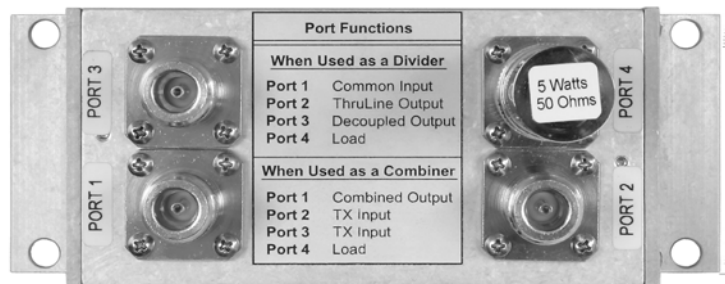




## Instruction Manual for Hybrid Directional Couplers Model Number 85-05/38/58/83-XX

Manual Part Number

7-9284-3



# Warranty

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***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.

## TERMS AND CONDITIONS OF SALE

### ***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.


<b>Manual Part Number 7-9284</b> <b>Copyright © 2006 TX RX Systems, Inc.</b> First Printing: August 2001	
Version Number	Version Date
1	08/08/01
2	01/20/06
3	02/28/06


***Symbols Commonly Used***



**WARNING**



**ESD Electrostatic Discharge**



**CAUTION or ATTENTION**


**Hot Surface**


**High Voltage**


**Electrical Shock Hazard**


**Use Safety Glasses**


**Important Information**



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## GENERAL DESCRIPTION

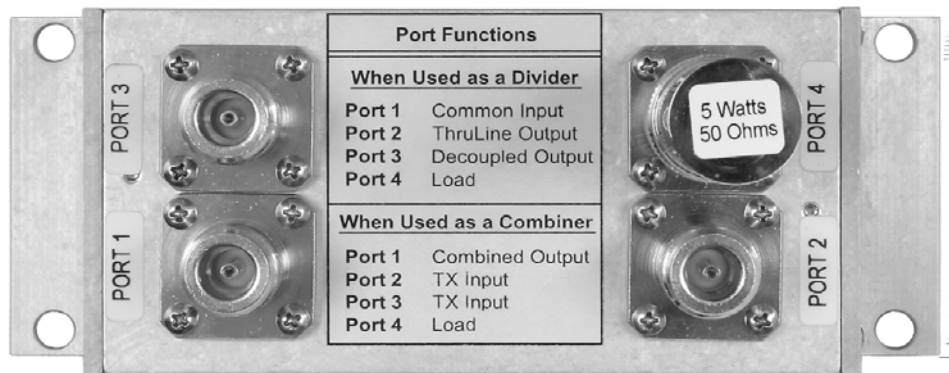
Hybrid Directional Couplers are intended for use as either power dividers/splitters or as transmitter combiners in 50-ohm transmission line systems. A hybrid coupler is a directional coupler with one of the 4 ports terminated with 50 Ohms, see **Figure 1**. TX RX hybrid couplers can be used bi-directionally, they provide very low loss (above the design coupling value) and typically provide -25 dB of port isolation. Isolated ports are 1-4 and 2-3. TX RX hybrid couplers are available in various related coupling losses that can be used to build a progressive hybrid combining system of 3 to N outputs with no unused outputs for any value of N, thus minimizing and balancing insertion losses. The couplers can be used for low or high power applications, depending on the load specified. 5 Watt loads are standard but when the coupler is used as a transmitter combiner the load size should equal or exceed the transmitter output power. Larger loads may be cabled to the coupler to handle situations with large reflected power.

TX RX hybrid couplers are available in three bands including VHF (132-174 MHz), UHF (350-520 MHz), and 800/900 (746-960 MHz). In addition harmonic hybrids are available that will work on all 3 bands simultaneously for use in complex multiband systems. Couplers are supplied under different model numbers for different splitting or decoupling ratios, as shown in **Tables 2 through 5**. The splitting or decoupling loss is fixed by construction as is the thru-line loss. A fourth connector (port 4) is always terminated in 50 ohms for proper operation, refer to **Figure 2 through 5**.

