ERAVANT
MAKING MILLIMETERWAVE ACCESSIBLE

TERAHERTZ PRODUCTS

Making millimeter wave accessible
Solutions up to 330 GHz

The Terahertz frequency range is commonly accepted as spanning 100 GHz to 3 THz. A major benefit of the Terahertz spectrum is that many materials are transparent or responsive at these frequencies. Applications include 6G and Space communications, concealed weapons detection, radio astronomy, collision avoidance radar, chemical spectroscopy, wideband and secure communications, medical diagnostic systems, atmospheric science, test and measurement equipment, and quality control systems.

TERAHERTZ COMPONENTS

Eravant THz components cover the frequency range of 100 to 300 GHz and include antennas, antenna accessories, low noise amplifiers, power amplifiers, mixers, frequency multipliers, and many other waveguide components.

Isolators

Eravant offers three types of waveguide isolators based on the Faraday rotation principle: Standard, Compact, and Miniature. Standard isolators offer excellent broadband performance in a sturdy waveguide configuration. Compact isolators offer similar performance but in a smaller package. Miniature isolators offer the smallest package size available and are highly resistant to stray magnetic fields. Measuring 0.75 x 0.75 x 0.52 inches, model STF-05-S1-M is a miniature Faraday isolator that operates from 140 to 220 GHz. The novel magnetic design, combined with a precision machined housing, achieves 23 dB typical isolation with 4.5 dB insertion loss. The ports are WR-05 waveguide with UG-387/U-M anti-cocking flanges.

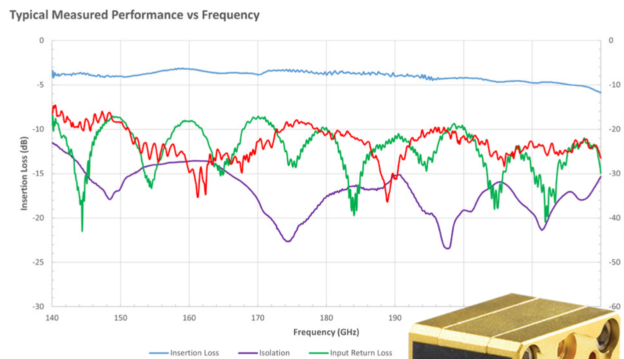
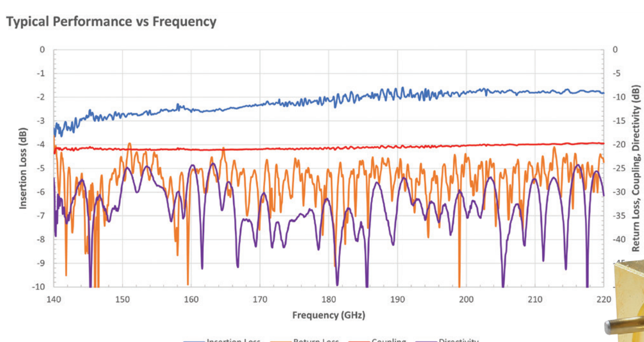


Figure 1. A miniature isolator provides 23-dB isolation from 140 to 220 GHz.

Directional Couplers

With frequency coverage up to 325 GHz, directional couplers with either one or two coupled ports provide coupling levels from 3 to 40 dB with directivity spanning 20 to 40 dB. Model SWD-2025H-05-SB is a G-band, three-port waveguide directional coupler that delivers 20 dB nominal coupling with 25 dB typical directivity across the full waveguide band from 140 to 220 GHz. Typical insertion loss is 2.1 dB. The coupler employs a traditional multi-hole, split block design that achieves flat coupling and low insertion loss. The interfaces are WR-05 waveguide with UG-387/U-M anti-cocking flanges.



