A K-Band Radiometer for the Microwave Weather Project

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The design of a K-band radiometer for use in the microwave weather project is discussed. The major components of the system, such as feedhorn, waveguide switch, and receiver assembly are described. The system will be installed at DSS 13 at Goldstone, California, when completed.

I. Introduction

The Microwave Weather Project forms part of an overall Radio Systems Development Project which seeks to optimize the spacecraft-to-ground communications link. The objective is to provide a mathematical model of atmospheric transmission at X- and K-bands. This model will allow practical predictions of link performance to be made and will also form the basis of a specification of the receiving sensitivity of a Deep Space Network ground station. The model, which contains both probabilistic and deterministic elements, is based on the statistical correlations of weather and communications capability at X- and K-bands.

An X-band radiometer has been designed and constructed and has been operated at DSS 13 since August 1975 to gather data for the statistical analysis. The radiometer (Ref. 1) and the data system (Ref. 2) have been described in previous reports. This radiometer will continue operation, and statistical X-band results will be periodically reported (Ref. 3). A K-band radiometer has been designed and is presently being constructed and tested. This article describes the design of this K-band radiometer and reports on the progress of construction and testing. On completion of the construction and testing the radiometer will be installed at DSS 13 near the X-band radiometer. The data from the K-band radiometer will also be fed into the existing data acquisition system.

The K-band radiometer has been designed to operate over the frequency range of 12.75 to 13.25 GHz, centered at 13.00 GHz. The radiometer system consists of a feedhorn, waveguide switch, receiver assembly, detector, and other components required to operate the system as a noise-adding radiometer (NAR). Figure 1 is a block diagram of the system front end.

The feedhorn has been built and tested (Fig. 2). It is a standard corrugated horn, linearly polarized, with a gain of 22 dB and 10-dB beamwidth of 26 deg. The reflection coefficient is 24 dB or greater. Standard WR-62 waveguide components are used to mate with the waveguide switch. The waveguide switch has been constructed and is presently under test (Fig. 3). It is designed to be extremely reliable, with low insertion loss and high isolation. Electronic controls select from the four positions. The switch is used for calibration with an ambient termination, a cryogenic termination, or a waveguide short.

The receiver assembly has been designed for reliable low noise and stable operation in all weather conditions at Goldstone (Fig. 4). Stability is greatly enhanced by operation in a noise-adding radiometer mode. For total power stability, the assembly is temperature-controlled. The receiver is built with low insertion loss isolators of high isolation and wide bandwidth. Typical values are: 0.5 dB insertion loss, 40 dB isolation, 150 MHz bandwidth. The mixer-preamp noise figure is less than 5 dB, DSB. The local oscillator is a Gunn-effect oscillator, fixed-tuned initially to 13.050 GHz. A coaxial port is provided to monitor the local oscillator frequency and power. Noise diode 1 is used for NAR operation, and noise diode 2 is used for calibration and linearity measurements. The IF system is approximately 40 MHz bandwidth, although filters may be used to limit the operational bandwidth to a lower value.

The detector, controls, and data acquisition system are located inside a building at DSS 13. The NAR control system will eventually be a new design under development, although initially a system using a computing counter and programmer will be used.

Subsequent reports will provide test results and operational performance of this system.

References

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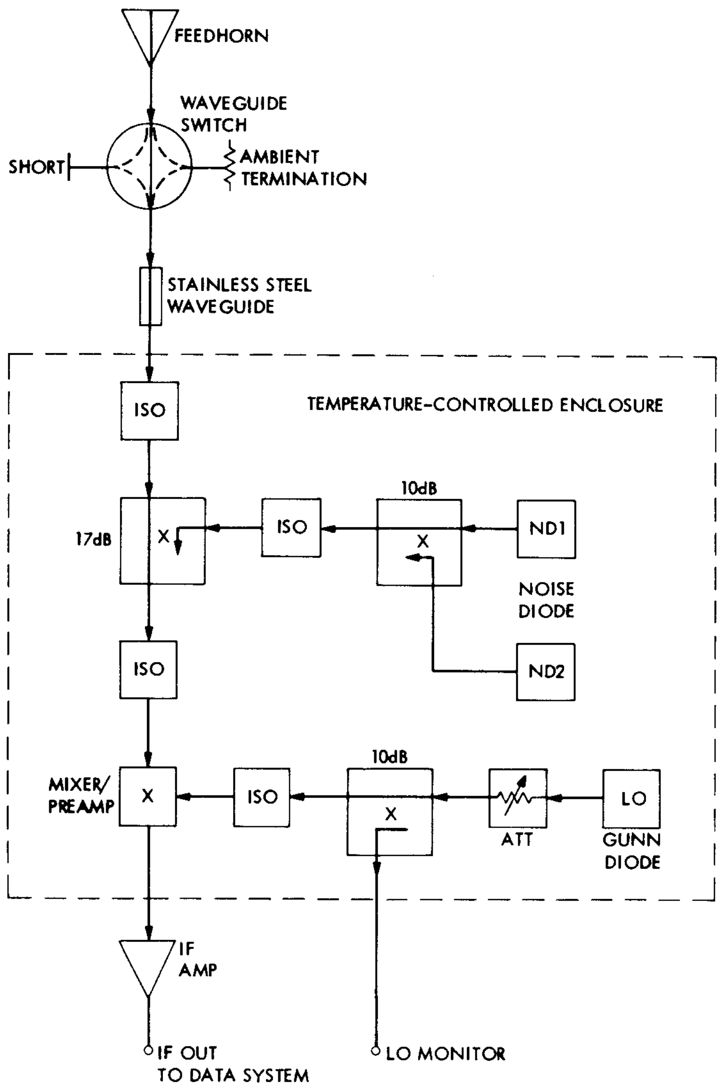

