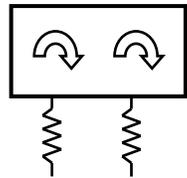
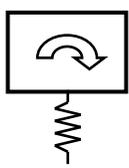




Isolator Tuning

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Introduction

The RF Isolator serves many purposes within a radio system. This device directs RF energy in a controlled manner, allowing proper handling of reflected power, and provides impedance matching between a transmitter, and an antenna or other device.

Construction

An isolator is a refinement of a common RF device called a circulator, and its main element is magnetically biased Ferro-ceramic material.

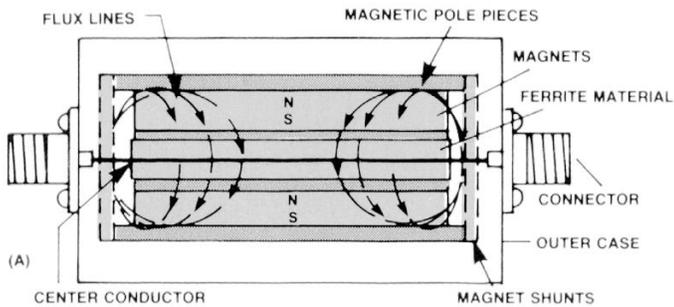


Figure 1 Mechanical drawing for Circular Isolator

The Ferro-ceramic pieces are sandwiched between powerful magnets in an aluminum enclosure. The molecules in the Ferro ceramic material are arranged so that they will direct RF energy at a specific frequency in a single direction. The direction of flow is determined by the strength and arrangement of the magnetic field inside the enclosure, but it is generally clockwise as viewed from the top of the isolator.

Isolators are available in single, dual, and triple stage enclosures, and isolation increases arithmetically with each additional stage. Single stage isolators can be connected together to increase isolation. A triple-stage isolator in one package offers better matching between stages than 3 separate devices, but the single unit has less available heat-sink area under high power operation.

Operation

The single isolator design provides 3 coupling points, or ports, where RF energy enters or exits the isolator. These ports are:

- 1- Transmitter
- 2 - Antenna
- 3 - RF Load

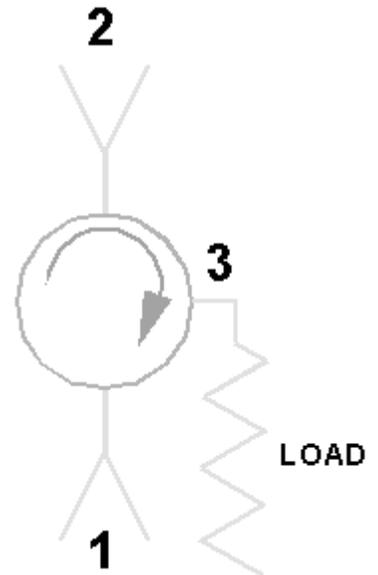


Figure 2 : Electrical Schematic for Circular Isolator

Each port of the isolator is tuned to the transmitter center frequency. The transmitter is connected to Port 1. RF applied to Port 1 is directed by the magnetic field toward Port 2 where the antenna is connected, and the transmitter energy exits from this port. An RF load capable of handling full transmitter reflected power is connected to Port 3.

The characteristic response curve of an isolator is unique. Insertion loss drops, and return loss rises at the center frequency, where the isolation approaches 25 dB per stage.

Under normal operating conditions, the transmitter and antenna are correctly matched, a small amount of power is reflected from the antenna, and no strong signal sources exist near the transmitting antenna. This small reflected power comes back down the cable and enters Port 2, where it is sent in a clockwise direction to Port 3. The load on Port 3 dissipates the reflected energy as heat.

Benefit's

Under adverse conditions, the isolator performs several critical functions:

- a. Antenna failure - Broken antenna, shorted or open cable, high VSWR.
All of these conditions will cause large amounts of power to be reflected down the transmission line toward the transmitter. The circulatory property of the isolator will direct this energy to the load port, and protect the transmitter. The load on the isolator must be capable
- b. Antenna system impedance changes – Age, water invasion, incorrect cable length.
The tuned ports of the isolator provide a constant 50 ohm impedance for the transmitter to avoid overheating and oscillation.
- c. Strong nearby signal source -
In-band or out-of-band RF energy couples into the transmitter, mixes with the primary frequency, and causes the radiation of new, undesired signals (intermodulation).
The isolator antenna port will reflect out-of-band energy back to the antenna. In-band energy enters the isolator, and is directed to the load.
When; no energy from nearby transmitters enters the primary transmitter, then; no intermodulation will occur.

