RFI Receiver

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In support of an effort to analyze and identify sources of RFI problems in the DSN tracking stations, an S-band RFI Receiver has been developed that will be upgraded later for S/X-band operation.

I. Introduction

The DSN tracking stations have experienced occasional problems with RF interference because of the extreme sensitivity of its receivers and antennas. The RF surveillance system has been developed as a possible aid to establish the characteristics of the RF environment at the Goldstone DSN Complex.

The RFI Receiver, shown in Fig. 1, is a constant-gain, double-conversion, open-loop receiver with dual sine/cosine channel outputs, providing a total of 20-MHz monitoring capability. This receiver is computer controlled using a MODCOMP II miniprocessor.

II. Design Considerations

The RFI Receiver has been designed to operate at a 150-kelvin system noise temperature accomplished by cascading two low-noise field effect transistor (FET) amplifiers for the receiver front-end. The first stage low-noise FET amplifier will be mounted at the feed horn to minimize any cable losses to achieve a lower system noise temperature. The receiver is tunable over the frequency range of 2150 to 2450 MHz in both sine/cosine output channels with a resolution of 100 kHz.

One output channel contains the IF signal mixed with the sine of the reference frequency of the digital controlled oscillator, and the other output channel contains the IF signal mixed with the cosine of the reference frequency. This is a complex mixer discussed in detail in Ref. 1.

Care was taken in the design of the complex mixer output stage for maintaining good phase and gain tracking between the sine/cosine output channels, thus suppressing unwanted image or ghost response in the power spectrum of the baseband signal.

Measurement data taken on phase tracking between the sine/cosine channel outputs, without the video amplifiers and low-pass filters, is shown in Fig. 2. The data represents the best phase tracking data obtained after a number of trial combinations were made between different manufactured 90-degree hybrids and mixers. The plots shown in Fig. 3 and Fig. 4 are exclusively on the video amplifier and the low-pass filter that track in phase within 6 degrees. As shown in Fig. 3, there is a large phase difference near 300 kHz and 800 kHz. Additional alignment was done to smooth the phase response of the video amplifier and low-pass filter. The phase tracking response of the low-pass filter and the video amplifiers were made to track in phase within 2 degrees across the pass band. The resulting phase tracking response of the video amplifier and low-pass filter, is shown in Fig. 4. The composite plot of the phase tracking between the sine/cosine output channels of the RFI receiver is shown in Fig. 5.

Gain tracking between the sine/cosine output channels of the RFI Receiver tracks within 1 dB across the receiving frequency band.

III. Theory of Operation

A simplified block diagram of the RFI Receiver is shown in Fig. 1 and is a double conversion open-loop receiver. The received S-band signal from the feed horn is converted to an IF signal in the first mixer using a fixed 2000-MHz local oscillator (LO) signal. The second mixer translates the IF signal to video. The LO signal for the second mixer is fed from a digitally controlled synthesizer through a 90-degree hybrid. The RFI Receiver is designed for measuring the S-band environment at the Goldstone DSN Complex using its own S-band feed horn; however, it has the capability of monitoring the Block IV receiver at DSS 14 at the 55-MHz IF or the 325-MHz IF.

IV. Future Plans

The future plan will be to upgrade this S-band Receiver to enable S- and X-band operation. This will be accomplished by providing an additional X-band receiving channel and will provide a total of 80-MHz monitoring capability at either S- or X-band. In addition, investigation of the design of lower system noise temperatures for the receiver will be conducted.

Reference

1. Winkelstein, R., "Complex Mixer Error Analysis," *Deep Space Network Progress Report*, Technical Report 32-1526, Vol. XII, pp. 47-50, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1972.