Energy coming out of the Decoupled Port is always attenuated by the amount (dB) shown in the tables under coupling levels. Conversely, energy coupled into the thru-line from the decoupled port is attenuated by the same amount. It is **important to note** that the coupling levels shown in the tables are only accurate for power flowing along the thru-line ports as indicated by the arrow. Insertion loss is called thru-line loss for these devices and is also shown in the tables. Coupling levels and thru-line loss tolerance is typically +/- 0.25 dB for couplers up to -7 dB decoupling and +/- 0.50 dB for couplers with greater than -7 dB decoupling. Specification accuracy is typically +/- 7% power rating (excluding load) 350 Watts, 500 Watts for 85-83-XX series. The split ratio and power split percentage for all of the available coupling levels is shown in **Table 1**.

Coupling Levels (dB)	Split Ratio thru-line:decoupled	Power Split % thru-line:decoupled
-3.0	1:1	50:50
-4.8	2:1	66:33
-6.0	3:1	75:25
-7.0	4:1	80:20
-10.0	9:1	90:10
-15.0	30:1	97:3
-20.0	99:1	99:1
-30.0	999:1	99:0.1

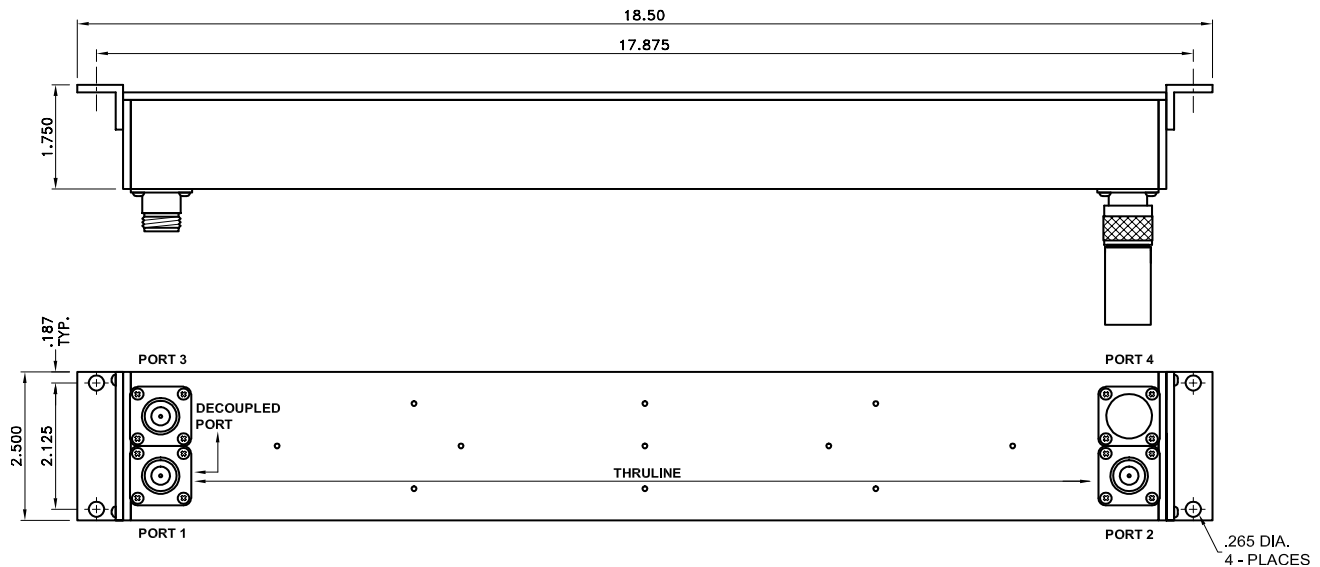
**Table 1: Split ratios and power split %.**



