## Problems and Remedies

**FCC**

**Brochures:** 30-455 MHz 132-255 MHz 406-512 MHz 606-1300 MHz

**Lit. Order No.:** A1004 A1004 A1004 A1004

**Also Available:**

**Tech-Aid 80008 (Lit. Order No. C01049) Duplexer Response Curves**

### Introduction

As an end user, you are the first line of defense in the field concerned with servicing Duplexers, TX-RX SYSTEMS INC. offers this field service guide along with our thanks for your patience and understanding. Advice from our technicians is always welcomed and is available for your personal convenience.

Duplexers are passive devices requiring little or no service once installed in a system. The proper design and application of a given Duplexer will greatly reduce the need for service. While problems do occur in a duplexer system, it is necessary to identify as many abnormal conditions as possible to zero in on the specific causes of the problem.

Unfortunately, there are only a few measurable or definable performance indicators in the diagnosis of the field environment, and any number of conditions may exist, which are representative for the observed phenomena.

Most Duplexer installation problems fall into three categories. Each of these three categories will be treated separately, using the symptom analysis and remedy approach.

### A. HIGH INPUT VSWR

#### Potential Cause

- **Antenna feed line is too long or too short.
- **Antenna feed line mismatch near the duplexer.
- **Antenna feed line is not properly terminated.
- **Antenna feed line is not properly balanced.
- **Antenna feed line is not properly shielded.

#### Remedies

- **Connect the feed line to the duplexer.
- **Adjust the feed line to the correct length.
- **Use a high-quality, low-loss coaxial line.
- **Use a balanced feed line.
- **Use a shielded feed line.

### B. EXCESSIVE LOSS

#### Potential Cause

- **Transmission line is too long or too short.
- **Transmission line is not properly terminated.
- **Transmission line is not properly balanced.
- **Transmission line is not properly shielded.

#### Remedies

- **Shorten the transmission line.
- **Use a low-loss coaxial line.
- **Use a balanced transmission line.
- **Use a shielded transmission line.

### C. DESENSITIZATION OF THE RECEIVER WHEN TRANSMITTER IS KEYED

#### Potential Cause

- **Transmission line is too long or too short.
- **Transmission line is not properly terminated.
- **Transmission line is not properly balanced.
- **Transmission line is not properly shielded.

#### Remedies

- **Shorten the transmission line.
- **Use a low-loss coaxial line.
- **Use a balanced transmission line.
- **Use a shielded transmission line.
FIELD SERVICE REMEDIES FOR PAGE ONE PROBLEMS

1. Turn a signal generator to the receive frequency and input it into the antenna terminal, sampling the signal at each equipment terminal. Revert the labels if necessary. It may be that the unit was ordered in the reverse frequencies. If so, the label will indicate this. The duplexer is symmetrical in design (usually indicated by the same number of Tx and Rx filter sections). Jumper the equipment labels and operate. Generally, no damage will be done to the duplexer when operated in reverse for a short time period. If other adverse symptoms appear, consult the factory.

2. Check the unit label. If needed, the duplexer may be field tuned. Consult the instructions and/or the factory if the duplexer is still under warranty or beyond field tuning capability.

3. Check cable, by substitution, using a terminating wattmeter, or a thru-line wattmeter into a good load. Check the antenna line input for reflected power.

4. To minimize high input VSWR reduce the number of series adaptors by making up proper interconnect cables. UHF connectors are non-constant impedance, and certain combinations can transform a 1.1:1 VSWR into a 2:1, or vice versa.

5. Consult the Instruction manual for field tuning procedures, or the factory, if unit is still under warranty or beyond field tuning capability. (We trust that our products will not be prone to this problem).

6. Consult the factory. The affected antenna cables may be field replaceable, or a "baking out" process may be possible.

7. To prove this condition, place a bandpass filter between the Tx and duplexer to clean up the spuriously, and put the wattmeter between the bandpass filter and the duplexer to measure reflected power from the duplexer. The bandpass filter selectivity should be equal to or better than that of the duplexer at about the 3.0 dB points.

