Millimeter Wave Harmonic Mixer Test Set

The purpose of this application note is to describe the methodology used in characterizing the conversion loss of OML's harmonic mixer (MxxHWD series). As background, the harmonic mixer is intended to substitute as a millimeter wave conversion stage in spectrum analyzer models with external mixer options to overcome the inherent microwave measurement limitations. For this reason, the test station is versatile to emulate many spectrum analyzers settings in terms of LO, IF and multipliers so the conversion loss can be used as correction factors in millimeter wave measurement scenarios.

Refer to the block diagram on the next page for the following explanation.

This test system is designed to test the conversion loss of OML harmonic mixers. The primary measurement device and the controller in the system is an Anritsu 37xxx vector network analyzer (VNA) operating as a single frequency (I.F.) calibrated power measurement receiver. The system R.F. and L.O synthesizers are Anritsu 68xxx microwave synthesizers. An Anritsu 6709B synthesizer is used as the calibration source and system power reference. A Keysight power meter is used for calibrating the various sources. The L.O. /I.F. diplexer, I.F. amplifier, and the bias supply have been assembled as a single unit by OML to ensure proper control of those functions. The entire system is made coherent through the use of a common 10 MHz reference signal.

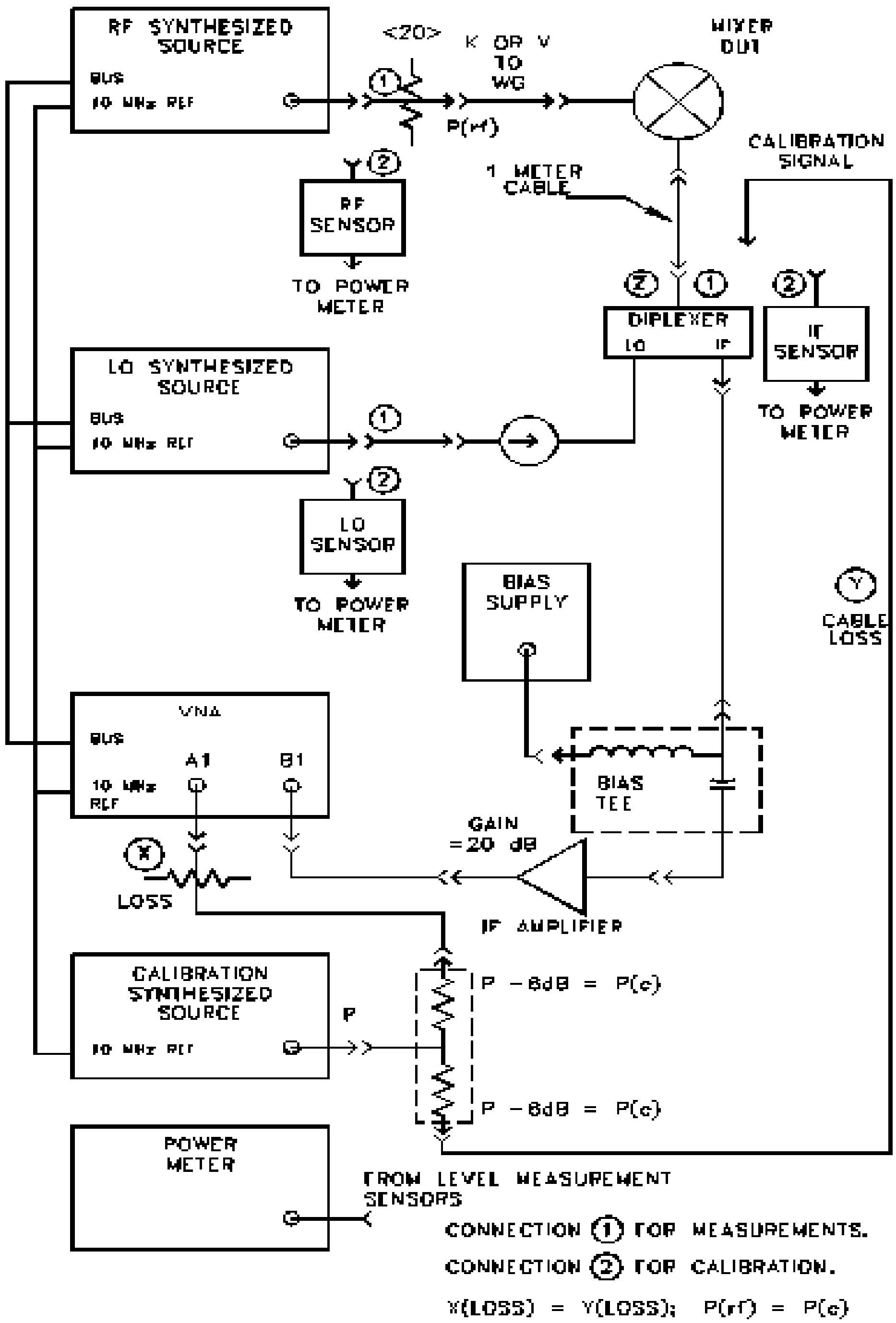
Files containing all of the R.F. and L.O. synthesizer and VNA setup information for each waveguide band for each spectrum analyzer type are maintained on the VNA hard drive. A file will include the R.F. frequency (including multiplier if needed), the L.O. frequency, multiplier and offset, and the I.F. frequency as well as power settings and all graphic display information for a given spectrum analyzer and waveguide band emulation.

The calibration source is set to -30 dBm (may change from setup to setup). All three signal sources are then measured with a calibrated power meter using the appropriate power sensor. The level of each signal source then receives any necessary adjustment to the level specified for that particular setup to ensure the accuracy of the measurement.

