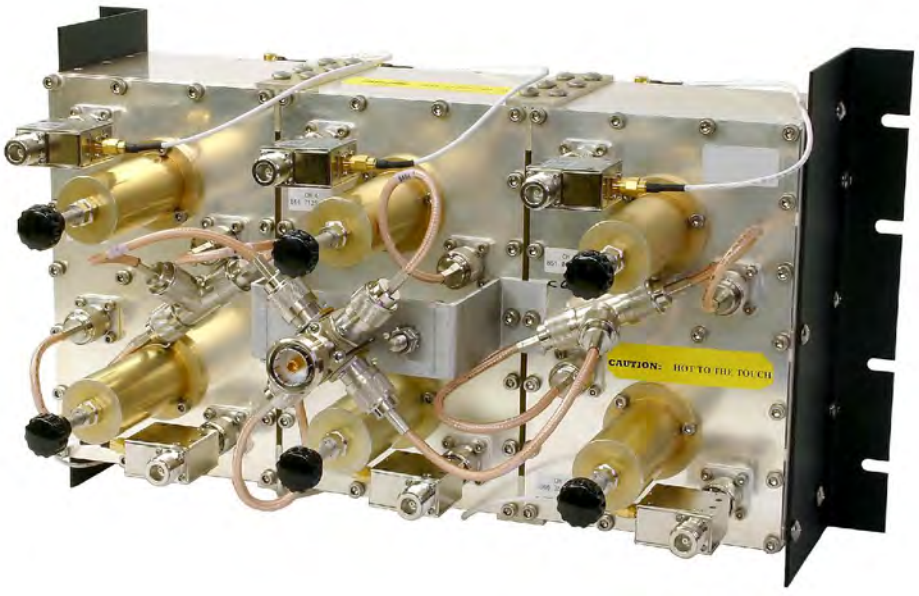
Instruction Manual for the
Model 44-83C/83D-50-1D-A Series
700/800 MHz Ceramic Cavity Transmit Combiners

Manual Part Number

7-9480



8625 Industrial Parkway, Angola, NY 14006 Tel: 716-549-4700 Fax: 716-549-4772 sales@txrx.com www.txrx.com

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This warranty applies for one year from shipping date.

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DISCLAIMER

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Version Number	**Version Date**
1	06/23/10

Symbols Commonly Used



WARNING



ESD Electrostatic Discharge



CAUTION or ATTENTION



Hot Surface



High Voltage



Electrical Shock Hazard



Heavy Lifting



Important Information

Changes to this Manua

We have made every effort to ensure this manual is accurate. If you discover any errors, or if you have suggestions for improving this manual, please send your comments to our Angola, New York facility to the attention of the Technical Publications Department. This manual may be periodically updated. When inquiring about updates to this manual refer to the manual part number and revision number on the revision page following the front cover.

Contact Information

Sales Support at 716-217-3113

Customer Service at 716-217-3144

Technical Publications at 716-549-4700 extension 5019

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GENERAL DESCRIPTION

The Ceramic Cavity 700 - 800 MHz Transmit Combiners are designed to connect multiple transmitters to a common antenna. These combiners use ferrite isolators in series with a ceramic cavity bandpass filter to provide simultaneous operation of multiple transmitters, operating at different frequencies, while connected to a common antenna. This design provides low channel insertion loss, high isolation between transmitters, high antenna-to-transmitter isolation, high intermodulation suppression, and excellent transmitter noise suppression.

The transmit combiners are available in two bands of either 763 - 776 or 851 - 869 MHz. The filters used at each band are the same except for the ceramic resonator inside of the filter cavity. The interconnect diagram of a typical 700 - 800 MHz ceramic cavity transmit combiner is shown in **Figure 1.**

Ferrite isolators are used to reduce or eliminate transmitter produced intermodulation and to protect the transmitter from high reflected power. An isolator is added at the input to each channel to increase channel isolation. The isolators will isolate the transmitter from unwanted signals that enter the system via the antenna. They prevent RF energy from getting to the transmitter output by dumping RF energy entering the output of the isolator into a dummy load. The transmitter sees an

