Reducing the RFI problems for GGAO
Science and Engineering

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Abstract

The Space Geodesy Project (SGP) has been dedicating a lot of their time and resources to the vision of co-locating various geodetic techniques at one site, with the goal of bringing the International Terrestrial Reference Frame (ITRF) within a spatial resolution uncertainty of 1mm. The VLBI (Very Long Baseline Interferometry) broadband development system was conceived to address the worsening radio frequency interference (RFI) issues while providing additional bandwidth that is required to meet this ITRF precision requirement. Broadband mean 2.14 GHz, but there are being transmitted to be damaged, filtering and filtering and absorbing/shielding.

There are spectrum sharing challenges associated with having four geodetic techniques coexisting at the same site. The 9.41 GHz Laser Hazard Ranging System (LHRS) radar and a 2036 MHz DORIS beacon power levels affect the VLBI broadband system. The cryogenic receivers are highly susceptible to RFI. To attenuate the RFI that the VLBI receiver is on, the equipment is designed to absorb X-band frequency, in conjunction with a reflector material will be position at the LHRS radar. With Network Analyzer tests, we identify which absorber/reflect material combination will be the most effective for building an RFI barrier deployed between the LHRS radar and the VLBI antenna.

Methods

Materials

The materials being tested with an Agilent Network Analyzer are:
1. Eccosorb SF-9.5 (Dark Gray) - Frequency range from 1 - 18 GHz [1].
2. Eccosorb DSF-9.5 (Gray) - Frequency range from 5 - 17 GHz [4].
3. AL100 reflector (Silver) - Frequency range from 100 MHz to 18 GHz [5].
4. Laminated MW Absorber (Black) - Offers protection for frequencies up to, and over, 10GHz [6].
5. Eccosorb SF-2.0 (Gray) - Frequency range from 1 - 18 GHz [3].
6. Eccosorb ANW-75 (ANW) - Frequency range greater than 2GHz [7].

Procedures

1. Turn on Agilent Network Analyzer and make sure coaxial cables are securely connected to Port 1 and Port 2.
2. Connect waveguide launchers to Port 1 and Port 2. A torque wrench may be required to tighten the connector between the coax cable and the waveguide launchers. Ensure that the correct waveguides are being used for the material tests. The WR75 waveguide kit is used for X-band frequency measurements (9-15 GHz).
3. Select Cal Wizard and follow the process to calibrate the Network Analyzer to the kit that is being used. The calibration wizard will go through several steps where the user will be required to select the type of connectors being used (in this case, X, K, and S-band waveguides) and the specific calibration kit being used.
4. After the calibration process will then go through a process in which a series of tests will be implemented. The first step will be to attach a "short" to the Port 1 launcher. Once connected, the user will need to click measure. The second step of the process is to connect the "short" to the Port 2 launcher and click measure. The third step of the process is to connect Port 1 directly to Port 2. The fourth, and final, step of the process is to insert the S-line between Port 1 and Port 2. Each of these steps require the user to the both apparatus together during the calibration measurements for optimum results.
5. Select frequency range that is relevant to the analysis. Again, X-band frequency range is 9-15 GHz.
6. If the materials had holes tapped into its surface it could interface with the waveguide launchers.
7. Select the material(s) to be analyzed and bolt the material to the waveguide launchers.
8. Place markers on the Network Analyzer’s screen at the frequencies of interest, e.g. 9.41 GHz.
9. Repeat steps 5-8 for all of the material combinations.

Test Results

Objective

The objective of this project is to determine the best combination between the reflective and absorbing material to attenuate RFI from a DORIS beacon and LHRS radars. The materials examined were Eccosorb SF-9.5, Eccosorb DSF-9.5, Eccosorb SF-2.0, Eccosorb ANW-75, AL100 reflector, Laminated MW Absorber. The main focus of these tests are on the X-band waveguides.

Introduction

Very Long Baseline Interferometry (VLBI) is a geodetic technique that has the ability to define an inertial reference frame and to measure the Earth’s orientation in this frame. It is measures the time difference between the arrival of two Earth-based antennas of a radio wave emitted by a distant quasar. Simple geometry can then be used to determine how far apart the telescopes that received the radio waves from the quasar actually are.

By taking numerous measurements using various VLBI antennas one can be told how the ground beneath the telescopes moves around and how the Earth rotates about its axis in a given day. The VLBI makes direct measurements of the Earth’s orientation in space. These measurements allow geodesists to study the Earth’s movement, moment of inertia, tides and currents, and the elastic response of the solid Earth [1].

The VLBI broadband (2-14 GHz) development system was conceived to address the worsening radio frequency interference (RFI) issues while providing additional bandwidth that is required to meet this ITRF precision requirement. There are available conflicts between the requirements for the VLBI development system and the absorbing/shielding [1]. The main focus is on the filtering and absorbing/shielding aspect of reducing RFI.

An Agilent Network Analyzer has been used to determine the Scattering Parameters (S-parameters) of 6 different materials as well as several different combinations of those materials. The S-parameters describe the electrical behavior of linear electrical networks when undergoing external input. These techniques are particularly useful in applications such as microwave engineering. The materials have been tagged with the VLBI waveguide launchers and tested under X-band and S-band frequency ranges.

Conclusion

Several materials were tested for their attenuations at X-band frequency using an Agilent Network Analyzer. The data from the experiment was compared to the experimental data obtained from the Network Analyzer. It was found that the experimental data did not deviate in terms of RFI parameters, but the reflectivity (dB) differed by less than what was predicted.

All the materials tested exhibited the same type of behavior in their reflective properties, with the exception of the Eccosorb ANW-75 absorber that displayed a different type of trend. Nevertheless, the attenuation that was obtained from the Agilent Network Analyzer hold great importance for design considerations. There is a clear null in all of the S11 parameters and all of the transfer coefficients were attenuated. At the end of the day, the combination of our RFI devices and testing at the LHRS radar is the Eccosorb ANW-75 in conjunction with the AL100 reflector wall shield.

References


Acknowledgements

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