8. Operate the duplexer system into a dummy load. If no desensitization occurs, check out all lines, antennas, and look for potential bad joints close to the radiating antenna where re-radiation of noise may be possible both into the system receiver. Loose metal-to-metal contacts on tower-guying systems have also been known to create system noise. Note the effect of vibrating tower guys on system noise.

9. Change the length of cable between the transmitter and duplexer traversing through a hill wave in increments of 1 to 2 inches until desensitization ceases or is minimal. A ferrite isolator will also cure this condition when installed between the transmitter and duplexer. However, this is a much more expensive remedy.

10. If the FM in the duplexer transmitter line (not antenna line) will show this by reducing or eliminating it. More isolation can be obtained by cascading filters if needed. However, FM at the magnitude indicates the system should be studied for possible revision to reduce the production of this FM.

11. Cables such as RG-8/U and RG-213/U should be at least 3-4 feet apart over 5-10 runs. Use of double shielded cable will reduce the susceptibility to this problem.

12. Consult the radio manufacturer. The condition can be verified by operating the transmitter into a dummy load while injecting a minimum quieting signal into the receiver. Some radios require special modifications before they are suitable for operator operation.

13. If this problem is suspected, consult the radio manufacturer for recommended duplexer isolation for TX noise suppression and carrier suppression. Duplexer isolators should be measured per instruction manual to verify required specifications are present. If more isolation is required, consult TX RX SYSTEMS for recommended filtering.

14. Consult the factory. Bandpass filter tests can be made to confirm this. In extreme cases, adjustments to the transmitter may be required.

15. Either reduce the antenna, or use an antenna less sensitive to be. A ferrite isolator can also be put at the transmitter output to improve the impedance match. Ferrite isolators cannot be put in antenna lines, as they will attenuate RF signals.

16. A mismatch may possibly be reduced by lengthening the cable between the power amplifier output and the duplexer input until the receiver desensitization disappears, as follows:

- 20 MHz to 512 MHz RANGE: BNC or N type adaptors may be inserted into the original cable, one at a time and not to exceed a total of 1/2 wavelength until desensitization disappears.
- 600 MHz to 1.5 GHz RANGE: Prepare a cable length 1/4 wavelengths longer than original cable and insert. If desensitization does not disappear, repeat with cables each 1/4 wavelength longer than previous length, until 1/4 wavelength.

17. We find this cause most commonly relates to shifting impedance of the transmitter or power amplifier with temperature. The duplexer "appears" detuned, since a "coarse" match (tuning air resistance, and matching resistance component) is approached by shifting the duplexer passed on above or below the 90° phase point, as determined by an increase in output power on the wattmeter. In this case, temperature control of the room is the only answer, other than upgrading the transmitter.
ISOLATION CURVES FOR...

DATA REFERENCE

The curves shown below for use with filters, duplexers, and multiplexers, indicate the amount of isolation or attenuation required between a typical 100 watt transmitter and its associated receiver at the Tx (carrier suppression) and Rx (noise suppression) frequency which will result in no more than a 1 db degradation of the 12 db S/N ratio sensitivity.

**132-174 MHz Band**

For Tx Power of:
- 25 watts = subtract 6 dB
- 50 watts = subtract 3 dB
- 100 watts = no correction
- 250 watts = add 3 dB
- 500 watts = add 5.5 dB

**400-512 MHz Band**

For Tx Power of:
- 25 watts = subtract 6 dB
- 50 watts = subtract 3 dB
- 100 watts = no correction
- 250 watts = add 4 db
- 500 watts = add 5.5 dB

Note: These are only "typical" curves. When accuracy is required, consult the radio manufacturers.

