X-Band Antenna Remoting for the NASA Deep Space Network*

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SUMMARY

We report on the design, fabrication, and testing of a low phase noise and high dynamic range fiber optic link to directly transport S-band (2.5 GHz) and X-band (8.4 GHz) microwave signals to a centralized signal processing center located up to 29 km away. This optical link consists of a diode-pumped YAG laser, an 18 GHz $LiNbO_3$ modulator, an RF preamplifier, and a 12 GHz optical receiver. It is designed to be inserted between the low noise amplifier and the down-converter in a current NASA Deep Space Network (DSN) receiving system. This link will permit the down-converter and related equipment to be moved out of the antenna to the signal processing center, and will substantially reduce the amount of equipment located at the antenna area. in systems with multiple, widely separated antennas, this new configuration will lower hardware and operating costs, and increase performance, flexibility, and reliability.

The phase noise of the optical link is measured to be less than -110 dBc/Hz at 1 Hz from the carrier frequency of 8.4 GHz, and is currently limited by the noise floor of the measurement system. The bandwidth of the optical link is determined by the RF preamplifier and the link gain is unity. This link is designed not to degrade the noise temperature of the signal receiving system by more than 0.1'70 and not to reduce its dynamic range by more than 1 dB.

This fiber optic link is evaluated for S-band performance in a test facility which simulates the DSN operating condition. A 12-km spool of single-mode fiber is used to simulate the path between the antenna and the signal processing center. 'l-he test shows that the insertion of the fiber optic link adds no observable degradation to the receiving system. We will report cm more results of the ongoing evaluation of this link at X-band in an actual operating DSN receiving system.

We also analyze the influence of the insertion of the optical link on the performance of the microwave receiving system, especially the gain, noise figure, and dynamic range of the system. From the analysis, we deduce limitations cm the magnitude of the relaxation oscillation peak, photocurrent, and other parameters of the optical link in order for the link to function according to our specifications.

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