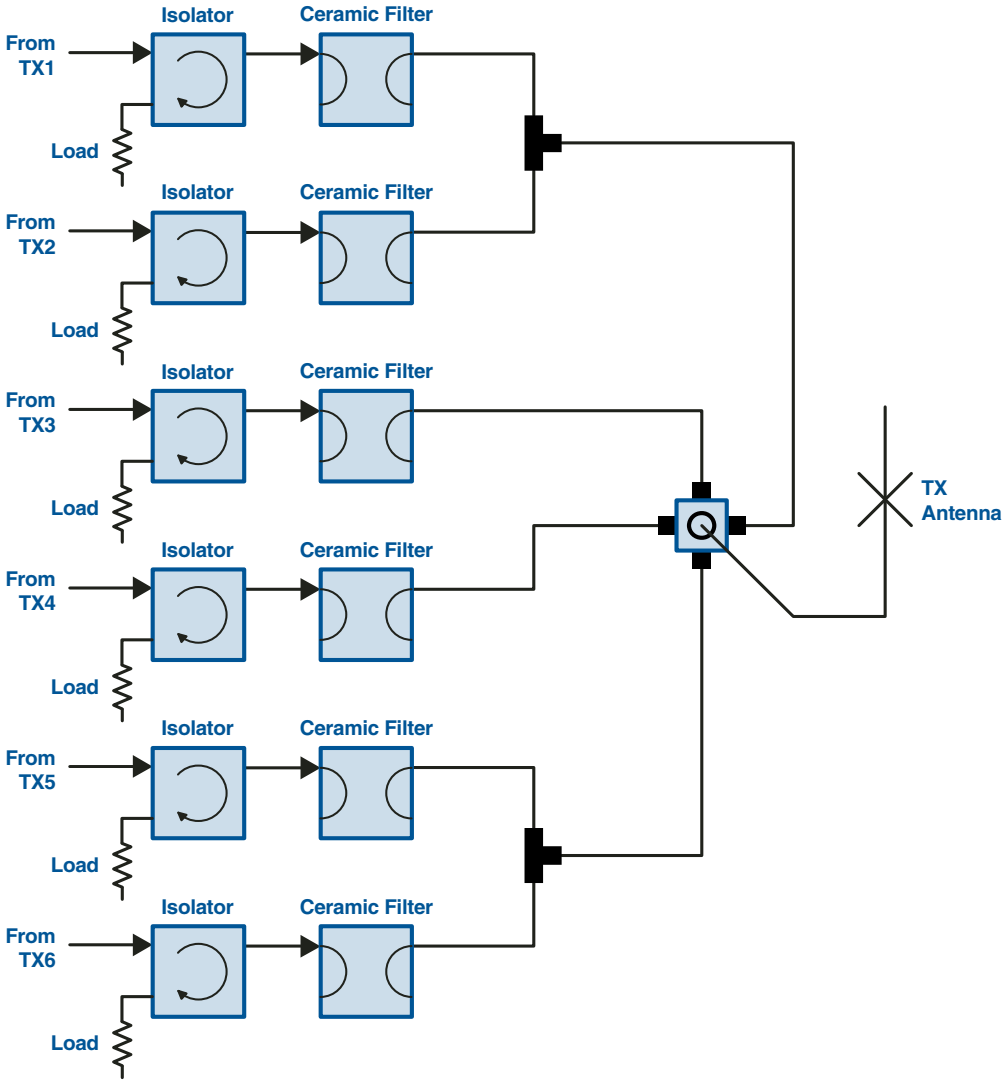


Figure 1: Block diagram. Six channel system shown as an example.

excellent impedance match on its output, because the isolator absorbs reflected power that would otherwise enter the transmitters output stage. This improves the stability, spectral purity and long-term reliability of the transmitter. Ferrite isolators offer low insertion loss high reverse isolation and excellent temperature stability.