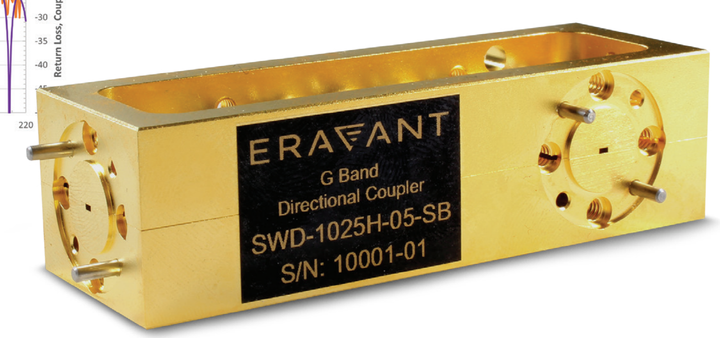
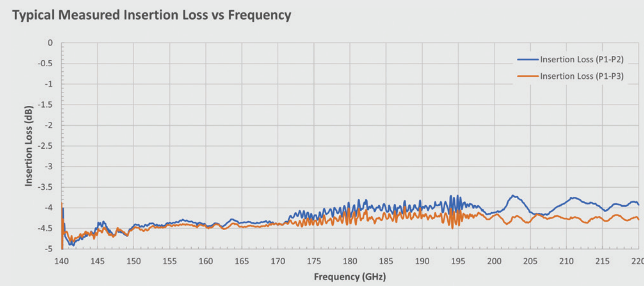


Figure 2. A directional coupler yields 20-dB coupling from 140 to 220 GHz.

Power Dividers / Combiners

A wide range of power divider configurations are available with the number of output ports ranging from 2 to 16. Both right-angle and in-line port arrangements are offered. Frequency coverage reaches up to 330 GHz. Model SWP-14422402-05-S1 is a G-band, 2-way right-angle power divider that operates from 140 to 220 GHz. The divider offers typical insertion loss of 1.7 dB with 20 dB isolation between output ports. Amplitude balance is within +/- 0.6 dB. All ports are WR-05 waveguide with UG-387/U-M anti-cocking flanges.



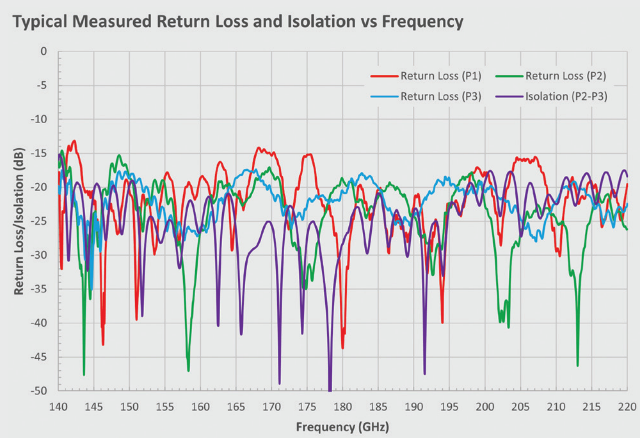


Figure 3. A two-way right-angle power divider provides more than 20 dB isolation from 140 to 220 GHz.

Low Noise Amplifiers

Eravant's low noise amplifiers cover frequencies from several GHz up to 270 GHz. In a WR-03 waveguide package, model SBL-2242741585-0303-E1 provides 15-dB gain with 8.5-dB noise figure from 220 to 270 GHz (Figure 4). A full-band amplifier, model SBL-1141743065-0606-E1 in a WR-06 waveguide package, provides 30-dB gain from 110 to 170 GHz with 6.5-dB noise figure.