**Figure 1:** Typical TX RX Hybrid Combiner. Model 85-85-01 shown as an example.

VHF, UHF and 800 MHz Harmonic 144 - 174 MHz, 450 - 530 MHz, 806 - 890 MHz						
Coupling Levels (dB)	Thruline Loss (dB)	5-Watt Load	25-Watt Load	Load Deleted	Dimensions (in.)	
		Model Number (2.8 lbs.)	Model Number (3.2 lbs.)	Model Number (2.6 lbs.)	'A'	'B'
		-3.0	-3.0	85-05-01		
-4.8	-1.8	85-05-02	85-05-0201	85-05-02-LT	18.5	17.875
-6.0	-1.2	85-05-03	85-05-0301	85-05-03-LT	18.5	17.875
-7.0	-1.0	85-05-04	85-05-0401	85-05-04-LT	18.5	17.875
-10.0	-0.5	85-05-05	85-05-0501	85-05-05-LT	18.5	17.875
-15.0	-0.2	85-05-06	85-05-0601	85-05-06-LT	18.5	17.875
-20.0	-0.2	85-05-07	85-05-0701	85-05-07-LT	18.5	17.875
-30.0	-0.2	85-05-08	85-05-0801	85-05-08-LT	18.5	17.875

**Table 2:** Specifications for the 85-05 series couplers.

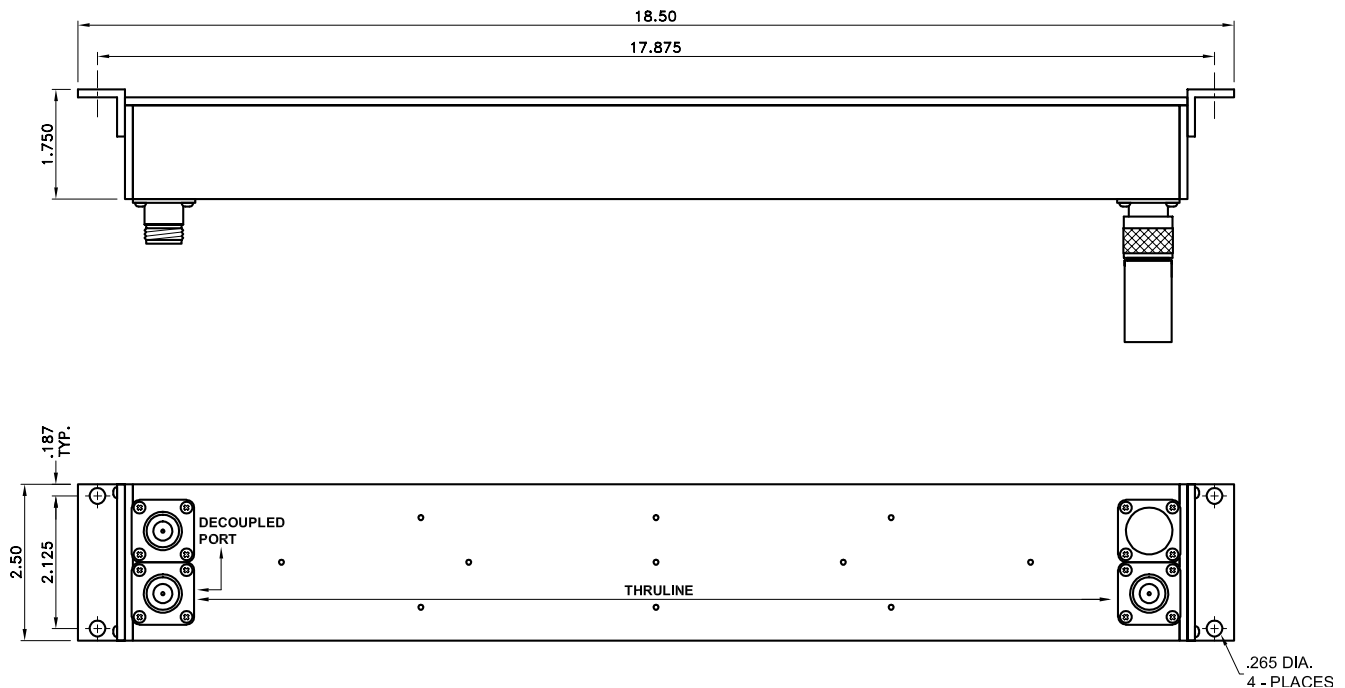


**Figure 2:** Physical dimensions of the 85-05 series couplers.



VHF 132 - 174 MHz						
Coupling Levels (dB)	Thruline Loss (dB)	5-Watt Load	25-Watt Load	Load Deleted	Dimensions (in.)	
		Model Number (2.8 lbs.)	Model Number (3.2 lbs.)	Model Number (2.6 lbs.)	'A'	'B'
-3.0	-3.0	85-38-01	85-38-0101	85-38-01-LT	18.5	17.875
-4.8	-1.8	85-38-02	85-38-0201	85-38-02-LT	18.5	17.875
-6.0	-1.2	85-38-03	85-38-0301	85-38-03-LT	18.5	17.875
-7.0	-1.0	85-38-04	85-38-0401	85-38-04-LT	18.5	17.875
-10.0	-0.5	85-38-05	85-38-0501	85-38-05-LT	18.5	17.875

