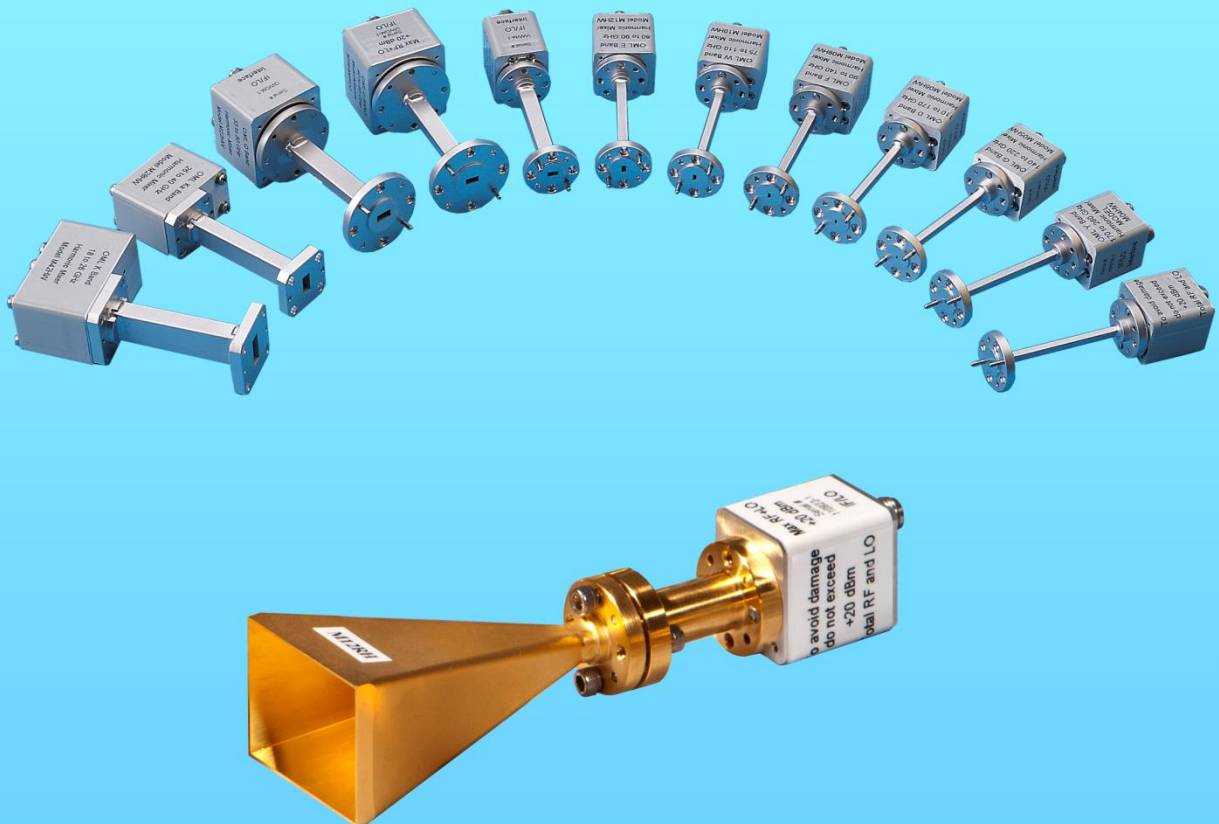




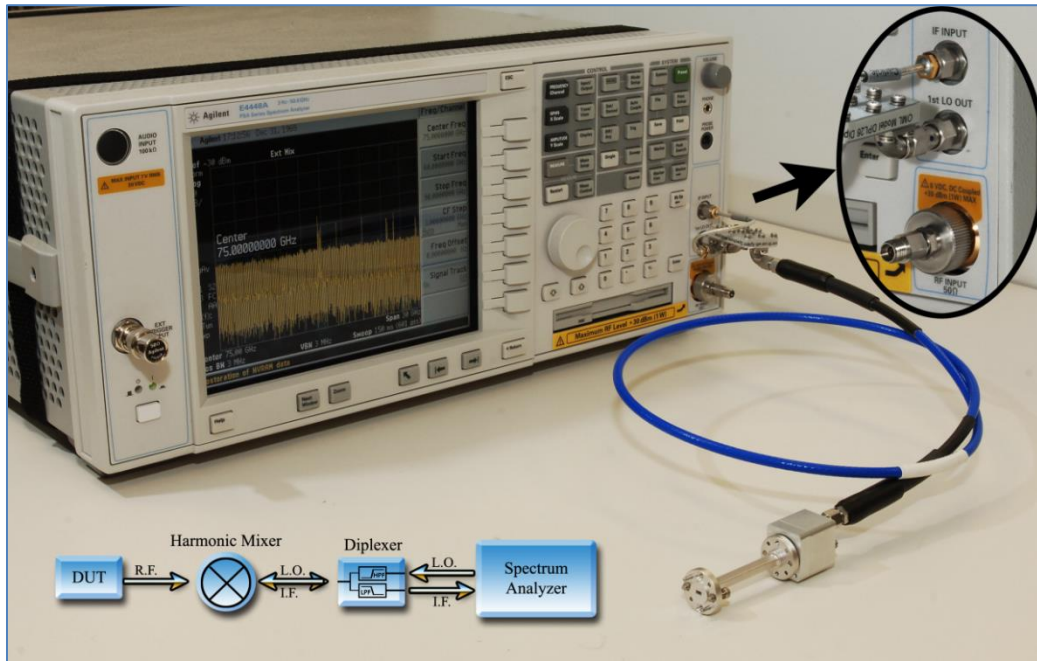
MILLIMETER WAVE HARMONIC MIXER BROCHURE



“Innovation in Millimeter Wave Measurements”

General Information

OML millimeter wave harmonic mixers connect to the test port of your existing spectrum analyzer to extend microwave measurement capabilities to millimeter and sub-millimeter wave frequencies between 50 and 325 GHz. A modern system configuration with the Keysight PSA is shown below, which consists of signal analyzer, diplexer, and OML harmonic mixer. The close-up inset shows connectivity between the spectrum analyzer L.O. & I.F. ports and the external diplexer accessory. Simply connect the output of your device to the waveguide interface of the two-port harmonic mixer to conduct mm-wave measurements using your existing microwave instrumentation.



