

May 1, 1998

Subject: 1) OML Single Diode Mixers (unbalanced)
 2) OML Two Diode Mixers (balanced)
 3) OML Mixer Test Set

Oleson Microwave Labs (OML) introduced a line of single diode, unbalanced mixers covering all waveguide bands from 18 to 325 GHz in November, 1996. In February, 1997, Tektronix contacted OML regarding this type of product. Tektronix had decided to discontinue the manufacture of millimeter wave harmonic mixers including the their 782 series of mixers. Tektronix inquired as to whether they could arrange to recommend to their customers the use of the OML mixers in replacement of the Tektronix mixers. At that time, OML forwarded data and procedures to Tektronix for their examination. A short while later the Tektronix field sales force began to send customers to OML to purchase millimeter wave harmonic mixers. Your company has also ordered some of these mixers during the past year.

The OML data sheet for the unbalanced mixers did not address conversion loss, but rather specified sensitivity in the form of "equivalent average noise level" in the same manner as had Tektronix for their 490 and 780 series of mixers. Included with the OML *Millimeter Wave Mixers* data sheet is a *Test Procedure* detailing the test set up and methodology used to check the mixers functionality. A frequency vs. conversion loss plot taken with this "scalar" type test set was included with each mixer shipped. Each mixer was also tested at several different frequencies to ensure that it met the "equivalent average noise level" specification. A "Certificate of Conformance" was included with each mixer to attest to the compliance of that mixer to the OML specifications. Early versions of the OML data sheet (current revision is "J" dated 10-14-97) referred to the fact that a more advanced test set was being developed and that more specific test data would be available as an extra cost option in the future. Much work has now been completed and significant insight in the testing of these mixers has been obtained (more details be given later in this paper). As a result of these investigations, the OML single diode harmonic mixer will continue to be specified with an "equivalent average noise level" specification, conversion loss will not apply as a specification.

During the above investigations OML discovered that the manufacturer's specifications applying to the spectrum analyzer interfaces serving the harmonic mixer have been typically quite loose with considerable variation experienced from one spectrum analyzer to another for a given manufacturer and model. In previous generations of spectrum analyzer design the physical properties such as L.O. power variation across the band and the inexact manner in which adjustment was made to the bias made it virtually impossible to set up a test emulation for many of those spectrum analyzers. The single diode unbalanced harmonic mixer will become OML's utility type of mixer with use for spectrum analyzers lacking the precision interfaces for harmonic mixers and for general scientific use. A new two diode, balanced even harmonic mixer design is being phased in as OML's premium spectrum analysis mixer.

New Products

OML will begin to accept orders for two diode balanced even harmonic mixers starting June 1, 1998 (earlier if possible) for delivery scheduled 60 days later. Initially mixers will be available covering only the following bands: WR-42 (18 to 26.5 GHz), WR-28 (26.5 to 40 GHz), WR-22 (33 to 50 GHz), WR-19 (40 to 60 GHz). The design of the mixers has been completed and final characterization is in process. Additionally, OML has completed its new harmonic mixer test set with operation to 60 GHz. This new.

test set will be employed to produce final test data for each mixer where the spectrum analyzer type has been specifically indicated on the purchase order. This testing and deliverable test data will be included in the individual mixer price. In the same manner as the single diode unbalanced harmonic mixer, these new two diode balanced even harmonic mixers begin to yield best conversion loss performance when the L.O. level is above +12 dBm. The maximum L.O. input level is +17 dBm. The flattest conversion loss will occur when the L.O. is maintained at a level value, with no more variation than +/- 1.5 dB. OML testing is accomplished with +/- 0.8 dB.

