S-Band Demodulator

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This report describes a portable S-band demodulator. The demodulator is a first-order phase-locked loop designed to work directly with the nominal levels out of the Deep Space Instrumentation Facility exciter and or transmitter. This demodulator provides an independent means for verification of the exciter/transmitter performance. Its primary utilization is the measurement of exciter/transmitter, amplitude stability, short-term phase stability, modulation index, bandpass, and modulation fidelity.

I. Introduction

A requirement for a means of evaluating broadband modulation spectrum was defined by the multimission command. Modulation could not be evaluated because no existing instrumentation previously available allowed broadband observation of the total exciter/transmitter chain. To meet these requirements a wide-band demodulator was developed. This device is a first-order phase-locked loop whose predetection bandwidth is two orders of magnitude greater than the exciter/transmitter bandwidth.

II. Implementation

The decision to mount the demodulator in a standard attaché case dictated the use of miniature microwave components. The feasibility model was constructed on an aluminum chassis (Fig. 1). All intermodule cabling is semirigid coax to ensure phase stability versus temperature and vibration. The S-band demodulator is self-contained, requiring only standard 60-Hz line power and a coherent 66-MHz reference signal.

The phase detectors (Fig. 2), and all S-band modules have a bandwidth two decades greater than the exciter/transmitter spectrum bandwidth.

The S-band demodulator has a built-in self-calibration provision which takes a sample of the reference signal and injects it into the demodulator. This self-test provides a measurement of the demodulator amplitude stability and short-term phase jitter.

There are three internal meters that monitor the following functions:

(1) The reference level meter provides assurance that the 66-MHz input is connected, and that the X 32 frequency multiplier, the limiting amplifier, and the voltage-controlled phase shifter are all operating.

(2) The AGC voltage meter provides a measurement of the input S-band signal strength and can be used to set modulation index using the suppressed carrier method. The resolution of this meter is coarse, and is only used when modulation index setting is not critical (i.e., when measuring modulator bandwidth).

(3) The phase shifter input control voltage meter is calibrated in degrees of phase and has a 2-deg resolution. It is used to assure that the voltage-controlled phase shifter is in the center of its linear range and can be used to measure phase shift as well as setting low-frequency squarewave modulation index.

The outputs of the S-band demodulator are two phase detectors, one in quadrature with respect to the other. The 90-deg detector output is used to monitor carrier amplitude. It is calibrated to provide a reading of input level in dBmW into 50 Ω. This output is also used in either the MGC or AGC modes to provide short- and long-term exciter/transmitter amplitude stability. It can also provide an indication of modulation index by measuring carrier suppression.

The 0-deg detector output is used to measure exciter/transmitter short-term phase stability, exciter/transmitter bandpass, and the fidelity and power loss of the command modulation chain, by comparing the input modulation to the demodulated output waveform.

Table 1 lists design goals and achieved performance.

III. Summary

Testing of the demodulator for compatibility with DSIF has been successfully completed at CTA 21.

The S-band demodulator has been used to evaluate fidelity of planetary ranging modulation through the DSIF exciter chain, and has proved useful as a means of trouble-shooting individual exciter chain modules.

The S-band demodulator feasibility model will continue to be used for DSIF exciter-transmitter system performance confirmation and new system development.

Table 1. Design goals and achievement

Parameter	Design goal	Achievement
Relative amplitude of carrier	30-dB range	60-dB range
Modulation sideband spectra	±2 MHz	13 MHz
Dynamic range	40 dB	45 dB
Noise figure at maximum gain	No specification	9 dB
Amplitude stability	No specification	≥.05 dB
Loop bandwidth	No specification	1 and 0.5 Hz
AGC loop bandwidth	No specification	0.1 Hz
Internal phase meter	No specification	2 deg resolution
Modulation index measurement using square wave modulation	10 to 90 deg	0 to 90 deg

