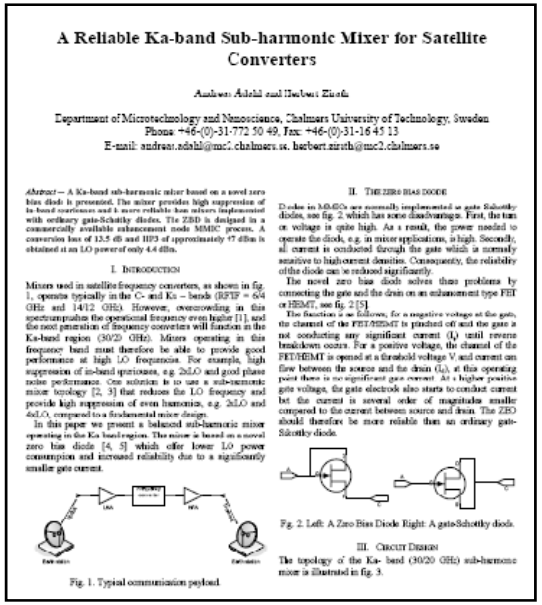
Success story: Microwave circuit research → satellite communication products

Microwave circuit research on so-called zero-bias mixers between Saab Space (now Ruag Space) and Chalmers has produced publications, one licentiate examination and designs for frequency converters. Products have been sold by Saab Space to satellite customers meaning that the research has directly strengthened Swedish space industry. Key personnel educated at Chalmers has been employed by Swedish telecom industry.

"CHACH has offered an important possibility to start early research and selection of technology for microwave products. Some circuits are now integrated as key components in the new product generation for the telecom market " **Paul Häyhänen, Antenna & Microwave Department Manager Saab Space, Göteborg (now Ruag Space AB)**

Research: CSIC Symposium, Ca. 2006



A Reliable Ka-band Sub-harmonic Mixer for Satellite Converters

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Abstract — A Ka-band sub-harmonic mixer based on a novel zero bias diode is presented. The mixer provides high suppression of in-band spurioseus and is more reliable than mixers implemented with ordinary gate-Schottky diodes. The ZBD is designed in a commercially available enhancement mode MMIC process. A conversion loss of 13.5 dB and IIP3 of approximately +7 dBm is obtained at an LO power of only 4.4 dBm.

I. Introduction

Mixers used in satellite frequency converters, as shown in fig. 1, operate typically in the C- and Ku – bands (RFIF = 6/4 GHz and 14/12 GHz). However, overcrowding in this spectrumpushes the operational frequency even higher [1], and the next generation of frequency converters will function in the Ka-band region (30/20 GHz). Mixers operating in this frequency band must therefore be able to provide good performance at high LO frequencies. For example, high suppression of in-band spuriouses, e.g. 2xLO and good phase noise performance. One solution is to use a sub-harmonic mixer teroloay [2, 3] that reduces the LO frequency and provide high suppression of even harmonics, e.g. 2xLO and 4xLO, compared to a fundamental mixer design.

In this paper we present a balanced sub-harmonic mixer operating in the Ka band region. The mixer is based on a novel zero bias diode [4, 5] which offer lower LO power consumption and increased reliability due to a significantly smaller gate current.

Fig. 1. Typical communication payload.

II. The Zero Bias Diode

D-mhe in MMICs are normally implemented as gate Schottky diodes, see fig. 2 which has some disadvantages. First, the turn on voltage is quite high. As a result, the power needed to operate the diode, e.g. in mixer applications, is high. Secondly, all current is conducted through the gate which is normally sensitive to high current densities. Consequently, the reliability of the diode can be reduced significantly.

The novel zero bias diode solves these problems by connecting the gate and the drain on an enhancement type FET or HEMT, see fig. 2 [5].

The function is as follows, for a negative voltage at the gate, the channel of the FET/HEMT is pinched off and the gate is not conducting any significant current (I_g) until reverse breakdown occurs. For a positive voltage, the channel of the FET/HEMT is opened at a threshold voltage V and current can flow between the source and the drain (I_d), at this operating point there is no significant gate current. At a higher positive gate voltage, the gate electrode also starts to conduct current but the current is several order of magnitudes smaller compared to the current between source and drain. The ZBD should therefore be more reliable than an ordinary gate-Schottky diode.

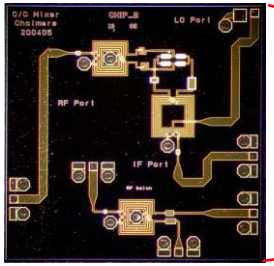
Fig. 2. Left: A Zero Bias Diode Right: A gate-Schottky diode.

III. Circuit Design

The topology of the Ka- band (30/20 GHz) sub-harmonic mixer is illustrated in fig. 3.

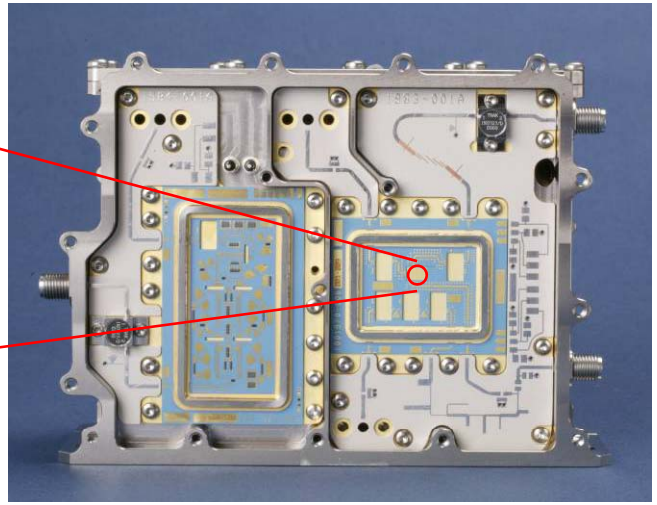
CHALMERS

Mixer design between Chalmers and Saab Space



SAAB

Exploitation: Frequency converters in satellite telecom products



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