Low Power Signal Detection in Emerging Transferred Electron Devices Using Vector Network Analyser above 100 GHz

Chong Li, Ata Khalid, Lai Bun Lok, and David R. S. Cumming

Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT

lichong@elec.gla.ac.uk

It is widely believed that a vector network analyzer (VNA) is not suitable for characterising an oscillator. Unlike a spectrum analyzer, a VNA is designed to measure the frequency response of a device under test (DUT) to a known stimulus [1]. However, extensive measurement results on planar Gunn diodes, RTD oscillators and commercial signal generator show that a VNA can be used as a complementary tool to a spectrum analyzer for measuring oscillators if care is taken. This leads to a simple measurement setup for determining the natural oscillation frequency of signal sources up to 110 GHz in a single sweep. In addition, a VNA can detect oscillation phenomena where there are only very weak signals. This is useful for establishing the presence of high order harmonics in the development of emerging millimetre-wave sources such as planar Gunn diodes.

We have used an Agilent N5250A VNA that operates from 10 MHz to 110 GHz in a single sweep to identify oscillation frequencies of planar Gunn diodes. The corresponding measurement method using a conventional spectrum analyzer requires at least three separate measurement setups to cover the same frequency range. For example, a stand-alone Agilent E4448A spectrum analyzer can operate up to 50 GHz. To enable spectral measurements beyond this frequency, external mixers, chosen according to band, e.g. the V band (50-75 GHz) and the W-band (75-110 GHz), are required. Figure 1 shows an example spectral measurement of a planar Gunn diode tested by a VNA compared to a spectrum analyzer. Using the VNA an oscillation at 106 GHz was observed. The same device was measured in three steps using a spectrum analyzer and two sets of mixers and probes. Both measurement methods show clearly that there is a single oscillation at 106 GHz.

Figure 2 shows the spectral measurement from another planar Gunn diode generating a second harmonic oscillation at 183 GHz. This signal was not able to be detected using a spectrum analyzer with an external mixer because of the high conversion loss of the mixer.

To conclude, we have demonstrated that VNAs can be used to identify the oscillation frequency of emerging source technologies that have modest output power. This has been verified on planar Gunn diodes, RTD oscillators and other signal sources. The drawback of using the VNA method is the inability to measure the signal power level. Nevertheless, the VNA measurement method is a useful complementary tool to the spectrum analyser.

Reference:

1. Robert A. Witte, “Spectrum & network measurements”. Scitech Publishing. Inc. 2006

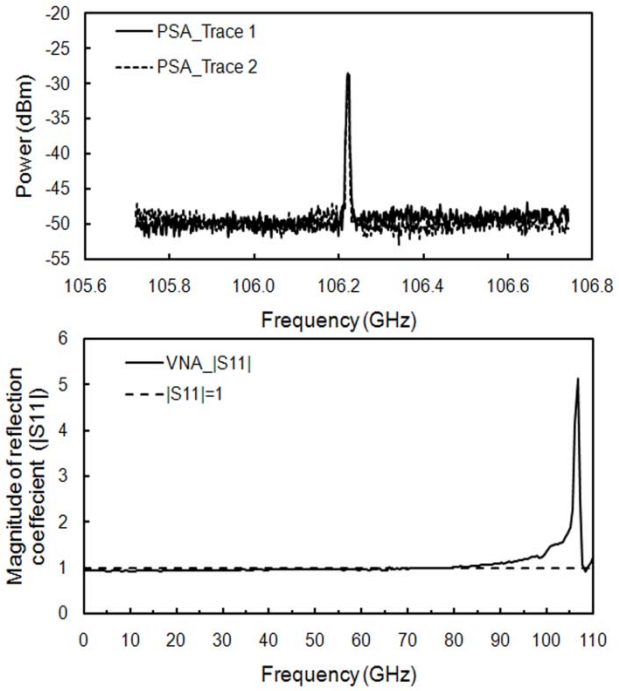

Figure 1. Planar Gunn diode spectrum measured using a spectrum analyzer (top) and VNA (bottom).

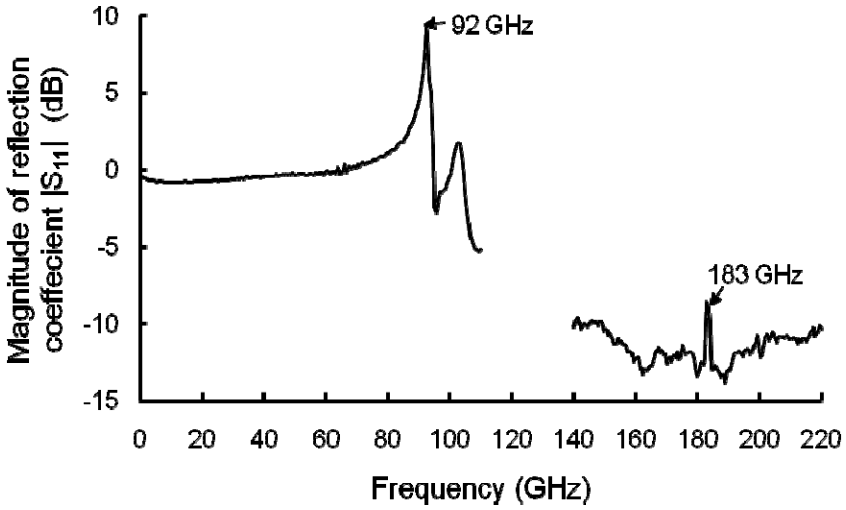

Figure 2. VNA measurement of a planar Gunn device showing its fundamental and its second harmonic oscillation. Two separate VNAs are required. The small peak right next to 92 GHz signal is spurious.