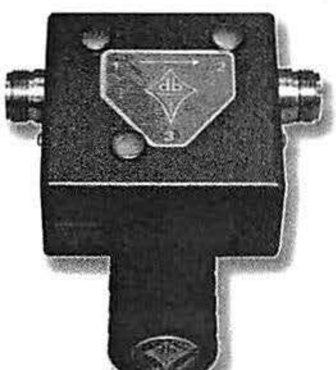
Practical notes on the ferrite isolator

By Harold Kinley

An isolator is sort of an RF lobster trap. Unidirectional, it isolates a source and load so that any reflected energy at the load is trapped or dissipated.

The photo below shows a single-section ferrite isolator. There are three ports, labeled "1," "2" and "3." Port #1 is the input port, port #2 is the output port and port #3 is the load port. The input (from the transmitter or source) is applied to port #1. The output (to the antenna or load) is taken from port #2. The dummy load is connected to port #3.

The direction of power flow is from input (port #1) to output (port #2) as shown by the arrow on the maker's plate. Any power that is reflected from the antenna or from some other load appears at port #2 and is directed to port #3, where it is dissipated in the 50Ω dummy load. If the isolator is properly tuned, the amount of reflected power appearing at the input port will be small.



A single-section ferrite isolator. *Photo courtesy of Decibel Products, Dallas.*

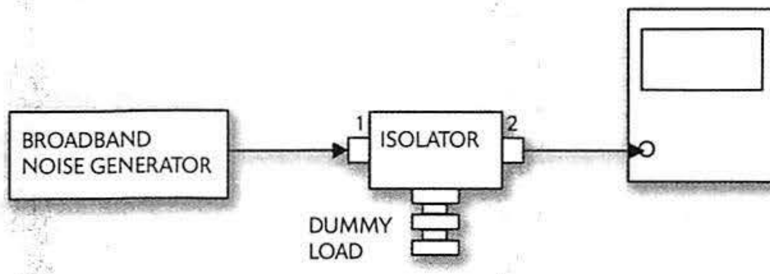


Figure 1. A broadband noise generator is used to check the frequency response of this isolator in the forward direction.

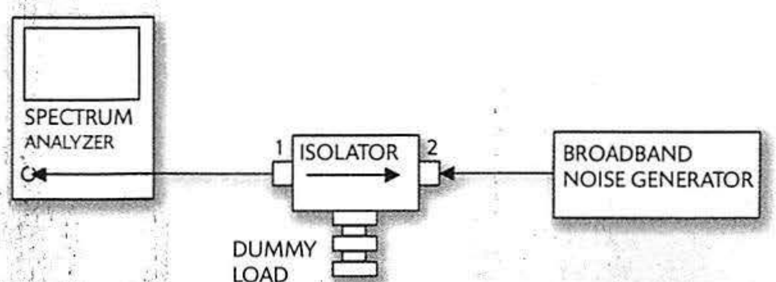
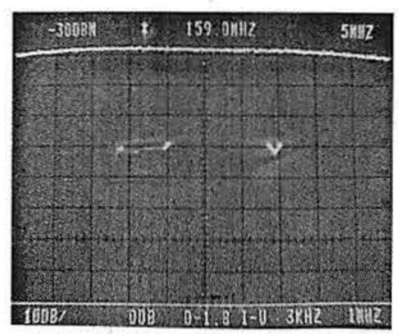


Figure 2. A broadband noise generator is used to check the frequency response of this isolator in the reverse direction.

Figure 1 above shows a test setup in which a broadband noise generator is used to view the response curve of an isolator in the forward direction. The frequency response in the forward direction is quite broad, as shown in the photo at the right. Figure 2 above shows the test setup for viewing the response of the isolator in the *reverse* direction. The photo on page 28 shows that the return loss or isolation is highest at the resonant frequency of the isolator, but it is still good at frequencies well removed from the center frequency.



The frequency response in the forward direction is quite broad.

Normally, the isolator is used immediately at the output of a transmitter, as shown in Figure 3 on page 28. An isolator's primary function is to prevent signals from nearby transmitters from entering its transmitter's final stage where they might mix with the transmitter signal or harmonics to produce strong intermodulation products. Such intermod products might cause interference to collocated receivers. A secondary function of the isolator is to provide the transmitter output with a constant 50Ω load impedance. Because the isolator dumps off any reflected power to the dummy load, the transmitter sees a near-perfect load impedance.

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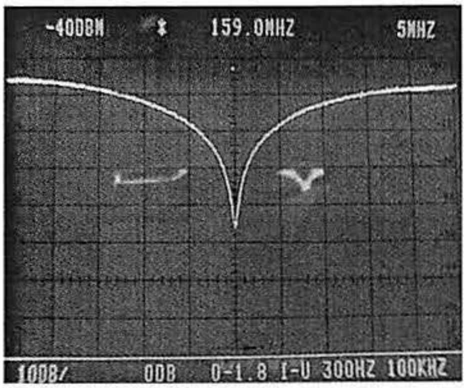


The return loss or isolation is highest at the resonant frequency of the isolator but is still good at frequencies well removed from the center frequency.