TX RX SYSTEMS INC. 8985 INDUSTRIAL PARKWAY, ANGOLA, NY 14004
TELEPHONE 716-549-4700  TELEX 19470  FAX 716-549-4776 (24 HRS.)
TX RX SYSTEMS, INC. offers this convenient means of determining the insertion loss of FILTER, DUPLEXERS, MULTICOUPLERS, and related products.

It should be remembered that the field accuracy of wattmeter readings is subject to considerable variance due to RF connector VSWR and basic wattmeter accuracy, particularly at low end scale readings. However, allowing for these variances, this graph should prove to be a useful reference.

For lower power levels, divide both scales by 10 (5 to 50 watts)
VARI-NOTCH FILTER TUNING PROCEDURE
For 4" Dia. Cavities covering 132-960 MHz

Applicable to Filters, Duplexers, or Multicouplers containing same.

PATENT No. 4186359, VARI-NOTCH

GENERAL

These cavities are usually of quarterwave design, and have a small aluminum enclosure mounted to the end cap, containing the small tuned circuit which is inductively coupled to the cavity resonator. This small enclosure is attached to the cavity end cap by two 4-40 screws, visible on the top surface. Some frequency bands have a number of these "VARI-Notch box" assemblies which look similar, but have varying coupling factors controlling the frequency separations they will tune, which also affects the insertion loss.

These versions all tune identically, and specific performance data should be obtained from the product specification sheets. The circuit in the enclosure is parallel resonant, and connected in series with the connector center pins. You should measure DC continuity between the center pins, but not center pin to ground, with all other cabling disconnected.

The cavity center probe tunes the passband of this filter, while a small air variable capacitor inside the "VARI-Notch box" tunes the reject notch. The passband tuning overrides the notch tuning, so your notch adjustment must be the last one made. The cavity resonance "punches" the passband into the wide notch produced by the lower 'Q' parallel resonant circuit. The notch, however, is not infinitely wide, and if the notch resonance is greatly off frequency and isolation is low in the desired area, the passband tuning will appear overly broad until the notch has first been tuned to the general area desired.

Access to the notch tuning is obtained by removing the small screw or rubber button in the side of the "VARI-Notch box".

A small insulated tuning tool must be used to make the notch adjustment. Where isolations obtained are high, (over 40dB) some sensitivity to tool contact on the capacitor rotor may be seen, but is easily taken care of by "offset tuning" the notch. (A tuning tool is available under our model 95-00-01.)

The passband tuning is a sliding adjustment, held securely by a 1/4" shaftlock. Should the tuning appear to stick while sliding, rotate and slide the probe while tapping on the rod with a screwdriver or other small tool. The shock will break the surface tension on the probe contact fingers, aiding fine tuning adjustments.

401.1011
We prefer shaftlocks to threaded locking devices, as tightening the lock nut causes axial tension and a resulting shift in frequency.

**Basic Filter Test Circuit**

1. Rough tune notch on reject frequency
2. Tune passband
3. Retune notch
4. Final tune passband
5. Final tune notch, always the last adjustment.

Attenuation is determined by substituting attenuator for filter and matching detector levels.
VARI-NOTCH DUPLEXERS

MODEL: 26-52-02 (220-225 MHz)
26-65-02, 28-70-02, 28-69-02 (406-512 MHz)
26-37-04, 26-37-05, 29-37-06 (144-174 MHz)

TUNING INSTRUCTIONS

TL-3

GENERAL

These instructions apply to the above models, consisting of four cavities in a symmetrical circuit configuration.

The VARI-NOTCH circuit, an exclusive design of TX RX Systems, Inc., produces a wide, deep notch of isolation with selective passband characteristics within the band of operation.

The VARI-NOTCH circuit in the above models is contained in the small housing attached to the cavity end cap. One circuit assembly tunes the high pass or low pass response as required. The insertion loss of each VARI-NOTCH assembly is fixed per the design specifications for each model, but may be factory adjusted to satisfy other specification requirements.