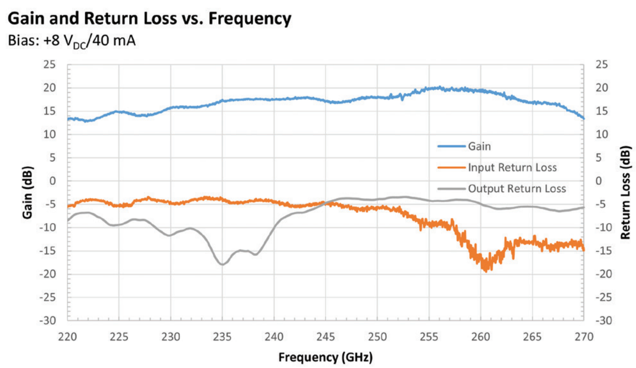
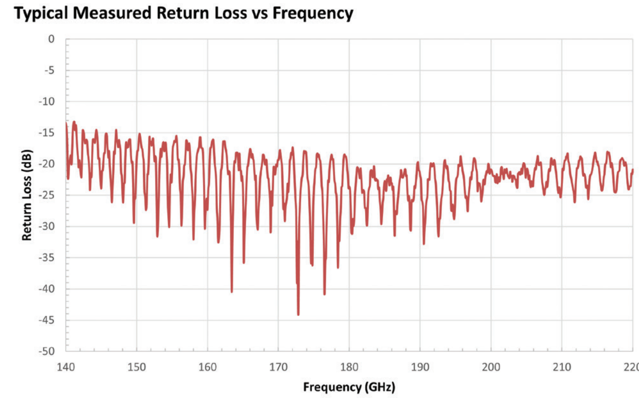


Figure 4. The Measured Performance of 220 to 270 GHz Low Noise Amplifier

Gaussian Optics Antennas

Making the most of THz power often means selecting antennas with the highest available gain. Eravant's Gaussian Optics Antennas operate up to 220 GHz with 1-degree typical beam width and gains ranging from 40 to 46 dBi. Model SAG-1442244501-059-S1 is a 6-inch diameter G-band Gaussian antenna that covers 140 to 220 GHz with 45 dBi nominal gain and 1 degree half power beam width. The antenna supports linear and circular polarizations and utilizes a corrugated feed horn for excellent aperture efficiency, high cross-polarization rejection, and low side lobe levels.



Contactless Waveguide Straight Sections

Straight waveguide sections with Proxi-Flange™ contactless waveguide flanges support rapid and flexible testing of components and systems by eliminating the need to tighten waveguide screws when making temporary connections between waveguide components. The novel contactless flange design includes a choke ring populated with an array of pins to form a gap structure that suppresses signal leakage and minimizes reflections when placed in close proximity to a conventional waveguide flange. Model STQ-WG-05025-FB-CF is a straight waveguide section with a Proxi-Flange™ interface that operates from 140 to 220 GHz. The insertion length is 2.5 inches. Nominal insertion loss is 4.5 dB with typical return loss of 25 dB. Other Proxi-FlangeTM models operate from 18 to 330 GHz.

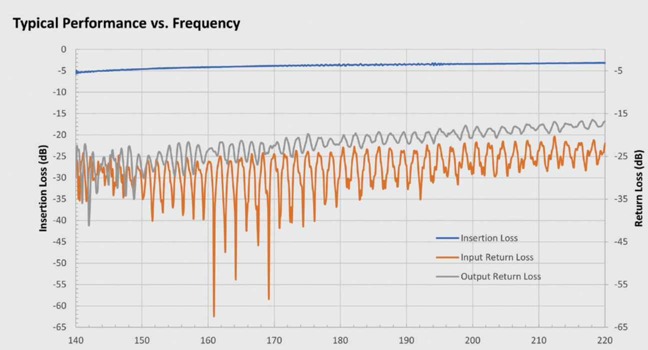


Figure 5. A straight WR-05 waveguide section with a Proxi-Flange™ conactactless waveguide flange has typical insertion loss of 4.5 dB and return loss of 20 dB from 140 to 220 GHz.

Frequency Multipliers

Frequency multipliers are often used with signal sources to achieve higher output frequencies. Multiplication preserves the frequency accuracy and stability of the signal source with minor increases in sideband noise, and possibly higher harmonic content that can be filtered out if necessary. Both passive and active frequency multipliers are available.

