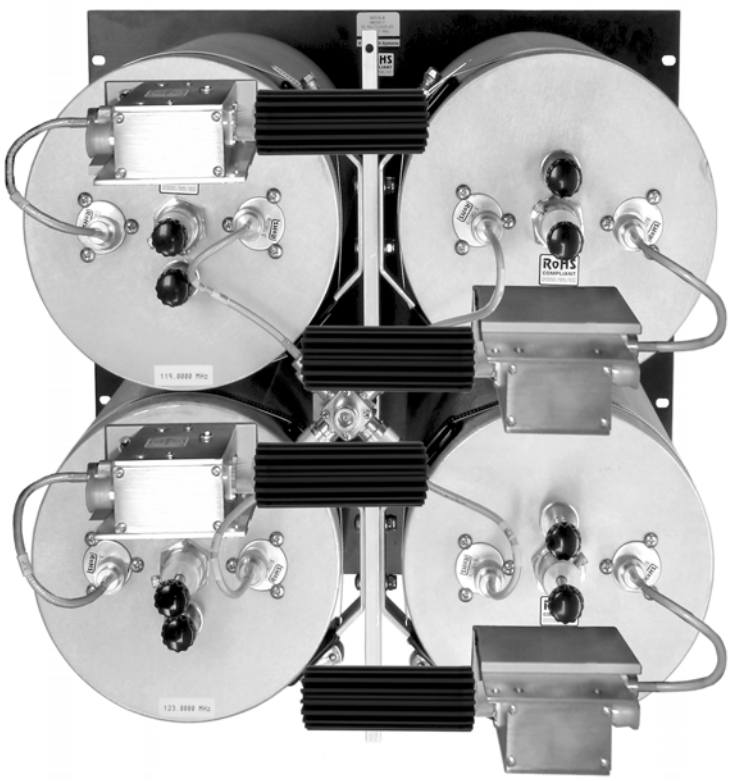
Instruction Manual for
Transmit Combiner
Model Number 44-35A-02093-X

Manual Part Number

7-9309-2



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Warranty

This warranty applies for one year from shipping date.

TX RX Systems Inc. warrants its products to be free from defect in material and workmanship at the time of shipment. Our obligation under warranty is limited to replacement or repair, at our option, of any such products that shall have been defective at the time of manufacture. **TX RX Systems Inc.** reserves the right to replace with merchandise of equal performance although not identical in every way to that originally sold. **TX RX Systems Inc.** is not liable for damage caused by lightning or other natural disasters. No product will be accepted for repair or replacement without our prior written approval. The purchaser must prepay all shipping charges on returned products. **TX RX Systems Inc.** shall in no event be liable for consequential damages, installation costs or expense of any nature resulting from the purchase or use of products, whether or not they are used in accordance with instructions. This warranty is in lieu of all other warranties, either expressed or implied, including any implied warranty or merchantability of fitness. No representative is authorized to assume for **TX RX Systems Inc.** any other liability or warranty than set forth above in connection with our products or services.

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PRICES AND TERMS:
Prices are FOB seller's plant in Angola, NY domestic packaging only, and are subject to change without notice. Federal, State and local sales or excise taxes are not included in prices. When Net 30 terms are applicable, payment is due within 30 days of invoice date. All orders are subject to a $100.00 net minimum.

QUOTATIONS:
Only written quotations are valid.

ACCEPTANCE OF ORDERS:
Acceptance of orders is valid only when so acknowledged in writing by the seller.

SHIPPING:
Unless otherwise agreed at the time the order is placed, seller reserves the right to make partial shipments for which payment shall be made in accordance with seller's stated terms. Shipments are made with transportation charges collect unless otherwise specified by the buyer. Seller's best judgement will be used in routing, except that buyer's routing is used where practicable. The seller is not responsible for selection of most economical or timeliest routing.

CLAIMS:
All claims for damage or loss in transit must be made promptly by the buyer against the carrier. All claims for shortages must be made within 30 days after date of shipment of material from the seller's plant.

SPECIFICATION CHANGES OR MODIFICATIONS:
All designs and specifications of seller's products are subject to change without notice provided the changes or modifications do not affect performance.

RETURN MATERIAL:
Product or material may be returned for credit only after written authorization from the seller, as to which seller shall have sole discretion. In the event of such authorization, credit given shall not exceed 80 percent of the original purchase. In no case will Seller authorize return of material more than 90 days after shipment from Seller's plant. Credit for returned material is issued by the Seller only to the original purchaser.

