Simplified Millimeter Wave Intermodulation Distortion Measurements

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Introduction

The theories and operations of intermodulation distortion (IMD) are well understood. It is one of the key metrics in categorizing the linearity of active and passive electronic components and devices. There are various instruments available from leading equipment manufacturers to perform IMD measurement in the RF and microwave region - two signal generators, a power combiner and a spectrum analyzer; a vector network analyzer with a signal generator and a power combiner. However, extending the IMD measurement to the millimeter wave and sub-millimeter wave frequency ranges is quite another matter.

Most engineers are left to devise their own millimeter wave IMD measurement setup fashioned after the two signal generators, a power combiner and a spectrum analyzer system. Often, engineers end up spending hours identifying, assembling and troubleshooting the setup before any IMD measurements can be done, and usually the IMD testing is done manually and at a few selected frequency points. With the added IMD option to the existing OML millimeter wave T/R module, IMD and swept IMD measurement have been make simple using the traditional millimeter wave vector network analyzer single-instrument single-connection configuration.

Improvised Millimeter Wave IMD Measurement System

Since there are no readily available off-the-shelf millimeter wave IMD test solutions; engineers obtain millimeter wave IMD measurements by extending the proven RF and microwave IMD measurement setup such as the two signal generators/spectrum analyzer system into the millimeter wave realm, figure 1. The challenges associated with do-it-yourself (DIY) millimeter wave IMD testing systems often are the adequate and accurate offset frequency and power control, isolation of the two signals as not to contribute or interfere with the IMD measurement, a highly linear receiver such that its IMD product does not overshadow those of the DUT and a simple method or automated method of performing multiple frequency points or swept IMD measurements.