Direct Connect Solutions

The two-port MxxHWD series of harmonic mixers are compatible with spectrum analyzers that offer an external mixer option. These spectrum analyzer manufacturers include: Advantest, Anritsu, Keysight/Agilent, IFR (Marconi), Rohde & Schwarz, and Tektronix. In general, the external mixer option adds two features that enable substitution of the harmonic mixer for the existing microwave R.F. input:

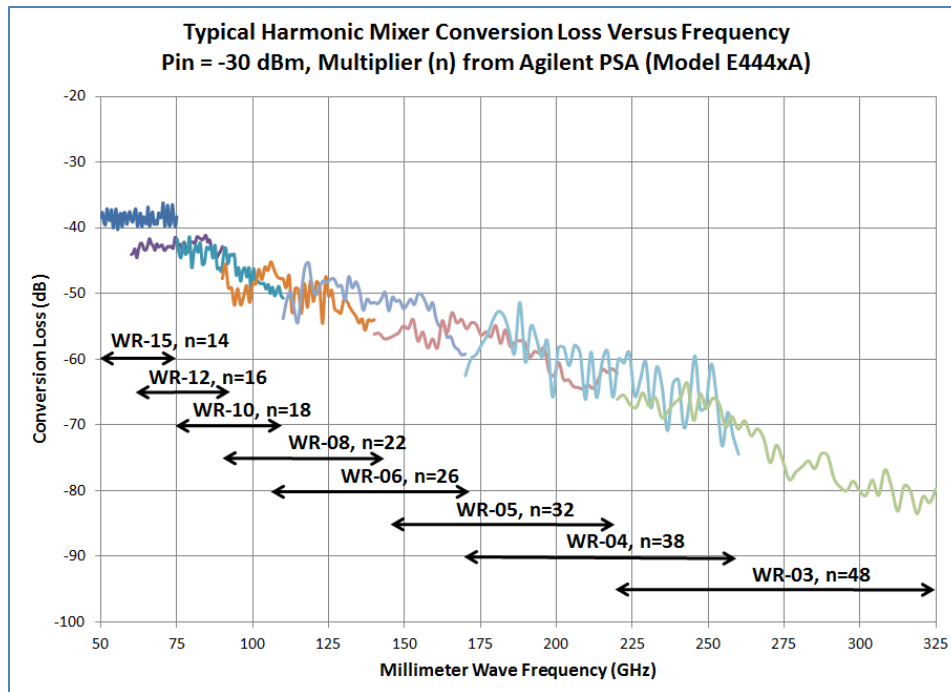
1. External hardware connections for access to the internal L.O. and I.F. signals.
2. Firmware updates to manage predefined multipliers for the available harmonic mixers.

