S/X-Band Open-Loop Receivers

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The existing open-loop receivers at DSS 14 are being modified on an R&D basis to support the Mariner Venus–Mercury 1973 mission. These modifications will provide both S- and X-band phase-stable receivers to obtain occultation data. A description of the modifications is presented in this article.

I. Introduction

Beginning with the Mariner Mars 1964 mission, measurements of the effect of planetary atmospheres on the communications link with spacecraft have been made at S-band using open-loop receivers. The Mariner Venus–Mercury 1973 (MVM 73) mission presents the first opportunity to perform these measurements at both S- and X-band. Of prime importance is the difference in the effect of the planetary atmosphere on each of these two frequencies. To measure accurately the differential effect, the open-loop receivers at DSS 14 are being modified to provide phase stable systems at both S- and X-band. These modifications are described below.

II. Receiver Modifications

There are two S-band open-loop receivers at DSS 14 of the type described in Ref. 1. To support the MVM 73 mission, two design changes are being made. These changes will:

(1) Provide the capability of operating one of the receivers at X-band so that the occultation measurement can be made on both the S- and the X-band signals from the spacecraft.

(2) Improve the phase stability of the receivers so that the differences in the effect of the planetary atmosphere on S- and X-band can be accurately measured.

The method used to modify the receivers to include these design changes and the reasons for selecting this particular method are the following:

(1) The present operational mode of the open-loop receiver is S-band. The modification to add X-band capability had to be done in a manner that did not disturb the present S-band operational mode. The method selected to add this X-band capability to one of the open-loop receivers was to precede the S-band operational receiver with an X-to-S down converter (Fig. 1). The open-loop receiver can then be changed from an operational S-band mode to an R&D X-band mode, depending on the mission requirements (switches 1–4 of Fig. 1).

(2) The largest contributors to the receiver phase instability are the oscillator sources and the frequency multipliers of the receiver local oscillators. The instabilities of both local oscillators contribute to the differential drift between the S- and X-band receivers. These instabilities are being minimized by utilizing a common oscillator source and frequency multipliers for the S- and X-band local oscillators.

These modifications will reduce the possible differential phase drift between receivers from a couple of wavelengths peak-to-peak at S-band to less than 0.1 wavelength peak-to-peak. Without these modifications, the differential phase drifts would mask the occultation data.

The coherent S- and X-band local oscillators have been designed to receive two signals of the ratio 3/11 (S/X). The receiver outputs consequently have the same frequency ratio. Tracking in the S/X mode then requires that the bandwidth selected for the X-band receiver be approximately 11/3 of the bandwidth of the S-band receiver. In addition, the local oscillator frequency must be selected so that both the S- and the X-band signals fall within the receiver bandwidths. If it is desired to reduce the X-band receiver bandwidth, the spare Dana synthesizer could be utilized to track some of the doppler (Fig. 1). The stability degradation in this configuration would be negligible.

III. Conclusion

These two modifications are necessary to obtain usable differential occultation data. It is planned to modify, on an R&D basis, the receivers at DSS 14 to support the MVM 73 mission. These modified units will be made operational at DSS 14 and added to the open-loop receivers at DSS 43 for the occultation measurements of Viking 1975.

Reference

1. Donnelly, H., and Friedenberg, S. E., "Multiple-Mission Open-Loop Receiver," in *The Deep Space Network Progress Report for March and April 1973*, Technical Report 32-1526, Vol. XV (this issue). Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1973.

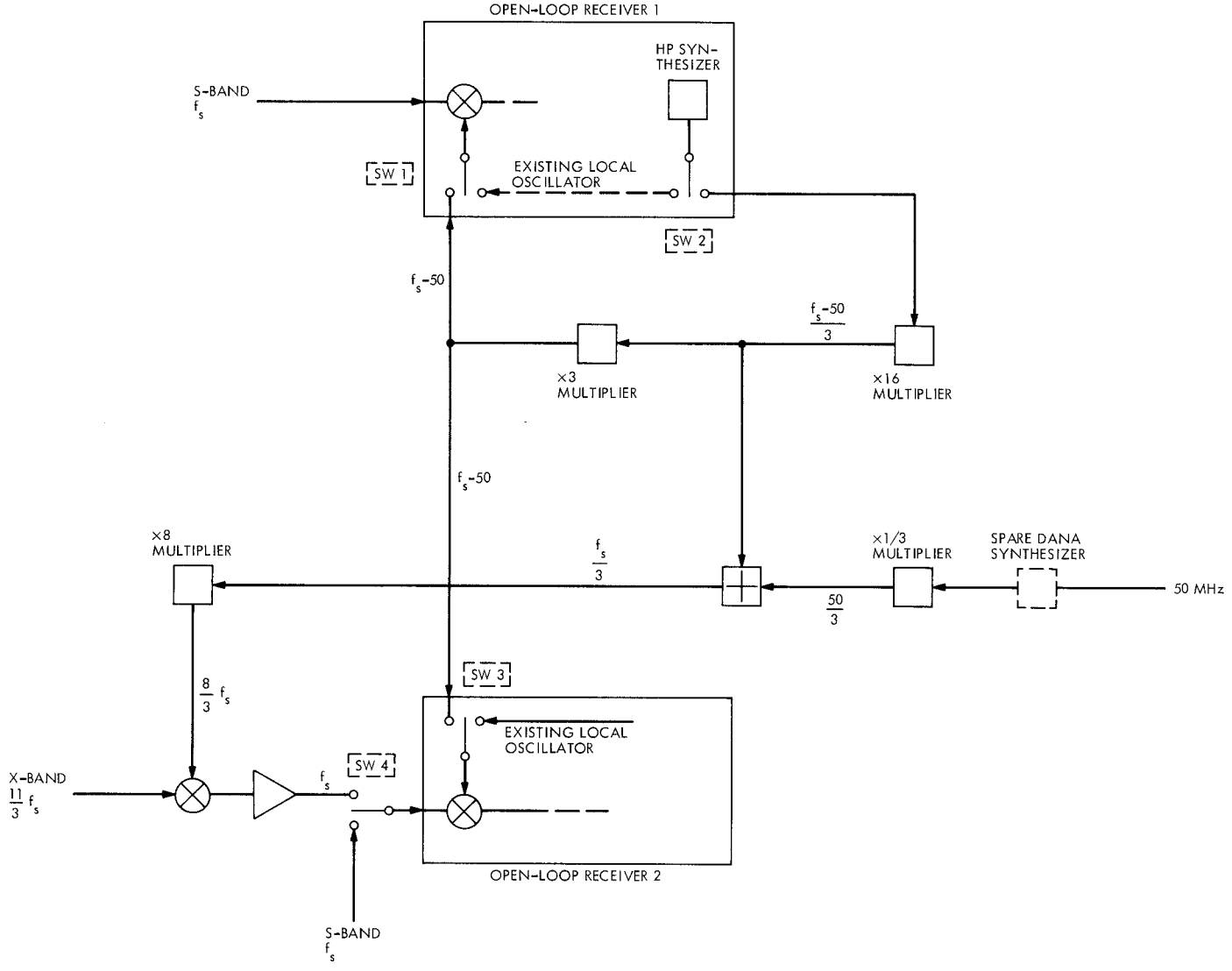

Fig. 1. S/X-band open-loop receivers