Modular VNA Extenders for Terahertz Frequencies

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An early prototype shown at IMS 6/2008

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Background

- VDI has an established history of building broadband receivers and sources; generally for science applications.
- These same subsystems are exactly what is needed for high-quality VNA extenders.
A Modular 140 - 1,000 GHz “Starter Kit”

WR-10 Amp & Multipliers

- Series of cascaded multipliers and detectors for *scalar* measurements
- Tunerless, instantaneous sweeping over > 40% bandwidth
  - Rapidly interchangeable components

Matching set of new zero-bias detectors
Modular 140 – 1,000GHz Transmitter System

Output power vs frequency

- Power (mW)
- Frequency (GHz)

Plot showing output power vs frequency for Modular 140 – 1,000GHz Transmitter System with different frequency ranges marked as x2, x3, x2x2, x2x3, and x3x3.
VDI Broadband Mixers are a standard commercial product & are continually improved: Example – WR6.5SHM

VDI Model: WR6.5SHM
110-170 GHz Sub-Harmonic Mixer

- LO noise suppression
- LO at ½ RF Frequency
- Mixer conversion loss: 5-9 dB (DSB)
- IF bandwidth: > 10 GHz
- No diplexer required
- Waveguide flanges
  RF: WR-6.5
  LO: WR-13

Contact VDI today for specifications and quotation details.
VDI’s First VNA Extender Project

- In ~2006 ESA-ESTEC was looking for an extender for a R&S ZVA40 for their antenna test range.

- Goals:
  - Cover WR6.5 and WR4.3 bands.
  - Greater Tx power and dynamic range than was commercially available at the time.

- VDI developed an initial prototype extender that yield ~100dB dynamic range across the waveguide band.
THz Systems – VNA Extensions

WR-4.3 Receiver:
170-260 GHz

WR-4.3 Transmitter:
170-260 GHz
Initial Testing with ZVA40 at ESA
WR6.5 Tx Power and Rx Sensitivity

![Graph showing Tx Power (dBm) and Rx Loss (dB) (SSB) vs Frequency (GHz)](image-url)
WR-4.3 Transceiver with ZVA-40 VNA

Dynamic Range of VDI Tx-Rx with ZVA-40

Dynamic Range (dB)

Frequency (GHz)
WR-4.3 Transceiver with ZVA-40 VNA

Phase Stability: Tx + WR-4.3SHM & WR-4.3HM

• Initial temperature settling (10-15 minutes).
• Fixed frequency, open lab environment.
WR-4.3 Transceiver with ZVA-40 VNA

Loss of WR-5 LSA-CM

- Measure loss of Custom Microwave WR-5 Level Set Attenuator
  - Set to full attenuation
- Demonstrates ability to measure samples with very high loss

Meas: TX + Coupler + WR-4.3SHM

Virginia Diodes, Inc.

4/27/2009
WR-2.2/1.5 Modular VNA Extender

An early prototype, with excellent performance but yet to be productized.
WR-2.2/1.5 Modular VNA Extender
First WR1.0 Dynamic Range Measurement for a VDI Extender

BW = 100Hz

Dynamic Range (dB)

Frequency (GHz)

Conclusion:

- VDI has used high quality mixers and multipliers to demonstrate VNA extenders with very high dynamic range throughout the 100 – 1,000GHz band.
- These have been demonstrated with modern R&S and Agilent VNAs with good results.
- VDI is presently shipping extenders for WR10 – WR1.5.
- Also, the physical layout and frequency bands are “negotiable.”
- The system stability is quite good and the cal kits & procedures are being developed.
- This is a good example of a “THz” technology developed for Science that is now being transitioned for more broad applications.