MICROWAVE AND MILLIMETER-WAVE CONVERSION PRODUCTS

Specification Definitions

- MIXERS
- IMAGE REJECTION MIXERS
- MODULATORS
- MULTIPLIERS
- CUSTOM PRODUCTS

MITEQ
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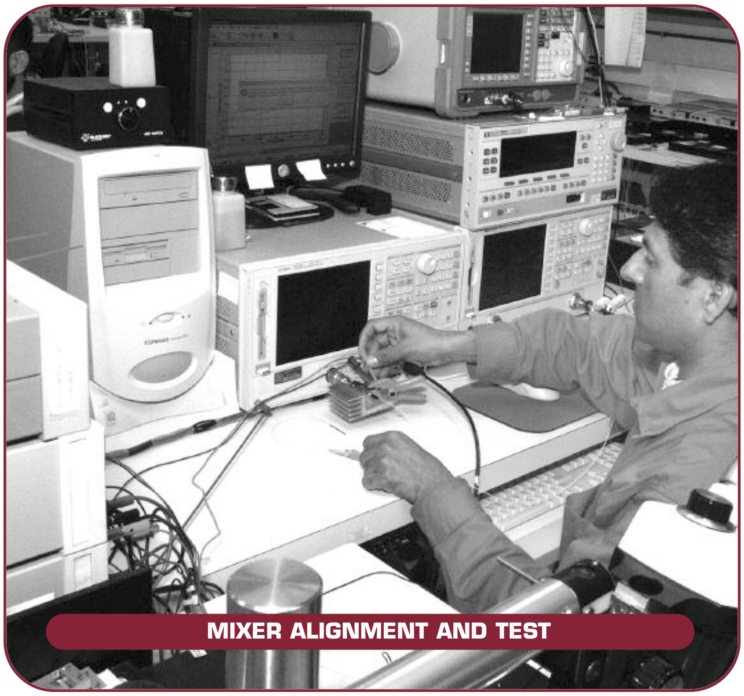
SPECIFICATION DEFINITIONS

GENERAL SPECIFICATIONS

Most models defined within this catalog are classified by several specifications, namely:

- Operating frequency range
- Output power at 1 dB compression
- Conversion loss
- Noise figure
- Input and output VSWR
- DC supply voltage and current consumption

Most of the specifications for the MITEQ mixers listed in this catalog are based on operation at normal room ambient conditions of 25°C. For mixer requirements at other temperatures and environments, please contact MITEQ or your local representative.



MIXER ALIGNMENT AND TEST

OPERATING FREQUENCY RANGE

The operating frequency range is the range of frequencies over which the mixer will meet or exceed the specification parameters. The mixer may perform beyond this frequency range, and in cases where the mixer is specified over less than an octave, the actual frequency response may be significantly greater than the specified operating frequency range.

CONVERSION LOSS

The ratio of RF input power to the IF output power of one sideband (either $F_{LO} - F_{RF}$ or $F_{LO} + F_{RF}$).

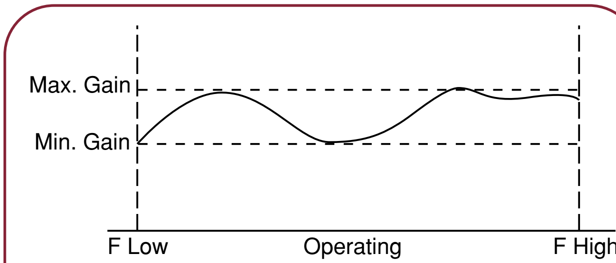
GAIN

Gain is defined as the ratio of the power measured at the output of a mixer/amplifier to the power provided to the input port. It is usually expressed in decibels and is typically measured in a swept fashion across the operating frequency range. Unless specified, 100% test data supplied by MITEQ will include gain data taken at several points within the band; however, in all cases, the mixer/amplifier gain has been measured in a swept fashion with performance verified over the entire frequency band.

GAIN FLATNESS

Gain flatness describes the variation in a mixer/amplifier's gain over the operating frequency range at any fixed temperature within the operating temperature range. As such, it does not include the variation of gain as a function of temperature (see Gain Variation vs. Temperature).

