A D-BAND MILLIMETER-WAVE CROSSBAR MIXER

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ABSTRACT

Broadband crossbar mixers in the frequency range from 110-170 GHz using Schottky beam lead diodes were designed and fabricated using 5-mil Duroid substrate. Conversion loss is as low as 7 dB for IF as high as 18 GHz.

SUMMARY

Introduction

This paper describes broad instantaneous bandwidth balanced planar mixers (IF up to 18 GHz) in the 110-170 GHz frequency range. Using standard MIC fabrication techniques, the mixer circuits are realized with suspended substrate stripline using 5 mil Duroid substrate. The advantages of using soft substrates (versus quartz) to make planar crossbar mixers at this frequency are demonstrated in terms of low cost, good performance and high reproducibility.

Mixer Circuit

The complete planar mixer assembly is shown in Figure 1. It is a conventional crossbar structure consisting of a LO probe, an IF filter and a pair of beam lead diodes mounted on suspended substrate stripline to minimize losses.[1,2] The LO is coupled to the diodes via a probe transition from waveguide to suspended substrate stripline. To extend the IF performance of this device and to optimize the LO match, a quarter-wave length broadside coupler is included in the LO path.

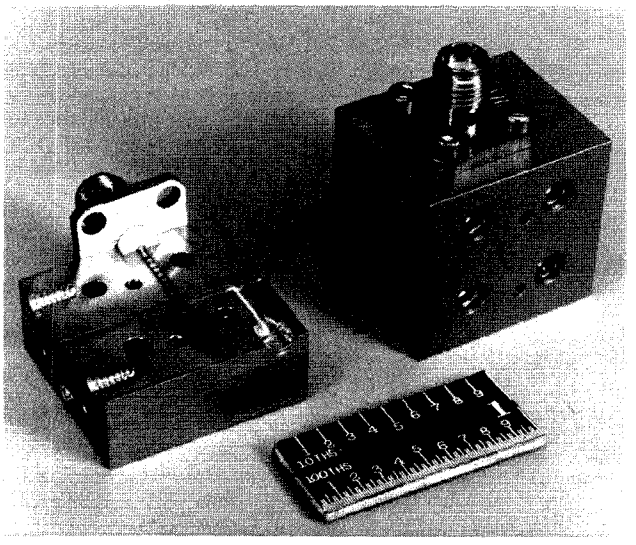

Fig. 1 Complete crossbar mixer assembly.

In the RF port, full-height waveguide is used to ease the mounting of beam lead diodes in series, (Reduced-height waveguide can be used to increase the RF bandwidth of the mixer further, if necessary). The IF signal is extracted through a low pass filter. The electrical length of each filter section is equal to one-quarter wavelength at LO frequency. The normalized impedance of each section can be obtained from Levy's table[3] or by using Rhode's approximation closed-form formulas.[4] Lower and upper ground-plane spacings are selected to provide the range of required impedances. Typical upper and lower ground-plane spacings are equal to the substrate thickness (5 mil thick duriod). The distance from the diode pair to the first section of the filter is approximately one-half wavelength at LO frequency. Figure 2 shows the front and back of the complete mixer circuit.

Measure Performance

The measured performance of the mixer is shown in Figure 3. A conversion loss as low as 7 dB is achieved at an LO drive of (typically 15 mW. A typical conversion loss of 7.5 $\pm$ 1 dB is achieved across the desired frequency band. Work is in progress to reduce this value further (by 1.5 dB), using diodes with higher cutoff frequency.

CONCLUSION

Broadband, planar, balanced crossbar mixers with up to 18 GHz instantaneous IF bandwidth were designed using soft substrate in the 110-170 GHz RF range. The measured conversion loss is 2.5 dB better than any previously reported.[5]

ACKNOWLEDGMENT

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REFERENCES

(1) G. Spacek, "Stripguide Balanced Mixer," U.S. Patent 3,584,308 (1970).

