

# Millimeter-Wave S-Parameter Measurements

Agilent Technologies  
and OML, Inc.

## Make millimeter-wave S-parameter measurements with frequency extension modules for your vector network analyzer

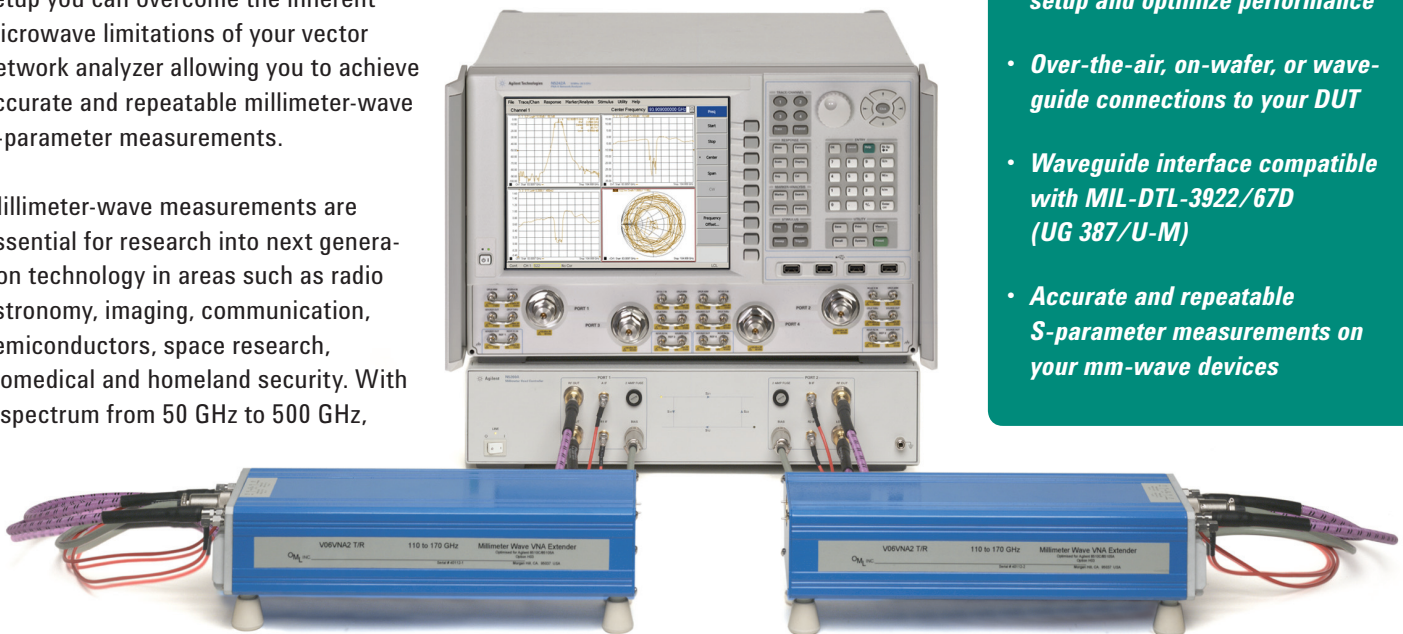
Millimeter-wave (mm-wave) measurements require the same fundamental tools that engineers use for the RF & microwave spectrum. For S-parameter measurements this means a vector network analyzer (VNA). Frequency extension of a microwave vector network analyzer is possible up to 0.5 Terahertz (THz). The key enablers for millimeter-wave S-parameter measurements are harmonic mixer and multiplier technologies. By adding VNA modules to your setup you can overcome the inherent microwave limitations of your vector network analyzer allowing you to achieve accurate and repeatable millimeter-wave S-parameter measurements.

Millimeter-wave measurements are essential for research into next generation technology in areas such as radio astronomy, imaging, communication, semiconductors, space research, biomedical and homeland security. With a spectrum from 50 GHz to 500 GHz,

and greater, the complexity of measurements requires specialized solutions, especially as the wavelengths approach sub-millimeter in length.