ORDER CANCELLATION OR ALTERATION:
Cancellation or alteration of acknowledged orders by the buyer will be accepted only on terms that protect the seller against loss.

NON WARRANTY REPAIRS AND RETURN WORK:
Consult seller's plant for pricing. Buyer must prepay all transportation charges to seller's plant. Standard shipping policy set forth above shall apply with respect to return shipment from TX RX Systems Inc. to buyer.

DISCLAIMER

Product part numbering in photographs and drawings is accurate at time of printing. Part number labels on TX RX products supersede part numbers given within this manual. Information is subject to change without notice.

Manual Part Number 7-9309 Copyright © 2006 TX RX Systems, Inc. First Printing: April 2002	
Version Number	**Version Date**
1	04/05/02
2	07/28/06

Symbols Commonly Used

WARNING

ESD Elecrostatic Discharge

CAUTION or ATTENTION

Hot Surface

High Voltage

Electrical Shock Hazard

Use Safety Glasses

Important Information

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Figures and Tables

GENERAL DESCRIPTION

The model 44-35A-02093-X Transmit Combiners are multichannel systems which use ferrite isolators in series with a bandpass filter to provide simultaneous operation of multiple transmitters, operating at different frequencies, while connected to a common antenna. The system provides high isolation between transmitters, high antenna to transmitter isolation, high intermodulation suppression, and excellent transmitter noise suppression. The “X” in the model number represents the number of channels the system is designed to accommodate. Models are available from 1 through 12 channels. Specifications for the model 44-35A-02093-X family of transmit combiners are listed in **Table 1**. A system diagram is included with each shipment that shows the layout of the system in schematic form as well as the factory tuned frequencies of each channel.

Ferrite isolators are used to reduce or eliminate transmitter produced intermodulation and to protect the transmitter from high reflected power. The isolators prevent RF energy from getting to the transmitter output by dumping RF energy entering the output of the isolator into a dummy load. Ferrite isolators offer low insertion loss, high reverse isolation and excellent temperature stability. External loads are used to provide maximum flexibility and ease of replacement.

Specification	Quantity
Cavity Tuning Range (MHz)	118 - 137
Min. Channel-Channel Separation	150 KHz
Cavity Insertion Loss	0.9 dB
Max. Channel Insertion Loss	2.0 dB

Table 1: System Specifications.

A high Q coaxial 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. In addition, the cavity is helpful in reducing or eliminating unwanted “off-frequency” signals that might enter the final stages of

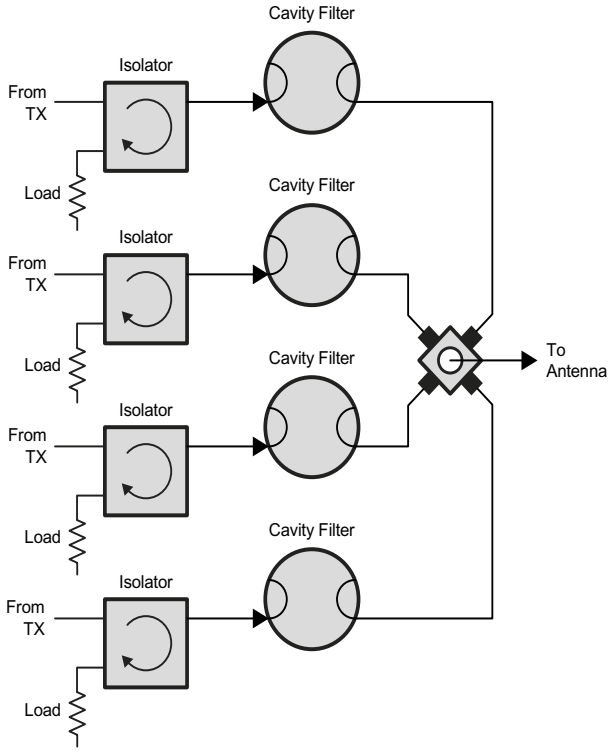


Figure 1: Block diagram of a four channel system.

the transmitter and cause transmitter produced intermodulation interference. Bandpass cavities are particularly suitable for use with radio systems in frequency congested areas and are helpful in reducing or eliminating all types of interference that is frequency rejectionable.

