Mini-Circuits
Modern Mixer Terms Defined

Statistical Processing

Today's stringent demands for precise electronic systems places a heavy burden on circuit and systems design engineers. Mini-Circuits provides the most comprehensive database for its RF/MW signal-processing components with its exclusive computer-automated performance data or CAPD and its specification charts which include X and sigma values.

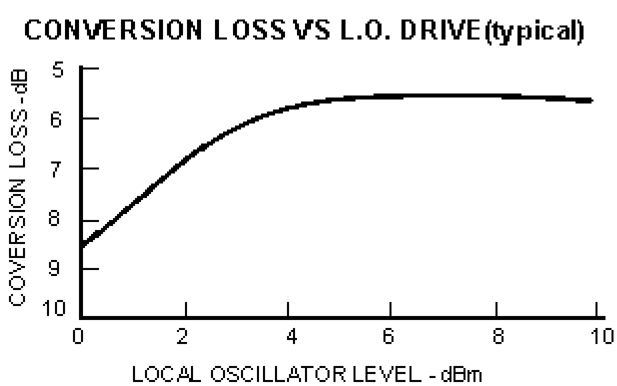
Statistical process control combined with the most modern automated production and test equipment are responsible for Mini-Circuits exclusive 5-year guarantee on mixers along with guaranteed 4.5 sigma, which basically means only four units in a million-lot production run approach the spec limit. For a full explanation of statistical process control terms such as X, (average value of a group of samples), sigma (standard deviation unit), Cp (process capability), and Cpk (modified process capability factor), please refer to "Statistical Processing" in the General section, see Table of Contents for page number.

Conversion Loss

Conversion loss is a measure of the efficiency of the mixer in providing frequency translation between the input RF signal and the output IF signal. For a given frequency translation, two equal output signals are produced, a lower sideband and an upper sideband signal. Since only one sideband is generally of value, the specifications given in this handbook are for a single sideband output. If two sidebands are useful, then the conversion loss is 3 dB lower than in the single sideband case.

Conversion loss of a mixer is equal to the ratio of the IF single sideband output to the RF input level. All measurements are based on a 50 ohm system and with a local oscillator level specified in accordance with the appropriate mixer type. For example, level 7, +7 dBm; level 17, +17 dBm; and level 23, +23 dBm.

When the local oscillator power level deviates from the recommended level, the conversion loss will change slightly.



Conversion Compression

Conversion compression is a measure of the maximum RF input signal for which the mixer will provide linear operation. Normally, the IF output signal level is equal to a constant ratio of RF input signal level. However, when the RF signal level is within 10 dB of the LO drive level, the constant ratio between IF and RF levels will exhibit a change of about 0.1 dB. As the RF level increases further, there will be a greater change in the constant ratio. The conversion loss will increase as the RF input level increases. The IF output level does not exactly follow the increase in RF input level.

The criteria used to describe the deviation from linearity between the RF input level and the IF output level is a fixed amount of compression. Mini-Circuits specifies the 1 dB compression point. Naturally, if a higher compression point were selected, the corresponding RF input level would be higher.

Conversion compression provides an indication of the mixer two-tone performance. The compression point is useful when selecting a mixer for maximum linear operation. The compression point will change as a function of LO drive level. Therefore it is meaningful to specify the actual LO drive level when discussing the compression point.

Conversion loss desensitization is a measure of the non linearity caused by an unwanted RF signal at the mixer input. When the undesired RF input level causes the mixer conversion loss to increase by 1 dB, for the desired low-level RF input signal, then the 1 dB desensitization level is reached and the maximum undesired RF input level is defined.

Isolation

Isolation is a measure of the circuit balance within the mixer. When the isolation is high, the amount of "leakage"or "feed thru" between the mixer ports will be very small. Typically, Mini-Circuit's mixer isolation falls off with frequency due to the unbalance in the transformer, lead inductance, and capacitive unbalance between diodes. Generally, at the highest frequency of operation, Mini-Circuits' mixers provide isolation of 30 dB.

The L to R isolation is the amount the LO drive level is attenuated when it is measured at the RF port; the IF port is terminated with 50 ohms. The L to I isolation is the amount the LO drive level is attenuated when it is measured at the IF port; the RF port is terminated with 50 ohms. Normally, only the LO isolation is specified since for RF isolation the RF signal power is much lower than the LO drive level; therefore, RF leakage is usually not a problem.

Dynamic Range

Dynamic range is the power range over which a mixer provides useful operation. The upper limit of the dynamic range is limited by the conversion compression point. The lower limit of the dynamic range is limited by the noise figure of the mixer. Since the mixer noise figure is only about 0.5 dB higher than its conversion loss, the lowest conversion loss is desirable to obtain the largest dynamic range.

DC Polarity

DC polarity defines the polarity of the IF voltage output when the mixer is used as a phase detector. Normally, the RF and LO signals are in phase, 0^o, and are of equal amplitude. Mini-Circuits' mixers provide a negative polarity except where noted.