The gain flatness of a mixer/amplifier is measured by viewing the swept gain and determining the difference between the minimum gain and the maximum gain recorded over the operating frequency range. Unless the mixer/amplifier is specified to operate over a defined temperature range, this measurement is performed at room ambient temperature (25°C). If a range of temperatures is specified, the measurement must also be verified at the temperature extremes.



$$\textbf{GAIN FLATNESS} = \pm \frac{(\text{Max. Gain} - \text{Min. Gain})}{2}$$

NOISE FIGURE

Noise figure is classically defined as:

$$\text{Noise figure} = \frac{S_i/N_i}{S_o/N_o} = \frac{\text{Signal-to-noise ratio at the amplifier input}}{\text{Signal-to-noise ratio at the amplifier output}}$$

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SPECIFICATION DEFINITIONS (CONT.)

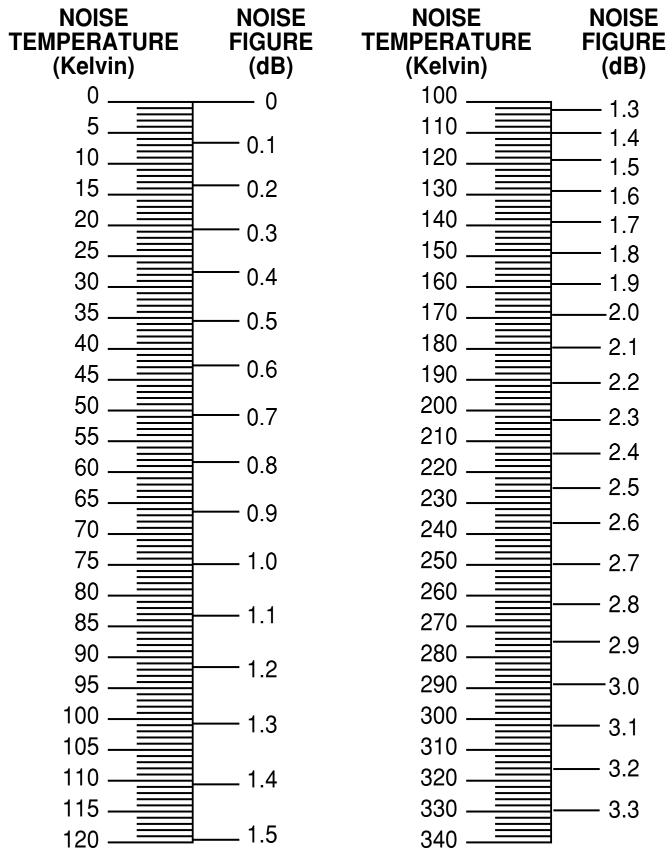
Since all amplifiers add thermal noise, the signal-to-noise ratio at the output will be degraded. Therefore, the noise figure will be a ratio greater than one, or when expressed in decibels, a positive number i.e. NF dB = 10 Log_{10} (NF Ratio). The additive noise of an amplifier can also be expressed in a parameter referred to as noise temperature. In this approach, the noise temperature of the amplifier is equal to the temperature (in Kelvin) of a 50 ohm termination at the input of an ideal noiseless amplifier with the same gain and generating the same output noise power.

The relationship between noise figure and noise temperature is :

$$\text{Noise Figure} = 10\ \text{Log}_{10} \left\{ \frac{\text{Noise Temp. (K)}}{290\ \text{K}} + 1 \right\}$$

Noise figure data is measured at discrete frequencies throughout the band. Test data is supplied at +25°C unless specified otherwise.

NOISE FIGURE CHART



NOISE FIGURE VERSUS NOISE TEMPERATURE

INPUT POWER AT 1 dB COMPRESSION

The 1 dB input compression point of a mixer is simply defined as the input power level at which the conversion loss increases by 1 dB.

VSWR

Most RF and microwave systems are designed around a 50 ohm impedance system. A mixer impedance is designed to be as close as possible to 50 ohms; however, this is not always possible, especially when attempting to simultaneously achieve a good noise figure. The Voltage Standing Wave Radio (VSWR) is a measure of a mixer's actual impedance (Z) with respect to the desired impedance (Zo), in most cases 50 ohms.