A ceramic cavity bandpass filter is located between the isolator and the antenna to reduce spurious outputs and reduce transmitter noise radiation which might otherwise interfere with the operation of nearby receivers. Each filter passes one narrow band of frequencies and attenuates all others with increasing attenuation above and below the pass frequency. In addition, the filter is helpful in reducing or eliminating unwanted “off-frequency” signals that might enter the final stages of the transmitter and cause transmitter produced intermodulation interference. The filter is particularly suitable for use with radio systems in frequency congested areas and is helpful in reducing or eliminating all

Parameter	Model 44-83C-50-1D-A Series	Model 44-83D-50-1D-A Series
Frequency Range	763 - 776 MHz	851 - 869 MHz
Number of Channels	2, 4, 6, 8	
Isolator Type	Single Junction	
Isolation, TX - TX	32 dB (minimum)	
Isolation, ANT - TX	20 dB (minimum)	
Insertion Loss @ channel spacings	(500 KHz) **2** channels < 2.7 dB, **4** channels < 3.0 dB, **6** channels < 3.3 dB, **8** channels < 3.3 dB (250 KHz) **2** channels < 3.0 dB, **4** channels < 3.3 dB, **6** channels < 3.6 dB, **8** channels < 3.8 dB (150 KHz) **2** channels < 3.8 dB, **4** channels < 4.1 dB, **6** channels < 4.4 dB, **8** channels < 4.7 dB	
Continuous Power per channel	110 Watts	
Minimum Return Loss @ feedline	3 dB (due to antenna system failure)	
Input Return Loss	20 dB	
Output Return Loss	> 10 dB	
input / Output Connectors	N (F) on input 7/15 DIN (F) on output	
Operating Temperature	-10 to +55 ℃	
Height (nominal)	**2** channel: 7.0 inches **4** channel: 7.0 inches **6** channel: 10.5 inches **8** channel: 14.0 inches	
Width (inches)	19 inch Rack-Mount	
Depth (inches)	< 10	
Weight [lbs. (kg)]	**2** channel: 13 lbs. (5.89) **4** channel: 27 lbs. (12.24) **6** channel: 40 lbs. (18.14) **8** channel: 53 lbs. (24.04)	

Table 1: Specifications.

types of interference that is frequency rejectionable.

All of the information for installation of your combiner system is included in this manual. The combiner is easy to install and has been factory tuned in most cases so that no adjustments are necessary. The specifications for the 700 and 800 MHz combiners are listed in **Table 1**. The front view of a typical combiner is shown in **Figure 2A and 2B**.

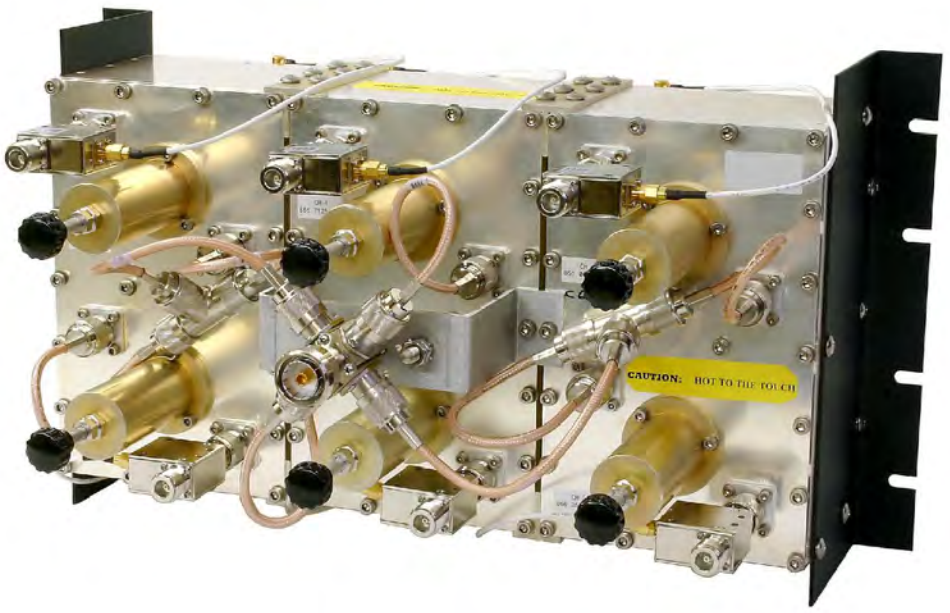


Figure 2A: Six channel configuration.

