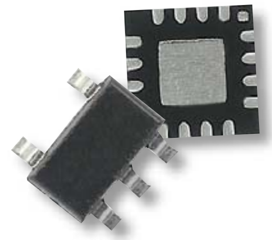
Key Parameters for Choosing Mixers



What to look for when choosing a mixer for your requirements.

MIXER MANUFACTURERS:

- Aeroflex
- Analog Devices
- Anaren Microwave Inc.
- ES Microwave
- Mini-Circuits
- Miteq, Inc.
- Mouse Electronics
- Pasternack Enterprises
- Peregrine Semiconductor
- Pulsar Microwave Corp.
- Richardson Electronics
- Sirenza Microdevices
- Spacek Labs Inc.
- Synergy Microwave
- Teledyne Cougar
- Teletronics International
- WJ Communications, Inc.

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Mixer Products are the backbone of frequency conversion in communication and radar applications. As such, an understanding of relationship between mixer parameters, performance and cost is crucial to the designer of these applications. The following is a list of the six mixer parameters that most accurately depict the application requirements. This is followed by a brief description of four general mixer types with advantages and disadvantages of each type.

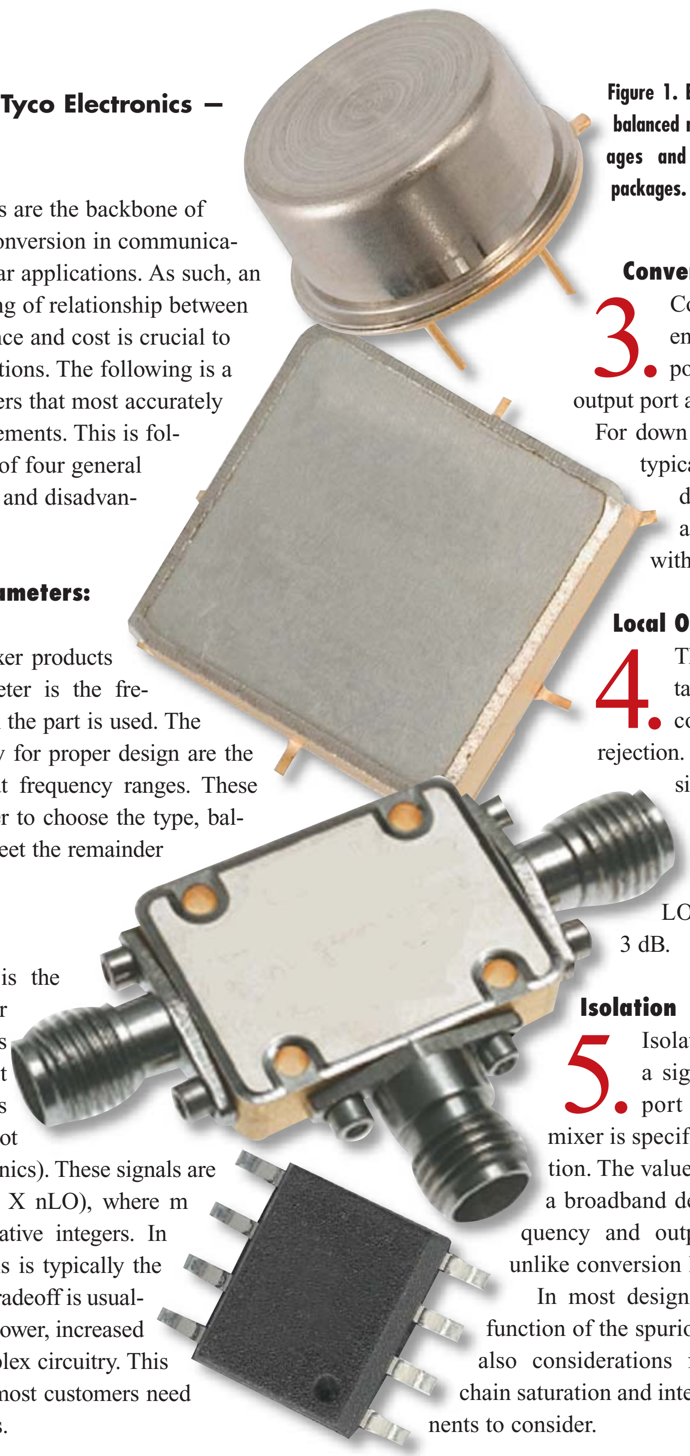

Figure 1. Examples of single, double and triple balanced mixers including hermetic metal packages and low cost plastic surface mount packages.