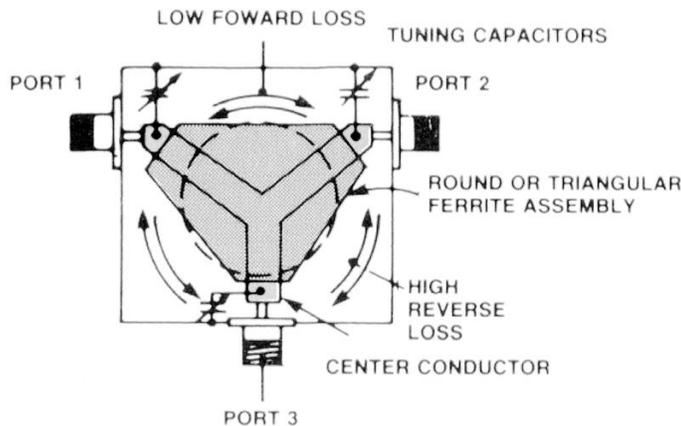


Figure 3. Functional schematic of Circular Isolator

Single Isolator Tuning

Notes :

- a. After tuning sequence is completed, re-check the measurements as adjustments do interact with each other.
 - b. See Figure #4 and #6 for more detail.
1. Network Analyzer / Spec Ann – Tracking Gen Settings
 - a. Set Output power +5 dbm.
 - b. Set Center Frequency.
 - c. Set Span = 10 megacycles.
 - d. Scale = 10 db per division
 2. Tune for Forward Insertion Loss
 - a. Analyzer Port 1 connected to “Input Port”.
 - b. Analyzer Port 2 connected to “Output Port”
 - c. 1/4 watt 50 ohm load connected to “Load Port”.
 - d. Adjust **C1**, and **C2** for maximum reading at center frequency.
 3. Tune Output Port Return Loss
 - a. Analyzer Port 1 connected to “Output Port”.
 - b. ¼ watt 50 ohm load connected to “Input Port”.
 - c. ¼ watt 50 ohm load connected to “Load Port”.
 - d. Adjust **C3** for maximum reading at center frequency.

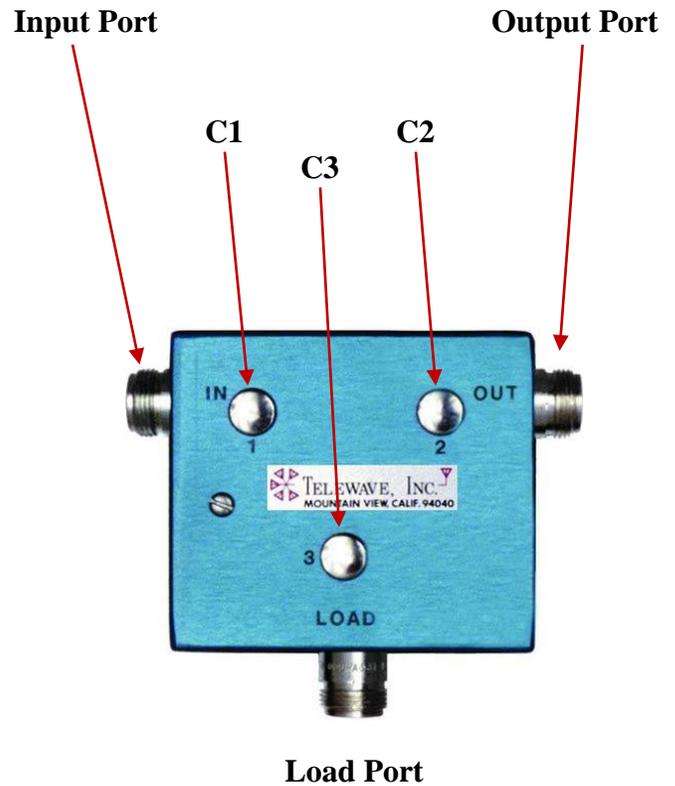


Figure 4 : Telewave T-1530 Isolator

Dual Isolator Tuning

Notes :

- a. After tuning sequence is completed, re-check the measurements as some adjustments may interact with each other.
- b. See Figure #5 and #6 for more detail.

1. Network Analyzer / Spec Ann – Tracking Gen Settings

- e. Set Output power +5 dbm.
- f. Set Center Frequency.
- g. Set Span = 10 megacycles.
- h. Scale = 10 db per division

2. Tune for Forward Insertion Loss

- e. Analyzer Port 1 connected to “Input Port”.
- f. Analyzer Port 2 connected to “Output Port”
- g. 1/4 watt 50 ohm loads connected to “Load Port #1” and “Load Port #2”.
- h. Adjust **C1**, **C2**, **C3** and **C4** for maximum reading at center frequency.

3. Tune Input Port Return Loss

- a. Analyzer Port 1 connected to “Input Port”.
- b. 1/4 watt 50 ohm load connected to “Output Port”
- c. 1/4 watt 50 ohm loads connected to “Load Port #1” and “Load Port #2”.
- d. Adjust **C2** and **C6** for minimum reading at center frequency.

4. Tune Output Port Return Loss

- e. Analyzer Port 1 connected to “Output Port”.
- f. 1/4 watt 50 ohm load connected to “Input Port”.
- g. 1/4 watt 50 ohm loads connected to “Load Port #1” and “Load Port #2”.
- h. Adjust **C4** for minimum reading at center frequency.