Data derived from this testing will be in graphic format. The graphic data will consist of a frequency vs. conversion loss plot representing 401 data points equally spaced across the specific waveguide band. An example data sheet is attached. A tabular data option will consist of a listing of frequency vs. conversion loss. The number of tabular data points can be specified by the purchaser as: 51, 101, 201 or 401 points. The 401 point tabular data can be supplied in addition to the graphic data at no extra charge. The test set is calibrated based on the number of test points. A number of test points other than 401 will require recalibration and thus an extra charge. The test set has been designed to emulate different specific spectrum analyzers. The data sheet, either graphic or tabular, will identify the specific type of spectrum analyzer being emulated.

The following three OML emulated specification items will be specifically identified on the data sheet as there most likely will be variances from unit to unit of that type of spectrum analyzer: 1) the input test power, typically -30 dBm, 2) nominal L.O. power used, as specified by the spectrum analyzer manufacturer, 3) the specific current limited bias voltage applied (if bias is used as is the case when operating the balanced even harmonic mixer as an odd harmonic mixer or when using the single diode unbalanced mixer). The test set R.F. and L.O. sources are operated in the leveled mode with variation of less than +/- 1 dB across the band of interest. The outer limits of the variance of these two power sources will be measured and their impact will be taken into account in the "uncertainty" data along with other contributors that can be identified. One source of "uncertainty" is the cable used to connect the harmonic mixer to the spectrum analyzer. OML has selected a one meter long high quality cable manufactured by Semflex as the standard cable for the test set. A plot of the cable insertion loss and VSWR is attached. The cable part number is S119BRFSS10039. If the manufacturer plans on supplying its own cable with the mixers to their customers, the cable supplied must be equivalent in performance to this Semflex cable for the OML data to be valid. This Semflex cable is optionally available from OML. The final "uncertainty" data will be listed on the data sheet.

The test set uses a millimeter vector network analyzer (VNA) as single frequency (I.F.), calibrated power measurement receiver. The VNA processor is used for controlling a large portion of the spectrum analyzer emulation. Files on the VNA hard disk will contain the frequency range, multiplier (n), power level and step size for the R.F. and L.O. synthesizers. Such a file will be dedicated to each waveguide band for each specific spectrum analyzer to be emulated. The VNA system to be employed consists of current model Anritsu Lighting VNA's and El Toro Synthesizers. A phase locked Anritsu or HP source with excellent power stability will be used as the absolute power reference in the system. Power levels will be measured using Anritsu and HP power meters. All equipment carries current calibration.

Future Products

OML is currently developing two diode even harmonic mixers to cover the waveguide bands from 50 to 110 GHz. Until that development is completed the OML single diode mixers will be the only available product, sold subject to the conditions previously described. Two diode, even harmonic mixers covering: WR-15 (50 to 75 GHz), WR-12 (60 to 90 GHz), WR-10 (75 to 110 GHz) are scheduled to become available in the September time frame. In addition to the completion of the mixer designs, OML must finish the construction of multiplier assemblies to extend the frequency range of our current 60 GHz synthesizer. The multipliers themselves have been OML products for over four years. The element needed is the completion of a high quality R.F. signal power leveling system. OML's goal is to achieve a R.F. power flatness of +/- 1 dB over each of the above waveguide bands.

Emulation Data Base

In order to support you, the manufacturer, and your customer, certain data is needed to properly configure the OML harmonic mixer test set. OML has determined that each one of the following items must be included to achieve a credible emulation for each waveguide band. The items number shown here correspond to the number blanks on the Emulation Data Sheet: 1) L.O. frequency range, 2) nominal L.O. power, 3) L.O. equation, i.e., $= (n \pm \text{I.F.})$, 4) Does the user have choice of harmonic to be utilized? if so what are the choices?, 5) I.F. frequency, 6) Bias voltage and current range, 7) Bias source impedance (very important), 8) Is the bias indicated on the analyzers readout? in voltage or current? 9) Is the diplexer internal or external, 10) Any other specific conditions that should be observed.

