An ***RF Isolator*** is a two-port ferromagnetic passive device which is used to protect other RF components from excessive signal reflection. Isolators are common place in laboratory applications to separate a device under test (DUT) from sensitive signal sources. An ***RF Circulator*** is a three-port ferromagnetic passive device used to control the direction of signal flow in a circuit and is a very effective, low-cost alternative to expensive cavity duplexers in base station and in-building mesh networks. Examples of both applications will be covered later in this article.

To understand how these components control the signal flow, think of a cup of water into which you place a spoon and stir in a clockwise motion. If you sprinkle some pepper into the cup and continue to stir, you will notice that the pepper easily follows the circular motion of the water. You can also see that it would be impossible for the pepper to move in a counterclockwise direction because the water motion is just too strong. The interaction of the magnetic field to the ferrite material inside isolators and circulators creates magnetic fields similar to the water flow in the cup. The rotary field is very strong and will cause any RF/microwave signals in the frequency band of interest at one port to follow the magnetic flow to the adjacent port and not in the opposite direction.

Isolation

An important consideration when specifying an isolator or circulator is to ensure the device has adequate isolation for your given application. Isolation is a unit of measure (in dB) that states the separation of signal levels on adjacent ports of a device. The greater the isolation value, the less interference from a signal on one port is present at the other. The amount of isolation is directly affected by the VSWR presented at port 3 of the isolator. If the match on port 3 is poor, you can expected isolation below 10 dB, but if the match is improved to 1.10:1 by using a good termination device in the circuit, then the isolation would improve to over 20 dB.

Insertion Loss

Another important consideration when specifying circulators and isolators is to ensure the device has minimal insertion loss when inserted in a transmission path. Generally, the insertion loss of a circulator/isolator (or any microwave device for that matter) becomes more significant at higher frequency, namely because loss increases with frequency and higher frequency power sources are considerably more expensive. Accordingly, the criteria of low insertion loss will prevent precious power from being wasted.

Common Applications

As described earlier, a common application for a circulator is as an inexpensive duplexer (a transmitter and receiver sharing one antenna). When the transmitter sends a signal, the output goes directly to the antenna port and is isolated from

the receiver. Good isolation is key to ensure that a high-power transmitter output signal does not get back the receiver front end as is governed by the return loss of the antenna. In this configuration, all signals from the antenna go straight to the receiver and not the transmitter because of the circular signal flow (remember the cup of water).

Power Ratings

Most isolators are designed with an internal 10w load capability. However, the recommended maximum power that our devices can sustain is 2w to allow for de-rating and heat transfer. Higher isolator power levels can be achieved utilizing our circulators with an external load which would make the limiting factor the ferrite material and not an internal resistor. As previously outlined, if the match on the terminated port is poor, you can expect isolation below 10 dB, but if the match is improved to 1.10:1 by using a good termination device in the circuit, then the isolation would improve to over 20 dB.

Special Handling & Storage

Isolators and circulators have magnets that produce strong fields to control signal flow. As is the case with any magnet, when placed in close proximity to another, the magnetic fields oppose one another, and over time, will weaken the strength of the magnets. This is called degaussing. A similar effect can be seen when stored in close proximity to ferrous metals. Special care should be taken when storing any isolators/circulators and we recommend that the devices should be separated by 3 inches from each other and all ferrous surfaces to reduce degaussing effects.