The diplexer, which is either internal or external to the spectrum analyzer, simplifies the overall setup for bench measurements by combining L.O. & I.F. into a single connection. For the external scenario, OML offers an external diplexer accessory that adapts the separate L.O. & I.F. connections on the spectrum analyzer to the second coaxial port on the harmonic mixer.

Please indicate to your sales representative the target spectrum analyzer so OML can characterize the harmonic mixer using the corresponding predetermined L.O., I.F., and multiplier settings.

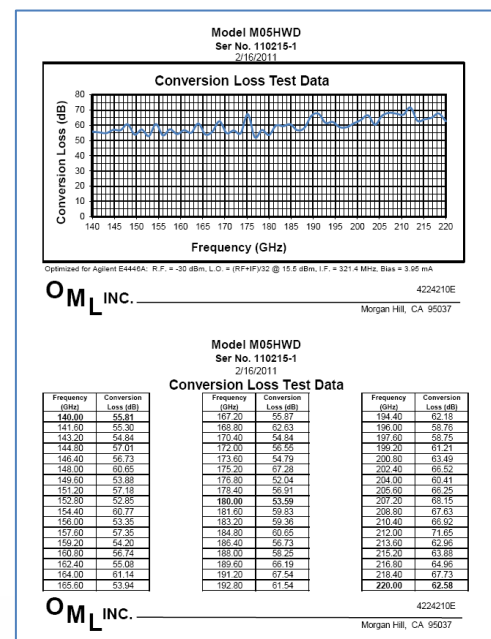
Typical Performance at a Glance

Using the Keysight PSA Signal Analyzer (model E444xA) as a target spectrum analyzer, the following chart overviews the typical conversion loss of our single diode unbalanced harmonic mixer versus the mm-wave frequency range. The waveguide designator and corresponding multiplier factor overlays help in deciphering the typical conversion loss values. These results are typical for the predefined L.O., I.F., and multiplier settings of the PSA. Results may vary when using other spectrum analyzers due to differences in their respective L.O., I.F., and multiplier settings.



Typical Test Report On Conversion Loss

OML characterizes the MxxHWD mixer by using the predefined settings of the external mixer option in the target spectrum analyzer. These settings include L.O., I.F., and multiplier values. As shown in the sample M05HWD test report, the results contain both a graphical plot versus frequency and 51-point readout for amplitude corrections. This test report format is shipped with every mixer so you can manually correct for these conversion loss values in your spectrum analyzer readouts. Some spectrum analyzers offer automatic amplitude correction features to simplify this correction.



For a nominal charge, OML can also provide this test data in an electronic CSV format on USB flash drive. Contact OML for more details on this optional output capability.