Attached is a form that you are requested to complete and return by FAX. All information will be held confidential. This information is needed so that our emulation of your spectrum analyzer products will be as correct as possible. This will allow OML to support you and your customers with a device that will enhance your product. Without this manufacturer confirmed information from you OML will have to construct it's emulation based on catalog data and information gained by using the actual spectrum analyzer when one becomes available. The 1) L.O. frequency range, can usually be found in the manufacturers catalog but should be confirmed. The 2) Nominal L.O. power, is very important as the catalog data may list a minimum power specification that is significantly lower than the "in factory" or typical power level. OML cannot emulate a power characteristic that changes across the band, such as a downward slope. Our L.O. synthesizer is specified by the manufacturer to be flat +/-0.8 dB, a specification that we have found it meets through periodic verification. OML must use a single value that represents the average L.O. power output of the typical spectrum analyzer of that model, so that the data generated will be as valid as possible. The 3) L.O. equation, will give our emulation the correct multiplier number and tell us if the L.O. is above or below the R.F. Some spectrum analyzers allow the user the 4) Choice of harmonic to be utilized. If your spectrum analyzer has this feature, OML needs to know the default or preferred harmonic. Also some of your customers may want to use a more optimum harmonic over a narrow portion of the band so we need to know if your spectrum analyzer allows this. OML must know the 5) I.F. frequency, for it's emulation. The adjustment limits of your spectrum analyzers 6) Bias voltage and current must be known. For OML to provide correct bias information to the customer 7) The bias power supply source (current limiting) impedance, must be emulated in our system. The use of a single "common" bias source impedance

has developed incorrect data. Only the very recent models of spectrum analyzers have included a 8) Readout of bias voltage (current). If such a feature is included in your spectrum analyzer, the OML test condition bias voltage as listed on the data sheet will directly usable by your customer. Most readouts have been in voltage, is yours in voltage or current? Whether your spectrum analyzer has an 9) Internal diplexer or needs an external diplexer, is relevant only in that it enables OML to bring to the customers attention that an external diplexer may be needed. OML has developed diplexer kits which are listed in the OML *Millimeter Wave Mixers* data sheet. If there is any other 10) Pertinent data, that would improve the quality of the OML emulation please provide it. OML requests that your company provide copies of all data sheets or catalogs covering your current spectrum analyzer capable of supporting external millimeter wave harmonic mixers.

Price and Delivery

Price and delivery quotations for WR-42, WR-28, WR-22, and WR-19 mixers are available at this time. The quoted prices will include the testing outlined above. Orders will not be accepted until the requested spectrum analyzer emulation data has been received. The quote will not include the test cable unless so requested. OML desires to support the manufacturers effort in every manner possible. Please do not hesitate to contact us with any questions that you might have.

For a quote or with questions from outside of the United States, please contact:

Radar Systems Technology Tel # 650 969 5534 FAX # 650 969 7078.

10/8/99

Oleson Microwave Labs Spectrum Analyzer Emulation Data Sheet

Manufacturer _____ Spectrum Analyzer Model Number _____

1) Overall harmonic mixer L.O. frequency range available _____

2) Typical L.O. power available _____ Specified L.O. power _____

3) L.O. Equation: WR-42 _____ WR-28 _____ WR-22 _____

(as preset)

WR-19 _____ WR-15 _____ WR-12 _____

WR-10 _____ WR-08 _____ WR-06 _____

WR-05 _____ WR-04 _____ WR-03 _____

4) L.O. Harmonic: WR-42 _____ WR-28 _____ WR-22 _____ WR-19 _____ WR-15 _____ WR-12 _____

(if optional)

WR-10 _____ WR-08 _____ WR-06 _____ WR-05 _____ WR-04 _____ WR-03 _____

5) Harmonic Mixer I.F. Frequency (ies) _____

6) Bias voltage range available _____ Bias current range available _____

7) Bias power supply source impedance _____

8) Bias readout on the display Yes _____ No _____ In voltage or current? _____

9) Internal or External diplexing _____

10) Other information

Engineering contact Tel. # _____ FAX # _____

Other contact: Tel. # _____ FAX # _____

All data will be kept as "Company Confidential" if requested.