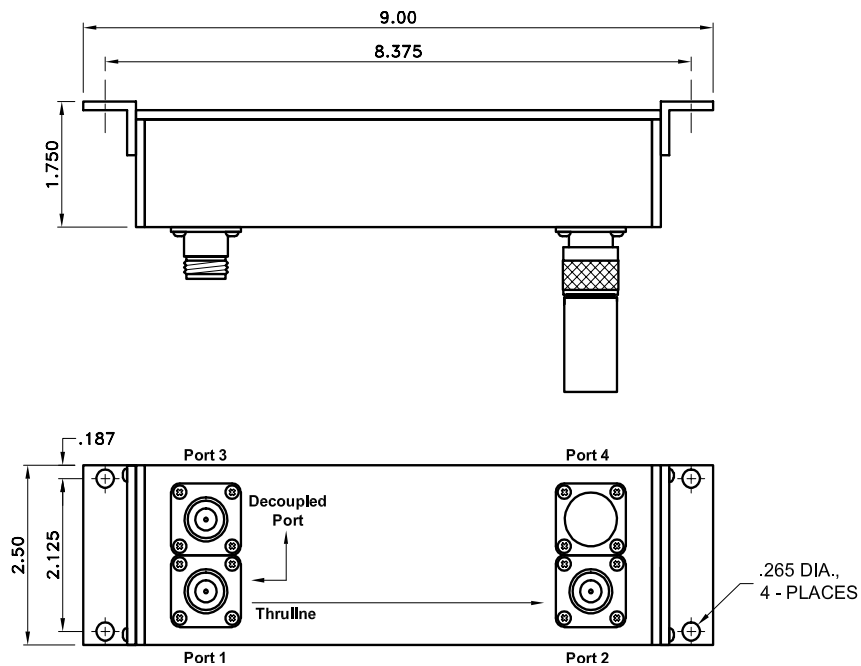
**Table 3:** Specifications for the 85-38 series couplers.



**Figure 3:** Physical dimensions of the 85-38 series couplers.

UHF 350-520 MHz						
Coupling Levels (dB)	Thruline Loss (dB)	5-Watt Load	25-Watt Load	Load Deleted	Dimensions (in.)	
		Model Number (1.6 lbs)	Model Number (2.0 lbs)	Model Number (1.4 lbs)	'A'	'B'
-3.0	-3.0	85-58-01	85-58-0101	85-58-01-LT	9.0	8.375
-4.8	-1.8	85-58-02	85-58-0201	85-58-02-LT	9.0	8.375
-6.0	-1.2	85-58-03	85-58-0301	85-58-03-LT	9.0	8.375
-7.0	-1.0	85-58-04	85-58-0401	85-58-04-LT	9.0	8.375
-10.0	-0.5	85-58-05	85-58-0501	85-58-05-LT	9.0	8.375
-15.0	-0.2	85-58-06	85-58-0601	85-58-06-LT	9.0	8.375
-20.0	-0.2	85-58-07	85-58-0701	85-58-07-LT	9.0	8.375
-30.0	-0.2	85-58-08	85-58-0801	85-58-08-LT	9.0	8.375