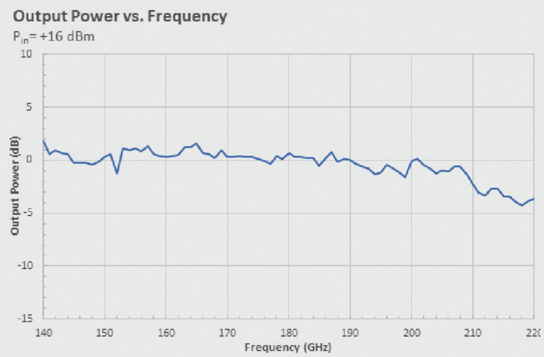


Figure 7. The Measured Performance of G Band Passive Doubler

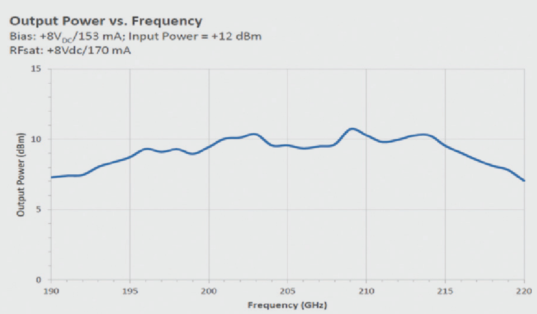


Figure 8. The Measured Performance of G Band Active Multiplier

Passive multipliers typically employ Schottky diodes and generally provide multiplication factors of 2, 3, or 4. Many models operate over full waveguide bands up to 220 GHz. Passive multipliers require no DC power and have relatively straightforward implementations but they exhibit significant conversion loss. In contrast, active multipliers combine passive multiplier circuits, filters and amplifiers to provide higher output power and higher multiplication factors. Most of Eravant's frequency multipliers cover full waveguide bandwidths. Alternatively, custom units with narrower frequency coverage can be designed to reach other performance goals such as lower conversion loss or lower harmonic content. Model SFP-05210-S2 is a passive frequency doubler that provides full G-Band coverage from 140 to 220 GHz with output power around 0 dBm when driven with +16 dBm input power (Figure 7). Model SFA-194224208-0510-E1 is an active doubler that yields output signals from 190 to 220 GHz at +8 dBm using an input signal of +12 dBm and a DC supply of +8 Volts at 170 mA (Figure 8).

Power Amplifiers

Power amplifiers typically incorporate GaAs, InP or GaN semiconductor technologies to achieve output levels that are relatively high for THz components. Power combining techniques in planar circuits and in waveguide configurations are used to achieve the best electrical and mechanical performance possible. Model SBP-2142351507-0404-E1 covers the frequency range of 210 to 230 GHz with 15 dB gain and +10 dBm output power in a WR-04 waveguide package (Figure 9).

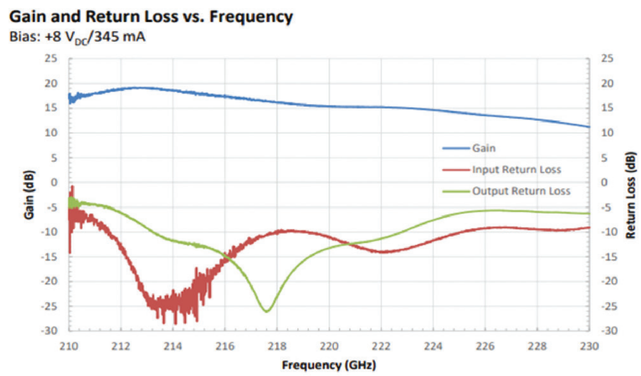


Figure 9. The Measured Performance of 210 to 230 GHz Power Amplifier

Mixers

Model SFB-05-E2 is an externally biased balanced mixer that covers the full G-Band from 140 to 220 GHz. Its conversion loss is about 13 dB using +3 dBm of LO power. The waveguide interfaces are WR-05.

Precision Machined Waveguide Sections

Machined waveguide sections are fabricated using split-block designs that provide unsurpassed mechanical strength and electrical stability for applications such as antenna test ranges and high-volume component manufacturing. Machined waveguide sections include 90-degree twists, H-plane bends and E-plane bends. Model STQ-WB-03090-E1 is a 90-degree WR-03 E-plane bend with UG-387/U-M anti-cocking flanges. With a bend radius of 0.75 inches, the waveguide section operates from 220 to 330 GHz. Typical insertion loss is 3.5 dB.

