Blocking NGSLR Radar RFI Emissions to Improve VLBI Function

Introduction

Radio frequency interference, RFI, also known as electromagnetic interference (EMI) is an issue that affects electrical circuits, and is defined as an interruption or degradation of the functioning capacity of an electrical circuit due to electromagnetic radiation from external sources. This radiation consists of charged particles that travel in a wave-like fashion. Interference from electromagnetic radiation can cause deterioration in data ranging from minimal loss up till a complete loss of data. In order to counter this, engineers have developed RFI shielding. Some shielding consists of a spray that utilizes nickel, silver or copper to block all RFI. Other kinds, however, consist of an absorber material that, when placed in the proper position, blocks RFI from a specific source. The Next Generation Satellite Laser Ranging (NGSLR) station at NASA's Goddard Geophysical and Astronomical Observatory tracks satellites as they orbit the Earth. The station is equipped with a radar to detect nearby aircraft before they enter the laser's line-of-sight and turn off the laser automatically. This radar, however, emits RFI that prevents nearby instruments from functioning fully. These instruments include the Very Long Baseline Interferometry (VLBI) Antenna that measures the arrival time of energy from quasars. The purpose of this project is to design an RFI blocker that will sufficiently reduce the interference from the NGSLR station's radar in order to allow the VLBI to function at a higher sensitivity.

Methodology

The main device used to test RFI was a signal generator, which simulated the RFI signal released by the first side lobe of the NGSLR radar. By using, the test set-up in Figure 1, power level readings (measured in logarithmic units of dBm) were taken of the signal from the generator. The generator's signal is transmitted through a standard gain horn. Graphs produced by the VLBI were saved. A blocker was placed between the horn and the VLBI as indicated in Figure 2 and another reading was taken and saved.

