S-Band Planetary Radar Receiver Development

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This article describes the design of a wideband 2295/2388-MHz converter, which is a part of the DSS 14 bistatic radar receiver. This receiver is an open-loop superhetrodyne receiver used for development of communication techniques. This converter design eliminates the need for separate converters at each frequency. The 2295/2388-MHz converter has been installed at DSS 14 and is now being used in the Venus radar mapping experiments.

I. Introduction

During this period the design and installation of a 2295/2388-MHz converter has been completed. This converter is a major subsystem of the S-Band Planetary Radar Receiver (Ref. 1), used to support wideband, high-resolution radar experiments. The design was initiated because of the need for a greater dynamic RF input range, and to reduce changeover time required when a new operating frequency was desired.

II. Implementation

The 2295/2388-MHz converter is contained in an aluminum box mounted in the DSS 14 antenna (Fig. 1). It consists of a local oscillator (LO) chain with drive level monitor, a balanced mixer, and an IF amplifier (Fig. 2). Because of design requirements, all components are wideband. The first multiplier in the LO chain is $\times 2$ (Fig. 3) and has been designed around commercial wideband hybrid amplifiers and a wideband doubler module with the following specifications: bandwidth is greater than 10 MHz, distortion is less than 5%, and input and output impedance is 50 ohms. The $\times 32$ multiplier is a commercial unit with a typical bandwidth as shown in Fig. 4. Its harmonics and spurious response are 60 dB down, and phase noise is equal to -92 dB rad^2/Hz at 10 Hz.

The balanced mixer is also a commercial module, and has a bandwidth of dc to 4 GHz.

The IF amplifier has a maximum noise figure of 1.5 dB, a bandwidth of 5 to 60 MHz, an input/output voltage standing wave ratio (VSWR) of 1.3 to 1 over the rated

bandwidth, and a 1-dB output power compression point of +31 dBm. The overall tuning range of the converter is limited by the bandwidth of the ×32 frequency multiplier which allows tuning from 2202 to 2414 MHz.

The noise figure of this converter over the design operating range is plotted (Fig. 5) and the converter limiting curve is shown in Fig. 6. The total harmonic distortion is 5%.

III. Conclusion

The 2295/2388-MHz converter has been installed at DSS 14 and is being used to support the Venus radar mapping experiments. Its improved performance has been demonstrated not only in improved technical parameters but also it has eliminated down time due to operator confusion associated with the past system of switches and cable changes when changing operating frequencies.

Reference

1. Foster, C. F., "S-Band Planetary Radar Receiver Development," in *The Deep Space Network*, Space Programs Summary 37-41, Vol. III, pp. 107–110. Jet Propulsion Laboratory, Pasadena, Calif., Sept. 30, 1966.

