



MILLIMETER WAVE CALIBRATION KIT BROCHURE



“Innovation in Millimeter Wave Measurements”

General Information

OML's millimeter wave calibration kits contain the waveguide components that accurately calibrate your vector network analyzer for precision S-parameter measurements. The calibration techniques supported include: TRL, SSoLT, and SSoLs. Waveguide calibration kits are available in the millimeter and sub-millimeter wave frequencies between 50 and 500 GHz.






The VxxCAL Series of calibration kits satisfies the EU Directives on Restriction of Hazardous Substances (RoHS).



Waveguide calibration components are valuable assets in your test environment so proper care and protection is necessary to ensure accurate and repeatable calibrations. For this reason, the calibration elements are provided in a wooden case (as shown above) with protective enclosures and visual labeling. The calibration kit is designed with high quality precision components to offer you the best possible calibration so you can make the most accurate S-parameter measurements.

Calibration Kit Overview

OML offers three calibration kits to satisfy your needs: Universal, Standard, and Standard plus Sliding Load. The following table summarizes the calibration kit contents to help with the selection process. All the following calibration kits support the popular calibration techniques of TRL & SOLT. The availability of an adjustable waveguide load enables the calibration flexibility to also conduct SSoLs (Short, Offset Short, and Adjustable Load). The ‘xx’ in the part number corresponds to the waveguide band (e.g., V10CAL for WR-10).

| Part Number | Overview | Contents |
|---|---|---|
| <p>VxxCAL Universal Calibration Kit</p> |  | <ul style="list-style-type: none"> 2 ea. Waveguide Loads 1 ea. Adjustable Waveguide Load (except WR-02.2) 1 ea. Waveguide Section (test artifact) 2 ea. Precision Waveguide Flush Shorts 1 ea. Precision Waveguide Shim (1/4 wavelength) 1 ea. #4-40 Hex Screwdriver 8 ea. Alignment Pins 12 ea. WG Screws 1 ea. USB Flash Drive (mechanical calibration data) 1 ea. 3.5" Floppy Disk (mechanical calibration data) 1 ea. Laminated Card (mechanical calibration data) |
| <p>VxxCAL1 Standard Calibration Kit</p> |  | <ul style="list-style-type: none"> 1 ea. Waveguide Load 1 ea. Waveguide Section (test artifact) 1 ea. Precision Waveguide Flush Short 1 ea. Precision Waveguide Shim (1/4 wavelength) 1 ea. #4-40 Hex Screwdriver 8 ea. Alignment Pins 12 ea. WG Screws 1 ea. USB Flash Drive (mechanical calibration data) 1 ea. 3.5" Floppy Disk (mechanical calibration data) 1 ea. Laminated Card (mechanical calibration data) |
| <p>VxxCAL2 Standard Calibration Kit plus Sliding Load</p> |  | <ul style="list-style-type: none"> 1 ea. Waveguide Load 1 ea. Adjustable Waveguide Load (except WR-02.2) 1 ea. Waveguide Section (test artifact) 1 ea. Precision Waveguide Flush Short 1 ea. Precision Waveguide Shim (1/4 wavelength) 1 ea. #4-40 Hex Screwdriver 8 ea. Alignment Pins 12 ea. WG Screws 1 ea. USB Flash Drive (mechanical calibration data) 1 ea. 3.5" Floppy Disk (mechanical calibration data) 1 ea. Laminated Card (mechanical calibration data) |

| | | |
|--|---|---|
| <p>VxxCAL3</p> <p>Standard Calibration Kit plus 1 additional Load & 1 additional Short</p> |  | <ul style="list-style-type: none"> 2 ea. Waveguide Loads 1 ea. Waveguide Section (test artifact) 2 ea. Precision Waveguide Flush Shorts 1 ea. Precision Waveguide Shim (1/4 wavelength) 1 ea. #4-40 Hex Screwdriver 8 ea. Alignment Pins 12 ea. WG Screws 1 ea. USB Flash Drive (mechanical calibration data) 1 ea. 3.5" Floppy Disk (mechanical calibration data) 1 ea. Laminated Card (mechanical calibration data) |
|--|---|---|