DC Offset

DC offset is a measure of the unbalance of the mixer. For an ideal mixer, the DC offset is zero. DC offset defines the IF voltage output when the mixer is used as a phase detector and only the LO signal is applied, the RF-port is terminated in 50 ohms.

two-tone third order intermodulation distortion

This distortion term describes the degree by which the mixer conversion loss is non-linear. The two-tone third order distortion term is the amount of signal level at the IF output generated as a result of a third order frequency term. One frequency term corresponding to third order is (2f R2 - f R1) ± fL, where f R represents the RF input signal and fL represents the LO drive.

Normally, this parameter is not specified on the data sheet because it is dependent upon frequencies, terminating impedances, and levels.

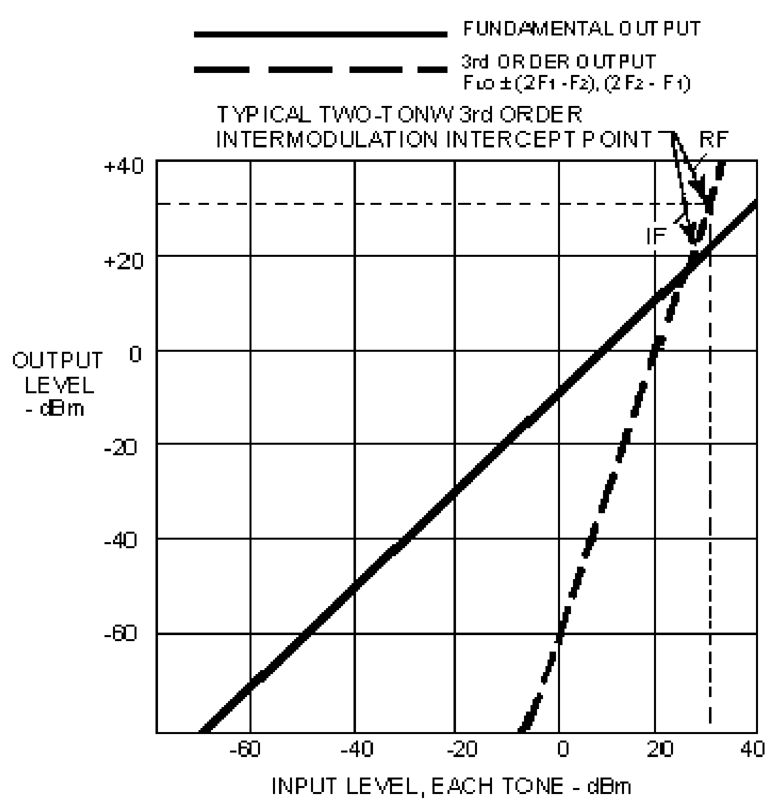
Intercept Point

Two-tone third-order intermodulation distortion is a measure of the third-order products generated by a second input signal arriving at the R port of a mixer along with the desired signal. A popular method of determining the suppression capability of a mixer is the "third-order intercept" approach. The third-order intercept point is a theoretical point on the RF input versus IF output curve where the desired input signal and third-order products become equal in amplitude as RF input is raised.

A convenient way to describe intermodulation products relative to input signal level is to state the relative difference between the two in dB; for example, a mixer may be specified as 60 dB down for two 20 dBm input signals. This means the mixer, with two-20 dBm signals as its input, will suppress third-order products by 60 dB. Now if the input level is reduced an additional 10 dB, the third-order product level would decrease by a factor of three, or 30 dB. The difference between the two would be 20 dB and thus, the mixer would offer 80 dB suppression with two -30 dBm signals at its input. With another 10 dB drop in signal level, third-order products would drop another 30 dB with a difference of 20 dB between the two. Thus, two -40 dBm signals would produce third order products suppressed by 100 dB. When will the two types of signal (input and third-order) theoretically become equal? The original input levels were -20 dBm and thus, the third-order products were 60 dB lower, or -80 dBm. Now if the input is raised 30 dB to +10 dBm, the third-order products would be increased by a factor of three or 90 dB; a 90 dB increase added to the original -80 dBm or +10 dBm, thus establishing equal amplitude for the desired and distorted signals.

Graphically, the intercept point is obtained by linearly extending the desired signal curve past the compression point until it intersects the third order curve.

A rule-of-a-thumb method for determining the intermod level is as follows: (1) find the 1 dB compression level (this is the RF input power level that caused the conversion loss to increase by 1 dB). (2) determine the intercept point. At the low end of the frequency range, this point is about 15 dB above the 1 dB compression point. As the mid to upper frequency range is approached, the intercept point drops to about 10 dB above the 1 dB compression point. (3) Multiply the difference between the intercept point and RF input level (equal RF levels) by the order of harmonic. (4) Subtract this number from the intercept point. This is the intermod level. For example: given a) 1 dB compression point at RF input of +1 dBm. b) RF input level -10 dBm, RF at low end of range. c) what is third-order intermod level? Solution: (1) Compression point is +1 dBm. (2) Intercept point equals 1 dBm +15 dBm = +16 dBm. (3) +16 dBm-(-10 dBm) equals +26 dBm. 26 dBm times third-order= +78 dBm (4) Intermod level equals +16 dBm -78 dBm = -62 dBm.



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