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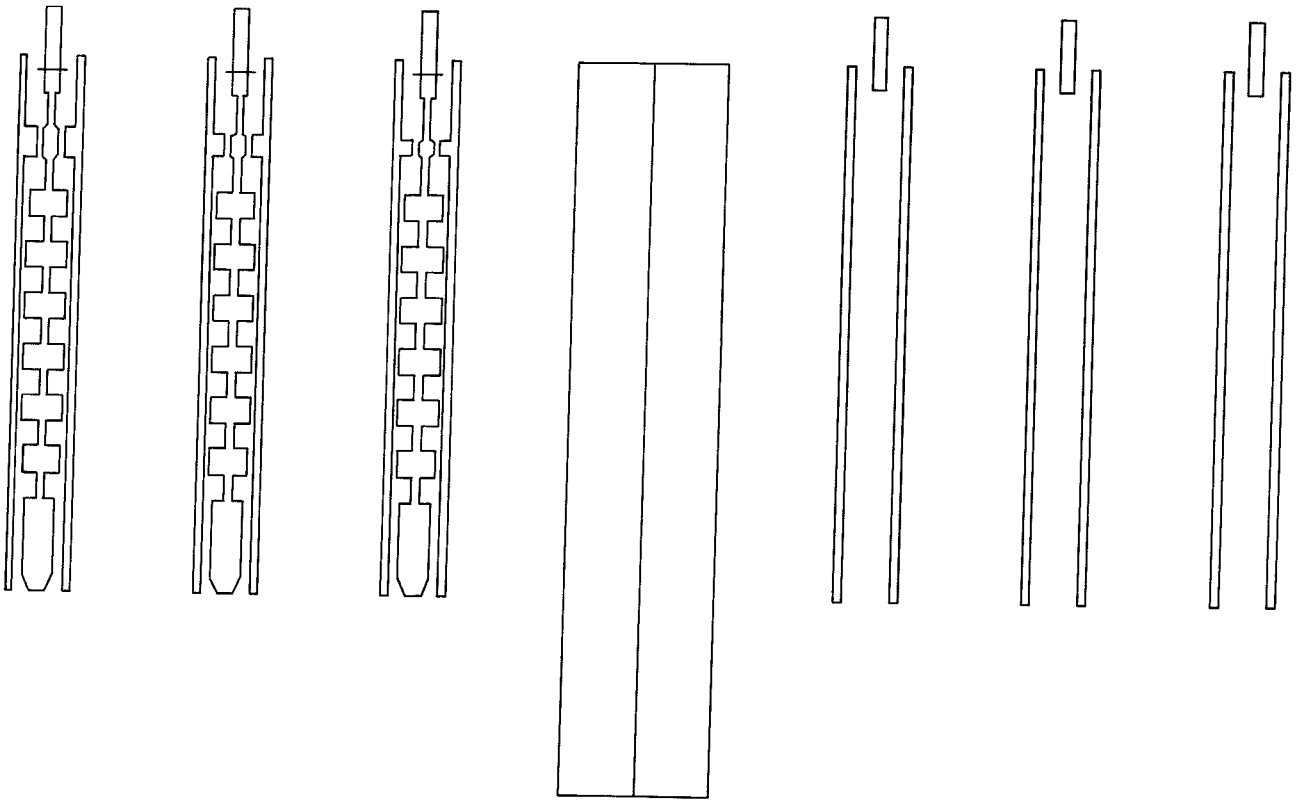

Fig. 2 Front/back of mixer circuit.

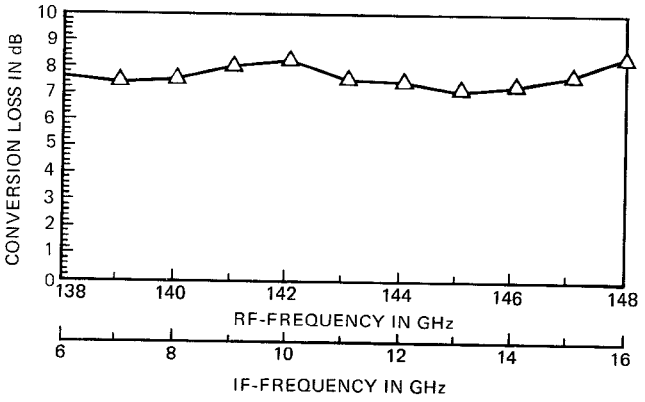

Fig. 3 Typical conversion loss.

(2) L.T. Yuan, "Design and Performance Analysis of an Octave Bandwidth Waveguide Mixer," IEEE Trans, Microwave Theory Tech., Vol. MTT-25, No. 11, pp. 1048-1054, Dec. 1977.

(3) R. Levy, "Tables of Element Values for Distributed Low-Pass Prototype Filter," IEEE Trans. on Microwave Theory and Techniques, Vol. MTT-13, No. 5, Sept, 1965, pp. 514-536.

(4) J.D. Rhodes, Theory of Electrical Filters, (New York: John Willey), 1976.

(5) W. Menzel, "A 140 GHz Balanced Mixer for Finline Integrated Circuits," Proc. 13th European Microwave Conference, Nurnberg, West Germany, 5-8 September 1983.