Ordering Information

| Universal Calibration Kit | Calibration Kit Description | Frequency, GHz |
|---------------------------|---------------------------------|----------------|
| V15CAL | WR-15 Universal Calibration Kit | 50-75 |
| V12CAL | WR-12 Universal Calibration Kit | 60-90 |
| V10CAL | WR-10 Universal Calibration Kit | 75-110 |
| V08CAL | WR-08 Universal Calibration Kit | 90-140 |
| V06CAL | WR-06 Universal Calibration Kit | 110-170 |
| V05CAL | WR-05 Universal Calibration Kit | 140-220 |
| V03CAL | WR-03 Universal Calibration Kit | 220-325 |

| Standard Calibration Kit | Calibration Kit Description | Frequency, GHz |
|--------------------------|----------------------------------|----------------|
| V15CAL1 | WR-15 Standard Calibration Kit | 50-75 |
| V12CAL1 | WR-12 Standard Calibration Kit | 60-90 |
| V10CAL1 | WR-10 Standard Calibration Kit | 75-110 |
| V08CAL1 | WR-08 Standard Calibration Kit | 90-140 |
| V06CAL1 | WR-06 Standard Calibration Kit | 110-170 |
| V05CAL1 | WR-05 Standard Calibration Kit | 140-220 |
| V03CAL1 | WR-03 Standard Calibration Kit | 220-325 |
| V02.2CAL1 | WR-02.2 Standard Calibration Kit | 325-500 |

| Standard Calibration Kit plus Sliding Load | Calibration Kit Description | Frequency, GHz |
|--|--|----------------|
| V15CAL2 | WR-15 Standard Calibration Kit plus Sliding Load | 50-75 |
| V12CAL2 | WR-12 Standard Calibration Kit plus Sliding Load | 60-90 |
| V10CAL2 | WR-10 Standard Calibration Kit plus Sliding Load | 75-110 |
| V08CAL2 | WR-08 Standard Calibration Kit plus Sliding Load | 90-140 |
| V06CAL2 | WR-06 Standard Calibration Kit plus Sliding Load | 110-170 |
| V05CAL2 | WR-05 Standard Calibration Kit plus Sliding Load | 140-220 |
| V03CAL2 | WR-03 Standard Calibration Kit plus Sliding Load | 220-325 |

| Standard Calibration Kit plus additional Load and Short | Calibration Kit Description | Frequency, GHz |
|--|--|-----------------------|
| V15CAL3 | WR-15 Standard Calibration Kit plus 1 additional Load & 1 additional Short | 50-75 |
| V12CAL3 | WR-12 Standard Calibration Kit plus 1 additional Load & 1 additional Short | 60-90 |
| V10CAL3 | WR-10 Standard Calibration Kit plus 1 additional Load & 1 additional Short | 75-110 |
| V08CAL3 | WR-08 Standard Calibration Kit plus 1 additional Load & 1 additional Short | 90-140 |
| V06CAL3 | WR-06 Standard Calibration Kit plus 1 additional Load & 1 additional Short | 110-170 |
| V05CAL3 | WR-05 Standard Calibration Kit plus 1 additional Load & 1 additional Short | 140-220 |
| V03CAL3 | WR-03 Standard Calibration Kit plus 1 additional Load & 1 additional Short | 220-325 |
| V02.2CAL3 | WR-02.2 Standard Calibration Kit plus 1 additional Load & 1 additional Short | 325-500 |

Waveguide Calibration Reference

The following table overviews various two-port and one-port waveguide calibration types available in modern vector network analyzers.

| Two Port Calibrations | |
|------------------------------|---|
| LRL | Line / Reflect (short) / Line |
| LRM | Line / Reflect (short) / Match (Load) |
| TRL | Thru / Reflect (short) / Line |
| TRM | Thru / Reflect (short) / Match (Load) |
| TSD | Thru / Short / Delay |
| SoSoLsT | Offset Short / Offset Short / Load (sliding) / Thru |
| SoSoLT | Offset Short / Offset Short / Load (fixed) / Thru |
| SoSLsT | Offset Short / Short / Load (sliding) / Thru |

| One Port Calibrations | |
|---|---|
| SoSL | Offset Short / Short / Load (fixed) |
| SoSoL | Offset Short / Offset Short / Load (fixed) |
| SoSoLs | Offset Short / Offset Short / Load (sliding) |
| SoSLs | Offset Short / Short / Load (sliding) |
| SoSLLo | Offset Short / Short / Load (fixed) / Offset Load (fixed) |
| So₁So₂So₃ | Three different offset shorts (<180 deg. total) |

