AN 8-18 GHz FET YIG-TUNED OSCILLATOR

Robert T. Oyafuso
Avantek
Santa Clara, CA

## ABSTRACT

A unique FET yig tuned oscillator with buffer amplifier is described. Power output is 10 dBm minimum from 8-18GHz and extended tuning range is from 6GHz to 19.5GHz.

## Introduction

It has been previously demonstrated [1] that FET YTO due to its efficiency and reliability is a superior alternative to Gunn diode YTO's in broadband microwave sweepers, frequency agile ECM systems, synthesizers and LO's. Until recently these FET YTO's were available in standard waveguide bandwidths only. This paper describes a unique oscillator design with greater than 3 to 1 tuning range, thus combining X and Ku band in a single oscillator. These results were obtained with an FET utilized in the common source configuration rather than the common gate configuration more frequently mentioned in the literature. [2,3,4]

## DESIGN CONSIDERATIONS

The circuit used to achieve these results is shown in Figure 1. The design procedure describing conditions for oscillations has been treated extensively in the literature. [2,3,4] Briefly this synthesis procedure requires first, measurement of S-parameters of the active device. Secondly, modeling possible circuit and feedback topologies and finally, analyzing the admittance presented to the yig resonator by the active device and feedback circuit. In comparison with the c-g (common-gate) configuration in which a feedback inductance in the gate is used to control the frequency range of negative resistance, the c-s (common source) circuit uses a feedback capacitance in the source to control the range over which negative resistance can be generated. The c-s configuration may be generated by taking the dual of the c-g configuration, i.e., exchanging the gate-source terminals and replacing the feedback inductance with a feedback capacitance.

The amplifier stages are single ended with devices similar to that used in the oscillator. A design procedure for matching between the oscillator output and amplifier input that will maximize band width and power is not available. However, by recognizing that the oscillator will work into an open circuit and that the amplifier input has a relatively low impedance, an approximate matching element that will satisfy these conditions is a quarter wave transformer. A similar argument may be made for the interstage matching. The output impedance of $Q_2$ is high and the input to $Q_3$ is high and the input to $Q_3$ is relatively low.

The entire circuit is implemented on thin film $Al_2O_3$ substrate .010 in. thick and .5 in. long x .3 in. wide. The circuit is housed in a magnetic shell two inches in diameter 1.4 inches high and weight, 17 oz. A small magnetic gap of .050 inches was required in order to limit tuning power to less than 5 watts. The yig sphere is .015 inches in diameter with a $4\pi M_S$ of 1780 gauss.

The device used is an Avantek type M107 with gate length of .5µm and gate width of 300 µm. The operating voltage is between 5 - 6 volts drain to source and the current between 30-40 ma. The MAG's for these devices is 7dB at 13GHz and the transconductance is 30 millimhos.

## RESULTS

Power output from this oscillator-amplifier combination is typically 10dBm at 25°C and a minimum of 7dBm over the full military temperature range of -54°C to +71°C. The two-stage amplifier provides sufficient isolation to reduce frequency pulling to less than 1.0 MHz into a 3:1 VSWR. Typical performance is illustrated by the photograph in Fig. 2. Performance over temperature for power and frequency stability is shown in Fig. 3. Linearity for these units are less than .1 percent. It should be noted that this oscillator was developed against a minimum power specification of +7dBm minimum power over 8-18GHz frequency range. With a slight modification in the existing design, power output in excess of 13dBm has been obtained and tuning range extended beyond 21GHz.

## CONCLUSION

It has been demonstrated that the common-source configuration shows promise as a multi-octave oscillator. It would appear that 4 - 18GHz is feasible and that performance through K-band is likely.

## REFERENCES

1 Tom Ruttan, "X-Band GaAs FET Yig-tuned Oscillator," IEEE MTT-S International Microwave Symposium Digest, 1977, pg. 264-266.

2 Timothy L. Heyboer, et al. Yig-tuned GaAs FET Oscillators, IEEE-MTT-S International Microwave Symposium, 1976, Pg. 48-49.

3 R.J. Trew, "Octave-Band GaAs FET Yig-tuned Oscillators," Electronics Letters, Oct. 1977, pg. 629-630.

4 Tom Ruttan, "GaAs FETs Rival Gunns In Yig-tuned Oscillators," Microwaves, July, 1977.

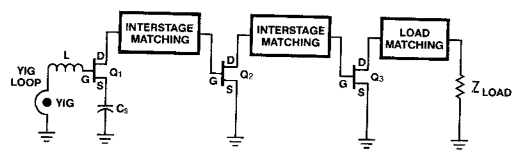


Fig. 1 Simplified Schematic Diagram

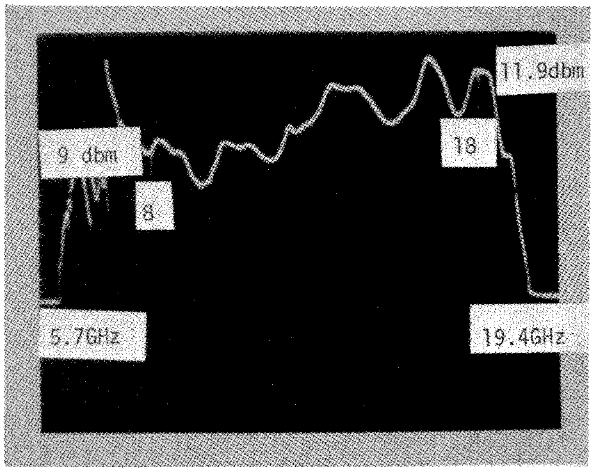


Fig. 2 Power vs. Freq.

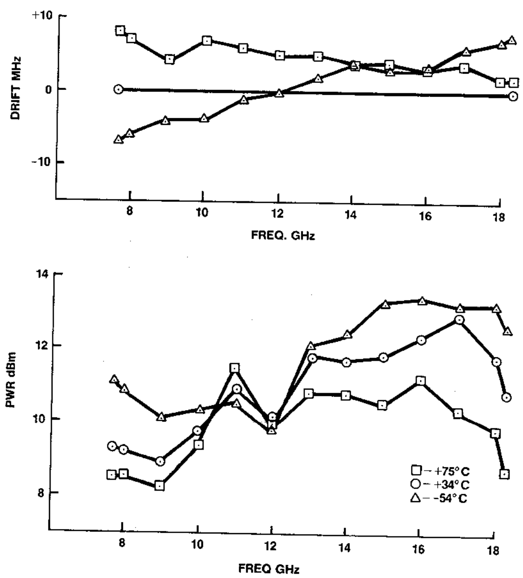


Fig. 3 Power and Frequency Stability vs. Temperature