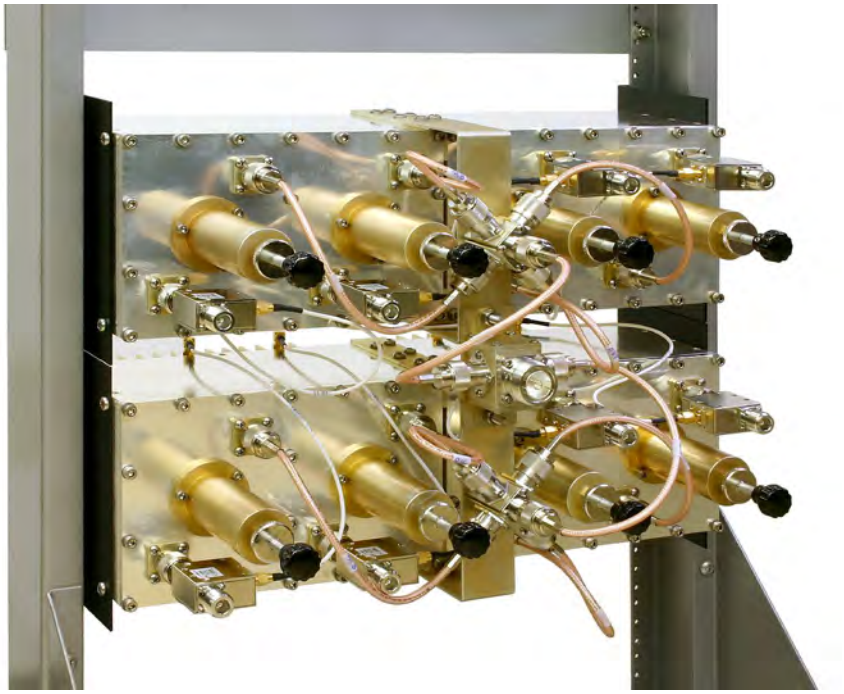


Figure 2B: Eight channel configuration.

UNPACKING

It is important to visually inspect the system components for any shipping damages as soon as possible after taking delivery. It is the customers responsibility to file any necessary damage claims with the carrier.

The transmit combiner is well packed for damage-free shipping to any place in the world. However, a high impact during shipping can have a detrimental affect. A damaged shipping container is a sure sign of rough handling. The most easily damaged parts of the combiner are the tuning rods. These rods are marked where they exit from the locking nut with a dab of red varnish or other color/type of paint. If this seal appears to be broken it may indicate that the system has been detuned in transit.

INSTALLATION OVERVIEW

The combiner should be located in a dry and level area, indoors. It is best if all transmitters are as equal in distance as possible from the combiner so that cable losses are the same for all channels. A work area space should be left unobstructed in front of the combiner so that the tuning controls are easy to access. This will facilitate tuning if channel frequencies are changed.

Each transmitter connects to its respective channel through an ‘N style’ female connector on the isolator. We recommend that all N-type connections are tightened to the torque specification of 20 in-lb. (2 N*m). A torque wrench should be used to tighten down all N-type connectors (Andrew part# 244379). We also recommend using a high quality double shielded or semi flexible cable. The combiner connects to the antenna through a 7/16” DIN connector. We recommend that all 7/16” DIN connectors are tightened to the torque specification of 250 in-lb. (25 N*m). A torque wrench should be used to tighten the 7/16” DIN connector (Andrews part# 244377).

This system is designed for use with separate transmit and receive antennas. For best operation, the transmit and receive antennas should be separated vertically by 20 feet with little or no horizontal offset between antennas. Lesser separations can be used but with an increased risk of harmful interference between radio systems. In most cases, it will be desirable to mount the receive antenna higher than the transmit antenna to maximize the talk-back range of low power portable radios.

RF Cables and Connectors

All connections to and from the combiner system should be made with double-shielded or semi-rigid heliax cable. High quality 'N' connectors that use either silver or gold plated contacts should be used.

Intermodulation Considerations

Following the previously mentioned antenna spacing recommendations will go a long way toward minimizing or eliminating intermodulation (IM) interference. IM is the result of a frequency mixing process that occurs when two or more RF signals are present simultaneously in the same circuitry where nonlinearity occurs. Product frequencies generated have frequencies that are determined by relatively simple mathematical relationships such as F(im) = 2F1-F2 and are normally determined by doing a computer intermodulation analysis for the antenna site. These products can be generated in a corroded tower joint, metal-roofing, transmitter final amplifier or the receiver front-end.