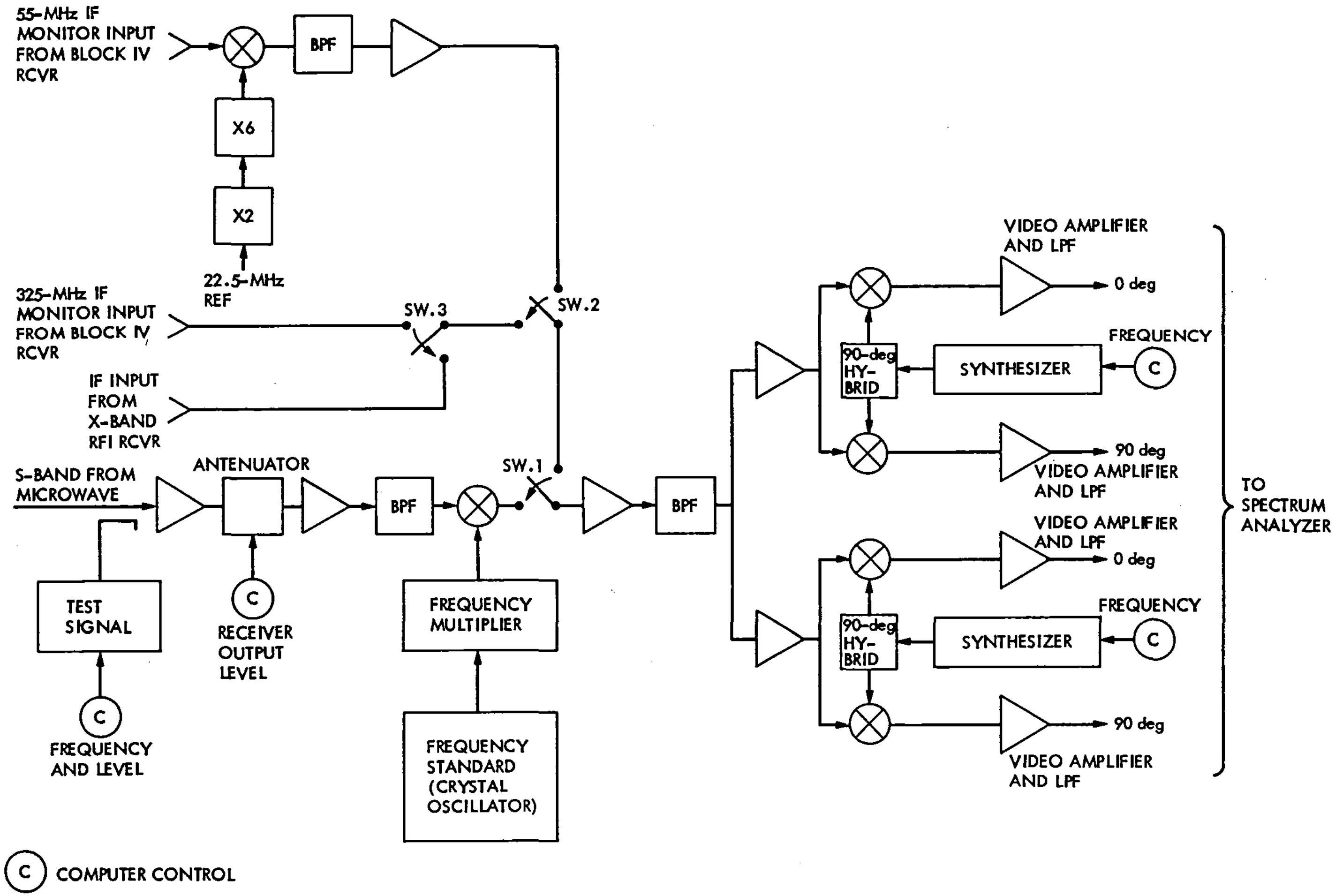

Fig. 1. RFI Receiver block diagram

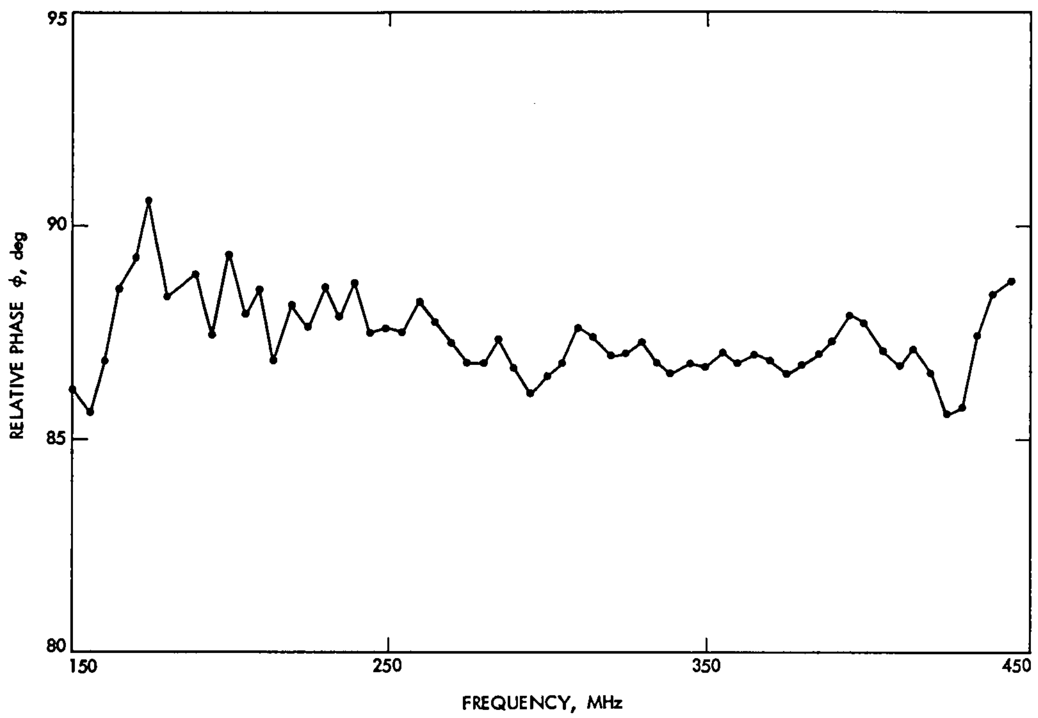

Fig. 2. Phase tracking response between the sine/cosine channels without the video amplifiers and low-pass filters

