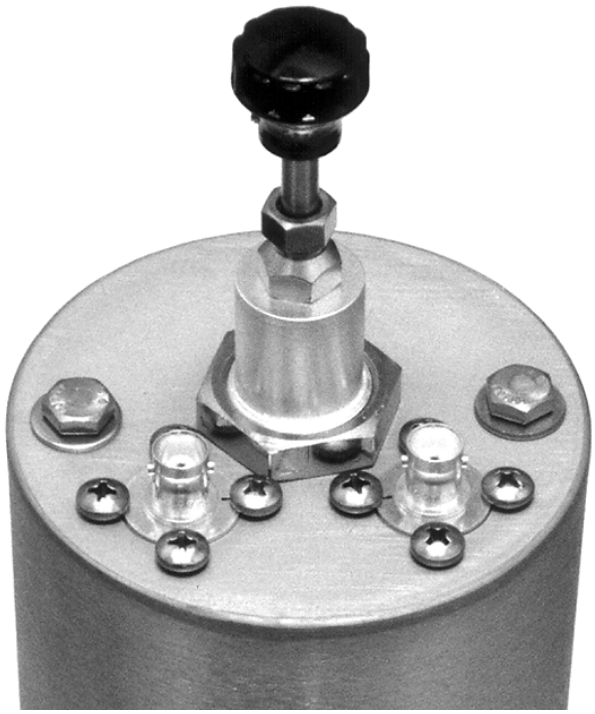
Instruction Manual for
Bandpass Cavity Filters
4” Diameter

Manual Part Number

7-9151



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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.

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.

Manual Part Number 7-9151

First Printing: October 1996

Version Number	Version Date
1	10/18/96
2	01/31/07

Symbols Commonly Used

WARNING

ESD Elecrostatic Discharge

CAUTION or ATTENTION

Hot Surface

High Voltage

Electrical Shock Hazard

Use Safety Glasses

Important Information

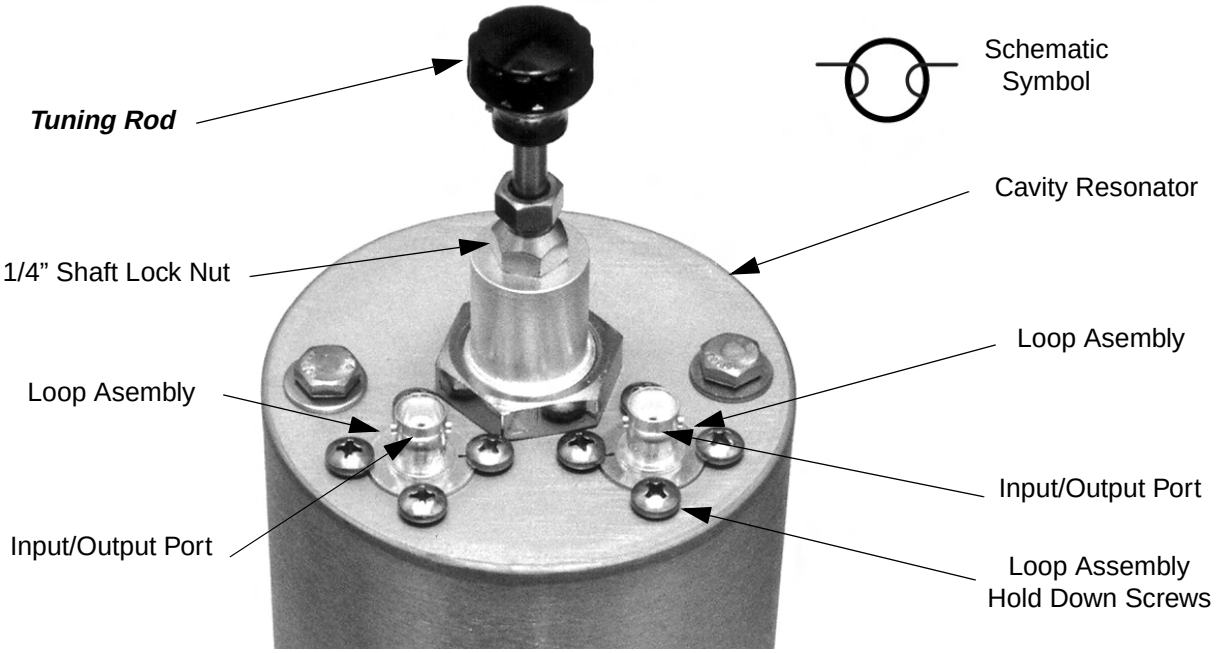


Figure 1: The 4” Bandpass filter.