Both the cavity filters and isolators will isolate the transmitters that are connected to the combiner from one-another, thus reducing intermodulation interference. However in all transmitter combiners, intermodulation products are reduced in strength but never completely eliminated. They have to be reduced by an amount to meet the Federal Communications Commission, *43 + 10 Log (Power Out)* rule for spurious output reduction. Because of the limitations imposed by the tension and friction joints in connectors, IM products will be down 100 to 120 dB below carrier so they are still strong enough to cause problems if they fall on a near-by receiver frequency.

To avoid transmitter generated IM problems, do not put two channels on the same combiner that your IM software predicts will cause interference by generating either 3rd or 5th order IM products. Having at least two transmitter combiners allows maximum flexibility in dealing with transmitter generated IM.

General Installation Procedure

It is assumed that all work done on the combiner system is performed by a qualified field engineer who is familiar with the communications system.

1) Install the Ceramic Cavity Combiner in the radio equipment room.

2) Connect the transmitters and the transmitting antenna to the appropriate connectors. The transmitters connect to the input ports of the isolators and the transmit antenna connects to the open port of the star junction.

3) Verify proper operation of each channel by measuring the power output for each individual channel.

MAINTENANCE

No special maintenance is required. The ceramic cavity transmit combiners are passive devices of rugged mechanical and electrical design. They are tuned at the factory for the systems original design specifications and require no further adjustment or maintenance. The system will stay properly tuned unless it is physically damaged or is tampered with. Check for loose or corroded connections on the interconnect cables whenever an inspection is performed on other station equipment.

Because these combiners are passive devices, field repairs are rarely required. Field repair is limited to the replacement or repair of damaged cables. When damage occurs to the cavities or isolators it is usually due to catastrophic failure from lightning or transmit power which is far in excess of the systems rating. If cavity or isolator problems are suspected, the assembly should be returned to the factory for repair. Due to the critical alignment of parts within these subassemblies field repair is not recommended.

TUNING

Any input port of the transmit combiner can be retuned to any frequency within the operating band (763 to 776 MHz or 851 to 869 MHz) by retuning the cavity filter associated with the input port. Likewise, any additional channels added to the combiner will also require cavity tuning. Be sure to observe the minimum frequency separation between channels (listed in **Table 2**) whenever you are tuning filters. The isolators are broadband devices and do not require field tuning.

Channel Spacing	Loss (dB) versus Number of Channels			
	2	4	6	8
500 KHz	2.7	3.0	3.3	3.5
250 KHz	3.0	3.3	3.6	3.8
150 KHz	3.8	4.1	4.4	4.7

Table 2: Channel spacing and insertion loss.

Cavity Tuning

The only field adjustable parameter in the ceramic cavity filter is the passband. Changes in the position of the tuning rod determine the center frequency of the filter.



WARNING: Tuning while under transmit power can result in damage to the filter.

Required Equipment

Due to the sensitivity of the adjustments, it is strongly recommended that the proper equipment be used when tuning the individual filters, otherwise the filter should be sent to the factory or to a factory authorized representative for retuning. The following equipment or its equivalent is recommended in order to properly perform the tuning adjustments for the ceramic cavity filter.

1) Network Analyzer. Hewlett Packard models 8713A/B or 8714A/B as examples.

2) Calibration kit for the analyzer and calibrated 50 Ohm test cables.

Adjusting the Pass Frequency

The pass frequency is adjusted by monitoring the output of the network analyzer after it passes through the filter. The following is a step-by-step procedure. The cavity filter being tuned should be temporarily disconnected from the system and tuned using test instrumentation only. Do not adjust the filters while they are under transmit power as this can result in damage to the filter.



The filters are physically constructed two per housing. Although two filters share the same housing they are each electrically independent from each others.

1) Power down all the transmitters connected to the system.

2) The cavity filter that is going to be tuned must be electrically disconnected from the system.

Disconnect the cables which connect the filter to the isolator and the antenna port. It is not necessary to physically remove the filter from the rack, but it must be electrically removed from the system.