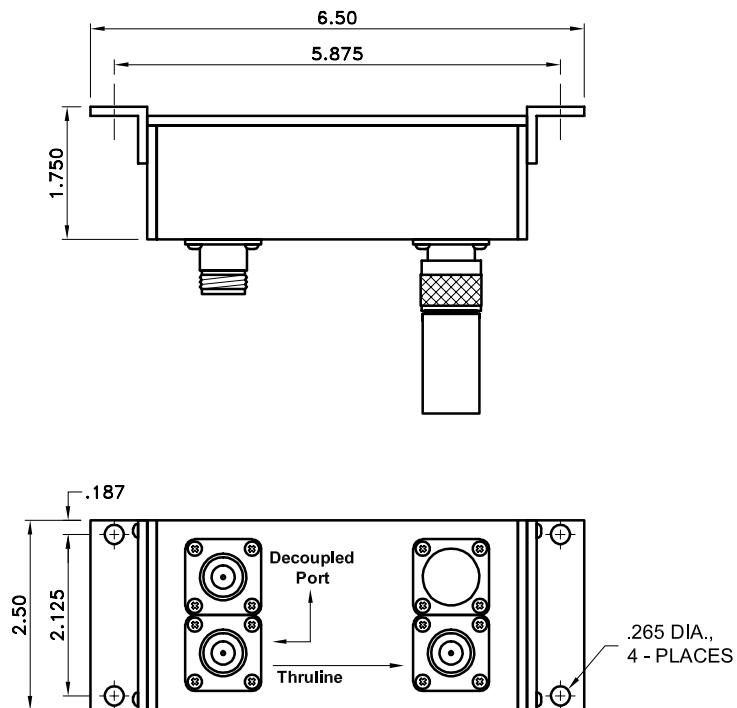
**Table 4:** Specifications for the 85-58 series couplers.



**Figure 4:** Physical layout of the 85-58 series couplers.

800 MHz 746-960 MHz						
Coupling Levels (dB)	Thruline Loss (dB)	5-Watt Load	25-Watt Load	Load Deleted	Dimensions (in.)	
		Model Number (1.6 lbs)	Model Number (2.0 lbs)	Model Number (1.4 lbs)	'A'	'B'
-3.0	-3.0	85-83-01	85-83-0101	85-83-01-LT	6.5	5.875
-4.8	-1.8	85-83-02	85-83-0201	85-83-02-LT	6.5	5.875
-6.0	-1.2	85-83-03	85-83-0301	85-83-03-LT	6.5	5.875
-7.0	-1.0	85-83-04	85-83-0401	85-83-04-LT	6.5	5.875
-10.0	-0.5	85-83-05	85-83-0501	85-83-05-LT	6.5	5.875
-15.0	-0.2	85-83-06	85-83-0601	85-83-06-LT	6.5	5.875
-20.0	-0.2	85-83-07	85-83-0701	85-83-07-LT	6.5	5.875
-30.0	-0.2	85-83-08	85-83-0801	85-83-08-LT	6.5	5.875