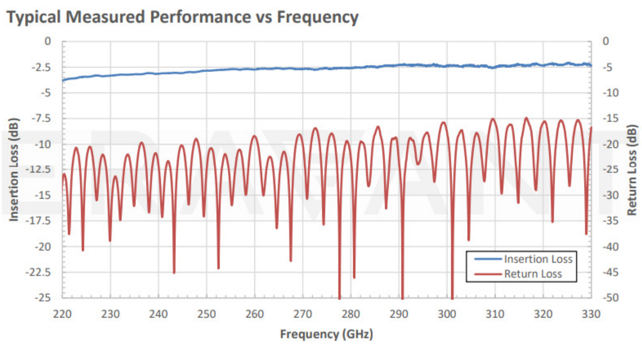
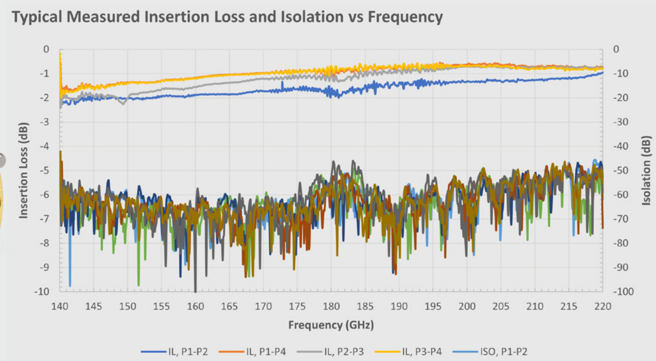


Figure 10. Typical measured performance Vs frequency for STQ-WB-03090-E1 WR-03 E-Plane Waveguide Bend.

Motorized Waveguide Switches

Waveguide transfer switches are found in many applications including automated test systems and high-reliability communication and radar systems. They provide fast mechanical switching between different antennas or between redundant components such as power amplifiers or low-noise receivers. Model SWJ-05-T1 is a motorized four-port transfer switch with a TTL driver that covers the frequency range of 140 to 220 GHz. The E-plane switch connects each port to either one of its adjacent ports, switching in less than 0.2 seconds. Typical insertion loss is 2.5 dB



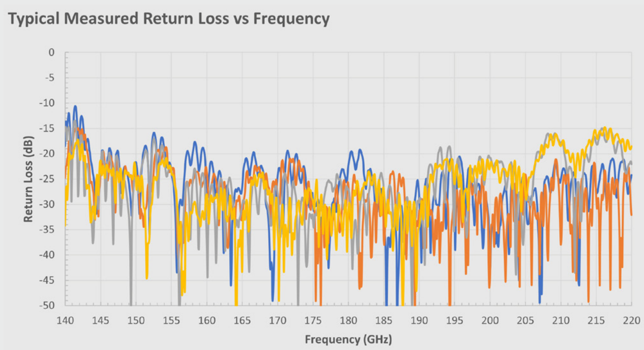


Figure 12. Measured performance of 140 to 220 GHz E-Plane waveguide switch.

Orthomode Transducers

Polarization diversity is commonly used to carry separate transmit and receive signals through a single antenna feed, or provide on-demand polarization options in radar and communication systems. Orthomode transducers (OMTs) are highly effective in separating or combining linearly polarized signals passing through a common waveguide interface, with low insertion loss and high isolation between the separated signals. Model SAT-FG-05105-S1 is a WR-05 OMT that operates between 140 and 220 GHz with 20 dB cross-polarization rejection.