OML provides vector network analyzer frequency extension technology that connects as external modules to the Agilent PNA or PNA-X for mm-wave S-parameter measurements. The external VNA modules extend the frequency range of the vector network

- *Perform millimeter-wave S-parameter measurements*
- *Millimeter-wave extension modules for your vector network analyzer*
- *Extend the frequency range of your Agilent PNA and PNA-X*
- *External VNA modules simplify setup and optimize performance*
- *Over-the-air, on-wafer, or waveguide connections to your DUT*
- *Waveguide interface compatible with MIL-DTL-3922/67D (UG 387/U-M)*
- *Accurate and repeatable S-parameter measurements on your mm-wave devices*



*Anticipate — Accelerate — Achieve*



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analyzer into the mm-wave bands. By using external modules the connections to the device-under-test (DUT) are closer giving improved dynamic range. They can be interfaced to the DUT via over-the-air, on-wafer, or waveguide connections. The waveguide interface is compatible with MIL-DTL-3922/67D (UG 387/U-M).

Once connected, the OML VNA modules utilize the predetermined RF, LO and IF to effectively multiply the PNA or PNA-X microwave capabilities to the mm-wave spectrum. The familiar front panel operation for setup, calibration, measurement, and output are the same, except the readouts are in the mm-wave instead of microwave spectrum. The Agilent PNA and PNA-X are plug-and-play compatible with the frequency extension modules available from OML.

A typical mm-wave S-parameter configuration consists of a PNA or PNA-X vector network analyzer, an optional mm-wave test set controller

and the external VNA module(s). For one-port S-parameter measurements ( $S_{11}$ ), the VNA module configuration is transmit/receive. For one-path, two-port measurements ( $S_{11}$ ,  $S_{21}$ ), two VNA modules are necessary — transmit/receive & transmit configurations. For all four S-parameters ( $S_{11}$ ,  $S_{21}$ ,  $S_{12}$ ,  $S_{22}$ ), two transmit/receive modules are necessary. For active device testing, an optional 25 dB manual adjustable attenuator is available and for antenna applications, optional 15 dB amplification can be used to overcome long cable runs in RF & LO paths. Waveguide calibration kits are also available as separate accessories.

OML's external frequency extension modules when combined with an Agilent vector network analyzer allow you to extend the frequency range of your instruments to perform accurate and repeatable S-parameter measurements on your millimeter-wave band circuits and devices.

## System Components

### Agilent Technologies

**PNA/PNA-X** Vector network analyzer

### OML, Inc.

<b>V15VNA2</b>	WR-15, 50-75 GHz
<b>V12VNA2</b>	WR-12, 60-90 GHz
<b>V10VNA2</b>	WR-10, 75-110 GHz
<b>V08VNA2</b>	WR-08, 90-140 GHz
<b>V06VNA2</b>	WR-06, 110-170 GHz
<b>V05VNA2</b>	WR-05, 140-220 GHz
<b>V03VNA2</b>	WR-03, 220-325 GHz
<b>V02.2VNA2</b>	WR-02.2, 325-500 GHz
<b>Option - A</b>	Add 25 dB manual attenuator (Except WR-02.2)
<b>Option - RLA</b>	Add RF&LO amps (15 dB)

To learn how this solution can address your specific needs please contact Agilent's solutions partner, OML, Inc.

[www.agilent.com/find/OML](http://www.agilent.com/find/OML)



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Solutions Partner

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**OML, Inc.** is a premier supplier of innovative millimeter and sub-millimeter wave frequency extension products for vector network analyzers, scalar network analyzers, spectrum analyzers, converters, and signal generators. Our solutions empower engineers in R&D and manufacturing to pursue opportunities in emerging applications spanning radio astronomy, communication, imaging, space research, and homeland security [www.omlinc.com](http://www.omlinc.com)

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