The passband of the vari-notch circuit is tuned by adjusting the cavity probe. The isolation notch is tuned by adjusting a capacitor located in the vari-notch enclosure, access being through a threaded port normally closed by a 10-32 screw in the side of the housing. An insulated tuning tool must be used when adjusting this capacitor. A sketch of the type of tool required is shown at the end of this instruction. (The factory can also supply such a tool at a nominal charge.)

BASIC TUNING PROCEDURE:

1. Isolate each filter section for individual tuning.
2. Tune the cavity probe for the circuit pass frequency.
3. For each cavity, using an insulated tuning tool as shown, tune the capacitor, for the circuit reject frequency.
4. Repeat steps 2 and 3 at least once for each filter section.
5. Completely interconnect the duplexer filter sections, and repeat steps 2 and 3, making the isolation adjustments (capacitor) last. In this case, you will inject the test signal into the antenna port and detect at the TX or RX port as determined by the particular adjustment being made. Load the opposite port (TX or RX) in 50 ohms when making this adjustment.

TEST EQUIPMENT REQUIRED:

1. A receiver on each duplexer frequency to act as a detector.
2. A metering circuit for the receiver last limiting level.
3. A 6 dB or greater 50 ohm pad for the receiver input.
4. A signal generator capable of an output of least 95 dB above the receiver sensitivity, including input pad.

401.1020

TXRX SYSTEMS INC. BEZ INDUSTRIAL PARKWAY AURORA NY 14062 PHONE 716-540-4700 FAX 716-540-4770 TELEX 759720
Isolation is measured by the substitution method using the calibrated attenuator of the signal generator. Match signal levels, with and without the filter section, using the 1st limiter reading as a level indicator. The difference in attenuator settings is the filter isolation. Take care not to saturate the 1st limiter and use a 6 db or greater pad on the receiver input for forced 50 ohm reference.

Insertion loss is difficult to measure using the rough dbm calibration of signal generator attenuators. A substitution step attenuator calibrated in 0.1 db increments is the best method. A wattmeter input and output reading, taking certain precautions, will also give a reasonable indications of insertion loss, referring to TX RX Systems Tech-aid TA No. 76002, a graph of the insertion loss vs. power in and out.

**Typical Measurement Circuit**

![Diagram of measurement circuit]

**Single Filter Section**

- Vari-Notch Capacitor
- Tunes Rejection Notch
- Shaft Lock, Cavity Probe
- Tunes Vari-Notch Pass Frequency (Sliding adjustment)
- Filter Input/Output Terminals (Non-directional)

401.1020
FINAL TUNING CONFIGURATION

NOTE: Low Pass Input on left of unit is strictly a convenient convention. Follow labeling of unit is marked in reverse, as filter sections may be tuned either as low pass or high pass sections.

TUNING PROCEDURE

1. Inject the low frequency into the antenna terminal and detect with a low frequency receiver at the low pass input. Terminate the high pass input in 50 ohms. Tune the low pass probes for minimum loss and lock shaft locks.
2. Inject the high frequency into the antenna terminal and detect with a high frequency receiver at the high pass input. Terminate the low pass input in 50 ohms. Tune the high pass probes for minimum loss and lock shaft locks.
3. Inject the high frequency into the antenna terminal and detect with a high frequency receiver at the low pass input. Tune the capacitors in the vari-notch housing for maximum high frequency rejection.
4. Inject the low frequency into the antenna terminal and detect with a low frequency receiver at the high pass input. Tune the capacitors in the vari-notch housing for maximum low frequency rejection.

Your duplexer is now tuned and should meet the minimum published specification as shown in the enclosed chart.

40L1020
### VARISTOR NOTCH DUPLEXER SPECIFICATIONS

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**TUNING TOOL, critical dimensions**

1. Blade must be narrower than 3/32" insulated shank so as not to create metal shavings from blade scraping on inner threaded barrel of capacitor.

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![Diagram](image)