The calibration source is set to the mixer I.F. and its output power is split, with equal power P(c) going to the VNA A1 (reference port) and the diplexer input (Z) to calibrate the OML I.F. chain. The calibration signal power P(c) is set to the same level as the R.F. power P(rf) being applied to the mixer, typically -30 dBm. The VNA is set to display B1/A1, the ratio of the two equal calibration signal paths which is then put into memory to normalize the measurement. The mixer interconnect cable is then connected to the diplexer.

The mixer I.F. output signal, including the interconnect cable loss, at B1 is then ratioed against the stable power level of the calibration signal at A1. The resulting trace is the absolute mixer conversion loss.

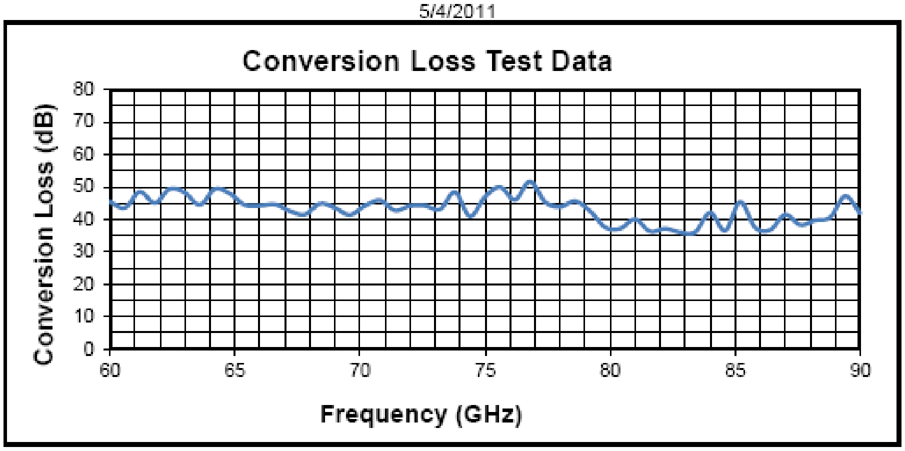
The mixer serial number and critical test setup data are annotated on the graphical test results. The response data represents 51 or more data points.



Sample Test Report

The conversion loss test results are supplied with the harmonic mixer. An example report is shown below. The highlighted text describes the designated spectrum analyzer and external mixer conditions used for the measurement. Also note that the conversion loss is provided in two formats: graphic and tabular. Both formats are generally provided using 51 data points.

Model M12HWD
Ser No. 110513-3
5/4/2011



Optimized for Agilent PSA: R.F. = -30 dBm, L.O. = (RF+IF)/16 @ 15.5 dBm, I.F. = 321.4 MHz, Bias = 6.78 mA

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Model M12HWD
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Conversion Loss Test Data

Frequency (GHz)	Conversion Loss (dB)	Frequency (GHz)	Conversion Loss (dB)	Frequency (GHz)	Conversion Loss (dB)
60.00	45.46	70.20	44.20	80.40	37.13
60.60	43.57	70.80	45.89	81.00	40.01
61.20	48.45	71.40	42.76	81.60	36.27
61.80	45.07	72.00	44.14	82.20	37.11
62.40	49.36	72.60	44.21	82.80	36.00
63.00	48.22	73.20	43.12	83.40	36.01
63.60	44.54	73.80	48.37	84.00	42.05
64.20	49.32	74.40	40.95	84.60	36.49
64.80	47.92	75.00	46.95	85.20	45.38
65.40	44.47	75.60	49.92	85.80	37.48
66.00	44.24	76.20	46.03	86.40	36.73
66.60	44.64	76.80	51.65	87.00	41.45
67.20	42.57	77.40	45.39	87.60	38.31
67.80	41.50	78.00	43.87	88.20	39.66
68.40	44.86	78.60	45.65	88.80	40.67
69.00	43.56	79.20	42.56	89.40	47.15
69.60	41.38	79.80	37.55	90.00	41.86

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Uncertainties (≤ 110 GHz)

Test conditions are stated on supplied test data to reflect external mixer conditions.

Measurement Accuracy: The "Root Sum Squares (RSS) Calibration Uncertainty" factors detailed below should be added to user's measurement data taken. All factors are (+/- dB) worst case.

Band (WR-xx)	42	28	22	19	15	12	10
Mixer Input Mismatch Loss	1.8	1.8	1.8	1.8	1.8	1.8	1.8
R.F. Signal Flatness	0.8	0.8	1.1	1.1	1.5	1.5	1.5
R.F. Power Accuracy	1.0	1.0	1.5	1.5	2.5	2.5	2.5
R. F. Attenuator Flatness	0.5	0.8	1.2	1.2	1.0	1.0	1.0
L.O. Signal Variation	0.8	0.8	0.8	0.8	0.8	0.8	0.8
I.F. Power Accuracy	0.3	0.3	0.3	0.3	0.3	0.3	0.3
VNA Log Accuracy	0.1	0.1	0.1	0.1	0.1	0.1	0.1
RSS Calibration Uncertainty	**2.5**	**2.5**	**3.0**	**3.0**	**3.7**	**3.7**	**3.7**

Uncertainties (> 110 GHz)

Test conditions are stated on supplied test data to reflect external mixer conditions.

RF power is measured using a calorimeter and is traceable to OML, Inc.

⚠ There are no power standards above 110 GHz on which to base conversion loss measurements and therefore, conversion loss measurement plot above is not traceable to any power standards and is used as an indication of operation.