UNPACKING

Care should be used when removing the system components from their shipping containers to avoid unnecessary damage. It is important to visually inspect the combiner system for any shipping damage as soon as possible after taking delivery. It is the customers responsibility to file any necessary damage claims with the carrier. Transmit combiners are rugged devices but may become detuned if severely jostled or dented during shipping. The most easily damaged parts of the system are the tuning rods of the cavity filters.

INSTALLATION

The system is shipped from the factory as separate 19" rack mount assemblies. These sections must be securely installed in a standard EIA 19" rack and then interconnected as shown in the system layout drawing shipped with the equipment. **Figure 1** shows the block diagram of a four channel system. Additional channels can be added or subtracted from this design using tee-connectors. **Figure 2** is a photograph of a four channel system showing the correct location for connecting your transmitters and antenna.

All RF connections should be made with double-shielded, 50-ohm coaxial cable. Flexibility in the cables will help prevent damage to the connectors. We recommend the use of high quality connectors with gold plated center pins. Cable assemblies using these type of connectors are available from TX RX Systems. The transmit combiner should be securely installed in a dry, vibration-free environment. Avoid areas of high heat or direct sunlight which can cause differential heating and drift. Attachment of the mounting rack to a common earth ground is recommended to maximize lightning protection.

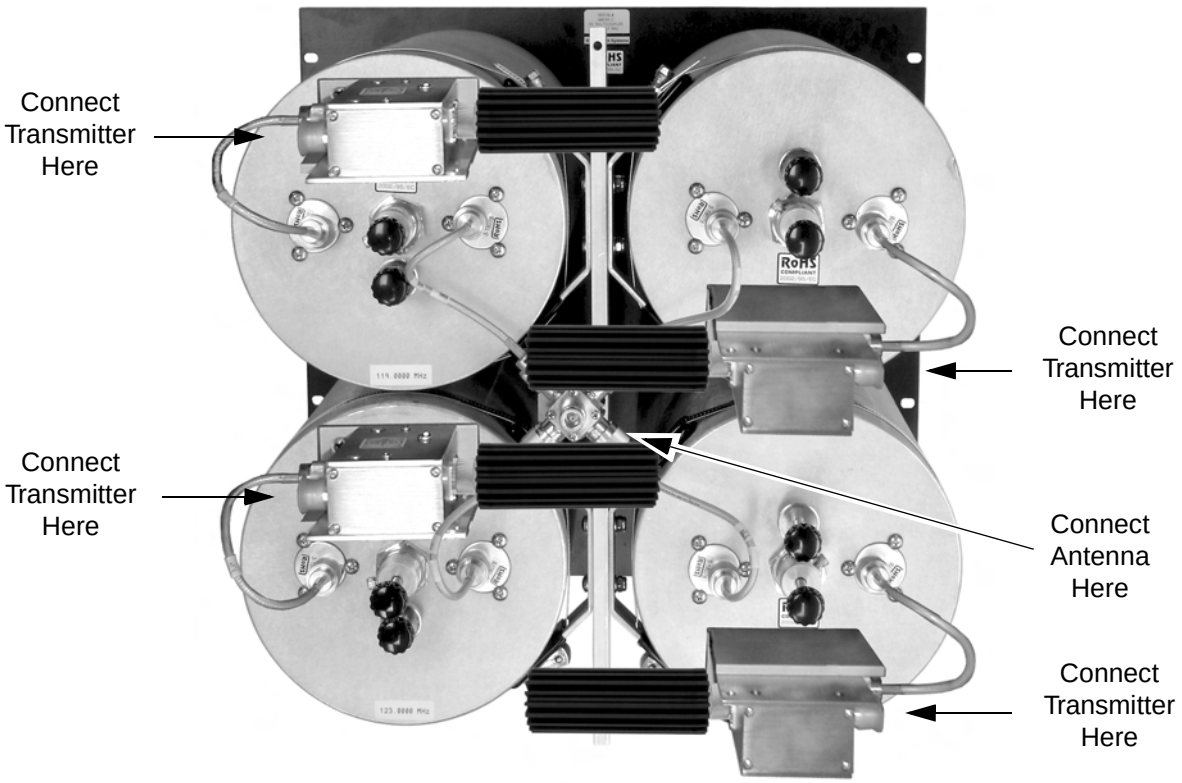


Figure 2: Interconnecting the four channel system.