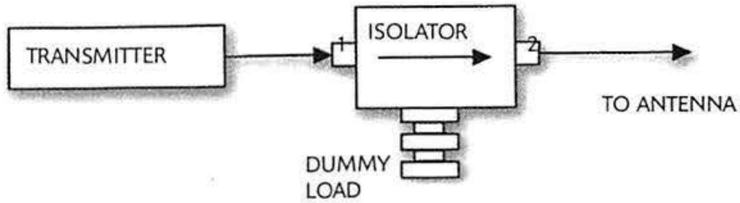
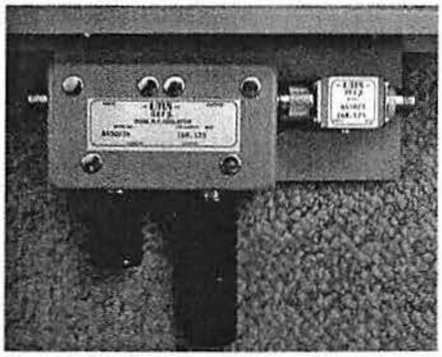


Figure 3. The isolator is connected directly to the output of the transmitter with the #1 port connected to the transmitter and the #2 port connected to the antenna. Any reflected power is dumped into the dummy load.

It is important that the dummy load of the isolator be large enough to handle any power that is reflected back into port #2 of the isolator. Let's say that the transmitter output is 100W, and that the line loss is 1.5dB. The power appearing at the antenna is about 71W. Assuming a worst-case mismatch at the antenna, 71W is reflected back down the line. Because this reflected power again encounters the line loss, the RF power appearing at port #2 of the isolator is 50W. If the dummy load of the isolator is rated at 50W, then the reflected RF power will be safely dissipated in the dummy load, and the transmitter will never see the mismatch. However, if the dummy load connected to port #3 of the isolator is rated at only 25W, then it will soon overheat and things will go haywire.

Heat is an enemy of the isolator.



The dual isolator has a larger dummy load connected to the side of the isolator that is close to the antenna line.

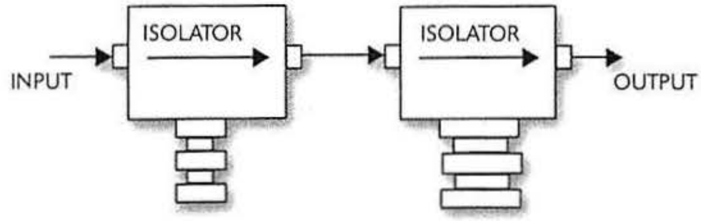


Figure 4. Two isolators can be connected in cascade as shown here to increase the amount of isolation. Make certain that the larger dummy load is located on the isolator nearest the output or load side.

So, it is important that the power rating of the dummy load be sufficient to handle a significant level of reflected power. As a rule of thumb, the power rating of the dummy load is chosen to be about 50% of the transmitter power output rating. You will see dummy loads that are attached directly to the isolator and those that are mounted away from the isolator. Dummy loads that are mounted away from the isolator tend to reduce the amount of heat transferred to the isolator in cases of high reflected power.

Isolators can be connected in cascade, as shown in Figure 4 above, to achieve a higher degree of isolation. When isolators are connected in cascade, the dummy load on the isolator that is connected to the antenna should be of a higher power rating. This is because it is the first line of defense and will receive the full reflected power (minus the small amount of insertion loss between ports #2 and #3). An alternative to connecting two isolators in cascade is to use a dual-section isolator, such as the one shown in photo at the left. As part of the intermodulation panel, a dual isolator is more efficient because it is manufactured *as* a dual isolator. The tuning is also more precise, with less insertion loss. Notice in the photo on page 30 that the dual isolator has a larger dummy load connected to the side of the isolator that is close to the antenna line. Also, notice that the isolator is followed by a lowpass filter between the antenna line and the isolator. This is because isolators tend to generate weak second harmonics and should always be followed by a lowpass filter to prevent these harmonics from reaching the antenna.

Several precautions should be observed when installing an isolator. Don't exceed the power input rating of the isolator. Use a dummy load that is at least 50% of the rated transmitter power output. If possible, use a dual-section isolator rather than cascading two single-section isolators. For maximum isolation, tune the isolator to the specific frequency of a particularly troublesome collocated transmitter. Follow the manufacturer's instructions on mounting the isolator. Some isolators might be detuned when mounted on the surface of a ferrous metal. Always follow the isolator with a lowpass filter.

By using an isolator on the output of a transmitter, many interference problems can be avoided—especially at densely populated transmitter sites.

Until next time—*stay tuned*! ■

Feedback

Some feedback about the column on Stabilant 22A:

Bruce Hislop, president of Perth Communications, Stratford, Ontario, writes: *I have been using it (Stabilant 22A) for years, since the GE Phoenix days. Remember those miserable, noisy, molex connectors in those radios? Stabilant got those radios working reliably. Also fixed those GE MPI audio board connectors for good, too. And not to let Motorola off the hook, it settled down the unstable VCOs in the MCX100! I can't recommend it enough. I use it everywhere. Try it on shields, to reduce noise, and all those fussy little connectors out there. The price of the stuff might shock you, but you only need a drop, so the little bottle lasts a long time.*

Another reader, Mike Moran, CET, writes: *Just read your article in the February* MRT *and wanted to share my experiences. I've used Stabilant 22A and some other products for about 10 years and found them to be well worth the money. One example: Back in the early '90s I was a public-safety tech. We had quite a number of Motorola KDT-480 mobile data terminals in our service base, and the most common problem was the unit refusing to boot when turned on, showing an "ERROR 08" on the screen. The logic units were trunk-mounted, and the universal fix was to remove them, disconnect and reseat all the connectors, and "crunch" all the socketed chips. Most of the time this worked, but on the ones that it didn't, we'd disconnect all the connectors and remove all the chips, then treat all the pins and sockets with Stabilant 22. I never saw this technique fail to bring a unit back to life, and the treated units generally never showed up again with that same problem. I've used Stabilant in a number of applications, along with the products of Caig Laboratories (**www.caig.com**) that offer a wider range of products. Based on my experiences, I can recommend both as useful shop tools, especially for those maddening come-and-go intermittents.* ■