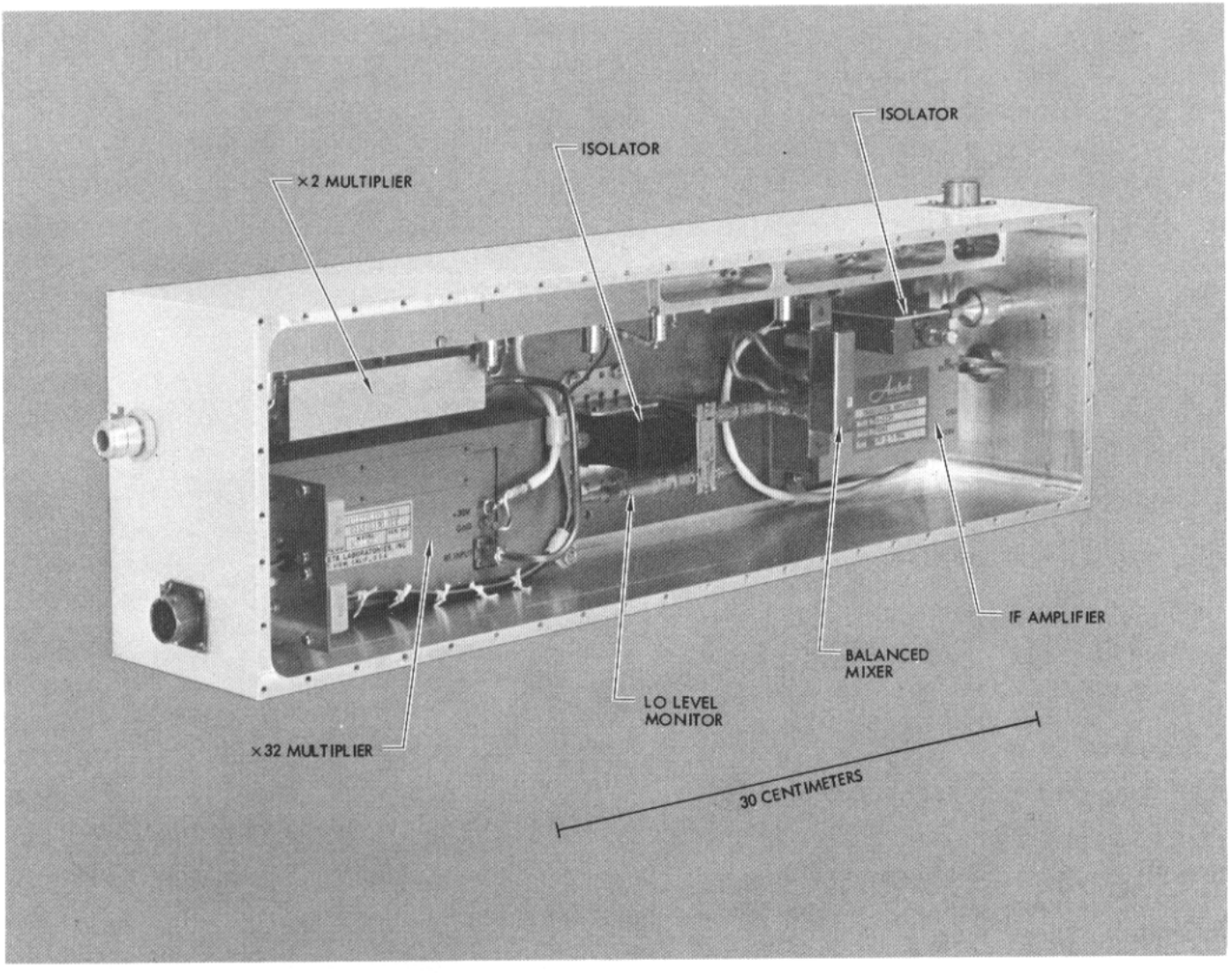

Fig. 1. 2295/2388-MHz converter

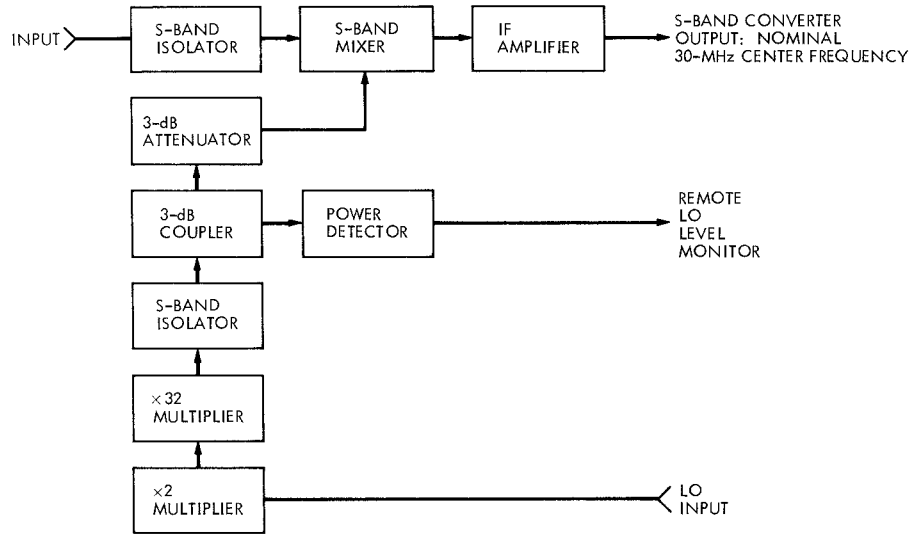

Fig. 2. Block diagram of 2295/2388-MHz converter

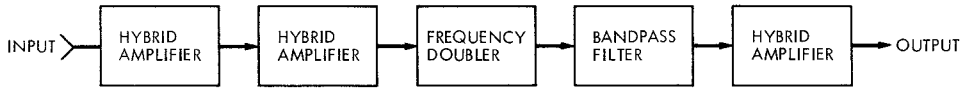

Fig. 3. Block diagram of ×2 frequency multiplier