MAINTENANCE

No special maintenance is required. The transmit combiner is a passive device of rugged electrical and mechanical design. The system is tuned at the factory for the customers original specified transmit frequencies and requires no further adjustment or maintenance. The transmit combiner will stay properly tuned unless it is physically damaged or is tampered with. Check for loose or corroded connectors on the interconnect cables whenever an inspection is performed on other station equipment.

Because the system is composed of 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 subassembly should be returned to the factory for repair. Due to the critical alignment of parts within these subassemblies field repair is not recommended.

TUNING & RETUNING

The filters and isolators are factory tuned to the customers specified transmit frequencies. Changes in the transmit frequencies may require retuning.

Tuning of the cavity filter is always required when changing channel frequencies. Tuning of the isolator is only necessary when the channel frequency changes by more that 1 MHz from the original. One other frequency restriction is that there is a minimum frequency separation between combiner channels. This means that there can not be two channels on the same frequency assignment and that no two channels may be closer together than 150 kHz.

WARNING

DO NOT adjust system components while under transmit power.

Cavity Tuning

The pass frequency is the only recommended field adjustable parameter in the cavity filter. Adjustment of the tuning rods will allow the passband to be centered at the desired frequency. The insertion loss of the cavity is determined by the position of its loop plates and is not field adjustable. The loop plates on the cavities used in the transmit combiner system should never be loosened or moved from

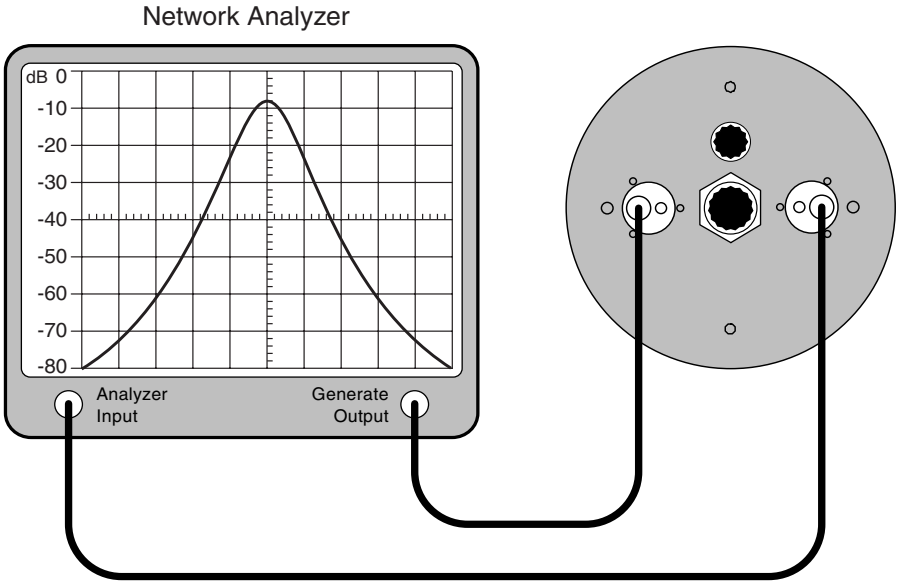


Figure 3: Configuration for tuning of pass frequency.

their factory preset positions. The systems interconnect cables are critical in length and must not be changed.

Due to the sensitivity of the adjustments, it is recommended that the proper equipment be used when tuning the filters and the work be performed by a qualified technician familiar with the system. Otherwise the filters should be sent to the factory or a factory authorized representative for retuning. Cavities can be field tuned if a network analyzer or spectrum analyzer with a tracking generator is available.

1) Connect the equipment as in **Figure 3.** Set the center frequency of the analyzer to the desired pass frequency.

2) Set the fine tuning knob at it's mid-point. Adjust the pass frequency by setting the peak (minimum loss value) of the response curve to the desired frequency. The resonant frequency is adjusted by using the coarse tuning rod, which is a sliding adjustment (invar rod) that rapidly tunes the filter's response curve. The resonant frequency is increased by pulling the rod out of the cavity and is decreased by pushing the rod into the cavity. Additionally, the fine tuning rod, also a sliding adjustment (silver-plated-brass rod), allows a more precise setting of the response curve after the coarse adjustment is made. The resonant frequency is increased by pushing the fine tuning rod in and is decreased by pulling it out, the exact opposite of the coarse tuning rod.