3) Setup the network analyzer for a 10 MHz span centered at the frequency at which the filter will be tuned. Although the setup and operation of different analyzers varies considerably some additional suggested settings might be;

System Bandwidth at medium
Transmission at 10 dB/division
Reflection at 10 dB/division

4) The resonant frequency of the filter is checked by connecting the output of the network analyzer to the input of the cavity filter while the RF input of the analyzer is connected to the filters output, as shown in **Figure 3**.

5) Adjust the pass frequency of the filter by setting the peak (minimum loss value) of the response curve to the desired frequency. See figure 3. The resonant frequency is adjusted by using the tuning rod, which is a sliding adjustment that rapidly tunes the filters response curve. Small movements of the tuning rod are facilitated by twisting the rod while gently pushing or pulling.

6) Once the desired response is obtained the tuning rod should be locked in place. The rod is locked by turning the knurled thumb nut. Failure to lock the tuning rod may result in detuning of the filter.

7) Re-install the filter in the system by reconnecting it to the isolator and antenna port.

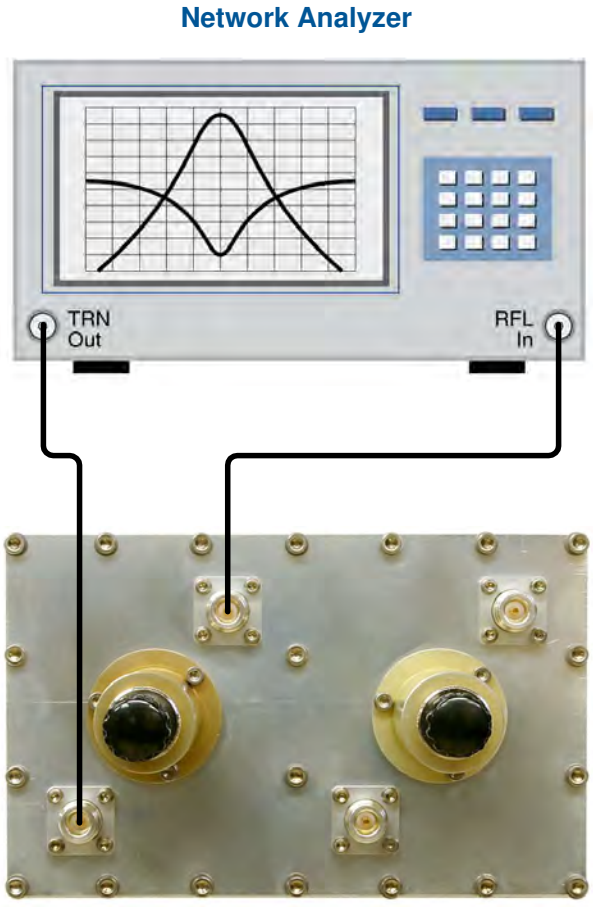
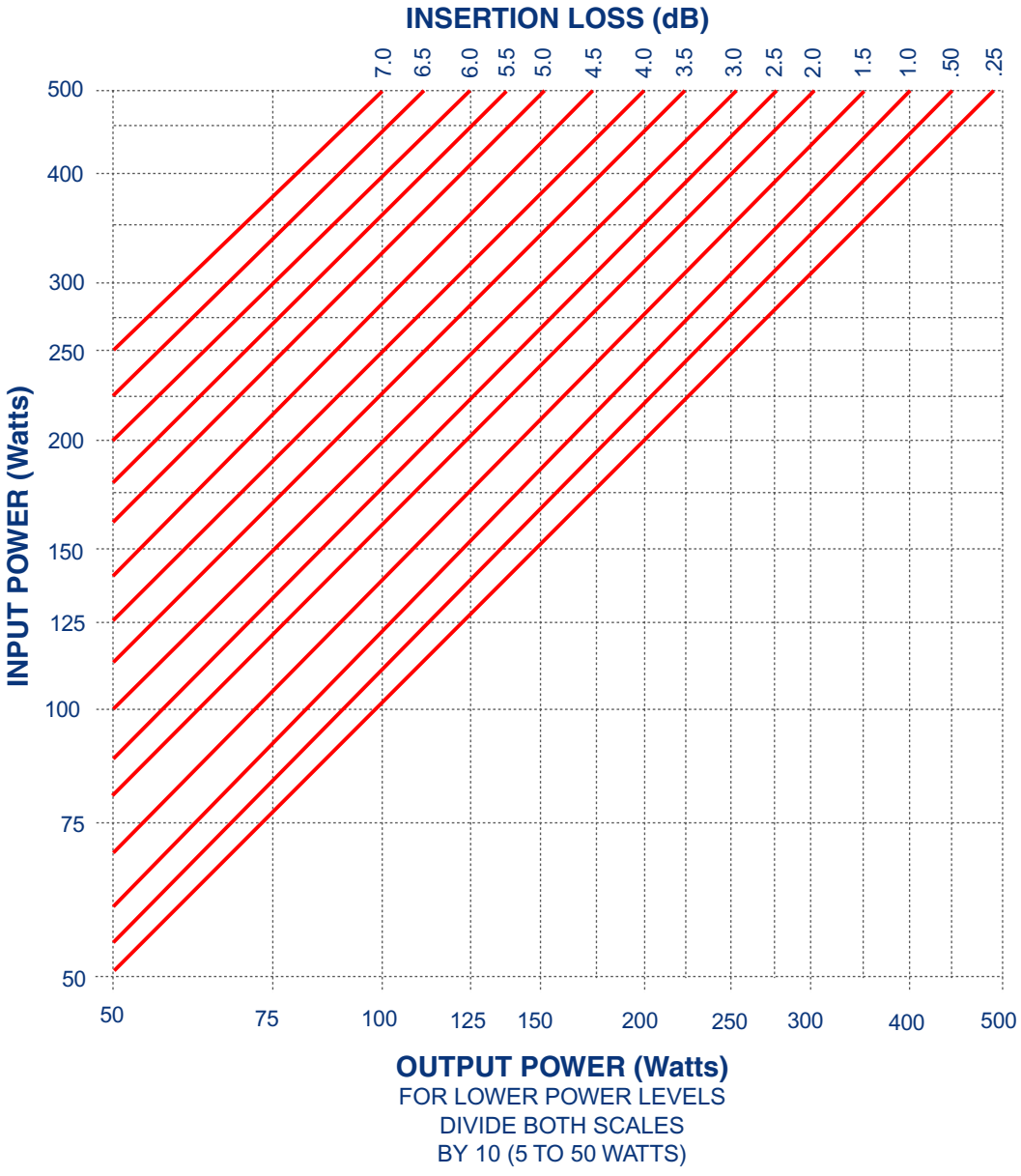