Six Important Mixer Parameters: Frequency Plan

1. When specifying mixer products an important parameter is the frequency plan in which the part is used. The parameters that are necessary for proper design are the LO, RF input and IF output frequency ranges. These parameters allow the designer to choose the type, balance/filter requirements to meet the remainder of the requirements.

Spurious Rejection

2. Spurious rejection is the difference in power of undesired signals to the desired signals. In most cases, these signals are less than the desired signals but not always (i.e. LO and its harmonics). These signals are usually designated by (mRF X nLO), where m and n are positive and negative integers. In broadband mixer circuits, this is typically the most critical parameter. The tradeoff is usually spurious rejection vs. LO power, increased insertion loss and more complex circuitry. This tradeoff is the question that most customers need to discuss with their suppliers.

Conversion Loss

3. Conversion Loss is the difference of power from the input port at the input frequency to the output port at the desired output frequency. For down converters, conversion loss is typically in the 5 to 8 dB range, depending on type, bandwidth and nonlinear element utilized within the mixer.

Local Oscillator Power Range

4. The LO power range is important for optimization of both the conversion loss and spurious rejection. Too little power causes conversion loss and spurious problems. Too much power results in LO leakage issues. Most standard parts will have an operational LO power range of 3 dB.

Isolation

5. Isolation is the power difference of a signal from one port to another port of the mixer. Typically, a mixer is specified for L-I, L-R and R-I isolation. The values are typically 15 to 20 dB for a broadband design. Note that the input frequency and output frequency are the same unlike conversion loss.

In most designs, the isolation required is a function of the spurious requirements, but there are also considerations for LO frequency radiation, chain saturation and inter-modulation in linear components to consider.

Input P1dB, IIP2 and IIP3

5. The input P1dB, IIP2 and IIP3 are related nonlinearities in a mixer circuit. The values specified are a function of LO power. Typically for a medium power mixer (LO=+10dBm), the performance would be +4, +24 and +14dBm for input P1dB, IIP2 and IIP3 respectively.

Four Basic Types of Mixers

The type of design required is usually determined by the electrical requirements. Some brief descriptions, strengths and weaknesses of each type are given below. The types are listed from lowest to highest complexity (i.e. lowest to highest cost). The nonlinear element can be any nonlinear element such as a diode or transistor.

Single Nonlinear Element Mixer

1. The simplest mixer is single nonlinear element without any baluns (balanced to unbalanced circuits). This type of mixer has no inherent isolation or spurious rejection, but does have the lowest conversion loss and complexity. Any spurious rejection or isolation is accomplished with external filtering.

Single Balanced Mixer

2. The second type of mixer is a single balanced configuration. This circuit is realized by using two nonlinear elements and a balun hybrid, which is either a 180 or 90 degree configuration. This circuit will provide some isolation and spurious suppression with minimal added complexity. The down side is the need for 3dB more LO power.

Double Balanced Mixer

3. The third type is a double balanced mixer. This configuration uses four nonlinear elements and two baluns, which are always 180 degree designs. This design provides improved isolation and much improved spurious rejection, but requires an additional 6 dB of LO power from the single nonlinear element approach and the complexity has increased to moderate.

Triple Balanced Mixer

4. The fourth type is a triple balanced mixer (sometimes called a double-double balanced mixer). In this design, there are now eight nonlinear elements and three balun circuits. This configuration is the best performer for isolation and spurious rejection and allows the IF frequency to overlap with the LO and RF frequencies. This is a quality not possible in the other three types with the exception of mixers with the ferrite core transformer baluns (limited to below 2 GHz). On the down side, 9 dB more LO power is required from the single nonlinear element approach and considerable complexity is present.

Conclusion

System designers need to know the six parameters described above. From this information, the feasibility of a design may be determined. The four mixer types described can be integrated into more complex subassemblies to help with noise figure, I/Q balance and isolation issues, but the basic mixing requirements are met by these four types.

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For additional information, please visit www.macom.com/mixers.