The VSWR is derived from the reflection coefficient Γ, where Γ is a ratio of the normalized impedance:

$$\Gamma = \frac{Z - Zo}{Z + Zo}$$

and:

$$\text{VSWR} = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

VSWR is "measured" with either a scalar or vector network analyzer. The reflection coefficients are determined by comparing the incident power and the reflected power at all ports of the device which in turn are converted and displayed as VSWR. The ratio of the reflected power to the incident power is also known as the return loss.

DC SUPPLY VOLTAGE AND CURRENT CONSUMPTION

Mixer/amplifiers, being active devices, require DC power supplies for their operation. MITEQ's mixer/amplifiers typically require 15 volts and include an internal voltage regulator. The use of a regulator allows for specification compliant operation even in the presence of power supply voltage variations, as long as minimum voltage supplied is greater than the specified drop-out voltage of the regulator. MITEQ also includes reverse voltage protection diodes on the DC line to prevent damage due to the application of a negative voltage.

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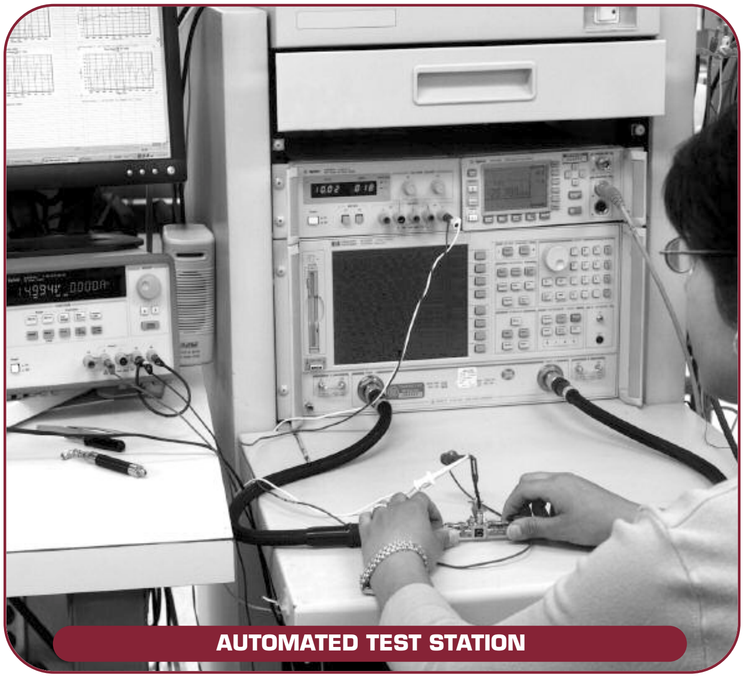
SPECIFICATION DEFINITIONS (CONT.)

ADDITIONAL SPECIFICATIONS

In addition to the electrical specifications for most of the models within this catalog, there are additional specifications useful to the engineer designing around stringent system requirements:

- Gain variation vs. temperature
- Overall gain window
- Intercept point
- Dynamic range
- Harmonic suppression
- Reverse isolation
- Phase and amplitude matching and tracking
- Phase linearity
- Recovery from saturation

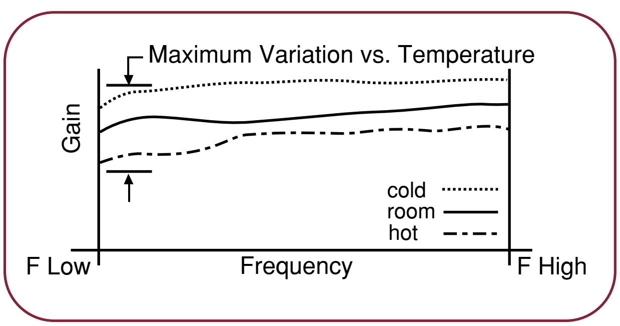


AUTOMATED TEST STATION

GAIN VARIATION VS. TEMPERATURE

Gain variation versus temperature defines the maximum allowable variation of the linear gain due to temperature at any discrete frequency. As a result, this parameter does not account for drift over frequency.