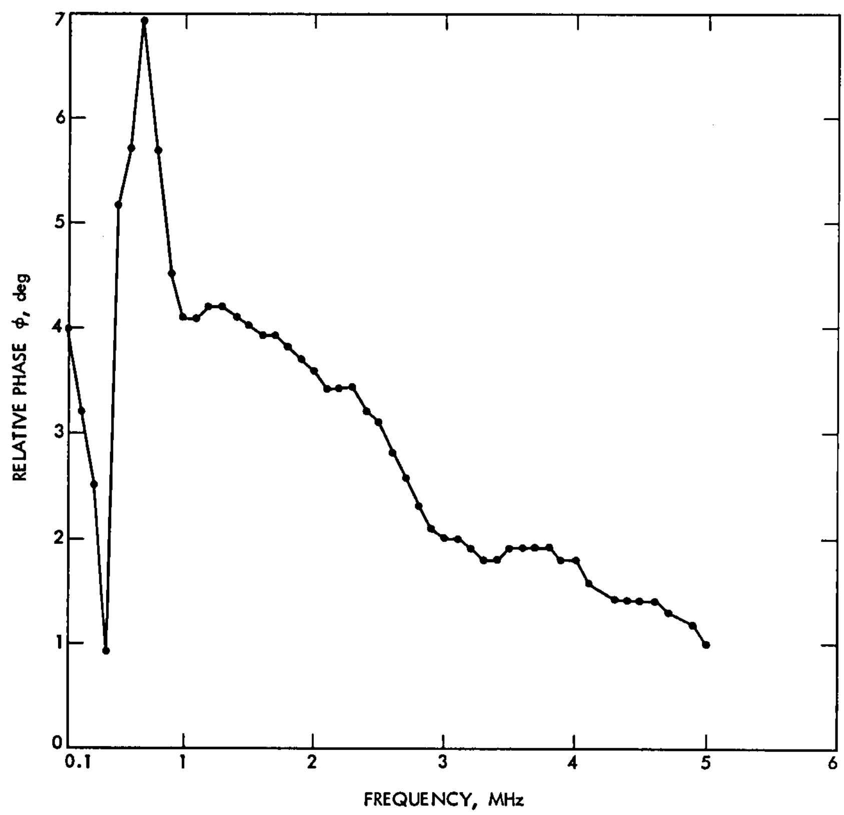

Fig. 3. Phase tracking response between the video amplifier and low-pass filter

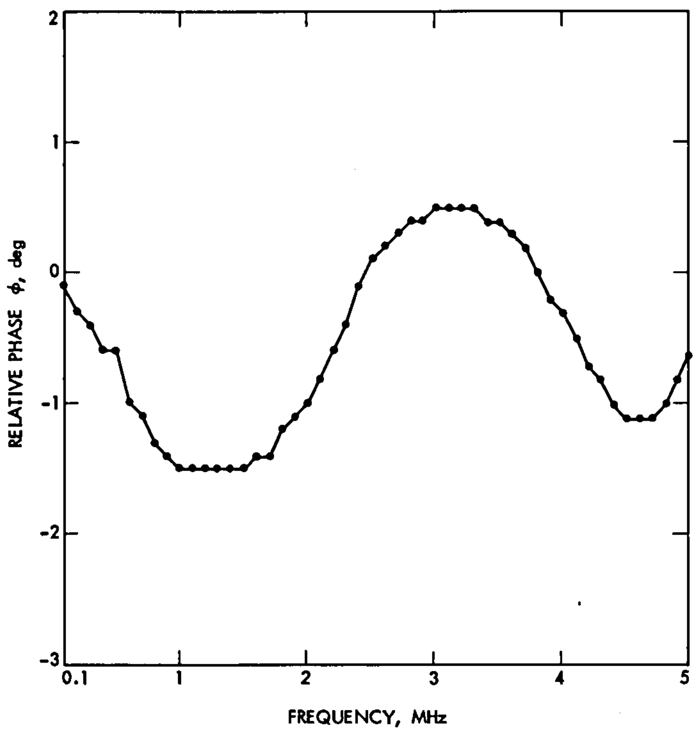