**Table 5:** Specifications for the 85-83 series couplers.



**Figure 5:** Physical dimensions for the 85-83 series couplers.

# Power Ratio and Voltage Ratio to Decibel Conversion Chart

Loss or Gain	Power Ratio	Voltage Ratio
+9.1 dB	8.128	2.851
-9.1 dB	0.123	0.351

← - dB + →

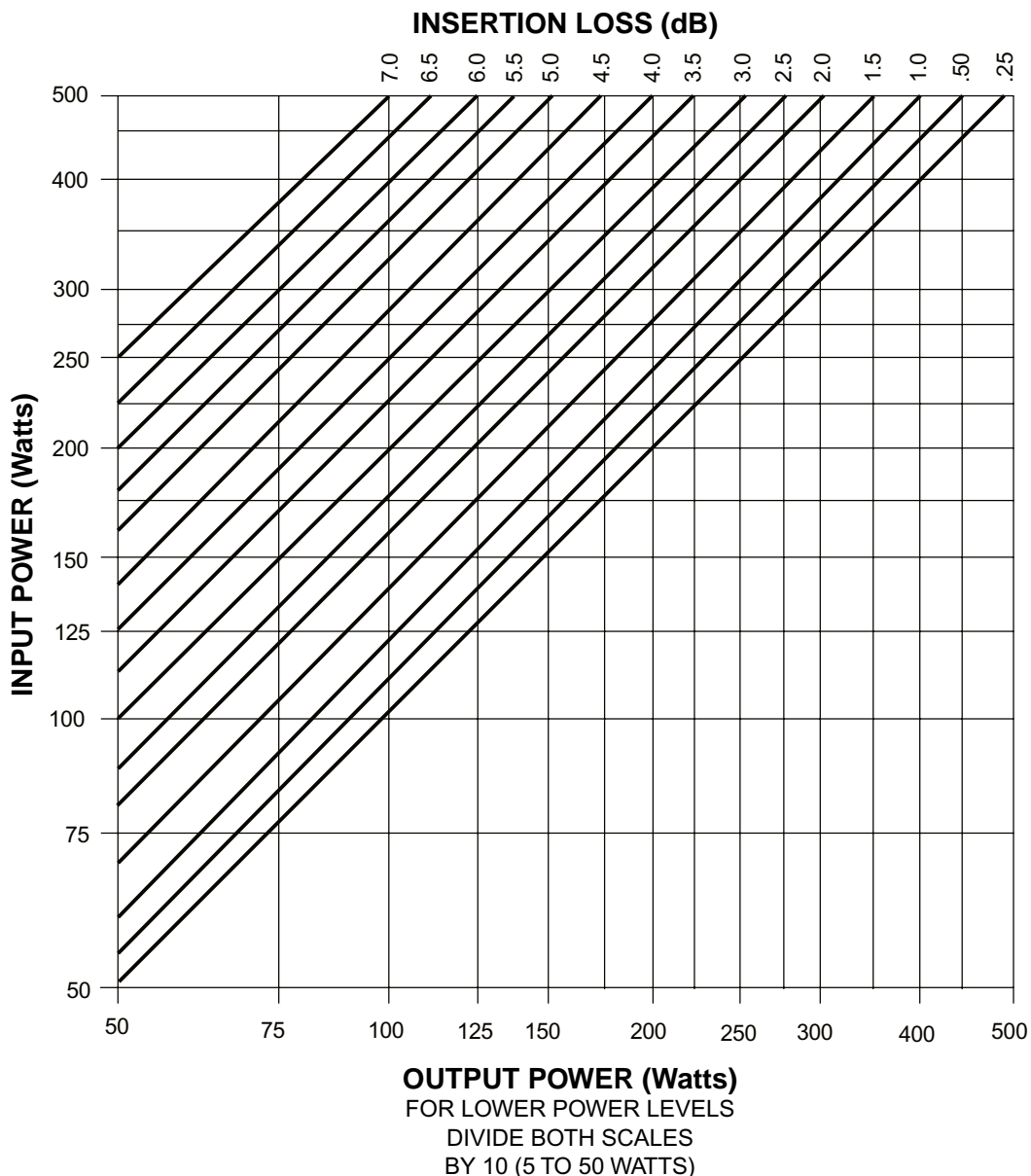
← - dB + →

Voltage Ratio	Power Ratio	dB	Voltage Ratio	Power Ratio
1	1	0	1	1
0.989	0.977	0.1	1.012	1.023
0.977	0.955	0.2	1.023	1.047
0.966	0.933	0.3	1.035	1.072
0.955	0.912	0.4	1.047	1.096
0.944	0.891	0.5	1.059	1.122
0.933	0.871	0.6	1.072	1.148
0.923	0.851	0.7	1.084	1.175
0.912	0.832	0.8	1.096	1.202
0.902	0.813	0.9	1.109	1.23
0.891	0.794	1	1.122	1.259
0.881	0.776	1.1	1.135	1.288
0.871	0.759	1.2	1.148	1.318
0.861	0.741	1.3	1.161	1.349
0.851	0.724	1.4	1.175	1.38
0.841	0.708	1.5	1.189	1.413
0.832	0.692	1.6	1.202	1.445
0.822	0.676	1.7	1.216	1.479
0.813	0.661	1.8	1.23	1.514
0.804	0.646	1.9	1.245	1.549
0.794	0.631	2	1.259	1.585
0.785	0.617	2.1	1.274	1.622
0.776	0.603	2.2	1.288	1.66
0.767	0.589	2.3	1.303	1.698
0.759	0.575	2.4	1.318	1.738
0.75	0.562	2.5	1.334	1.778
0.741	0.55	2.6	1.349	1.82
0.733	0.537	2.7	1.365	1.862
0.724	0.525	2.8	1.38	1.905
0.716	0.513	2.9	1.396	1.95
0.708	0.501	3	1.413	1.995
0.7	0.49	3.1	1.429	2.042
0.692	0.479	3.2	1.445	2.089
0.684	0.468	3.3	1.462	2.138
0.676	0.457	3.4	1.479	2.188
0.668	0.447	3.5	1.496	2.239
0.661	0.437	3.6	1.514	2.291
0.653	0.427	3.7	1.531	2.344
0.646	0.417	3.8	1.549	2.399
0.638	0.407	3.9	1.567	2.455
0.631	0.398	4	1.585	2.512
0.624	0.389	4.1	1.603	2.57
0.617	0.38	4.2	1.622	2.63
0.61	0.372	4.3	1.641	2.692
0.603	0.363	4.4	1.66	2.754
0.596	0.355	4.5	1.679	2.818
0.589	0.347	4.6	1.698	2.884
0.582	0.339	4.7	1.718	2.951
0.575	0.331	4.8	1.738	3.02
0.569	0.324	4.9	1.758	3.09