3) Once the desired response is obtained using the coarse and fine tuning rods, they are locked in place. The coarse rod is secured by tightening the 10-32 cap screw and the fine tuning rod is held in place by tightening the knurled thumb nut. **Failure to lock the tuning rods** will cause a loss of temperature compensation and detuning of the cavity.

Cavity Tuning Tip

When tuning a cavity that has been in service for some time it is not unusual to find the main tuning rod hard to move in or out. This occurs because because TX RX Systems Inc. uses construction techniques borrowed from microwave technology that provide large area contact surfaces on our tuning probes. These silver plated surfaces actually form a pressure weld that maintains excellent conductivity. The pressure weld develops over time and must be broken in order for the main tuning rod to move. This is easily accomplished by gently tapping the tuning rod with a plastic screwdriver handle or small hammer so it moves into the cavity. The pressure weld will be broken with no damage to the cavity.

Isolator Tuning

It is recommended that a network analyzer be used in the tuning of isolators. A spectrum analyzer with tracking generator may be used if a network analyzer is not available. The procedure listed below demonstrates the use of the IFR Model A-7550 spectrum analyzer/tracking generator and Eagle RLB-150 Return Loss Bridge (35 dB directivity). There are three (3) variable capacitors located on an isolator. Each will have to be adjusted in order to "peak" the isolators return loss, passband symmetry, and reverse isolation. To insure proper tuning all adjustments should be performed in a step by step fashion.

PROCEDURE

It is necessary to be able to set zero references for both return loss and reverse isolation measurements in order to determine if specifications are being met. This procedure is not outlined in the A-7550 spectrum analyzers operating manual but consists of using the "STORE" trace function in order to save the reference trace level and then putting the A-7550 into the reference mode which makes this stored trace the zero reference.

Setting the Zero dB Insertion Loss Reference requires a female barrel connector to be connected between the analyzer input and the generator output leads. When setting the Zero dB Return Loss Reference the return loss bridge is connected to the A-7550 spectrum analyzer but the LOAD port is left open. After this reference is set the bridge can be connected to the isolator to perform the described measurement.

HOT SURFACE: The isolator loads can get extremely hot while in operation. This can occur when an antenna system component fails causing high reflected power which is then dissipated by the isolator load. These loads can get hot enough to burn your skin so **USE CAUTION** when servicing these units.

1) Set the A-7550 spectrum analyzer for the desired frequency and bandwidth. Adjust for a 10 dB per division vertical scale.

2) Set a Zero dB Return Loss Reference by connecting the RLB-150 bridge to the analyzer/ generator but remember to leave the load port open while setting up this reference.

a) *Make sure that the unit is in "LIVE" mode.*

b) From the Mode Menu, "STORE" the trace.

c) Switch to the Display Menu and select "REF". The trace should appear at the 0 dB level.

3) Remove the capacitor covers. Note that the cover for capacitor #3 is a phillips-head screw.

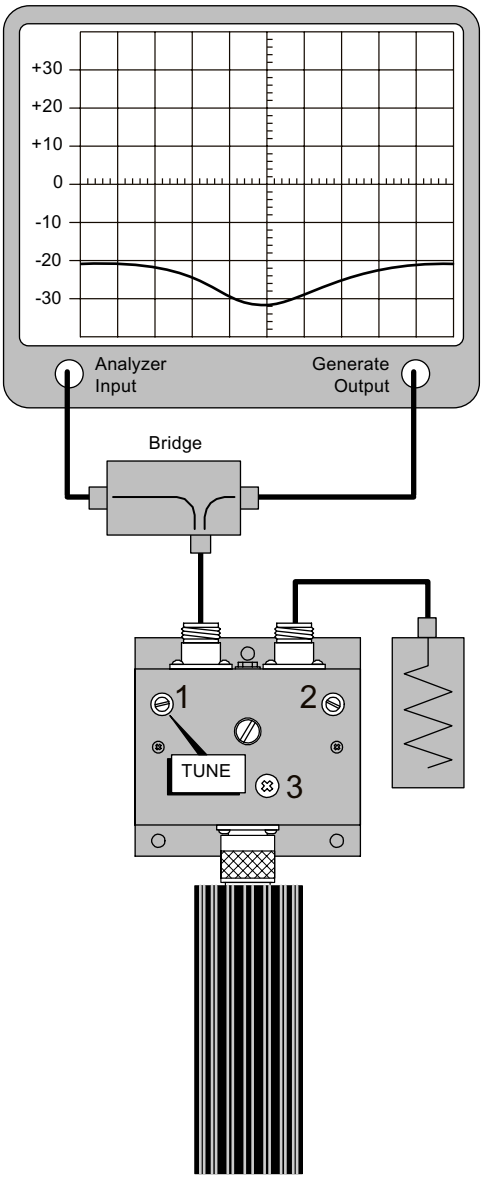


Figure 4: Tuning for max return loss (in port).