Fig. 1. K-band radiometer block diagram

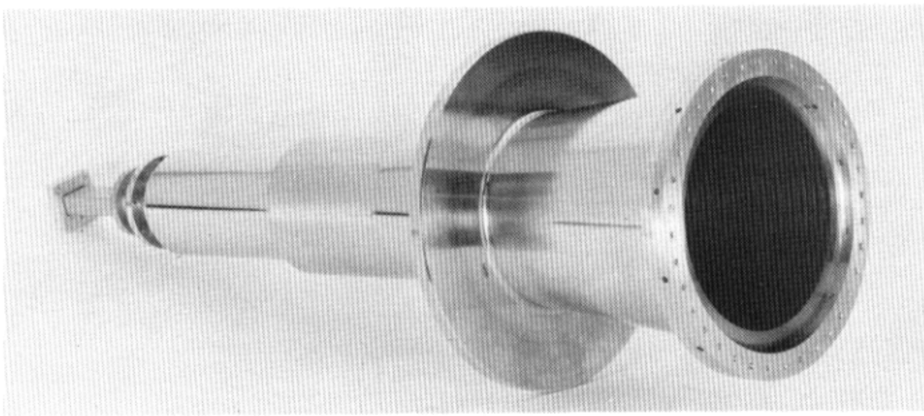

Fig. 2. Feedhorn

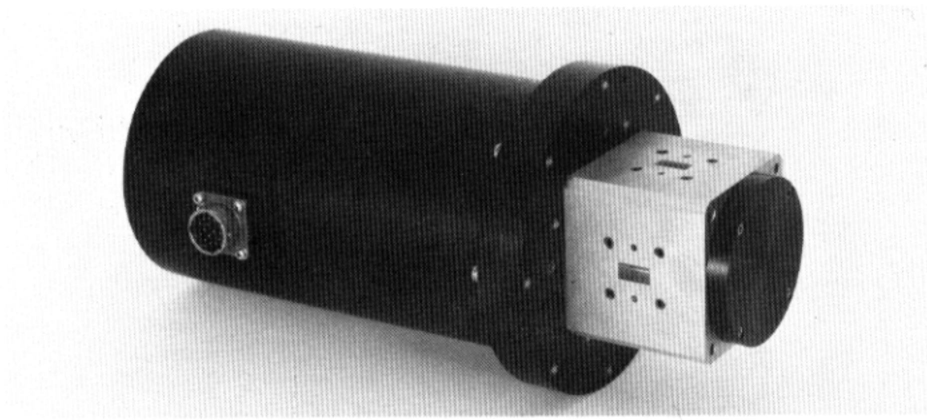

Fig. 3. Waveguide switch

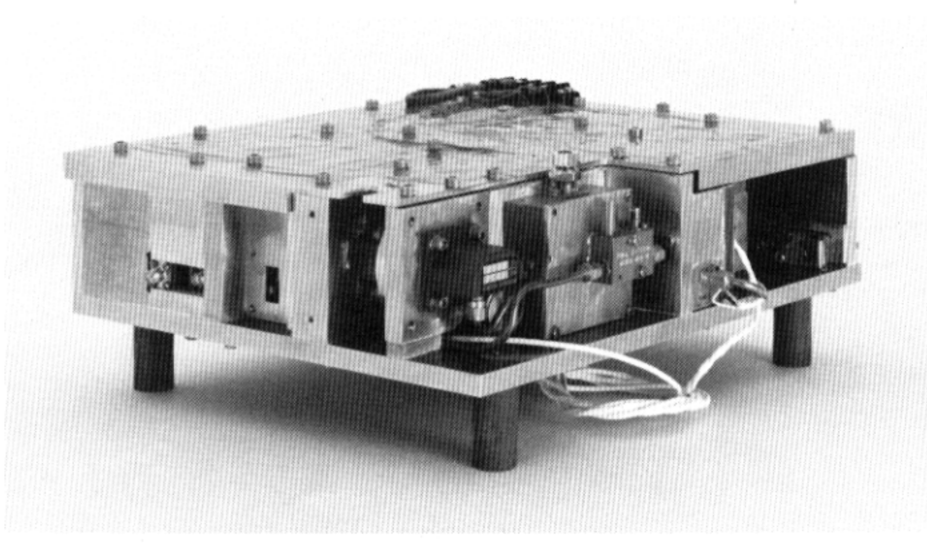

Fig. 4. Receiver assembly