# Summary of Performance Specifications
## VNA Frequency Extension Modules

| Waveguide Band (GHz) | WR28 | WR19 | WR15 | WR15 (SE Option) | WR12 | WR12 (SE Option) | WR10 | WR10 (SE Option) | WR8.0 | WR6.5 | WR5.1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard Frequency Coverage (GHz) | 26-40 | 40-60 | 50-75 | 50-75 | 60-90 | 60-90 | 75-110 | 75-110 | 90-140 | 110-170 | 140-220 |
| Extended Frequency Coverage (GHz)[Ŧ] | - | - | 47-77 | 47-77 | 55-95 | 55-90 | 67-115 | 67-110 | - | - | - |
| Dynamic Range (BW=10Hz,dB,typ) | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Dynamic Range (BW=10Hz,dB,min) | 110 | 105 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| Magnitude Stability (±dB, typical) | 0.15 | 0.15 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.15 | 0.25 | 0.25 |
| Phase Stability (±deg, typical) | 2 | 2 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 2 | 4 | 4 |
| Test Port Power (dBm, typ.) | 13 | 13 | 18 | 13 | 18 | 13 | 18 | -1 | 16 | 13 | 6 |
| Test Port Input Limit (est., dBm, damage) - TxRx, TxRef | 33 | 31 | 30 | 30 | 30 | 30 | 30 | 20 | 30 | 30 | 30 |
| Test Port Input Limit (est., dBm, damage) - Rx in Standard Operation | 40 | 40 | 36 | 36 | 43 | 43 | 42 | 23 | 30 | 30 | 30 |
| Test Port Input Limit (est. dBm, damage) - Rx in High Sensitivity Operation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Directivity (dB, typical) | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |

| Waveguide Band (GHz) | WR5.1 (EB Option) | WR4.3 | WR3.4 | WM710 (WR2.8) | WM570 (WR2.2) | WM380 (WR1.5) | WM380 (WR1.5) Mini | WM250 (WR1.0) | WM250 (WR1.0) Mini | WM164 (WR0.65)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard Frequency Coverage (GHz) | 140-220 | 170-260 | 220-330 | 260-400 | 330-500 | 500-750 | 500-750 | 750-1,100 | 750-1,100 | 1,100-1,500 | |
| Extended Frequency Coverage (GHz)Ŧ | 130-220 | - | - | - | 325-500 | - | - | - | - | - | |
| Dynamic Range (BW=10Hz,dB,typ) | 120 | 115 | 115 | 100 | 110 | 100 | 110* | 65 | 95* | 60* | |
| Dynamic Range (BW=10Hz,dB,min) | 110 | 110 | 105 | 80 | 100 | 80 | 95* | 45 | 75* | 40* | |
| Magnitude Stability (±dB, typical) | 0.25 | 0.3 | 0.3 | 0.5 | 0.5 | 0.4 | 0.4 | 0.5 | 0.5 | 1 | |
| Phase Stability (±deg, typical) | 4 | 4 | 6 | 6 | 6 | 4 | 4 | 6 | 6 | 20 | |
| Test Port Power (dBm, typ.) | 6 | 4 | 1 | -10 | -3 | -25 | -12 | -30 | -23 | -45 | |
| Test Port Input Limit (est., dBm, damage) - TxRx, TxRef | 30 | 28 | 26 | 16 | 10 | -3 | 7 | -3 | -3 | -3 | |
| Test Port Input Limit (est., dBm, damage) - Rx in Standard Operation | 30 | 30 | 20 | 16 | 10 | -3 | 7 | -3 | -3 | -3 | |
| Test Port Input Limit (est. dBm, damage) - Rx in High Sensitivity Operation | 0 | 0 | 0 | 0 | -10 | -10 | 0 | -10 | -10 | -10 | |
| Directivity (dB, typical) | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | |

*The dynamic range specifications assume that low phase noise sources are used, like those used in the modern Keysight PNA / PNA-X analyzers with DDS synthesizers. While compatible, other VNAs may reduce dynamic range.

**WM164 (WR0.65) performance is specified for a TxRx-Rx configuration. Performance of a TxRx-TxRx configuration is estimated to have a ~15dB degradation of dynamic range and may additionally require the use of a mmWave controller.

†Test Port Input Powers exceeding the peak Test Port Power of the TxRx or TxRef module will compress the module.

**General Notes:**

• Extension modules are compatible with all modern VNAs. Please consult with VDI to discuss VNA and module configurations that will yield the best performance for your application.

**Specification Notes:**

• Test Port Power is typical, reduced power is possible at band edges.

• Stability is specified for 1 hr. after system warm-up, in stable environment with ideal cables.

• Specifications assume a through measurement with two TxRx heads.

• Specifications are measured on a Keysight PNA/PNAX with front panel connection at 25°C typical.

• The dynamic range (RBW 10 Hz) is measured by first connecting two TxRx heads together and normalizing the un-calibrated S21 & S12. The heads are then disconnected and terminated with a waveguide short. The RMS average of 10 sweeps of the measured S21 & S12 gives the system dynamic range.

• Typical Module Dimensions exclude testport (2" standard testport for all modules except WM250 (WR1.0), where a 1" testport is used).

Ŧ Where noted, Extended Frequency Coverage applies; module performance within the standard band conforms to standard specifications while performance in the extended regions can be degraded as follows:
- The minimum and typical dynamic range is degraded by 10dB or less, compared to the specification for the standard band, with the exception for WR5.1-EB. For WR5.1, the minimum dynamic range is 95dB (15dB degradation compared to the standard band specification).
- The test port power typical across the extended band is degraded by 5dB or less compared to the specification for the standard band.