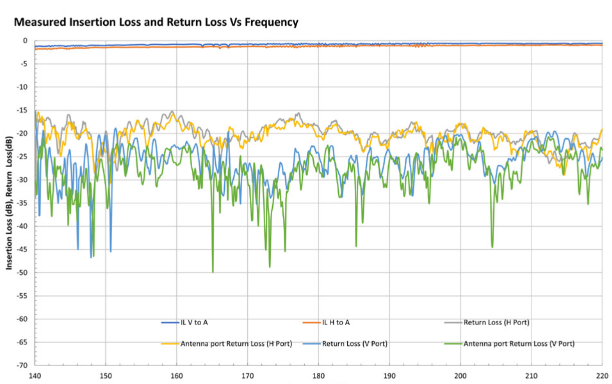
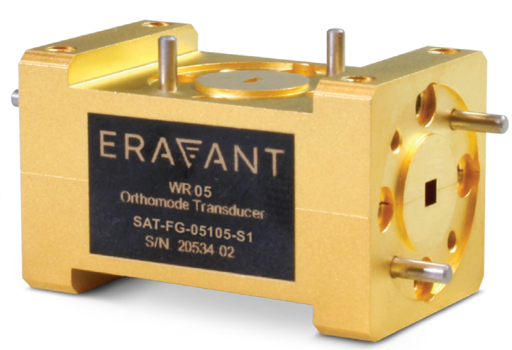


Figure 11. Measured performance of 140 to 220 GHz orthomode transducer.



Calibrated Noise Sources

Noise sources are widely used to measure the noise performance of amplifiers and receivers. They are also used with amplifiers to generate wide-band test signals for components and systems. Model STZ-14420412-05-IT2 is a WR-05 noise source that delivers 12 dB nominal ENR from 140 to 200 GHz. The RF port is a WR-05 waveguide interface with a UG-387/U-M anti-cocking flange. Typical return loss is 15 dB. A TTL-level trigger input supports modulation rates up to 1 kHz.

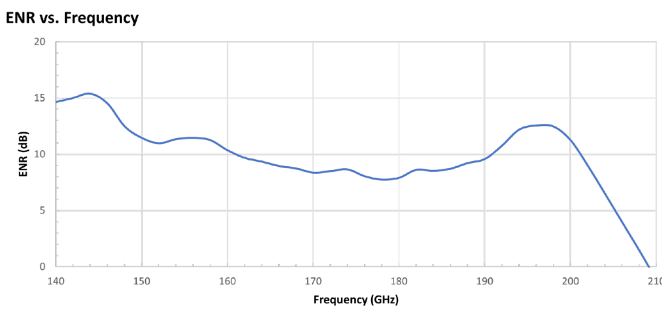


Figure 13. The Measured Performance of 140 to 200 GHz Calibrated Noise Sources.

Programmable Direct Reading Attenuators

Direct reading rotary vane attenuators are widely used in waveguide test systems. They provide adjustable attenuation with excellent accuracy and repeatability over full waveguide bands. By adding a stepper motor and a digital controller to this type of attenuator, the result is a versatile instrument that is fully programmable for use in automated test and measurement systems. Model STA-60-06-S1 is a dual function direct reading and programmable rotary vane type attenuator for use across the entire WR-06 frequency range of 110 to 170 GHz (Fig. 15). Attenuation is adjustable over a 60-dB range with minimum insertion loss of 3.0 dB. Accuracy is 0.15 dB or 3.5 percent of the reading, whichever is larger, up to 40 dB. Attenuation can be adjusted manually using a large control knob or automatically using commands sent over a USB interface.

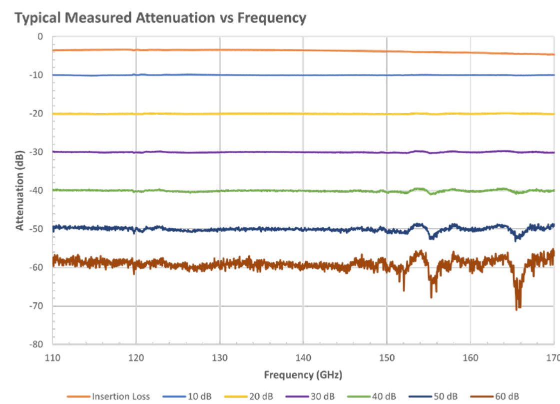


Figure 14. Measured performance of 110 to 170 GHz programmable direct reading attenuator.