SPECIFICATIONS ¹	MxxHWD MODELS					
	M42HWD	M28HWD	M22HWD	M19HWD	M15HWD	M12HWD
System Operating Freq. (GHz)	18 to 26.5	26.5 to 40	33 to 50	40 to 60	50 to 75	60 to 90
System Waveguide Interface ²	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12
Conversion Loss (dB) ^{3,4} RF in = -30 dBm	25 dB	31 dB	32 dB	32 dB	39 dB	43 dB
Sensitivity (dBm) ⁵	-119 dBm	-113 dBm	-112 dBm	-112 dBm	-105 dBm	-101 dBm
Maximum Power, RF + LO (mW, dBm)	100 mW (20 dBm)					
Typical LO Input (dBm) ⁶	+12 to +17 dBm					
Mixer Bias	±10 mA typical					
IF Frequency Range ⁷	DC to 2.4 GHz					
Typical RF Power to Avoid Compression (dBm) ⁸	-20 dBm (10 μW)					
Typical RF Match ⁸	6-9 dB					
Weight	< 8 ounces				< 6 ounces	
Size (L x W x H)	3.0" x 1.6" x 0.9"				2.9" x 0.9" x 0.8"	
System LO/IF Interface	SMA(f)					
Operating Temperature	+20 to +30°C					

¹ Specifications are typical and subject to change without notice

² Test Port Flange Configuration is compatible with MIL-DTL-3922/54 and MIL-DTL-3922/67D

³ Typical conversion loss for Keysight E444xA; results may vary when using other spectrum analyzers

⁴ No recognized reference standards > 110 GHz exist so conversion loss value in this scenario relies on RF power traceable to OML's calorimeter

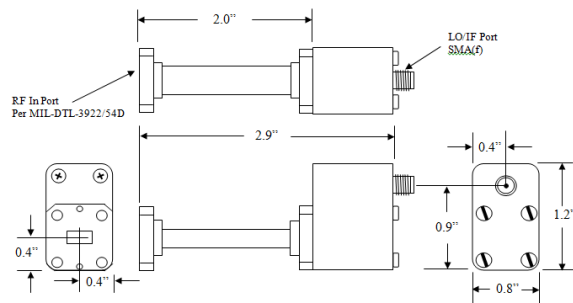
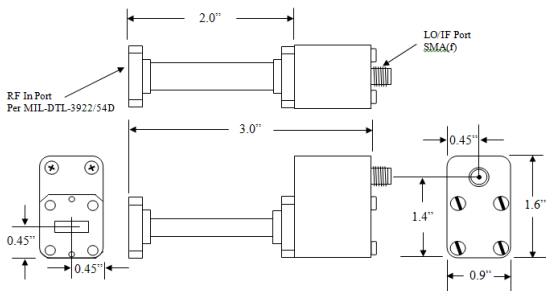
⁵ Calculate Sensitivity (RBW of 1 kHz) = -144 dBm + conversion loss; represents theoretical minimum discernable signal

⁶ Predetermined by spectrum analyzer manufacturer

⁷ Limited by diplexer's IF characteristics

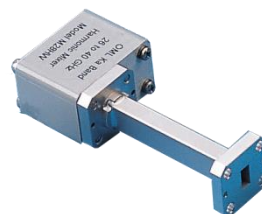
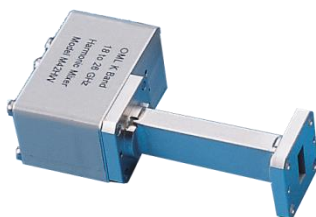
⁸ Not tested

MxxHWD's Mechanical Dimensions:



Model	W/G Flange	UG-xxx/U Equivalent
M42HWD	MIL-DTL-3922/54-001	UG-595U

Model	W/G Flange	UG-xxx/U Equivalent
M28HWD	MIL-DTL-3922/54-003	UG-599U



SPECIFICATIONS ¹	MxxHWD MODELS					
	M10HWD	M08HWD	M06HWD	M05HWD	M04HWD	M03HWD
System Operating Freq. (GHz)	75 to 110	90 to 140	110 to 170	140 to 220	170 to 260	220 to 325
System Waveguide Interface ²	WR-10	WR-08	WR-06	WR-05	WR-04	WR-03
Conversion Loss (dB) ^{3,4} RF in = -30 dBm	46 dB	47 dB	52 dB	59 dB	63 dB	74 dB
Sensitivity (dBm) ⁵	-98 dBm	-97 dBm	-92 dBm	-85 dBm	-81 dBm	-70 dBm
Maximum Power, RF + LO (mW, dBm)	100 mW (20 dBm)					
Typical LO Input (dBm) ⁶	+12 to +17 dBm					
Mixer Bias	±10 mA typical					
IF Frequency Range ⁷	DC to 2.4 GHz					
Typical RF Power to Avoid Compression (dBm) ⁸	-20 dBm (10 µW)					
Typical RF Match ⁸	6-9 dB					
Weight	< 6 ounces					
Size (L x W x H)	2.9" x 0.9" x 0.8"					
System LO/IF Interface	SMA(f)					
Operating Temperature	+20 to +30°C					

Specifications are typical and subject to change without notice

² Test Port Flange Configuration is compatible with MIL-DTL-3922/54 and MIL-DTL-3922/67D

³ Typical conversion loss for Keysight E444xA; results may vary when using other spectrum analyzers

⁴ No recognized reference standards > 110 GHz exist so conversion loss value in this scenario relies on RF power traceable to OML's calorimeter

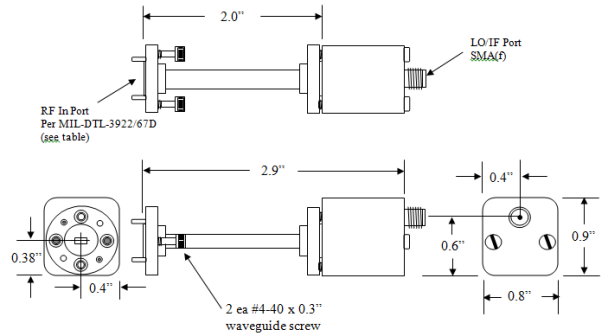
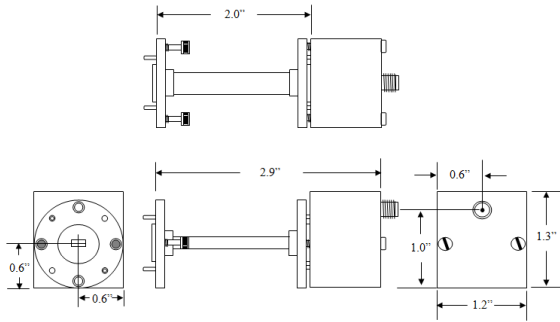
⁵ Calculate Sensitivity (RBW of 10 Hz) = -144 dBm + conversion loss; represents theoretical minimum discernable signal

⁶ Predetermined by spectrum analyzer manufacturer

⁷ Limited by diplexer's IF characteristics

⁸ Not tested

MxxHWD's Mechanical Dimensions:



Model	W/G Flange	UG-xxx/U Equivalent
M22HWD	MIL-DTL-3922/67D-006	UG-383U
M19HWD	MIL-DTL-3922/67D-007	UG-383U-M

Model	W/G Flange	UG-xxx/U Equivalent
M15HWD	MIL-DTL-3922/67D-008	UG-385/U
M12HWD	MIL-DTL-3922/67D-009	UG-387/U
M10HWD	MIL-DTL-3922/67D-010	UG-387/U-M
M08HWD	MIL-DTL-3922/67D-M08	UG-387/U-M
M06HWD	MIL-DTL-3922/67D-M06	UG-387/U-M
M05HWD	MIL-DTL-3922/67D-M05	UG-387/U-M
M04HWD	MIL-DTL-3922/67D-M04	UG-387/U-M
M03HWD	MIL-DTL-3922/67D-M03	UG-387/U-M



