

**Cryogenic 3dB 90° stripline hybrid  
couplers for the 2-14 GHz band:  
Design, manufacturing and  
measurement.**

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## 1 Introduction

The 2-14 GHz band has been established as the new standard for the VGOS (VLBI Global Observing System) stations for Geodesy observations. This ultra wide band represents an interesting challenge for several critical components of the receivers like feeds, polarizers and LNAs.

Wideband cryogenic LNAs with quite good performance in the 2-14 GHz band have been demonstrated<sup>1</sup>, but they usually present a high input reflection in the low frequency end. As cryogenic isolators for such a wide band are not feasible, the only possible alternative to obtain a good input match is to use a balanced configuration<sup>2</sup> made up of two 3 dB 90° directional couplers (hybrids) and two LNAs.

The feeds which are presently used in the VGOS antennas are of the quad-ridge type and provide two orthogonal linear polarizations. A single cryogenic 90° 3dB hybrid could be used to generate the two circular polarizations (right and left handed) which have been used traditionally in VLBI to avoid parallactic angle related problems.

This report presents the design, construction and measurement of a 3 dB 90° directional coupler for the 2-14 GHz band, specially conceived to operate satisfactorily when cooled down to 15 K. The materials and mechanical construction have been carefully selected and the result is a very compact, reliable and low thermal mass device, capable to withstand extreme thermal cycling. The coupling and reflection characteristics show very low temperature dependence.

## 2 Conclusions

We have designed and manufactured three different types of multioctave stripline 3dB 90° hybrid couplers for the 2-14 GHz band. All of them are specially conceived to operate when cooled to 20K. Its coupling and reflection characteristics show very little temperature dependence. The design with the best performance is the five stage coupler with M2 structure of layers.

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<sup>1</sup> A. H. Akgiray, S. Weinreb, "Noise Measurements of Discrete HEMT Transistors and Application to Wideband Very Low-Noise Amplifiers", IEEE Trans. Microw. Theory Tech., vol. 61, no.9, pp. 3285 - 3297, Sep. 2013

<sup>2</sup> R. S. Engelbrecht, K. Kurokawa, "A wideband low noise L-band balanced transistor amplifier", Proc. IEEE, vol. 53, pp. 237-247, March 1965.