Noise Figure and Gain Test System Extenders

Test systems that measure noise figure and gain are challenging to design and build for millimeter wave and THz frequencies. Fully integrated off-the-shelf noise figure and gain test systems operating at these frequencies are often cost-prohibitive. Fortunately, many low-frequency noise figure and gain test systems can be extended to higher frequencies using a straightforward and cost-effective solution. Model STG-06-S1 is a D-Band noise figure and gain test system extender that expands the capabilities of common test systems to the frequency range of 110 to 170 GHz (Fig. 14). The included noise source provides a nominal ENR of 12 dB. The downconverter noise figure is 16 dB and conversion gain is 20 dB.

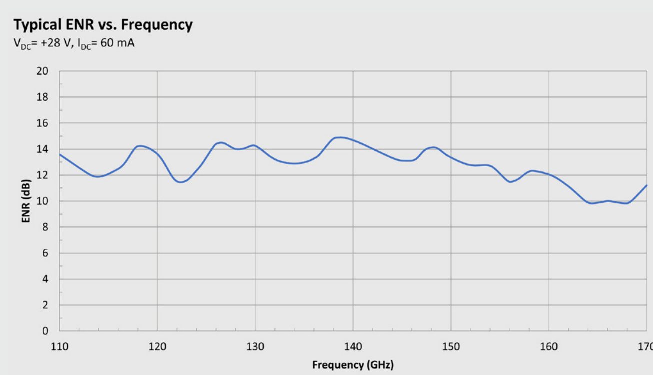


Figure 15. Typical ENR for D-Band Noise Figure and Gain Test System Extenders.

Transmit/Receive VNA Frequency Extenders
Automatic Vector Network Analyzers (VNAs) are powerful tools for developing and testing a wide range of components and subsystems. At millimeter wave and THz frequencies, VNA frequency extenders are the preferred method of extending the reach of coaxial VNAs to waveguide bands. Model STO-03203N05-C-E1 is a J-Band Transmit/ Receive (TX/RX) VNA frequency extender designed to achieve full two-port S-parameter testing from 220 to 330 GHz. The extender is compatible with modern VNAs such as the Rohde & Schwarz ZNA series, the Anritsu VectorStar™ series, the Keysight PNA-X series, and the Copper Mountain Cobalt Fx series. A single TX/RX frequency extender can measure either S11 or S22 while a pair of TX/RX extenders measures S11, S12, S21 and S22 simultaneously with typical dynamic range of 100 dB or better.

Figure 16. STO-03203N05-C-E1 VNA Tx/Rx Frequency Extender.

Figure 17. STO-03203N05-CM-E1 VNA Tx/Rx Frequency Extender with Attenuator.

Compact Transmit and Receive VNA Frequency Extenders
Automatic VNAs are often used in antenna measurement ranges due to their ease of use, accuracy, and wide dynamic range. The VNA is typically set up to measure S21 between a standard-gain antenna and an antenna under test in an anechoic chamber. At millimeter wave and THz frequencies, long segments of waveguide between the antennas and the VNA test ports are impractical. The preferred approach is to configure the antenna range with a pair of transmit-only (TX) and receive-only (RX) VNA frequency extenders placed near the antennas. Models STO-03203N05-T-E1 and STO-03203N05-R-E1 are TX and RX frequency extenders that operate from 220 to 330 GHz. Each extender occupies a volume of approximately 5.0 x 3.8 x 1.9 inches. The pair provides measurement dynamic range of 100 dB or more.

Figure 18. STO-03203N05-T-E1 and STO-03203N05-R-E1 are TX and RX frequency extenders that operate from 220 to 330 GHz

Waveguide Calibration Kits
Model STQ-TO-03-S1-CKIT1-CF is a metrology grade WR-03 waveguide calibration kit designed to work with industry standard network analyzers in the frequency range of 220 to 330 GHz. The calibration kit includes a fixed short, a matching load, and waveguide shims measuring 5/8, 1/4, and 3/8 wavelengths. The kit also features a pair of 2.5-inch metrology grade WR-03 straight waveguide sections with Proxi-Flange™ contactless flanges. Calibration data is provided on a USB thumb drive. The calibration kit is organized in a ruggedized weather-tight carrying case for long life and ease of use.

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