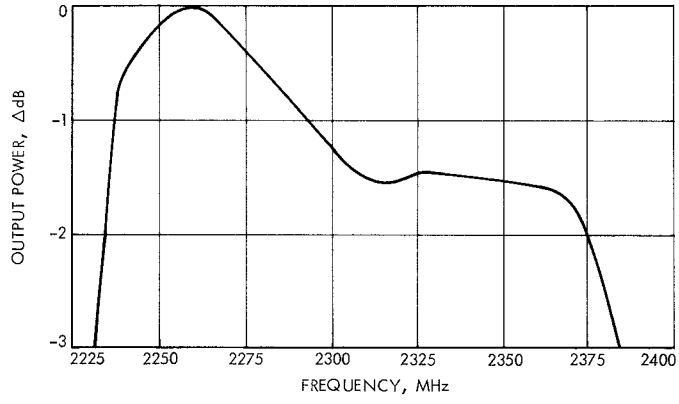

Fig. 4. ×32 multiplier bandpass

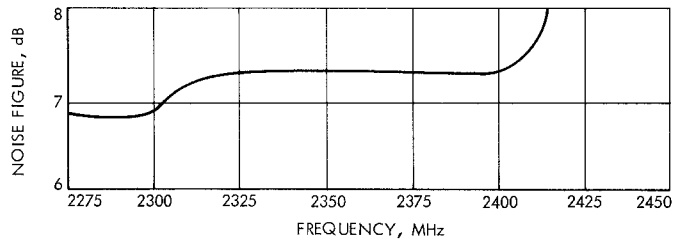

Fig. 5. 2295/2388-MHz converter noise figure vs received frequency

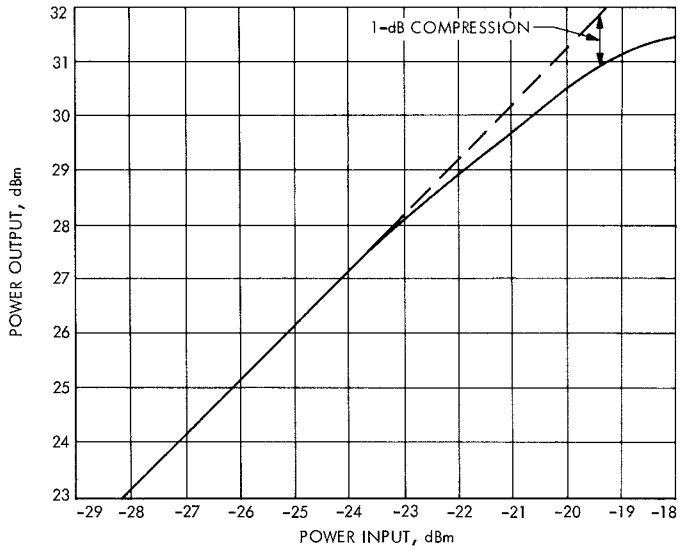

Fig. 6. 2295/2388-MHz converter limiting curve