Fig. 4. Phase tracking response of the video amplifier and low-pass filter

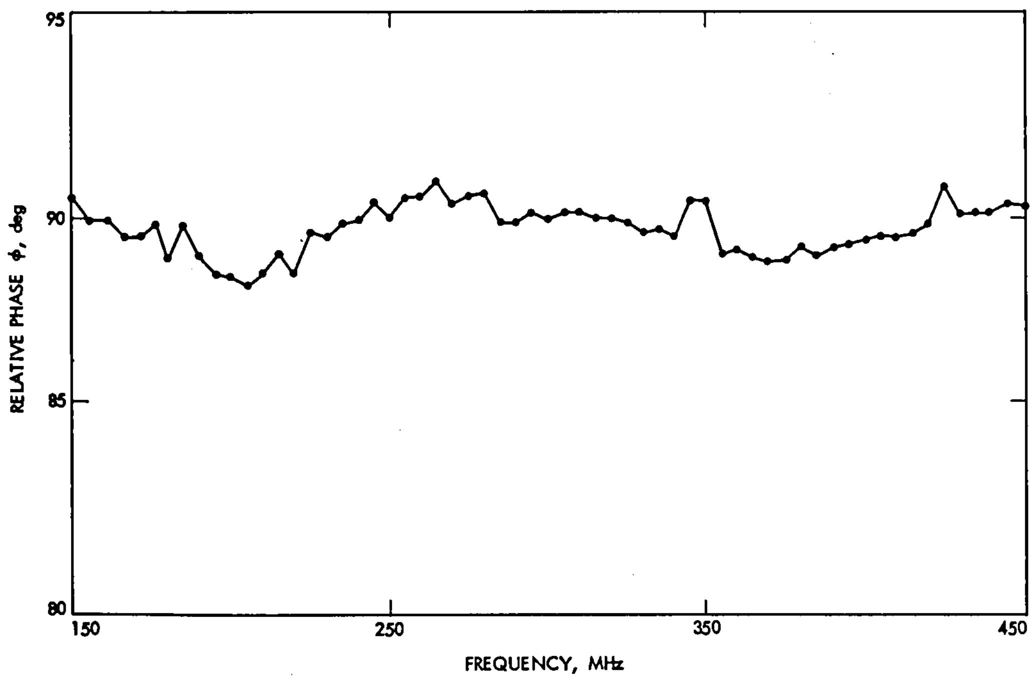

Fig. 5. Composite phase tracking response between the sine/cosine output channels of the RFI receiver