20.5: W-band SSVD[TM] High Power Amplifier and Electronic Power Conditioner, Modulator and Supply

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Abstract: *W-band high power amplifiers offer important and enabling opportunities in radar, directed energy and communications including SATCOM applications. In this study, W-band microwave power modules (MPMs) combining low power monolithic microwave integrated circuit (MMIC) driver amplifiers and Solid State Vacuum Device (SSVD[TM]) traveling wave tube (TWT) high power amplifiers are employed to provide high power density at low cost and small size and weight. In this work, we have also included the development of the necessary integrated power conditioner, modulator, and supply to enable a complete W-band SSVD[TM] microwave power module.*

Keywords: W-band; power supply; power conditioner; power amplifier; TWT; SSVD[TM]; MPM.

Introduction

Commercially available W-band MMICs with around 100 mW of output power and close to 20 dB gain are used to drive the specially designed W-band SSVD[TM] high power amplifier for this study. InnoSys has developed a unique interaction circuit suitable for microfabrication, high power, and broad bandwidth under our solid state vacuum device (SSVD™) technology and product development effort for the W-band SSVD[TM] high power amplifier.

Discussion

The W-band SSVD[TM] TWT has close to 30 dB gain (a shorter version of the device has >25 dB and the long version of the device has >30 dB gain) and saturated output power of close to 100 Watts. Desired beam current of 100 mA and 98% beam transmission were achieved in these device structures.

The W-band SSVD[TM] high power amplifier is relatively small and lightweight (around 7.5"-9" long and 2.2-3 lbs depending on gain and other features) with a bandwidth of larger than 4 GHz. Extensive design simulations based on MICHELLE and MAGIC-3D have been conducted and will be compared to our experimental measured data in this paper.

The overall gain of the combined MMIC/SSVD[TM] high power amplifier is high (more than 50 dB) and is coupled with the power supply to achieve an overall small-size and weight W-band high power MPM. InnoSys in-house manufactures these W-band high power MPMs.

Recognizing that another critical factor of a compact, lightweight high power MPM is the high voltage power supply system required by the high power amplifier, InnoSys has also developed high voltage integrated technologies for the implementation of compact, lightweight W-band high power MPMs. InnoSys's high voltage (HighV[TM]) integrated technology employs solid state electronics especially semiconductor devices and integrated circuits to address the compact, lightweight, and high efficiency high voltage power supply required by the high power amplifier.

Summary

In summary, solid state vacuum device (SSVD[TM]) technology, which combines the integrated circuit design, precision and lower cost manufacturing advantages of solid state and the high frequency high power performance advantages of vacuum electronics, is used for the design and implementation of W-band high power MPMs.

High voltage integrated technology, based on solid state electronics, offers compact, light, efficient, and low cost solutions along with the volume production capability for the high-voltage power supply system and power conditioner required for the W-band high power amplifier operation.
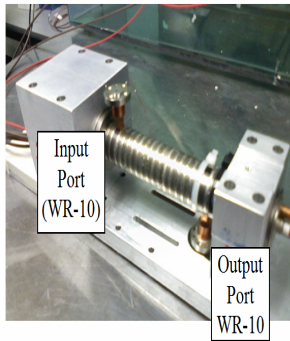
Figure 1: W-Band SSVD^{TM} TWT High Power Amplifier in a Test Fixture.
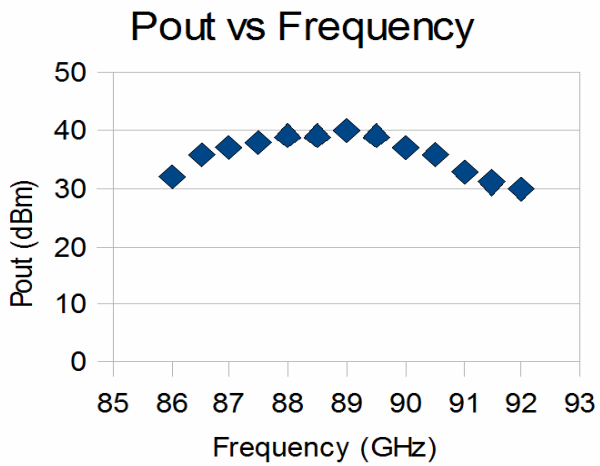

Figure 2: Measured Output Power from the W-band SSVD^{TM} TWT High Power Amplifier.

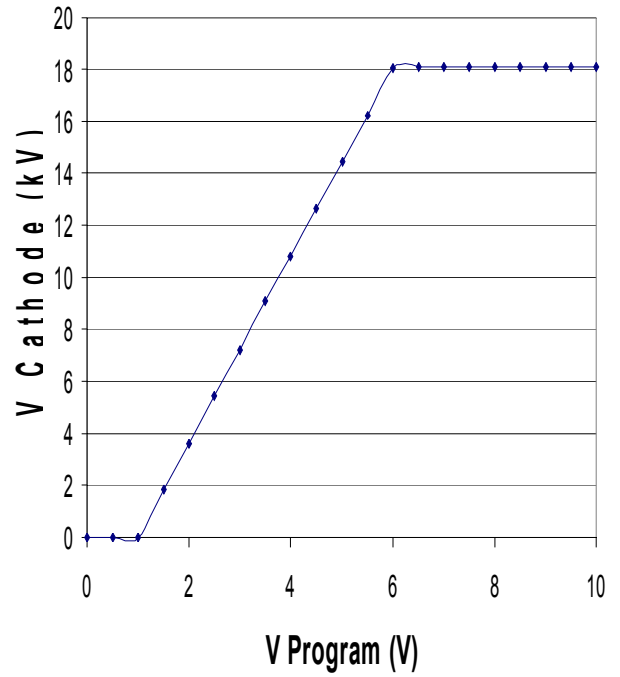**Figure 3:** Electronic Power Conditioner and Supply Circuit Successfully Operated and Used to Power the SSVD^{TM} TWT up to 18,000 Volts.