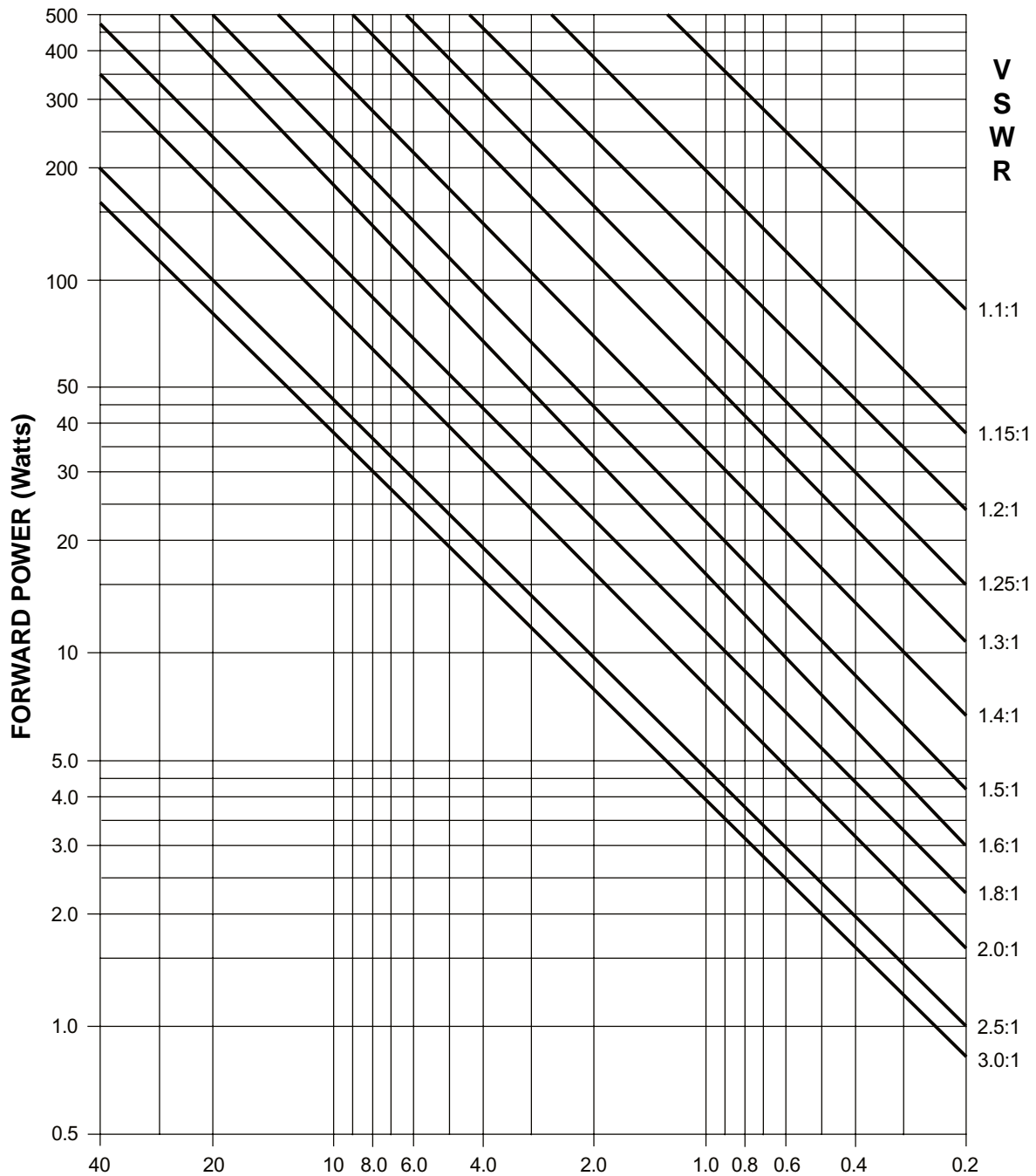
Voltage Ratio	Power Ratio	dB	Voltage Ratio	Power Ratio
0.562	0.316	5	1.778	3.162
0.556	0.309	5.1	1.799	3.236
0.55	0.302	5.2	1.82	3.311
0.543	0.295	5.3	1.841	3.388
0.537	0.288	5.4	1.862	3.467
0.531	0.282	5.5	1.884	3.548
0.525	0.275	5.6	1.905	3.631
0.519	0.269	5.7	1.928	3.715
0.513	0.263	5.8	1.95	3.802
0.507	0.257	5.9	1.972	3.89
0.501	0.251	6	1.995	3.981
0.496	0.246	6.1	2.018	4.074
0.49	0.24	6.2	2.042	4.169
0.484	0.234	6.3	2.065	4.266
0.479	0.229	6.4	2.089	4.365
0.473	0.224	6.5	2.113	4.467
0.468	0.219	6.6	2.138	4.571
0.462	0.214	6.7	2.163	4.677
0.457	0.209	6.8	2.188	4.786
0.452	0.204	6.9	2.213	4.898
0.447	0.2	7	2.239	5.012
0.442	0.195	7.1	2.265	5.129
0.437	0.191	7.2	2.291	5.248
0.432	0.186	7.3	2.317	5.37
0.427	0.182	7.4	2.344	5.495
0.422	0.178	7.5	2.371	5.623
0.417	0.174	7.6	2.399	5.754
0.412	0.17	7.7	2.427	5.888
0.407	0.166	7.8	2.455	6.026
0.403	0.162	7.9	2.483	6.166
0.398	0.159	8	2.512	6.31
0.394	0.155	8.1	2.541	6.457
0.389	0.151	8.2	2.57	6.607
0.385	0.148	8.3	2.6	6.761
0.38	0.145	8.4	2.63	6.918
0.376	0.141	8.5	2.661	7.079
0.372	0.138	8.6	2.692	7.244
0.367	0.135	8.7	2.723	7.413
