Abstract

Wireless systems rely on effective signal detection. In this work, a low power, wide bandwidth microwave detector was designed, fabricated and characterised. Factors limiting performance at zero bias were identified. Measurements were conducted to verify the simulation results obtained using Agilent ADS.

Introduction

Microwave signal detection forms a crucial part of many systems including receivers for communication systems, wireless test systems and sensors. In this project the Schottky diode was characterised, identifying factors limiting the operating frequency and detector sensitivity. A wide bandwidth detector prototype was designed, fabricated in a hybrid microstrip configuration and measured.

Designed Detector Prototype

Microwave detectors consist of a rectifying element (diode) followed by a low pass filter. The device tracks the envelope of the signal. A Schottky barrier diode (metal to semiconductor junction) is often used in detectors.

![Detector Diagram](Image)

The diode must rectify the incoming microwave signal. The junction capacitance $C_J$ and series resistance $R_s$ limit the diode cut off frequency of operation. Detection sensitivity is improved by providing the diode with a forward bias. For applications such as RFID tags, a “zero bias detector” is more suitable as it is powered from the incoming signal alone. Through simulation the parallel RC filter designed using passive components operated below 3GHz only. A microstrip transmission line circuit replaced this, offering better performance up to higher frequencies, at the expense of increased circuit size. Tailored matching should be included at the input to ensure that reflection of power at the designed operating frequencies is minimised. The best wideband matching strategy is a low Q reactive matching network [1].

Measurements

The function generator and sweep generator were configured to produce an OOK modulated microwave signal, which was applied at the detector input. A 0.4 MHz data signal was generated with the function generator. Since the detector outputs a relatively low frequency signal, an oscilloscope was used to perform the time domain measurements [2]. A separate setup was also used to investigate the signal reflection at the input. After performing SOLT calibration, a vector network analyser was used to measure the $S$-parameters of the systems.

![Sweep Generator](Image)

Results

The measured tangential output voltage of the detected signal with different input signal power levels is shown in the figure below.

![Oscilloscope Measurement](Image)

A sample measurement on the oscilloscope, with 4.4GHz carrier frequency and -6dBm input signal power is displayed below.

Conclusion

- Broad detection bandwidth of 2GHz was achieved with low signal power of -7dBm using a zero bias detector.
- Research identified the junction capacitance as the factor limiting the maximum frequency rectified by the diode.
- Wideband matching techniques were explored, suggesting a compromise must be made between the bandwidth and the quality of the matching.

References