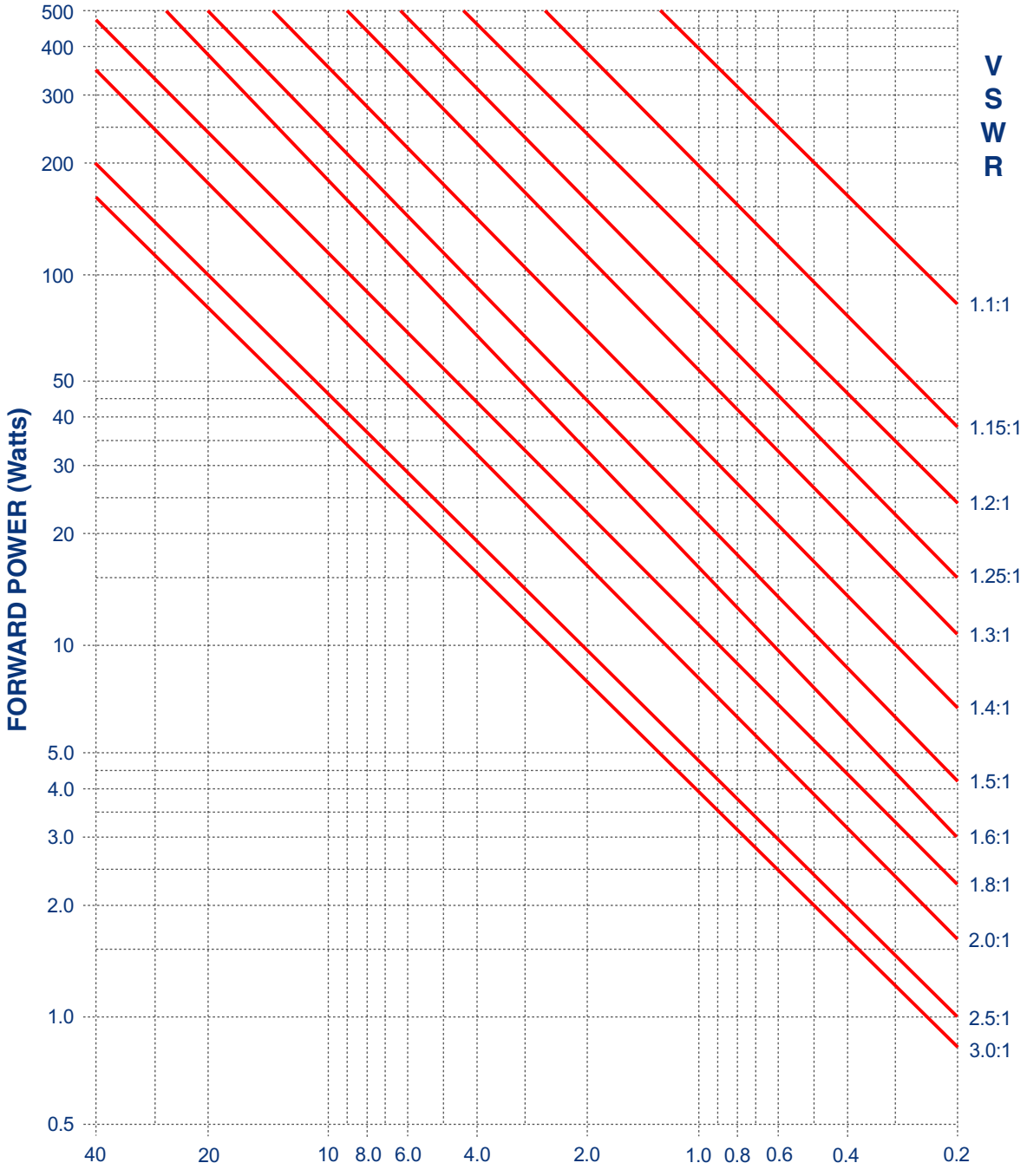
Figure 3: Connecting the network analyzer to the cavity filter.