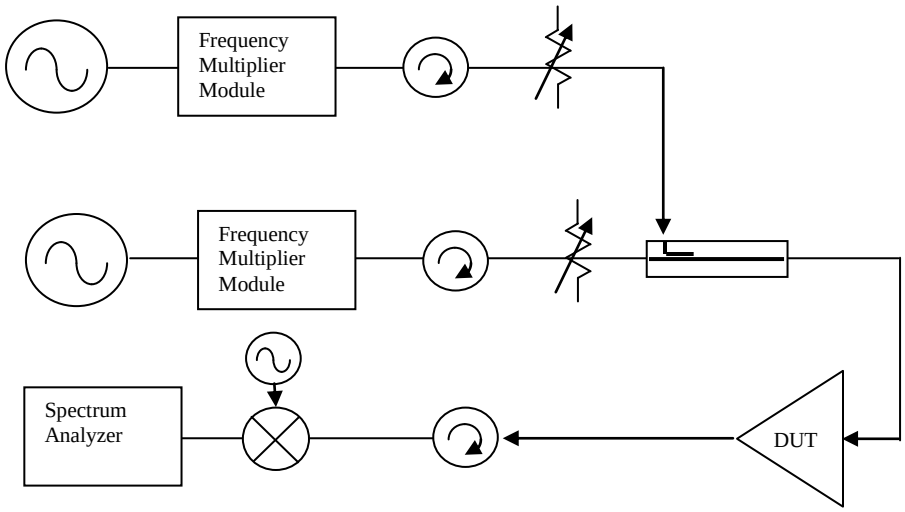

Figure 1 - Typical “DIY” Millimeter Wave IMD Measurement Block Diagram

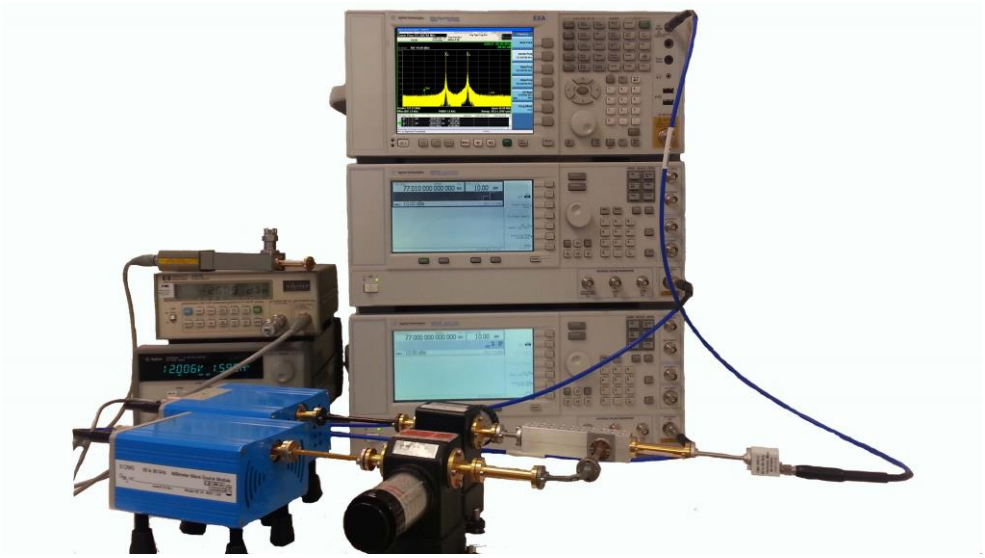

Figure 1.1 – Typical “DIY” IMD Measurement Setup

OML Millimeter Wave T/R Module with IMD Option

To provide an easy and simple IMD measurement setup in a single connection utilizing a single instrument; OML added the IMD option in its millimeter wave T/R modules. The T/R-IMD module, in conjunction with a vector network analyzer, removes the challenges associated with the do-it-yourself IMD measurement systems and allows the engineers to concentrate on qualifying and/or predicting the device/component/subsystem performances. Moreover, not only does the T/R-IMD module measurement system perform discrete frequency points and swept IMD measurements, it has the capabilities of performing S-parameter and gain compression measurements.

The IMD option adds a second millimeter wave source module and coupler into the existing T/R module. As shown in figure 2, the T/R-IMD module leverages the inherent precision, repeatability, reliability and stability of the standard T/R module. The combining coupler is positioned to minimize the impact to S-parameter measurements while offering insertion of the second signal with maximum preservation of millimeter wave power. The coupler selection ensures adequate isolation between the two signals.