0.363	0.132	8.8	2.754	7.586
0.359	0.129	8.9	2.786	7.762
0.355	0.126	9	2.818	7.943
0.351	0.123	9.1	2.851	8.128
0.347	0.12	9.2	2.884	8.318
0.343	0.118	9.3	2.917	8.511
0.339	0.115	9.4	2.951	8.71
0.335	0.112	9.5	2.985	8.913
0.331	0.11	9.6	3.02	9.12
0.327	0.107	9.7	3.055	9.333
0.324	0.105	9.8	3.09	9.55
0.32	0.102	9.9	3.126	9.772

# 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



**REFLECTED POWER (Watts)**

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

$\text{dBm} = 10\log P/1\text{mW}$   
Where P = power (Watt)

**Insertion Loss**

Input Power (Watts)

Insertion Loss	50	75	100	125	150	200	250	300
	25	38	50	63	75	100	125	150
	2.5	28	42	56	70	84	112	169
	2	32	47	63	79	95	126	189
	1.5	35	53	71	88	106	142	212
	1	40	60	79	99	119	159	238
	.5	45	67	89	111	134	178	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	104
	220	71	77	81	83	89	97	107
	460	78	84	87	90	96	104	113
	860	83	89	93	95	101	109	119
	940	84	90	94	96	102	110	120
	1920	90	96	100	102	108	116	126

Free Space Loss (dB)

Free space loss =  $36.6 + 20\log D + 20\log F$   
Where D = distance in miles and F = frequency in MHz

