Telewave.io Isolator Tuning

07/18/2023

Introduction

Refer to the product Data Sheet for the specific product parameters before making any adjustments.

The isolator functions as an RF check valve. It allows energy to flow in one direction.

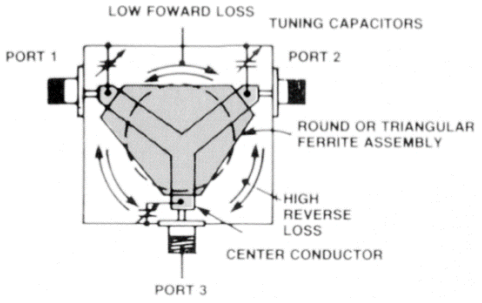
The Isolator serves two primary purposes.

- Protect the transmitter from its own energy that is reflected from the antenna, filters, or feedlines.
- Protect the transmitter from any other RF energy that may be received by the antenna and passed through the filters to the transmitter output circuitry (could cause intermodulation products.)

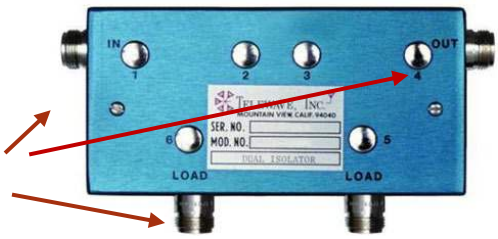
Telewave.io Isolators are built to work within a "range" of frequencies, and each is fine-tuned at the factory for optimal performance at a specific frequency in the range supported by the hardware. The isolators usually can be re-purposed without re-tuning up to 1% frequency delta from the factory tune.

The isolator is essentially one or more "circulators" mounted in a frame and fitted with a load to absorb any energy that is flowing in the "reverse" direction. Each section of the isolator will provide 30 to 35 dB of energy reduction (or isolation) in the reverse direction while only inserting from 0.3 to 0.5 dB of insertion loss in the "forward" direction. Low insertion loss flow is from

- Port 1 to Port 2
- Port 2 to Port 3
- Port 3 to Port 1



Typical LMR applications use a "dual isolator".



Secondary Cir Load Primary Cir Load

The isolator has three types of connectors on the case.

- 1 = Input = Connected to the Transmitter output.
- 2 = Output = Connected to the Filter/s or Antenna.
- 3 = Load = Connected to a 50 Ohm Load that can absorb any energy flowing in the reverse direction (there is a load connector for each circulator.)

Setup

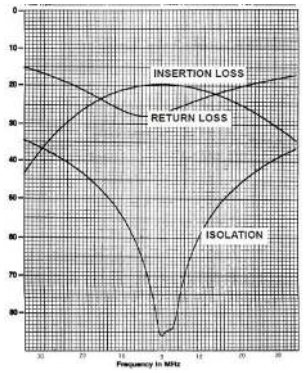
1. Setup the Test Leads – Cables
    a. Any quality 50-ohm flexible coaxial cable with Type "N" Connectors will work.
    b. The lead length should be an electrical increment of ½ wavelength of the primary frequency
        i. The actual length of the cable will depend on the cables velocity factor
        ii. The lead length does not need to be exact… for example, a set of cables cut to the center of the VHF high band will almost always be OK for the entire 144 to 174 MHz
        iii. Will need three cables if using an external directional coupler to measure return loss
2. Setup the Test Equipment
    a. Service Monitor (with a tracking generator), or a Network Analyzer
        i. Refer to the user manual for instructions on how to operate your test equipment.
        ii. Network analyzers generally work better for tuning operations since they can indicate return loss and insertion loss at the same time.
        iii. Tracking Generators will require an external directional coupler to indicate return loss (a directional coupler with > 30 dB isolation works best.)
    b. Configure the start and stop frequency of the sweep.
    c. Set a marker at the desired pass frequency.
    d. Set the transmit level to 0 dBm (1 mW)
    e. Normalize the leads that will be used to connect to the cavities (see equipment instructions)

Tools Required

- Vector Network Analyzer (VNA) or Service Monitor with a Tracking Generator (SM/TG assumed.)
- Directional Coupler w/N-F connectors, suitable for the frequency range & at least 30 dB isolation.
- 50 Ohm cables to connect the Test Equipment to the Combiner (Isolator connections M-F.)
- Screwdriver (size #0) (Non-ferrous, non-conductive for tuning the capacitors)
- Screwdriver (small metal – to remove the protective covers over the capacitors.)