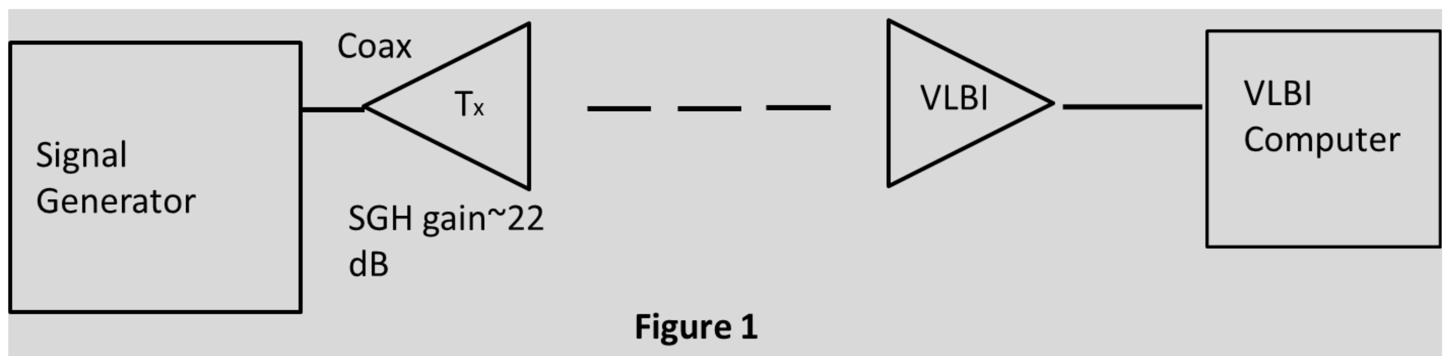


Figure 1

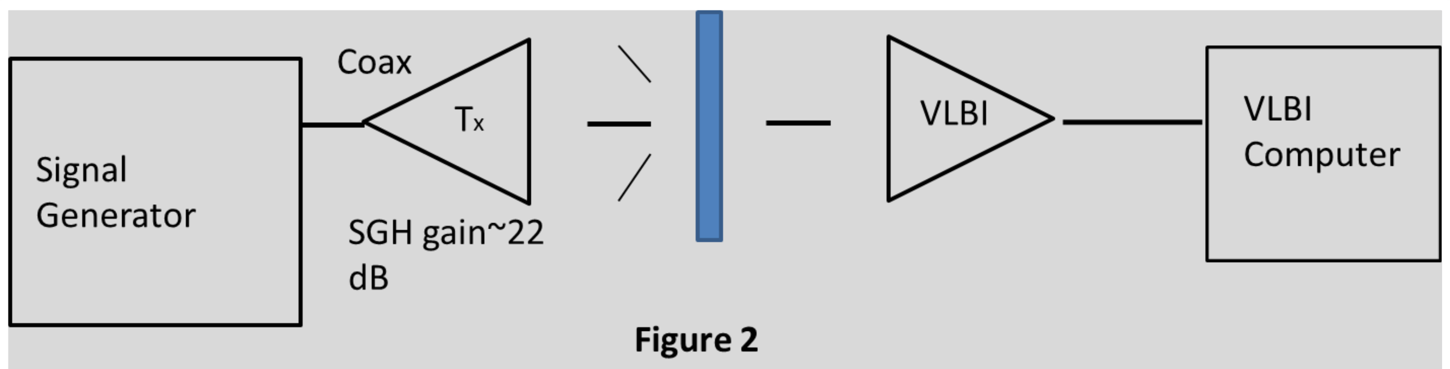


Figure 2

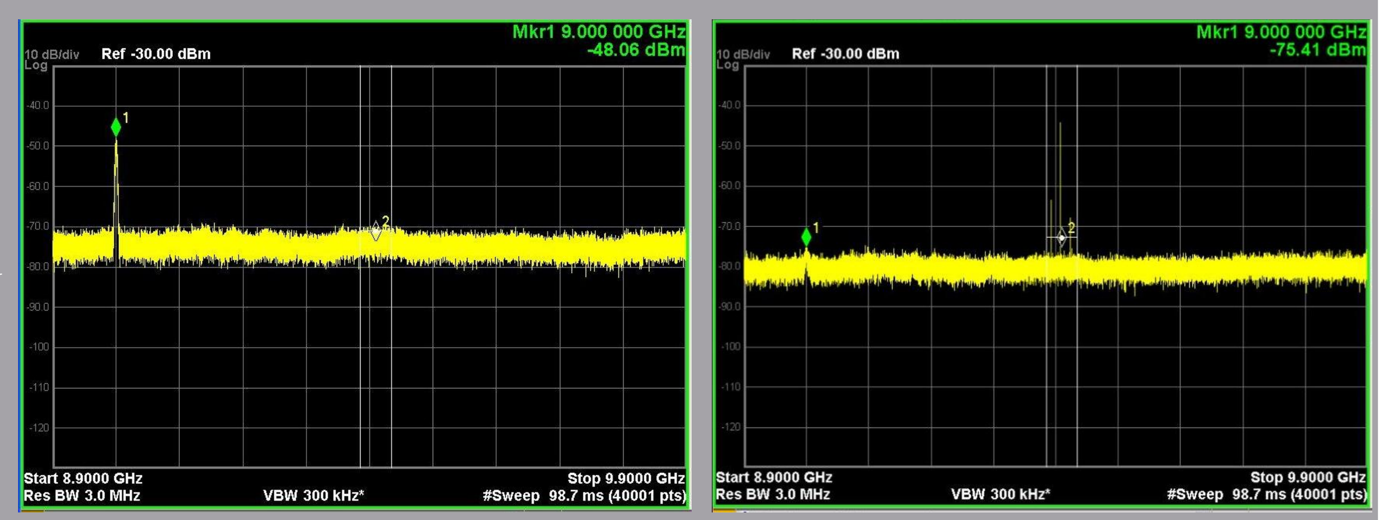
Findings

These graphs represent data taken from the VLBI. The thick yellow line represented the noise floor, or unwanted/unmonitored signals while the peaks represent the generated signal.

Power (dBm) vs Wavelength (MHz))

Without blocker | With blocker

Power in dBm

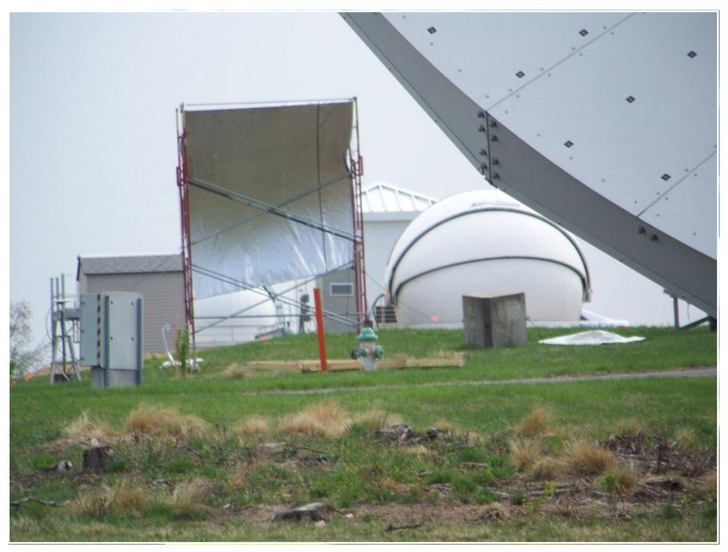


This graph shows the control measurement for the signal being received by the VLBI from the signal generator transmitted through the standard gain horn. It is represented by Marker 1(the green diamond) and has a value of about -48 dBm.

This graph shows the same measurement as the one on the left, but with the RFI blocker in place. It is represented by Marker 1 (the green diamond) and has a value of about -75 dBm.

Wavelength (MHz)

The null hypothesis for this investigation was that the RFI signal would continue to interfere with the VLBI's data collection capabilities. If the blocker worked however, the interference would be significantly reduced.



RFI Blocker

VLBI Antennae

Conclusion

The data showed a significant drop in simulated RFI power. The reflector succeeded in blocking 27 dB at a peak power position. The NGSLR radar, however, emitted 60 dBm of RFI. Future improvements may include coupling an RFI absorber with the reflector in order to further attenuate the RFI signal. Another issue with the radar is viability as a permanent structure. Due to the size of the reflective sheet, the blocker is extremely susceptible to wind damage. Another improvement may involve using a screen-like material that would block RFI while allowing wind to pass through the blocker. Future research would be applying blockers to other on-site equipment in order to improve their data gathering capabilities.

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