Gain variation versus temperature is measured by performing swept gain measurements at the specified temperature extremes and comparing the deviations between the two sweeps at each frequency to determine the greatest change. When a ± value is used, then the delta is taken at both temperature extremes with respect to room temperature (25°C).



TWO-TONE INTERMODULATION PRODUCTS

Undesired mixer output products caused by the simultaneous presence of two RF input signals (third order IM consists of $[(2F_{RF1} \pm F_{RF2}) \pm (F_{LO})]$ and $[(F_{RF1} \pm 2F_{RF2}) \pm (F_{LO})]$.

DYNAMIC RANGE

Dynamic range can be defined in several ways. The two classical methods are to define the linear dynamic range and the spurious free dynamic range.

The linear dynamic range defines the difference between the Minimum Detectable Signal (MDS), referred to the input of the mixer or receiver and the maximum signal level at which the device remains linear. This is typically defined by the input 1 dB compression point (P_{IN} 1 dB). The minimum detectable signal is defined by system constraints, such as noise figure, bandwidth and predetection signal-to-noise ratio.

Spurious free dynamic range is defined as the difference between the minimum detectable signal and the point at which the intermodulation signals generated from two equal tones would either equal this MDS or some other acceptable level. The dynamic range can be easily derived by the following relationship:

$$\text{Two-tone spurious free dynamic range} = (2/3)\,(IP^3{}_{INPUT} - MDS)$$

$$MDS\ (dBm) = -114 + 10\ Log_{10}\ (BW\ in\ MHz) + N.F. + SNR$$

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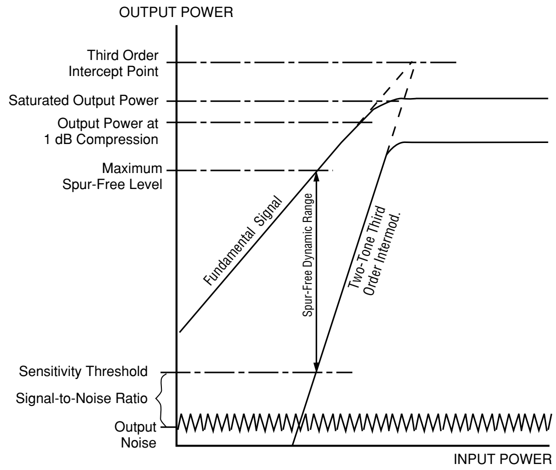
SPECIFICATION DEFINITIONS (CONT.)



DYNAMIC RANGE AND INTERCEPT POINT

ISOLATION

The amount of input signal is attenuated when measured at another mixer port.

PHASE MATCHING

Phase matching, in the strict sense, is defined as the difference in insertion phase between any two or more units. This parameter is usually defined across the operating frequency band, however, in some cases it is defined over frequency segments (F) within the overall operating band.

In the case of the definition over the entire band, the insertion phase is measured by means of a vector network analyzer, stepped across the band. The values at each frequency for two units are subtracted to provide a delta plot across frequency. Since each system has its own peculiarities, there are a wide variety of variations of this definition. Therefore, if your system requirements are such that this definition does not accurately meet your needs, or if this level of definition exceeds your real need and results in higher cost, you should contact MITEQ's engineering staff to discuss the most cost effective options.

PHASE TRACKING

Phase tracking is very similar to phase matching. However, an arbitrary fixed offset exists between the units that can usually be compensated by the system software. The offset, sometimes referred to as the DC component (because all that remains is the phase versus frequency ripple and slope), is calculated at each temperature based upon an average over the band. As with phase matching, there are many variations on this theme that also should be discussed with MITEQ's engineering before committing to a final specification.

AMPLITUDE MATCHING

Same as phase matching, except substitute gain for phase.

AMPLITUDE TRACKING

Same as phase tracking, except substitute gain for phase.

HARMONIC INTERMODULATION PRODUCTS

Mixer output signals other than the desired $F_{LO} \pm F_{RF}$, which are harmonically related to either or both of the input signals (also termed $N_{RF} + M_{LO}$, N x M or "spurs").

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