# SLOTLINE COUPLED VARACTOR TUNING OF VOLTAGE CONTROLLED OSCILLATORS

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## ABSTRACT

A new electronic means of tuning a dielectric resonator oscillator has been developed. The varactor control element is electro-magnetically coupled to the resonator by means of a slotline. The easily manufactured circuit has a relatively wide tuning range. It is ideally suited for narrow-band VCO's.

## INTRODUCTION

Strong coupling to a dielectric resonator and the tuning of its resonant frequency is difficult. Frequency tuning, by coupling to a microstrip line with a control element, is relatively small.

The coupling between a dielectric resonator and a slotline has been characterised previously (1). This coupling is much stronger than that of microstip-resonator coupling. Because the electric field extends transversely across the slotline (2), semiconductor elements mounted across the slot can be coupled to the resonator. This paper describes a new configuration for a voltage coltrolled dielectric resonator oscillator. The control element is a varactor diode mounted across a slotline.

## PHYSICAL CONFIGURATION

The configuration of the 13 GHz dielectric resonator transistor oscillator is shown in Figure 1. The impedance looking into the transistor at the gate, has a negative resistance component. The gate is connected to a microstripline which is coupled to the dielectric resonator. At the resonant frequency, the line presents a reactance to the transistor. At frequencies far away from the resonant frequency of the dielectric resonator, the gate is terminated in a 50 Ohm resistor at the end of the microstrip line.

A slotline, with an electrical length of half a wavelength ($\lambda_s/2$), is etched into the earth plane on the lower side of the substrate. The end of the slot, where the coupling is the strongest, is positioned under the center of the resonator. A varactor diode is mounted across the center of the slotline (Figure 2). The cathode of the varactor is decoupled from ground by a 1pF single layer chip capacitor, and the anode is connected to the ground plane on the other side of the slotline using a short bonding wire. The diode is reverse biased through a bonding wire which is connected to the cathode.

## COMPONENTS

A PTFE/glassfibre substrate with $\epsilon_r$=2.5 and 0.5 mm thickness was used. The dielectric resonator has a dielectric constant of 28.7, diameter of 5.06 mm and a thickness of 2.26 mm. A 30V high Q chip varactor diode with $C_j$=1pF at 4V, and a minimum tuning ratio of 4.5:1 was used. A general purpose 6-16 GHz GA FET transistor was used for the oscillator.

## RESULTS

The varactor diode was reverse biased between 2V and 8V. For a distance of 0.1 mm between the resonator and the substrate, a frequency tuning range of 30 MHz was obtained with a center frequency of 12.66 GHz. The coupling between the resonator and the slotline is strongest for a small distance between the two elements. Stronger coupling leads to a wider tuning range. The range obtained is



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superior to earlier results (3,4) for voltage tuned dielectric resonator oscillators at 10 GHz and 18 GHz where the resonator was coupled to a microstrip line.

## CONCLUSIONS

The frequency control of a dielectric resonator oscillator with a control element coupled to the resonator by means of a slotline was demonstrated. Because of the relatively wide tuning range, this configuration is convenient for narrow-band voltage controlled oscillators. The configuration lends itself to an inexpensive and reproducible manufacturing process.

## REFERENCES


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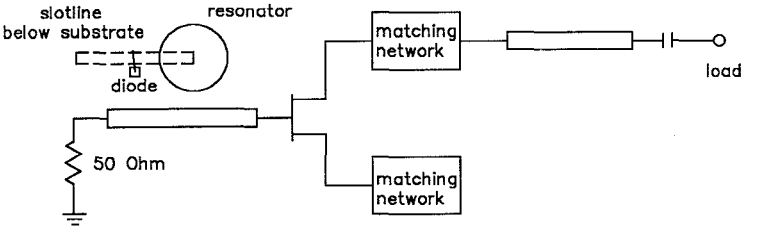


Figure 1. Oscillator configuration

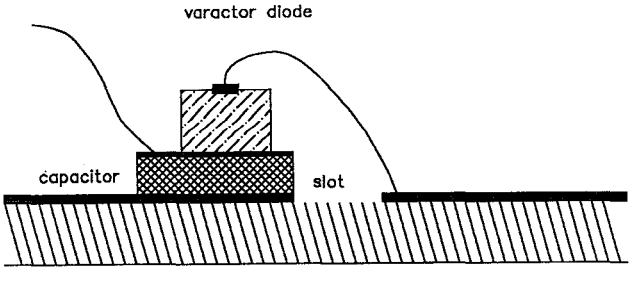


Figure 2. Element mounting