Introduction to Isolators & Circulators

Ferrite Circulator

This description assumes a coaxial device but the explanation for waveguide, drop-in or surface mount devices are similar.

When an RF signal is fed into the device the effect of the magnetic field on the ferrite disk is to cause the signal to be deflected within the device, thus forcing the signal to pass out of the next port. Normally the port that the signal is fed into is referred to as port 1, the port it comes out of as port 2.

In the case of a circulator, if a signal is fed into port 2 it will come out of port 3. Equally if fed into port 3, it will come out of port 1. Because no device is perfect a small amount of the signal fed into the device is absorbed in the ferrite material, the insertion loss of the device is the measurement of this power that is lost and should be as small as possible, and is a measure of the difference between the power coming out and this power going in.

If a signal is fed into port 1 and most of it is removed at port 2, a small amount of that signal will appear at port 3. This is an undesired effect and is called the isolation, which should be as high as possible. It is normally measured by connecting a load at port 2 which will absorb all of the signal coming out at this point and measuring the amount of power at port 3.

The third measurement made on a circulator has two names, but they both are a measure of the same thing. They are however stated in different ways and a conversion table is printed in the back of our catalogue. These are called Return Loss- quoted in dB's (Decibels), the same as isolation and insertion loss or V.S.W.R (Voltage Standing Wave Ratio). VSWR is quoted as a ratio e.g. 1:2:1.

A Brief Explanation

When a signal is sent down a cable or transmission line, any discontinuity, or interruption will cause some of that signal to be reflected or sent back from where it came. The amount of the reflected signal relative to the transmitted signal is called the Return Loss.

Isolators

In the case of an isolator the only difference is that one port is replaced by a load. Therefore any signal being fed into port 1 will come out of port 2 (less a small amount due to insertion loss). Any signal being fed into port 2 will be fed into the load (except a small amount due to the isolation).

For each of these cases a typical application is as follows.

Circulator

The signal from the transmitter is fed from the transmitter through the circulator into the aerial, where it is transmitted. The signal picked up by the aerial is then fed through the circulator into the receiver. This allows the two (transmitter and receiver) to use the same aerial and be used together and ensures that the transmitted signal is not fed into the receiver or the received signal from going back into the transmitter.

Isolator

By putting an isolator into the system, the unwanted received signal (or the reflected signal from the aerial) are stopped from being fed back into the transmitter which would cause distortion or even possible damage.

A further use of an isolator is as a matching device. As explained earlier all interruptions in a system will cause some signal to be reflected. Certain devices (e.g. Aerials, amplifiers etc.) in fact reflect a large amount of this signal, in some cases as much as 25 %. This reflected signal would cause either distortions or a loss of power available. The use of an isolator would reduce this reflection to a level of 0.01%, a considerable improvement thus allowing more power to be obtained with a lower level of distortion.

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