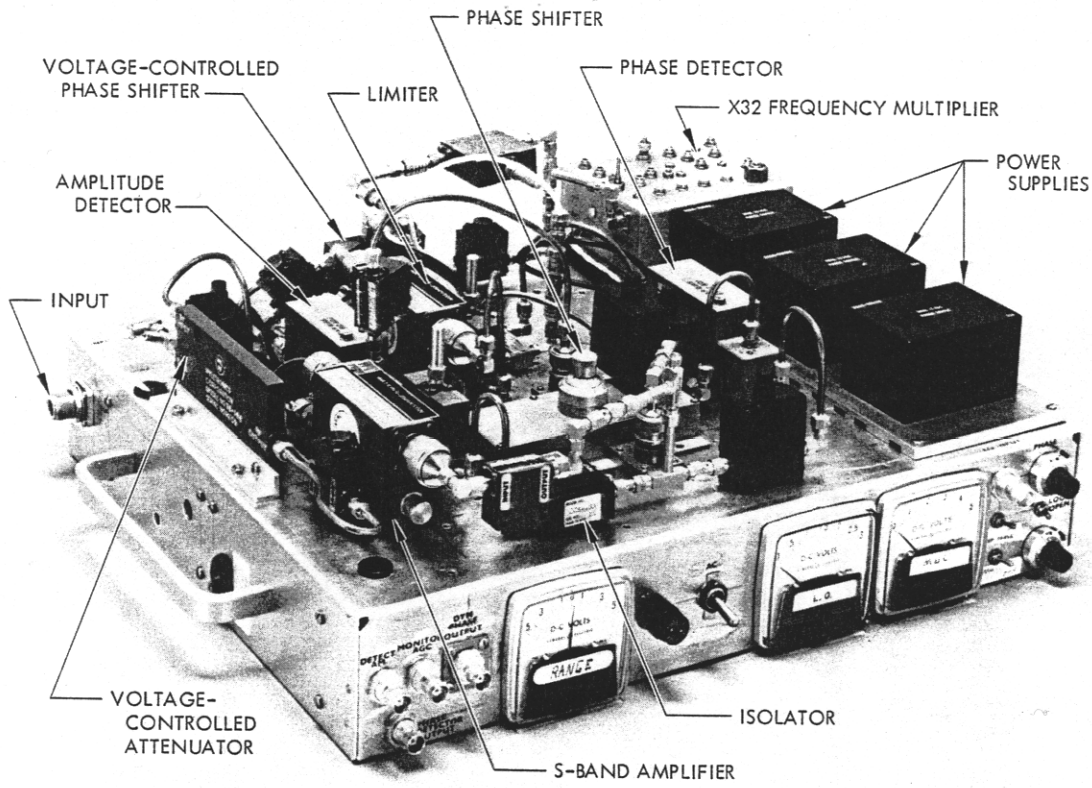

Fig. 1. S-band demodulator

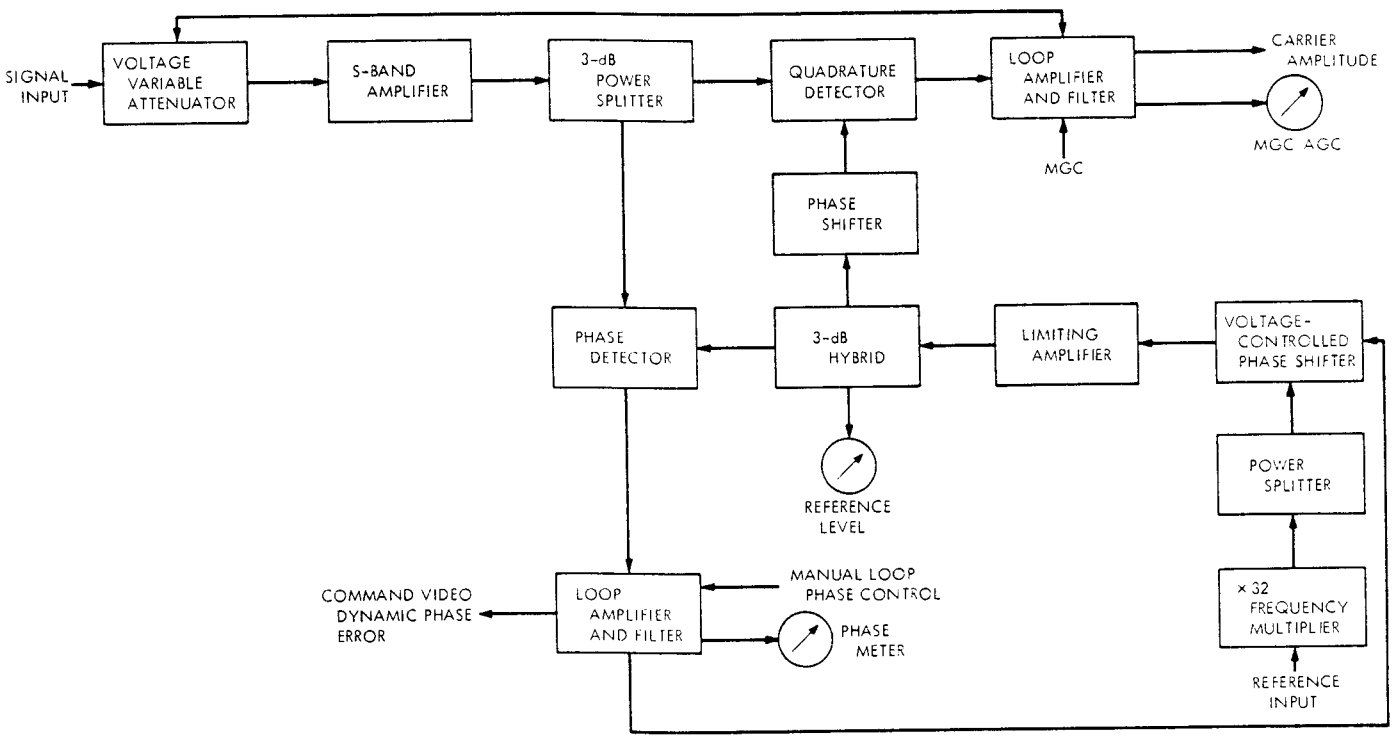

Fig. 2. S-band demodulator simplified block diagram