GENERAL DESCRIPTION

The Bandpass cavity filter passes one narrow band of frequencies (***passband***) and attenuates all others with increasing attenuation above and below the pass frequency. The insertion loss setting determines the filters selectivity and maximum power handling capability. Insertion loss is set at the factory and should not be adjusted in the field. A variety of models are available that cover the range of frequencies from 132 to 960 MHz. The portion of the frequency range that each model will tune across is determined by the cavity's physical length. All of the physical components of the filter are labeled in **Figure 1**, with the adjustable parts shown in emboldened italics.

TUNING

Required Equipment

The following equipment or its equivalent is recommended in order to properly perform the tuning adjustments for the Bandpass filter.

1. IFR A-7550 Spectrum Analyzer with optional Tracking Generator installed.

2. Double shielded coaxial cable test leads (RG142 B/U or RG223/U).

3. 1/4" open-ended wrench.

Tuning Procedure

Tuning of the filter requires adjustment of the (resonant) *pass frequency* which is adjusted by monitoring the output of a tracking generator after it passes through the filter.

1. Setup the analyzer / generator for the desired frequency and bandwidth (center of display) and also a vertical scale of 2 dB/div.

2. The resonant frequency of the filter is checked by connecting the tracking generator to the input of the cavity filter while the spectrum analyzer is connected to the output, as shown in **Figure 2**.

3. Insure the IFR A-7550 menu's are set as follows:
   DISPLAY - line
   MODE - live
   FILTER - none
   SETUP - 50 ohm/dBm/gen1.

4. Adjust the pass frequency by setting the peak (minimum loss value) of the response curve to the desired frequency (should be the center-vertical tragically line on the IFR A-7550's display). See figure 2. The resonant frequency is adjusted by using the tuning rod, which is a sliding adjustment (invar rod) that rapidly tunes the

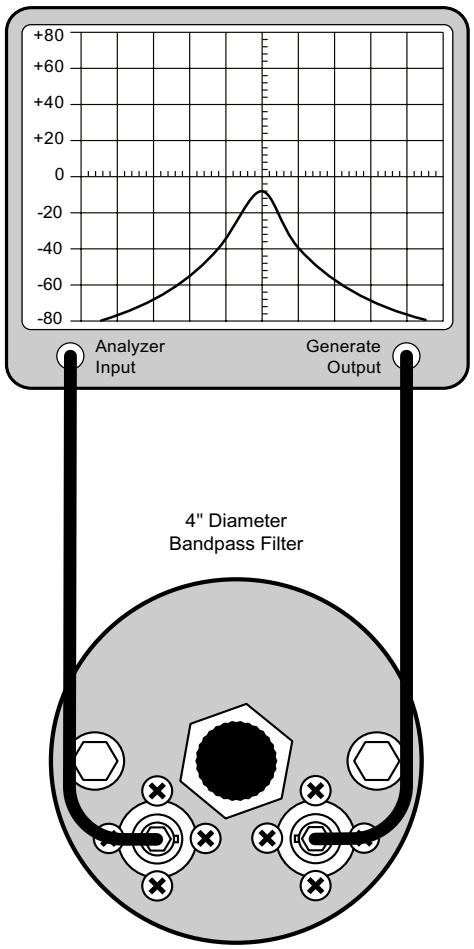


Figure 2: Checking Cavity Tuning.
Response curve shown for model 11-52-01.

filter's response curve. The resonant frequency is increased by pulling the rod out of the cavity and is decreased by pushing it into the cavity. For ease in making adjustments, rotate and slide the rod while gently tapping on it with a screwdriver or other small tool. This will break the surface tension on the probe contact fingers and allow smoother movement of the tuning rod.

5. Once the desired response is obtained using the tuning rod, it is "locked" into place by tightening the 1/4" shaft lock nut. **Failure to lock the tuning rod** will cause a loss of temperature compensation and detuning of the cavity.