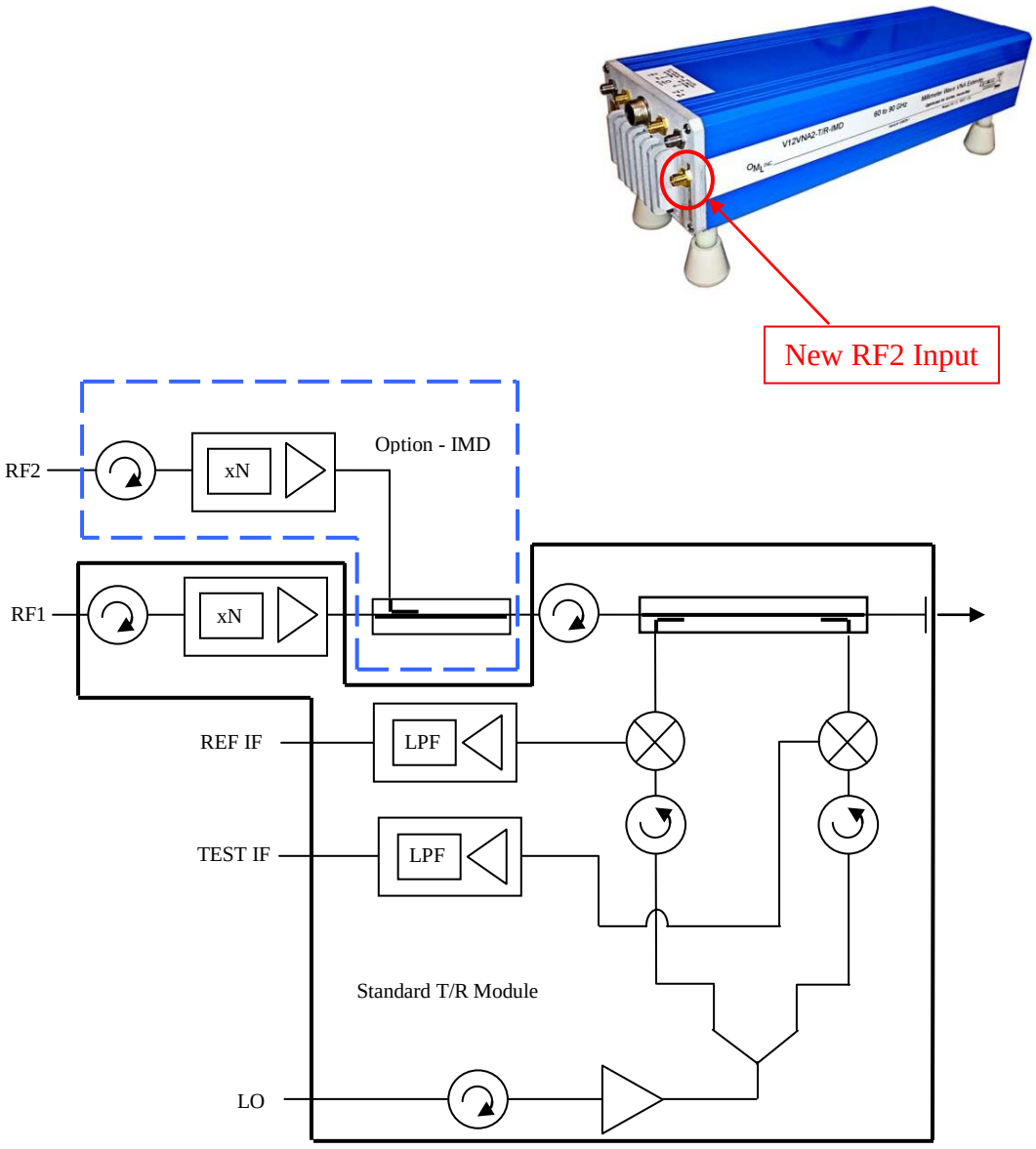

Figure 2 – OML T/R-IMD Block Diagram

Figure 2.1 depicts a single instrument IMD measurement setup. The single instrument IMD configuration consists of an OML T/R-IMD module and a T/R module connecting to an Agilent PNA-X/N5262A system. The PNA-X vector network analyzer is a 4 port, dual source with option 087 (IMD) installed. The T/R-IMD module and a T/R module are connected to the N5262A test set Port 1 and Port 2, respectively. These connections are identical to that of a normal 2 port S-parameter measurement setup. The T/R–IMD 2nd RF source is connected to Port 3 of the N5262A. Source power calibration and receiver calibration are done via the vector network analyzer. Swept IMD channel, IM spectrum and power sweep can be superimposed onto one display or into multiple displays.

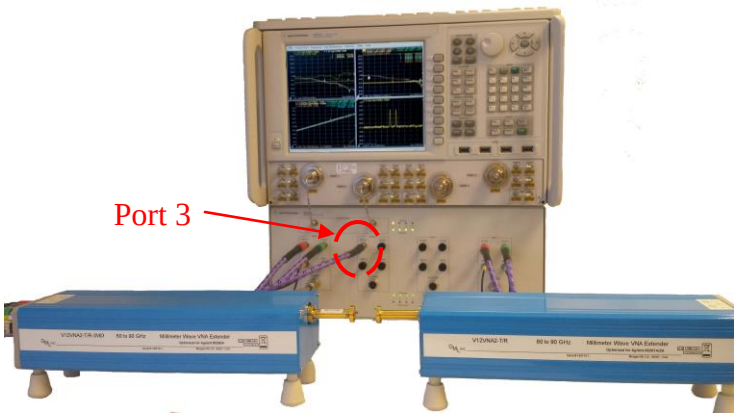

Figure 2.1 – Single Instrument Single Connection IMD Measurement Solution

The T/R-IMD module also works in a "direct-connect" millimeter wave vector network analyzer system environment. In the direct connect configuration, it only requires additional signal generator that acts as a second source, figure 3. Since the receiver in both the vector network analyzer and the spectrum analyzer are compatible with the T/R-IMD module IF output, the IMD measurement result can be shown on both system displays.

Figure 3 – Direct Connect IMD Setup

Conclusion

By integrating a second millimeter wave source and a coupler into the T/R module, the IMD measurement setup is straightforward and enables a further single connection multiple measurement scenarios.