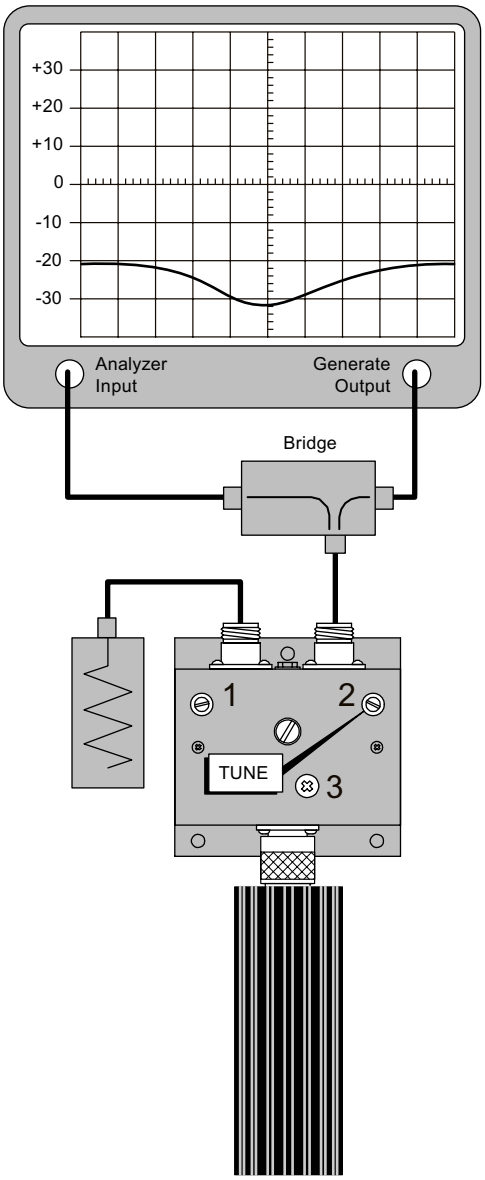


Figure 5: Tuning for max return loss (out port).

4) With the equipment connected as in **Figure 4**, adjust tuning capacitor #1 for maximum return loss at the desired center frequency.

5) Reversing the bridge and load connections as shown in **Figure 5**, adjust capacitor #2 for maximum return loss at the desired center frequency.

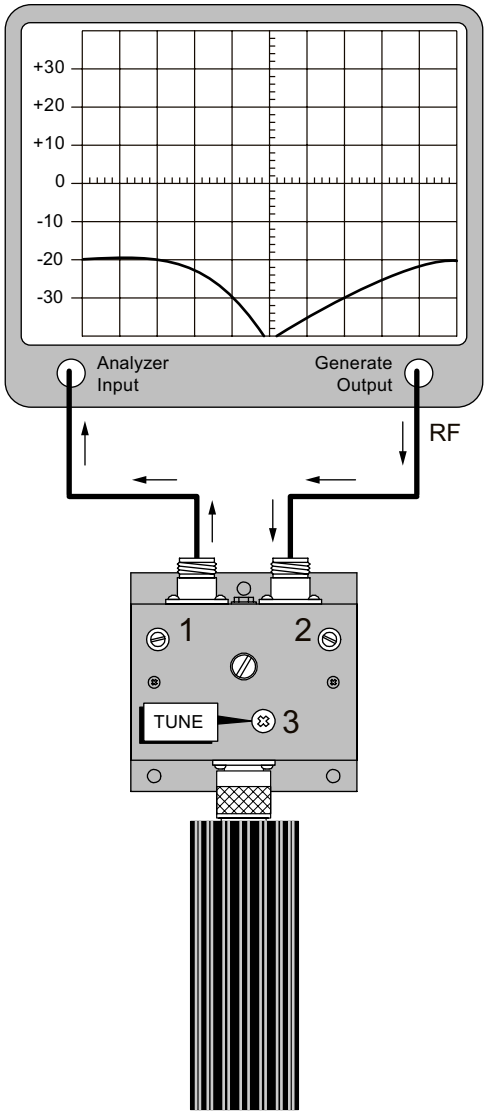


Figure 6: Tuning for reverse isolation.