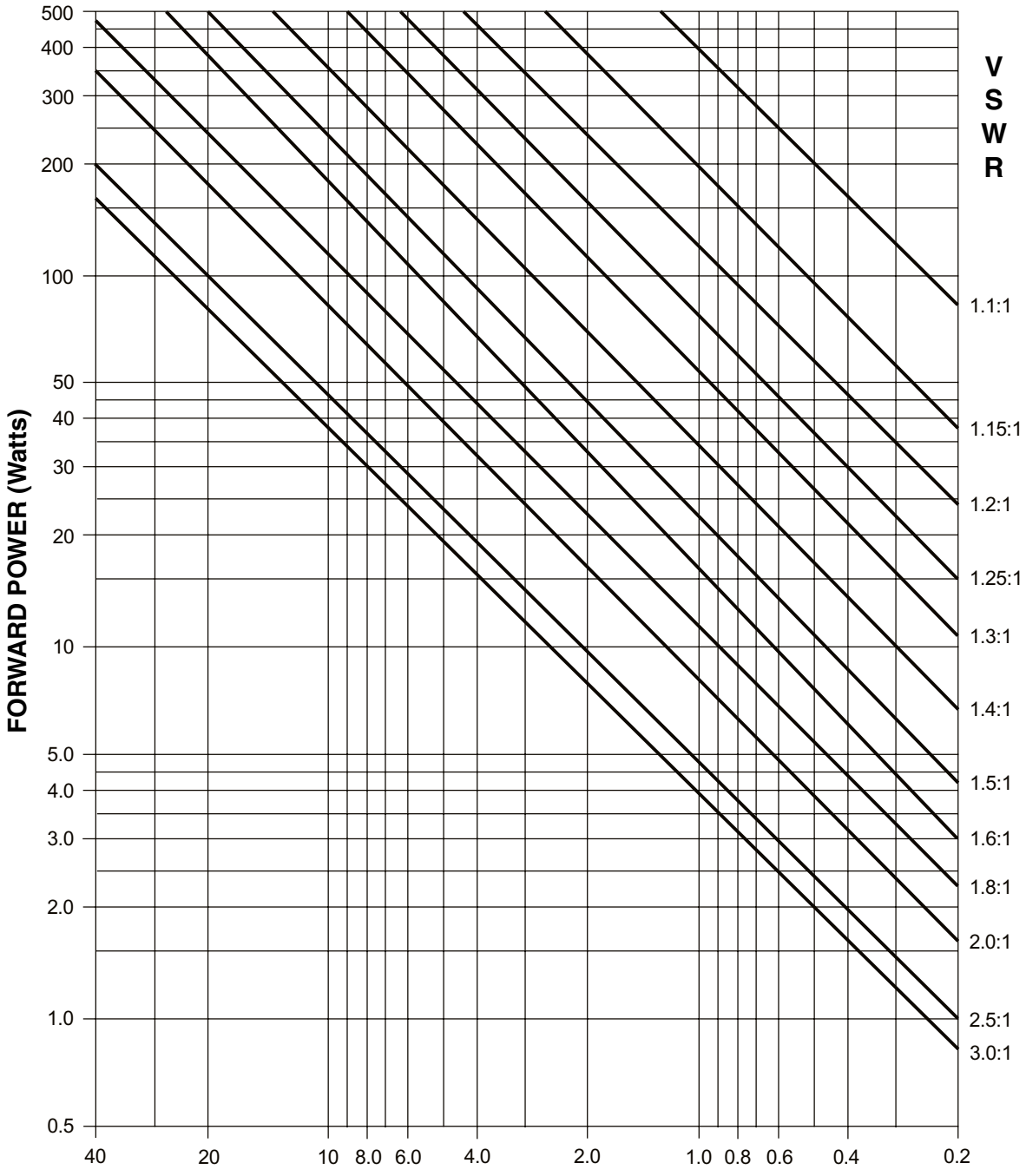
MULTIPLE CAVITY BANDPASS FILTERS

Bandpass filters can be ordered in multiple cavity arrangements of either two or three combined cavities. The filters are connected in a cascaded fashion with the output of each filter fed to the input port of the succeeding filter. The advantage of this is that the amount of attenuation provided by each of the filters is additive.

The interconnecting cable between the two filters, when cut to the correct length (odd multiple of 1/4 wavelength), will provide up to 6 dB of additional attenuation due to a mismatch of impedance between the cable and the filters. The 6 dB of mismatch attenuation does not occur at the filters passband but, only at frequencies where moderate to high attenuation occurs.

Because each of the filters in the multi-cavity arrangement are identical, the passband for the entire arrangement is generally the same as the passband for the individual filters. However, each filters individual insertion loss is also additive. When tuning a multi-cavity arrangement, each filter is tuned individually prior to interconnecting them. Then each is fine tuned to peak the overall response of the multi-cavity arrangement.

