 450 MHz @ +10 dBm and 600 MHz @ +5 dB and translate to system gains of 80 dB and 75 dB, respectively. Note very prominent out-of-band spectral regrowth and in-band spectral shape change are strong indications of nonlinearity.

Summary – When we deploy the 6-meter dish and receiver system in Pahala we should verify that any RFI pickup does not result in fiber optic receiver output levels that exceed approximately 0 dBm. If we do find that we exceed that level we can add a limited amount of attenuation (5 dB max) between the LNA and fiber optic transmitter.

-Derek

September 21, 2022 Derek Kubo Testing Log

linearity, nonlinearity, SNR, system characterization

Leave a Reply

Logged in as Derek Kubo. Edit your profile. Log out? Required fields are marked *

Comment *

Post Comment

FRB containers painted