6) Set the A-7550 spectrum analyzer for a 2 dB per division vertical scale.

7) Set a Zero dB Insertion Loss Reference by temporarily connecting a female barrel connector (UG29-N or UG914-N) between the two test leads.

a) *Make sure that the unit is in "LIVE" mode.*

b) From the Mode Menu, "STORE" the trace.

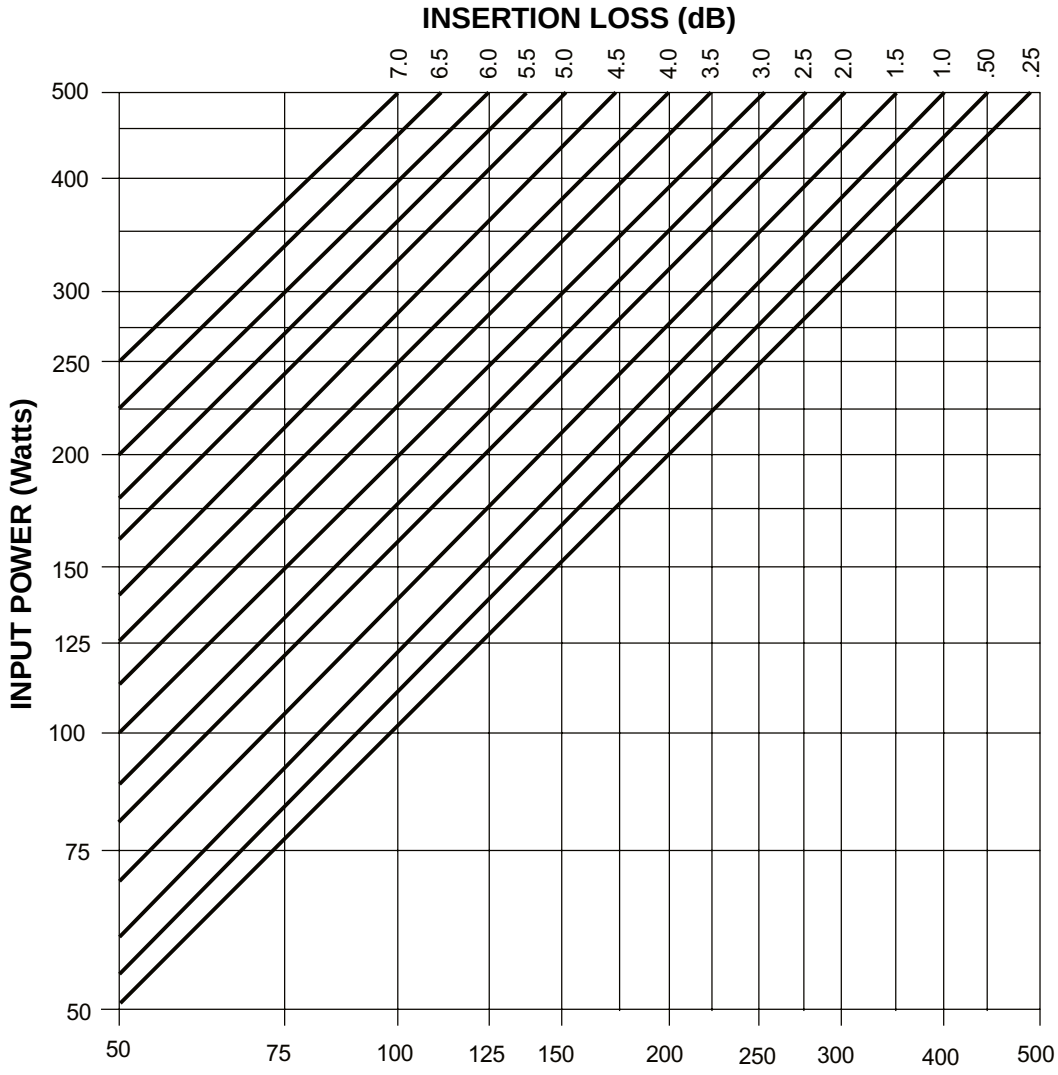
c) Switch to the Display Menu and select "REF". The trace should appear at the 0 dB level.

8) Connect the equipment as shown in **Figure 6** and adjust capacitor #3 for maximum attenuation (reverse isolation).