5. Measure and record Input Insertion Loss / Input Return Loss

- a. Analyzer Port 1 connected to the Input Port of the isolator
- b. Analyzer Port 2 connected to the output port of the isolator
- c. Connect 50 ohm loads to “Load Port #1” and “Load Port #2”.
- d. Record input insertion loss (S21).
- e. Record input return loss (S11)

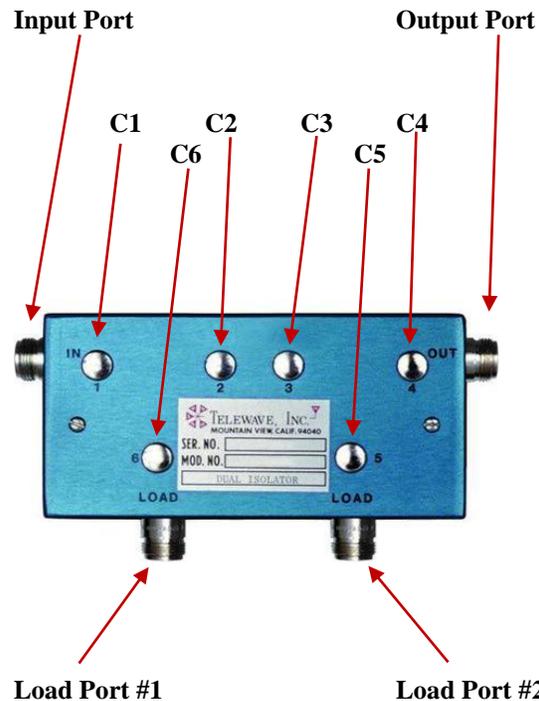


Figure 5 : Telewave T-1560 Isolator

6. Measure and record Output Insertion Loss / Output Return Loss
 - a. Analyzer Port 1 connected to the Input Port of the isolator
 - b. Analyzer Port 2 connected to the output port of the isolator
 - c. 50 ohm loads connected to both LOAD ports
 - d. Record output insertion loss (S12).
 - e. Record input return loss (S22)

Data Taken For: _____ Date: _____
Filter Type: _____ Model #: _____ FOM: _____

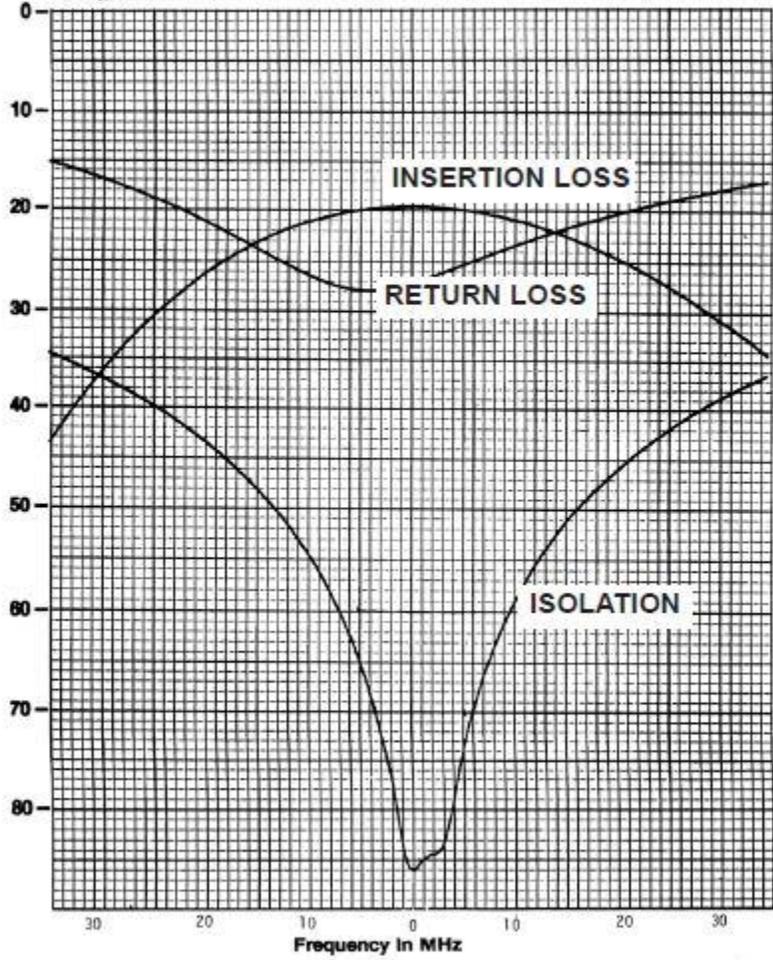


Figure #6 Isolator Response Curve

Additional Resources for Isolator Tuning

<https://www.youtube.com/watch?v=qWZoSGZOt90>