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| MILLIMETER WAVE RECTANGULAR TE ₁₀ WAVEGUIDE INFORMATION | | | | | | | | | | |
|--|---------------------------------|------------------------------------|-----------------------------------|--|--|------------------------------------|---|--|----------------------------|--------------------------|
| WG Band | Waveguide Frequency Range (GHz) | Wavelength Range λ_0 (mil) | Wavelength Range λ_0 (mm) | Guide Wavelength Range (λ_g/λ_0) | Waveguide Impedance Range (Ω) | TE ₁₀ Cutoff Freq (GHz) | TE ₁₀ Cutoff λ_c (mil) | TE ₁₀ Cutoff λ_c (mm) | Internal Dimensions (mils) | Internal Dimensions (mm) |
| WR-28 | 26.5 - 40.0 | 445.4 - 295.1 | 11.313 - 7.495 | 1.650 - 1.177 | 621.9 - 443.6 | 21.1 | 560.0 | 14.22 | 280.0 x 140.0 | 7.112 x 3.556 |
| WR-22 | 33.0 - 50.0 | 357.7 - 236.1 | 9.085 - 5.996 | 1.661 - 1.177 | 626.0 - 443.6 | 26.3 | 448.0 | 11.38 | 224.0 x 112.0 | 5.690 x 2.845 |
| WR-19 | 40.0 - 60.0 | 295.1 - 196.7 | 7.495 - 4.997 | 1.613 - 1.173 | 608.3 - 442.4 | 31.4 | 376.0 | 9.55 | 188.0 x 94.0 | 4.775 x 2.388 |
| WR-15 | 50.0 - 75.0 | 236.1 - 157.4 | 5.996 - 3.997 | 1.657 - 1.181 | 624.8 - 445.1 | 39.9 | 296.0 | 7.52 | 148.0 x 74.0 | 3.759 x 1.880 |
| WR-12 | 60.0 - 90.0 | 196.7 - 131.1 | 4.997 - 3.331 | 1.690 - 1.186 | 637.2 - 447.1 | 48.4 | 244.0 | 6.20 | 122.0 x 61.0 | 3.099 x 1.549 |
| WR-10 | 75.0 - 110.0 | 157.4 - 107.3 | 3.997 - 2.725 | 1.620 - 1.185 | 610.9 - 446.7 | 59.0 | 200.0 | 5.08 | 100.0 x 50.0 | 2.50 x 1.270 |
| WR-08 | 90.0 - 140.0 | 131.1 - 84.3 | 3.331 - 2.141 | 1.746 - 1.177 | 658.1 - 443.6 | 73.8 | 160.0 | 4.06 | 80.0 x 40.0 | 2.032 x 1.016 |
| WR-06 | 110.0 - 170.0 | 107.3 - 69.4 | 2.725 - 1.763 | 1.771 - 1.183 | 667.7 - 445.9 | 90.8 | 130.0 | 3.30 | 65.0 x 32.5 | 1.651 x 0.826 |
| WR-05 | 140.0 - 220.0 | 84.3 - 53.6 | 2.141 - 1.363 | 1.777 - 1.176 | 669.7 - 443.3 | 115.7 | 102.0 | 2.59 | 51.0 x 25.5 | 1.295 x 0.648 |
| WR-04 | 170.0 - 260.0 | 69.4 - 45.4 | 1.763 - 1.153 | 1.695 - 1.177 | 638.8 - 443.9 | 137.2 | 86.0 | 2.18 | 43.0 x 21.5 | 1.092 x 0.546 |
| WR-03 | 220.0 - 325.0 | 53.6 - 36.3 | 1.363 - 0.922 | 1.627 - 1.183 | 613.5 - 445.9 | 173.6 | 68.0 | 1.73 | 34.0 x 17.0 | 0.864 x 0.432 |
| WR-02.8 | 260.0 - 400.0 | 45.4 - 29.5 | 1.153 - 0.749 | 1.708 - 1.177 | 643.8 - 443.6 | 210.8 | 56.0 | 1.42 | 28.0 x 14.0 | 0.711 x 0.356 |
| WR-02.2 | 325.0 - 500.0 | 36.3 - 23.6 | 0.922 - 0.600 | 1.771 - 1.185 | 667.7 - 446.7 | 268.2 | 44.0 | 1.12 | 22.0 x 11.0 | 0.559 x 0.279 |
| WR-01.9 | 400.0 - 600.0 | 29.5 - 19.7 | 0.749 - 0.500 | 1.587 - 1.169 | 598.3 - 440.6 | 310.6 | 38.0 | 0.97 | 19.0 x 9.5 | 0.483 x 0.241 |
| WR-01.5 | 500.0 - 750.0 | 23.6 - 15.7 | 0.600 - 0.400 | 1.620 - 1.175 | 610.9 - 442.8 | 393.4 | 30.0 | 0.76 | 15.0 x 7.5 | 0.381 x 0.191 |
| WR-01.2 | 600.0 - 900.0 | 19.7 - 13.1 | 0.500 - 0.333 | 1.746 - 1.194 | 658.1 - 450.1 | 491.8 | 24.0 | 0.61 | 12.0 x 6.0 | 0.305 x 0.152 |
| WR-01.0 | 750.0 - 1100.0 | 15.7 - 10.7 | 0.400 - 0.273 | 1.620 - 1.185 | 610.9 - 446.7 | 590.1 | 20.0 | 0.51 | 10.0 x 5.0 | 0.254 x 0.127 |