9) Replace the capacitor dust covers. The isolator is now ready for use.

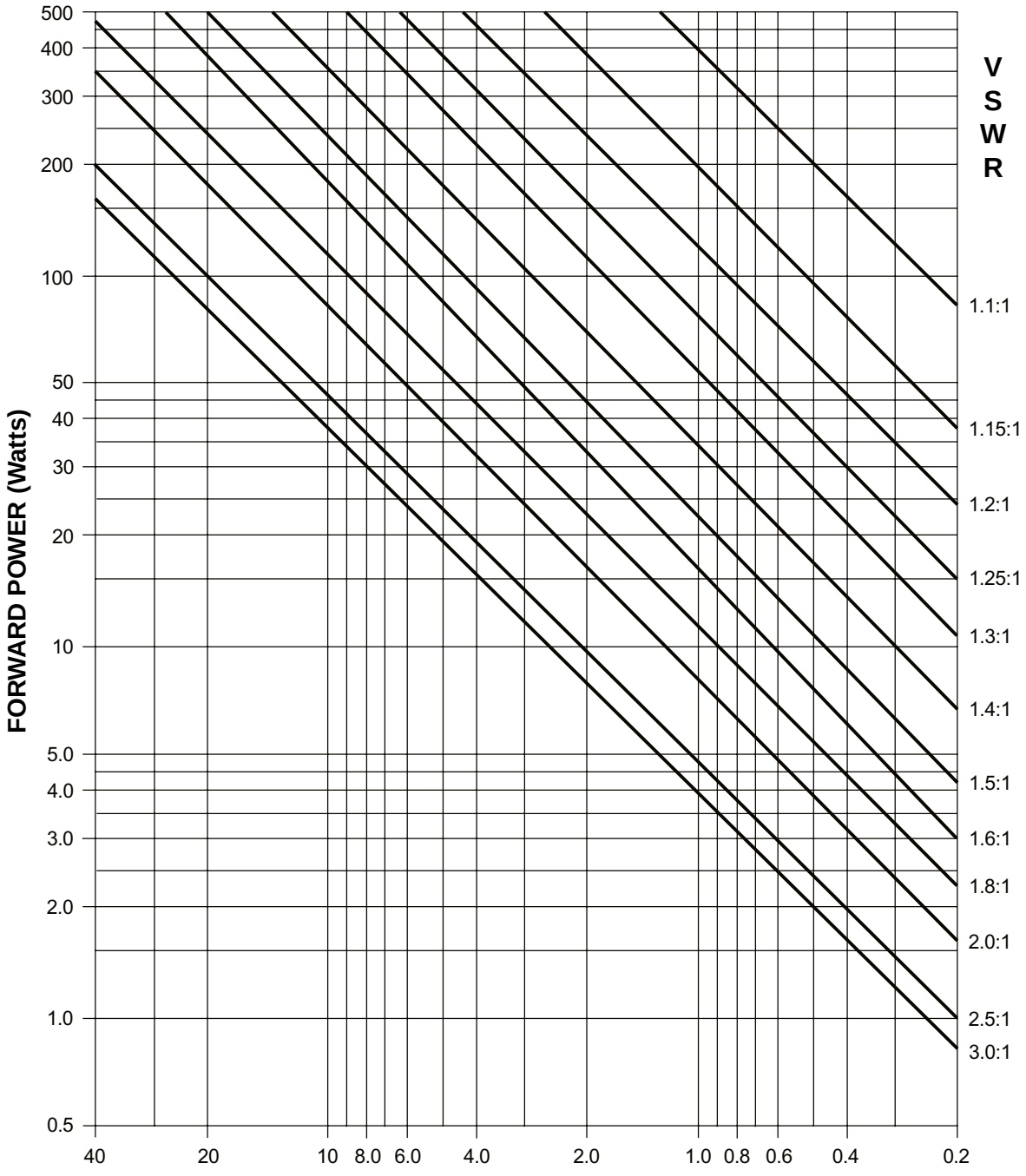
POWER IN/OUT
VS
INSERTION LOSS

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.



FOR LOWER POWER LEVELS
DIVIDE BOTH SCALES
BY 10 (5 TO 50 WATTS)

POWER FWD./REV.
VS
VSWR



FOR OTHER POWER LEVELS
MULTIPLY BOTH SCALES
BY THE SAME MULTIPLIER

TX RX Systems Inc.

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

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