Complex Mixer System Modifications

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Modifications of the complex mixer system to increase bandwidth and number of channels have been made. Three modified complex mixers have been installed at DSS 14 and were used to process planetary radar signals in March and April of 1977.

I. Introduction

The complex mixer system is an integral part of the R&D spectrum analyzer and is described in detail in Ref. 1. A third complex mixer module has been installed in the system, and all complex mixer modules have been redesigned to provide baseband bandwidth of DC to 2 MHz. The three independent channels can be operated in either of two modes, accepting the 10-MHz IF of the DSN receivers or the 2.5-MHz IF of the experimental receiver or microwave link.

II. Complex Mixer Module

A block diagram of a complex mixer module is presented in Fig. 1. The phase-locked loop and the SIN-COS generator of the original design were retained. The complex mixer section has been redesigned to increase the output bandwidth from 1 MHz to 2 MHz.

Figure 1 shows that the IF signal is applied to two separate channels. At the input of each channel is an isolation amplifier needed to prevent the modulation products generated by the mixers from contaminating the input source. The buffered IF signal is then mixed with the locally generated SIN and COS signals to translate the IF signal to baseband and generate the complex modulation products. Following the mixers are lumped constant passive low-pass filters which pass the difference frequencies (the desired baseband signal) while attenuating the sum modulation products and local oscillator leakage.

A two-section elliptic low-pass filter was chosen because it could supply the necessary selectivity with a minimum number of components, minimizing the problems of filter tuning to achieve the desired phase and amplitude tracking over the passband range. Ripples exist within and without the passband, and this was used to advantage by carefully placing one of the attenuation peaks of the stopband at exactly 2.5 MHz. In doing so, the 2.5-MHz local oscillator feedthrough was significantly suppressed. The passband ripple of these filters is 0.25 dB.

The filtered baseband signals are then amplified and fed to 50-Ω output buffers designed to drive 50-Ω coax cables terminated with 50-Ω loads.

III. Packaging

Three printed circuit boards (PCBs) are contained within each complex mixer module. The phase-locked loop and the SIN-COS generator occupy two of these boards and were not modified. A new PCB was designed to accommodate the circuitry of the 2-MHz complex mixer. Outside dimensions, mounting hole locations and electrical connection layouts were made the same as the old boards to facilitate easy retrofitting of the new boards.

Figure 2 shows the 2-MHz complex mixer PCB. All microcircuits are on sockets for easy field maintenance. Gain and DC offset adjustment potentiometers for each channel are provided on the PCB and are accessible through holes drilled in the module cover plates. Each low-pass filter is comprised of two ferrite torroidal inductors and five capacitors. Each capacitor is formed by paralleling up to three glass capacitors to achieve the desired value. Input and output connections to each filter are established by inserting plug-in jumpers. Installation of the jumpers in one set of sockets connects the filters into the complex mixer circuitry. Plugging the jumpers into an alternate set of sockets transfers the filter input and output connections to 50-Ω bulkhead connectors. This arrangement permits easy connection of the filter terminals to external test equipment. This is necessary when testing the two filters on each board for amplitude and phase tracking across the DC to 2-MHz band. Although the input-output phase relationship of these filters varies from 0 degrees at DC to over 100 degrees at 2 MHz, the filters track in phase to better than 1 degree over the entire range.

IV. Performance

Table 1 summarizes the typical characteristics of the modified complex mixer module. In each complex mixer, the real and imaginary outputs are balanced in gain to within 0.2 dB and in phase to within 6 degrees over the entire operating range of DC to 2 MHz.

V. Conclusion

A third complex mixer module has been added to the complex mixer system. All complex mixer modules have been modified to increase the output bandwidth to 2 MHz. The complex mixer system was used to process planetary radar signals during March and April of 1977.

Reference

1. Constenla, L. C., *Complex Mixer System*, Technical Report 32-1526, Jet Propulsion Laboratory, Pasadena, California, December 15, 1972.

Table 1. Complex mixer module specifications

Parameter	Value	Comment
Input impedance	50 Ω	
Output impedance	50 Ω	
Bandwidth	DC to 2 MHz	
Voltage gain	2	Single sideband gain with 50-Ω output loads.
Baseband freq. response	±0.5 dB	DC to 2 MHz
Amplitude tracking	0.2 dB	DC to 2 MHz
Phase tracking	< 6 deg	DC to 2 MHz
Maximum input voltage	1 VPP	
L.O. leakage	< 2 mVRMS	2.5 or 10 MHz mode
Maximum undistorted OP vol.	2.8 VPP	