POWER IN/OUT
VS
INSERTION LOSS

The graph below offers a convenient means of determining the insertion loss of filters, duplexers, multicouplers and related products. The graph on the back page will allow you to quickly determine VSWR. 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, these graphs should prove to be a useful reference.



POWER FWD./REV.
VS
VSWR



FOR OTHER POWER LEVELS
MULTIPLY BOTH SCALES
BY THE SAME MULTIPLIER

Return Loss vs. VSWR

Return Loss	VSWR
30	1.06
25	1.11
20	1.20
19	1.25
18	1.28
17	1.33
16	1.37
15	1.43
14	1.50
13	1.57
12	1.67
11	1.78
10	1.92
9	2.10

Watts to dBm

Watts	dBm
300	54.8
250	54.0
200	53.0
150	51.8
100	50.0
75	48.8
50	47.0
25	44.0
20	43.0
15	41.8
10	40.0
5	37.0
4	36.0
3	34.8
2	33.0
1	30.0

dBm = 10log P/1mW
Where P = power (Watt)

Insertion Loss

Input Power (Watts)

Insertion Loss	50	75	100	125	150	200	250	300
3	25	38	50	63	75	100	125	150
2.5	28	42	56	70	84	112	141	169
2	32	47	63	79	95	126	158	189
1.5	35	53	71	88	106	142	177	212
1	40	60	79	99	119	159	199	238
.5	45	67	89	111	134	178	223	267

Output Power (Watts)

Free Space Loss

Distance (miles)

Frequency (MHz)	.25	.50	.75	1	2	5	10	15
150	68	74	78	80	86	94	100	104
220	71	77	81	83	89	97	103	107
460	78	84	87	90	96	104	110	113
860	83	89	93	95	101	109	115	119
940	84	90	94	96	102	110	116	120
1920	90	96	100	102	108	116	122	126

Free Space Loss (dB)
Free space loss = 36.6 + 20log D + 20log F
Where D = distance in miles and F = frequency in MHz



8625 Industrial Parkway, Angola, NY 14006 Tel: 716-549-4700 Fax: 716-549-4772 sales@txrx.com www.txrx.com