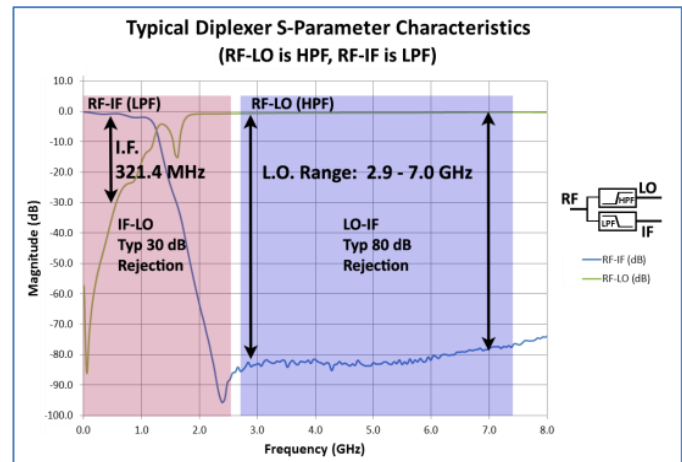
Compatible Spectrum Analyzers

OML characterizes conversion loss of the MxxHWD harmonic mixer using the available settings from manufacturers for their external mixer options. The following table overviews the compatible spectrum analyzers we currently emulate when characterizing conversion loss of our harmonic mixer.

Manufacturer	Compatible Spectrum Analyzer Models	Internal Diplexer
Advantest	R327x, R3172, R3182	Yes
Anritsu	MS2830A, 710C/D, 2702/ 2802, 2667C, 2668C, 2687B	Yes
Keysight (Agilent/HP)	PXA (N9030A), PSA (E444xA), 71209A, 8566B, 856x, E4407B,	No. External diplexer necessary. Except for PXA.
IFR	930/ 940, 1800, 239xA, 684x	No. External diplexer necessary.
Marconi	2393	No, external diplexer necessary
R & S	FSV, FSEK/M, FSIQ, ESMI, ESIB, FSQ, FSU, FSP-40	Yes. External diplexer possible in newer models
Tektronix	49x/ 27xx 2782/84	Yes. No, must use Tek 015-0385-00

Diplexer Function

Although it is more convenient when the diplexer is integrated into the spectrum analyzer, this is not always the case. For example, the Keysight PSA (model E488xA) requires an external diplexer as part of their external mixer setup. As shown in the typical DPL26 S-parameter measurements, the diplexer design enables signal flow with adequate signal separation to optimize performance for mm-wave spectrum analysis.



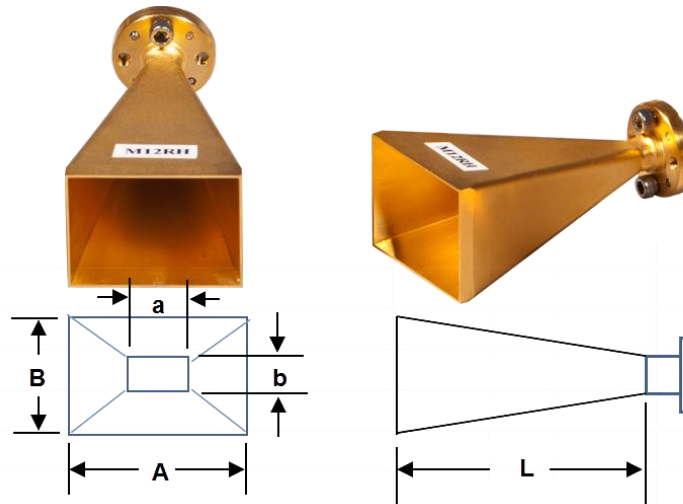
Standard Gain Horn Antennas

OML offers harmonic mixers and standard gain horn antennas for testing compliance according to FCC Part 15 regulations on transmitters operating in the 10 GHz to 100 GHz spectrum. Per FCC 15.33, four waveguide bands (WR-19, WR-12, WR-08 and WR-05) enable measurements of the highest fundamental up to the fifth harmonic (or to 200 GHz). Standard gain horn antennas (+24 dBi) also satisfy ANSI C63.4, C63.5 and C63.10. This solution is compatible with most high performance spectrum analyzers offering optional external mixer capabilities (e.g., Keysight PXA).



The following table overviews the available standard gain horn antennas from OML.