Expected Isolator Curve Example

- Results seen with the test equipment should look like this example.
- The input and output return loss >= 20 dB
- The forward insertion loss should be minimal and within the data sheet specifications.
- The output to input isolation should be within the data sheet specifications.



Procedure

- Configure the Tracking Generator to sweep from a frequency slightly below the lowest frequency to slightly above the highest frequency in use in the combiner.
- For all Return Loss tests – refer to the Directional Coupler connection instructions below.
- All steps below assume that the isolator is not connected to any other circuit.

- Primary (output side) & Secondary (input side) Load Test
    - Remove the load/s from the isolator.
    - Connect the load to the Tracking Generator via the Directional Coupler.
        - Sweep of the load should show a return loss >= 20 dB.
        - If the return loss < 20 dB = replace the load.
    - Connect secondary load back onto the Isolator body.
- Isolator Reverse Insertion Loss Test
    - Connect the Tracking Generator TX directly to Isolator output.
    - Connect the Tracking Generator RX directly to the primary load connector.
    - Tune C6 to minimum insertion loss.
    - Replace the primary load and remove the secondary load.
    - Connect the Tracking Generator RX directly to the secondary load connector.
    - Tune C5 to minimum insertion loss (there will be 30 to 35 dB loss from the primary cir.)
    - Replace the secondary load.
    - Connect the Tracking Generator RX directly to the isolator input.
    - Tune C2 & C3 to maximum insertion loss
        - Should see 30 to 35 dB insertion loss per circulator stage (most Telewave.io Isolators are dual stage (thus indicating 60 to 70 dB insertion loss)
- Isolator Forward Return Loss Test
    - Connect the Isolator input to the Tracking Generator via the Directional Coupler.
    - Tune C1 to maximum Return Loss, if < 20 dB = contact Telewave.io Tech Support.
- Isolator Reverse Return Loss Test
    - Connect the Isolator output to the Tracking Generator via the Directional Coupler.
    - Tune C4 to maximum Return Loss, if < 20 dB = contact Telewave.io Tech Support.
- Isolator Forward Insertion Loss Test
    - Connect the Tracking Generator TX to the Isolator input.
    - Connect the Tracking Generator RX to the Isolator output.
        - Should see 0.3 to 0.5 dB insertion loss per circulator stage (most Telewave.io Isolators are dual stage (thus indicating 0.7 to 0.9 dB insertion loss)
        - If the insertion loss is too high = contact Telewave.io Technical Support.

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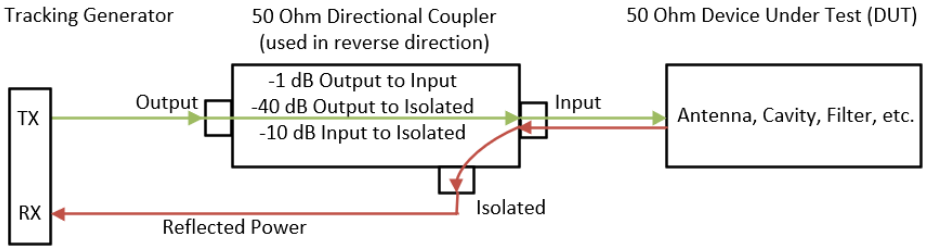
Return Loss measurement using a Tracking Gen & Directional Coupler

If tuning the cavity with a Tracking Generator the return loss cannot be checked until the tuning has been completed (and can only be checked on one side of the cavity at a time – input or output.)

- Connect the test equipment and Device Under Test (DUT) per the diagram below.
- For devices that have two or more ports, the unused ports must be terminated with 50 Ohm loads.
- Sweep the DUT from just below to just above the frequencies of interest.
- In the example below, the Return Loss = ((TX level dB – RX level dB) + 10 dB)



Cleanup

- Replace the tuning capacitor covers.
- Tighten the Loads – the load will change temperature during normal operation – make very tight.

Notes

- The Isolator adjustments interact.
- Some adjustments may disturb adjustments made earlier in the procedure.
- Move slowly and make as small as possible changes when adjusting.

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