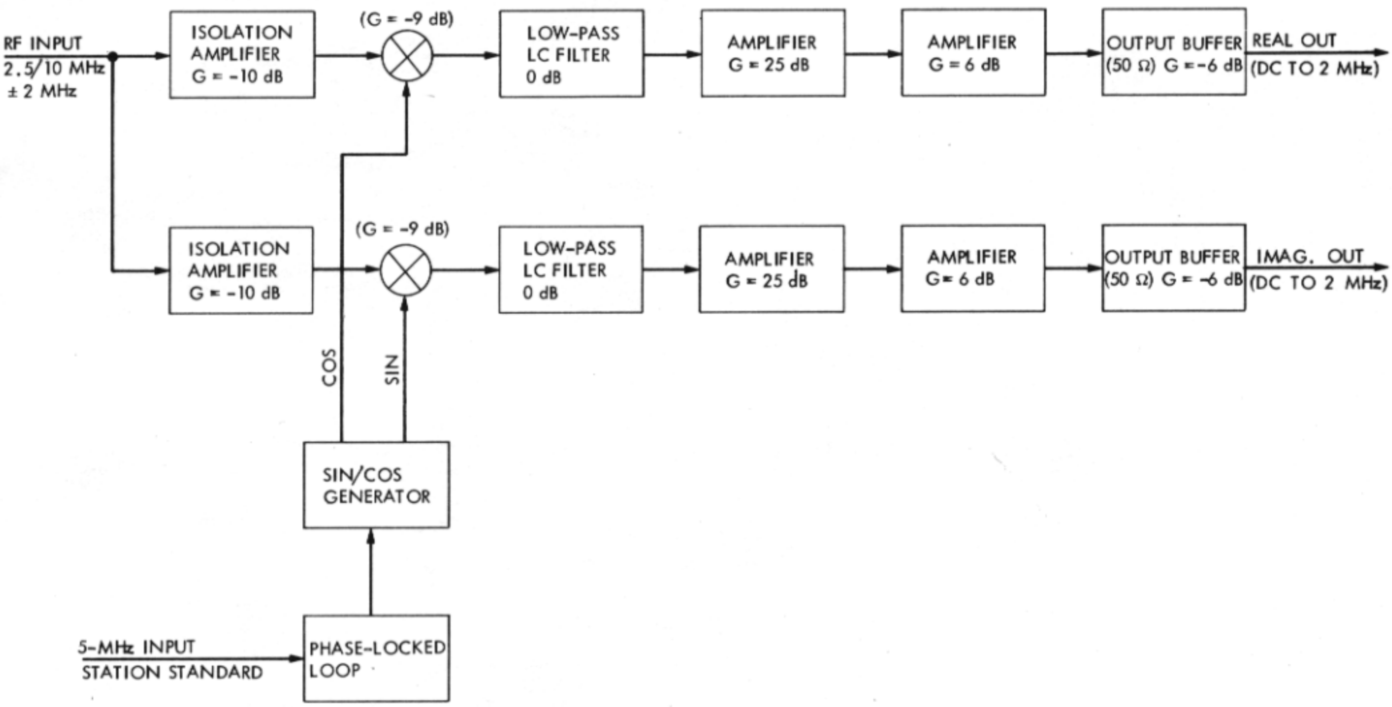

Fig. 1. Block diagram of complex mixer module

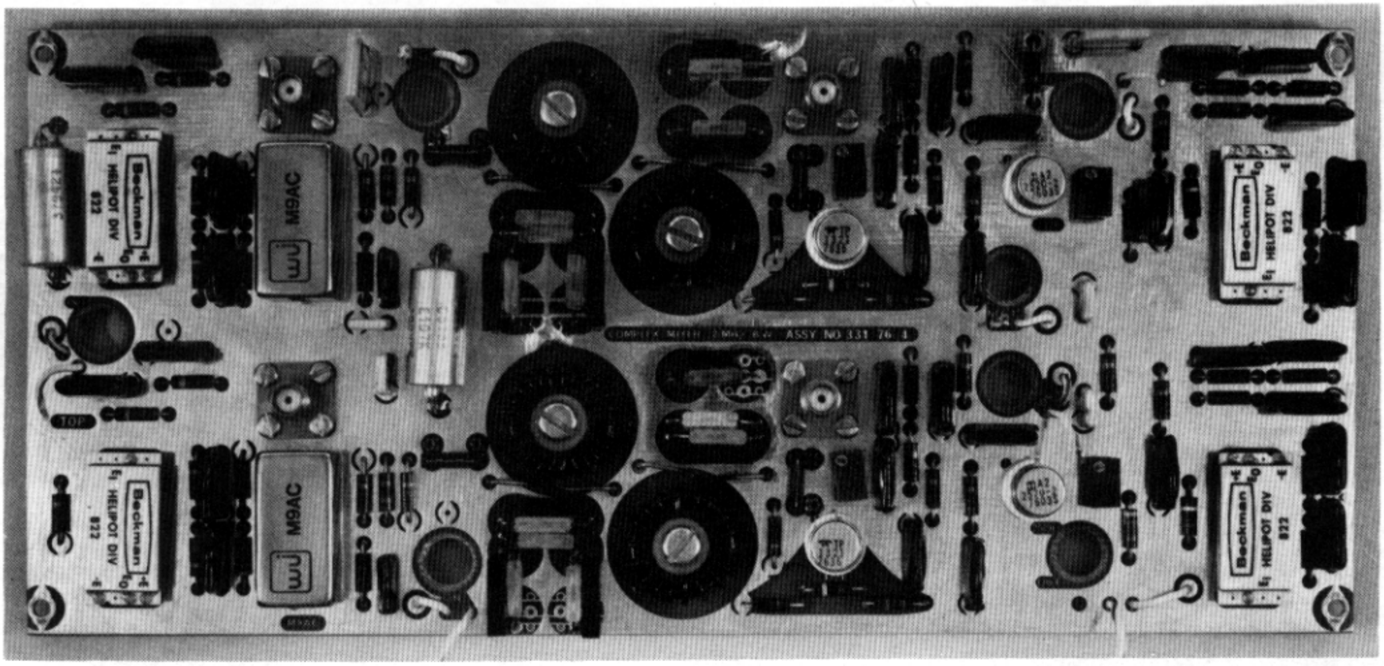

Fig. 2. 2-MHz complex mixer circuit board