AN S-BAND DOUBLE BALANCED MIXER WITH VERY HIGH LO/RF-PORT AND LO/IF-PORT ISOLATION.

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ABSTRACT

A double balanced ring mixer which obtains very high LO/RF-port and LO/IF-port isolation due mainly to the orthogonal orientation of the LO- and RF-signals, is described. This mixer is constructed in stripline and provides a planar type circuit which overcomes the usual problems involved with mounting the diodes.

INTRODUCTION

A double balanced mixer which operates in the 2.4GHz - 3.6GHz band with LO/RF-port isolation in excess of 50db and LO/IF-port isolation in excess of 35db is described. This mixer has the advantage of ease of construction and would be usefull in applications where higher than average port to port isolation is required.

To obtain high port-to-port isolation, it was decided to make use of a double balanced ring mixer, to utilise the combined effect of the inherent signal separation into odd and even order harmonics of this type of mixer together with the port separation due to circuit symmetry. The LO- and RF-baluns were furthermore constructed in such a way that the electric-field orientations of the applied LO- and RF-signals were perpendicular to each other. This is the single most important reason that allowed for the very high LO/RF-port isolation.

The design of the mixer was further complicated by the requirement that the IF-port had to operate from 20MHz to 1200MHz, which meant that the ratio of the highest IF-frequency to the lowest LO- and RF-frequencies were 1:1.8. The IF-signal could therefor not be approximated as a 'dc-signal ($f_{if} << f_{rf}$)' which is normally easy to extract from the mixer circuit.

MIXER DESIGN AND STRUCTURE

The large signal and small signal theoretical design was done using a harmonic balance routine and a small signal analysis routine, that was developed at the Department of Electrical and Electronic Engineering of the University of Stellenbosch.

The results of the small signal analysis were then used to design the mixer coupling network. Marchand baluns were used to construct both the RF- and LO-baluns. This was due to the fact that these baluns could be designed accurately in closed form and that these baluns exhibit excellent balance over wide bandwidths.

The operating bandwidths of these two baluns are far in excess of the mixer's operating bandwith because it is preferable to resistively terminate as many as possible higher order harmonics which are generated in the mixer.

The LO-balun was designed as a third order Marchand balun which operated from 2GHz to 8.4GHz with f_o=5.2GHz. This balun delivered a balanced signal with E-field polarity in the same plane as the mixer substrate.

The RF-balun was designed as a fourth order Marchand balun which operated from 2GHz to 12GHz with f_o=7GHz. This balun delivered a balanced signal with E-field polarity perpendicular to the substrate.

To construct the IF-circuit, it had to be taken into account that the RF-circuit acted in series, and that the LO-circuit acted in parallel to the IF-port. All the circuit elements of the LO- and RF-circuits were therefor incorporated into a lowpass filter structure, and by conventional filter approximation methods, the rest of the filter elements, which made up the IF-circuit, was calculated.

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The complete mixer circuit was constructed in stripline, using a soft substrate with dielectric constant of 2.45 and thickness of .508mm. The diodes that was used, were HP5082-2277 matched quads. The circuit was then mounted in an aluminium enclosure with suitable cavities to complete the balun construction and to provide connectors for interfacing the signals.

CONCLUSION

A double balanced mixer that was designed specifically for very high port-to-port isolation was described. The measured results confirmed that the design specifications were fully met.

REFERENCES

1) P.W. van der Walt, "Efficient technique for solving nonlinear mixer pumping problem", Electron Letters, Vol. 21, No. 20, pp 899-900, September 1985.

2) D.L. Gish, O. Graham, "Characteristic Impedance and phase velocity of a Dielectric-Supported Air Strip Transmission Line with Side Walls", IEEE Trans. on Microwave Theory and Techniques, Vol. MTT-18, No. 3, March 1970.

3) P.W. van der Walt, "A novel planar, double-balanced image recovery mixer", SAIEE Joint Symposium on antennas and propagation and microwave theory and techniques, August 1988, pp 17.1-17.12

Figure 1: Layout of the mixer circuit

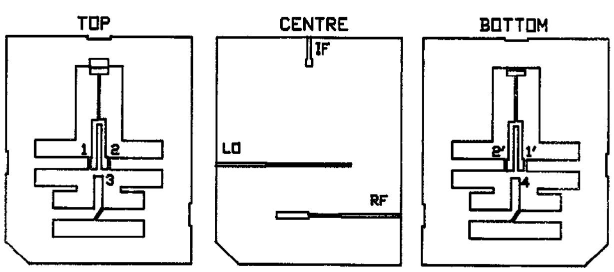
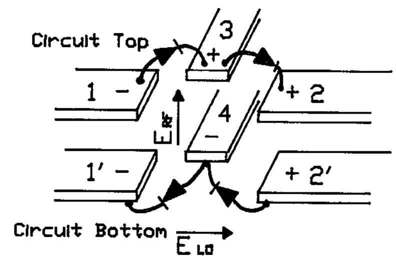


Figure 2: Mounting of the diode ring



(1/1' and 2/2' is strapped together)

Figure 3: Port isolation vs LO-frequency

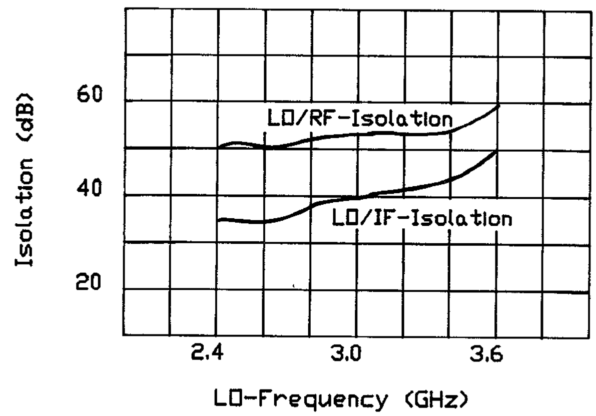


Figure 4: Conversion loss vs LO-Frequency