Mixer Evolution, The Balanced Mixer Family Circle

The balanced mixer family is made up of mixers that use in-phase and 180 degree out-of-phase power dividers in some combination. A balanced mixer out-phases or cancels certain intermodulation products between the LO and the RF signal inputs. These are the mixers most commonly offered.

The first member of the mixer family is the one-diode or single ended mixer. This mixer or diode is present in all mixers and provides the basic mixing process of spreading the input signal's energy in the frequency domain. All non-linear elements will do the same to some degree. The non-linear element used in most mixers is the Schottky-barrier mixer diode.

The subsequent members of the family are balanced mixers. Balancing is the same as out-phasing signals to create a reactive cancellation. This is accomplished with a channelization technique using phase-correlating power dividers of zero and 180 degree type. Consequently all multiple-diode-type mixers are channelized mixers. The number of diodes alone does not determine if the mixer is balanced; single balanced or double balanced. Mixer balance is the measure of cancellation of single-tone intermodulation products between the LO and RF signals. If the single diode mixer generates 100 percent of the intermodulation products, the single balanced mixer will reduce this to 50 percent, and the double balanced mixer will further reduce it to a 25 percent intermodulation content as viewed at the mixer's output (IF port).

There are two ways to make the simplest single balanced mixers. Both involve the use of baluns, the 180 degree reactive (no isolation between the two output ports) power dividers; and some form of an in-phase reactive power divider. The only significant difference between these two single balanced mixers is the way in-phase power division is accomplished. Single balanced mixers are the basic building blocks of the double balanced mixers. The difference between the two basic branches of the family of single/double balanced mixers is the way the in-phase power division is provided. Branch "A" of the family (Fig. 1), uses an in-phase power divider that first divides the signal input into two channels and then recombines the signals at the junction of the two diodes. Branch "B" of the family guides the signal input directly into the junction of the two diodes and provides two separate ground return paths for the signal. No significant performance difference will result from using the "A" type single balanced mixer or the "B" type single balanced mixer. Only the physical construction will dictate the use of one or the other type. The physical construction, then, is an important element in determining the total mixer performance, for it contains filter networks that basically provide the frequency

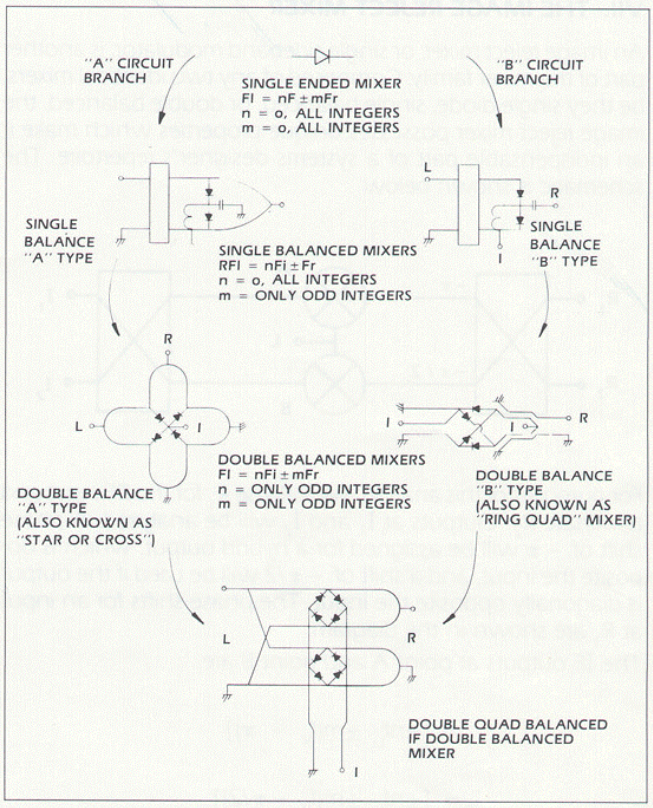

Figure 1. Balanced mixer family circle.

domain boundary conditions for the diodes.

The branch "'A" double balanced mixer is made by taking two "'A" type single balanced mixers and connecting them at the junction of their respective diodes, forming a four-diode junction, two diodes pointing into and two diodes pointing out of the junction. This type of double balanced mixer is also known as the "star" or "cross" mixer.

The branch "'B" double balanced mixer is built by taking two "'B" type single balanced mixers and connecting them at the diode ends where the baluns are found. The two baluns become one which serves both diode pairs. However, to make the mixer double balanced, one pair of diodes must be rotated so that the four diodes form a ring (Fig. 1). This is the well-known ring quad. If one pair of diodes is not rotated, a bridge quad is formed; which is also known as a full wave rectifier quad. The mixer thus created is a single balanced mixer having two channels and a balanced IF port. This bridge mixer has many useful applications that include a biasable wideband mixer. A new balun is created in the construction of both "'A" and "'B" type double balanced mixers. The minimum number of baluns necesary to make a double balanced mixer is two. Note that the bridge-type mixer actually has three baluns, but it is no more than a single balanced mixer. There are no significant differences between the "A" and "B" type double balanced mixers.