WG Band	OML Horn P/N	Wg Width "a" (in)	Wg Height "b" (in)	Aperture Width "A" (in)	Aperture Height "B" (in)	Horn Length "L" (in)	Gain (dBi) @ Fc	3 dB Beamwidth Elevation	3 dB Beamwidth Azimuth	Antenna Factor (dB/m)
WR-28	M28RH	0.280	0.140	2.712	2.069	5.000	23.8	8.7	9.2	36.9
WR-22	M22RH	0.224	0.112	2.170	1.656	4.070	23.9	8.8	9.2	38.7
WR-19	M19RH	0.188	0.094	1.821	1.390	3.480	24.0	8.7	9.1	40.2
WR-15	M15RH	0.148	0.074	1.434	1.094	2.780	24.0	8.8	9.2	42.1
WR-12	M12RH	0.122	0.061	1.182	0.902	2.350	24.1	8.9	9.3	43.6
WR-10	M10RH	0.100	0.050	0.969	0.740	1.940	24.2	8.8	9.2	45.4
WR-08	M08RH	0.080	0.040	0.775	0.591	1.560	24.2	8.9	9.3	47.3
WR-06	M06RH	0.065	0.033	0.630	0.481	1.260	24.1	8.9	9.4	49.1
WR-05	M05RH	0.051	0.026	0.494	0.377	1.040	24.3	8.9	9.3	51.0
WR-04	M04RH	0.043	0.022	0.417	0.318	0.860	24.3	8.8	9.2	52.6
WR-03	M03RH	0.034	0.017	0.329	0.251	0.710	24.5	8.8	9.2	54.5



Ordering Information

Please indicate to your sales representative the target spectrum analyzer for the harmonic mixer. As a prerequisite, the harmonic mixer setup relies on the optional external mixer in the spectrum analyzer. Without access to the internal L.O. & I.F. signals, the harmonic mixer setup will not work.

Harmonic Mixer	Standard Gain Horn	Waveguide Interface	Frequency GHz
M42HWD	N/A	WR-42	18-26.5
M28HWD	M28RH	WR-28	26.5-40
M22HWD	M22RH	WR-22	33-50
M19HWD	M19RH	WR-19	40-60
M15HWD	M15RH	WR-15	50-75
M12HWD	M12RH	WR-12	60-90
M10HWD	M10RH	WR-10	75-110
M08HWD	M08RH	WR-08	90-140
M06HWD	M06RH	WR-06	110-170
M05HWD	M05RH	WR-05	140-220
M04HWD	M04RH	WR-04	170-260
M03HWD	M03RH	WR-03	220-325

2378H231	FCC Part 15 Bundle, 40-220 GHz
M19HWD + M19RH	WR-19, 40-60 GHz, mixer + horn
M12HWD + M12RH	WR-12, 60-90 GHz, mixer + horn
M08HWD + M08RH	WR-08, 90-140 GHz, mixer + horn
M05HWD + M05RH	WR-05, 140-220 GHz, mixer + horn

For the external diplexer scenario, OML offers the following diplexer accessories to adapt the separate L.O. & I.F. connection on the spectrum analyzer to the single coaxial SMA(f) port of the harmonic mixer. As a practical tip, only a single diplexer is usually necessary per spectrum analyzer. In this way, one diplexer adapts the spectrum analyzer to the various harmonic mixers.

Diplexers	
DPL26	Diplexer, L.O. 2-7.5 GHz, I.F. < 1 GHz for Keysight
DPL313	Diplexer, L.O. 3-13 GHz, I.F. < 1 GHz
DPL518	Diplexer, L.O. 5-18 GHz, I.F. < 2 GHz
Diplexer Standard Accessories (Each diplexer includes the following items)	
V00LOIF	Test Port Ext. Cable, DC to 18 GHz, 3 ft, SMA(m) - SMA(m), 50 Ohm
M00IF	IF Test Port Ext. Cable, DC to 1 GHz, 5 inches, SMA(m) - SMA(m), 50 Ohm
M00DLP	Adapter, DC to 18 GHz, SMA(m)-SMA(m), 50 Ohm

Contact Information

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MILLIMETER WAVE RECTANGULAR TE₁₀ 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

Harmonic Mixer Brochure: Rev. C
 Release Date: 5-2012