



Custom VNA Applications

Introduction

In the early days of the cell phone, the head of marketing for Motorola stated the following while holding a Motorola “Star Tac” flip phone in his hand: “This phone is capable of making phone calls in a very convenient way. It greatly enhances our ability to communicate with each other and improves our safety by allowing expedient access to emergency services. But someday, the phone function will be just another feature, perhaps seldom used, and the device will help us organize our lives and provide us with timely and useful information.” He was certainly prescient, and it is a common theme for a technology to evolve from a large, single-function device to a miniaturized version buried within a more sophisticated system.

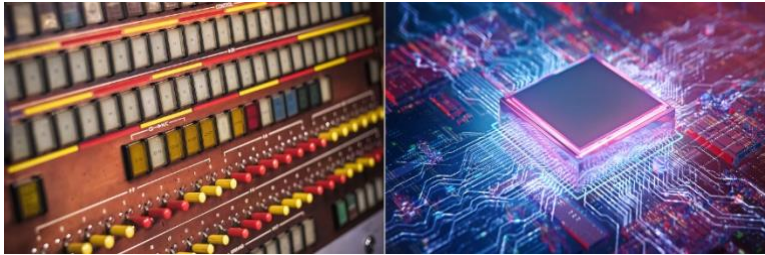


Figure 1 - CPU Evolution

The modern Vector Network Analyzer (VNA) began in the 1940s as a large rack-mounted device used mostly for radar and RF design central to the war effort. Modern VNAs are now much smaller (Figure 2) and for the first time, available as “bolt-in” modules from Copper Mountain Technologies for use in systems for soil analysis, agricultural product analysis, medical imaging, and industrial sensing just to name a few applications.

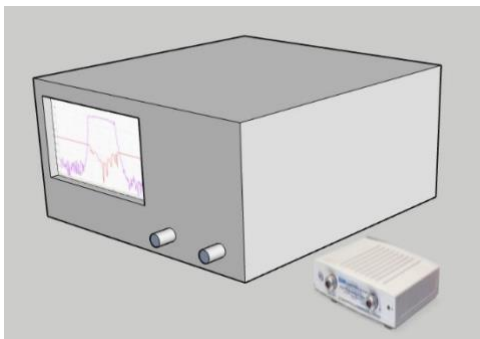


Figure 2- Legacy VNA compared to modern Compact VNA



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What kinds of Custom VNAs are Possible?

Almost anything is possible. Copper Mountain Technologies can miniaturize any VNA configuration. Figure 2 shows a 6 GHz 2-Port, “Bolt-In” or embedded VNA. This is a fully functional VNA with the same metrologically sound performance of CMT full-size products and can be provided with a certificate of NIST traceable uncertainties.

It might be desirable to embed a 2-port VNA in a system. Such a system might measure moisture content or gauge the ripeness of melons as in Figure 3. It also might be used to detect tumors in a medical application as in Figure 4.

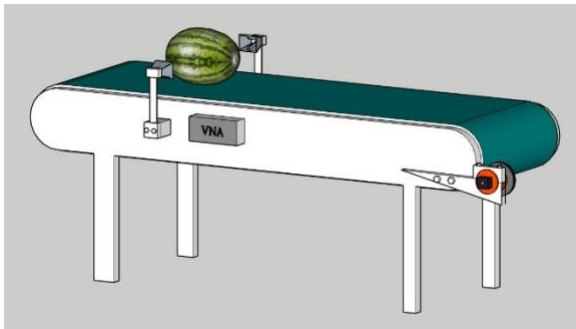


Figure 3 - Melon Ripeness Measurement



Figure 4 - Umbra Technologies MammaWave® System

Figure 5 shows a 1-Port VNA being used to analyze asphalt integrity. The VNA could be located on the end of the boom and directly attached to the antenna, greatly simplifying RF connectivity.



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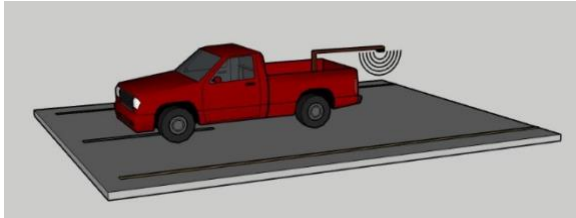


Figure 5 - Asphalt Analysis

A portable 1-Port VNA, or Reflectometer, can be used to measure soil moisture content. (Arkadiusz Lewandowski et al. studied this in some detail in [1]). 1-port VNAs have been used to measure liquid levels in pipes, wells, or even weightless liquid oxygen in a tank for a space vehicle with NASA.

A 1-Port VNA has been mounted on a drone and used to find survivors buried beneath building rubble after an earthquake.



Figure 6- Drone-mounted VNA

One and Two-Port Modules

Figure 7 shows a 1 GHz, 1-Port VNA. The small size allows it to be easily bolted into a larger system.





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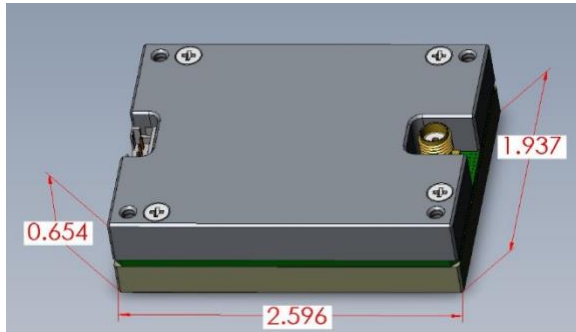


Figure 7- 1 GHz 1-Port VNA

Figure 8, shows the smallest metrologically sound, 2-Port 5.5 GHz VNA in the world. At four inches square and a little over a half inch in height, this VNA could be used in a limitless range of applications including electronic product test, medical or industrial imaging and agricultural analysis just to name a few.

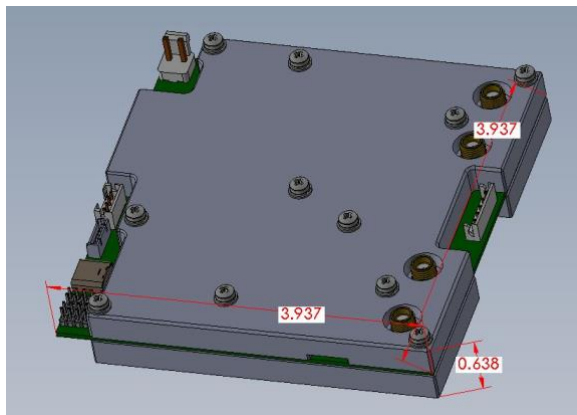


Figure 8- 5.5 GHz 2-Port VNA

All modules make stable measurements and a verification document listing measurement uncertainties traceable to NIST can be provided on request.

These 1- and 2-port modules may be configured and optimized for any specific application. Some configurable options might be frequency range, connector types and position, external time base reference and measurement triggering. Contact Copper Mountain Technologies at 317.222.5400 or email support@coppermountaintech.com to discuss your specific needs.

References:





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[1] A. Lewandowski , A. Szyplowska, A. Wilczek, M. Kafarski, J. Szerement, and W. Skierucha, "One-Port Vector Network Analyzer Characterization of Soil Dielectric Spectrum", IEEE Transactions on Geoscience and Remote Sensing, Vol. 57, No. 6, June 2019