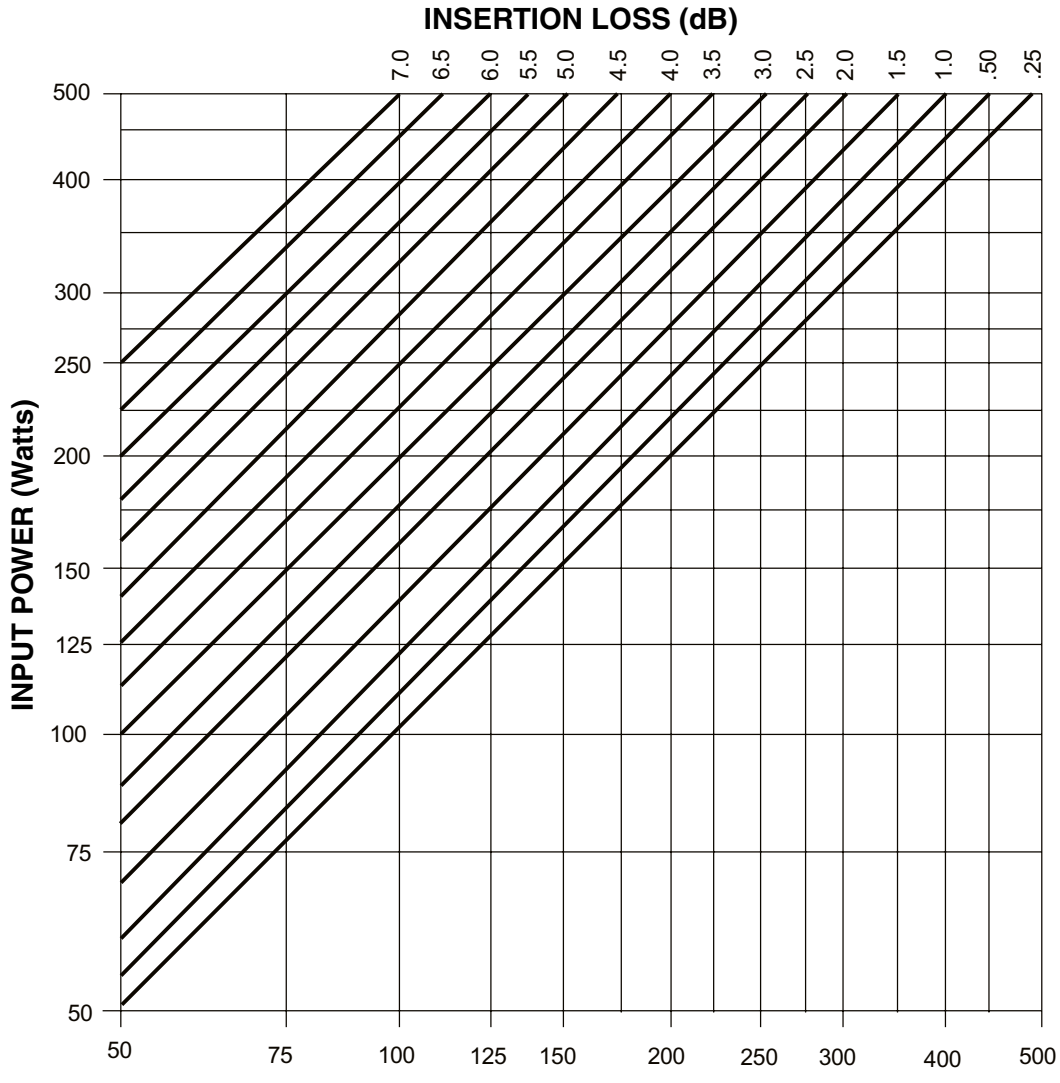
POWER FWD./REV.
VS
VSWR



FOR OTHER POWER LEVELS
MULTIPLY BOTH SCALES
BY THE SAME MULTIPLIER

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 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 + →

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

← - dB + →

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

Free Space Path Loss Estimator

Path Length (miles)	Frequency in MHz						
	50	**150**	**170**	**450**	**500**	**800**	**900**
0.1	50.58	60.12	61.21	69.66	70.58	74.66	75.68
0.25	58.54	68.08	69.17	77.62	78.54	82.62	83.64
0.5	64.56	74.10	75.19	83.64	84.56	88.64	89.66
1	70.58	80.12	81.21	89.66	90.58	94.66	95.68
2	76.60	86.14	87.23	95.68	96.60	100.68	101.71
3	80.12	89.66	90.75	99.21	100.12	104.20	105.23
4	82.62	92.16	93.25	101.71	102.62	106.70	107.73
5	84.56	94.10	95.19	103.64	104.56	108.64	109.66
6	86.14	95.68	96.77	105.23	106.14	110.22	111.25
7	87.48	97.02	98.11	106.57	107.48	111.56	112.59
8	88.64	98.18	99.27	107.73	108.64	112.72	113.75
9	89.66	99.21	100.29	108.75	109.66	113.75	114.77
10	90.58	100.12	101.21	109.66	110.58	114.66	115.68
12	92.16	101.71	102.79	111.25	112.16	116.25	117.27
14	93.50	103.04	104.13	112.59	113.50	117.58	118.61
16	94.66	104.20	105.29	113.75	114.66	118.74	119.77
18	95.68	105.23	106.31	114.77	115.68	119.77	120.79
20	96.60	106.14	107.23	115.68	116.60	120.68	121.71
30	100.12	109.66	110.75	119.21	120.12	124.20	125.23
40	102.62	112.16	113.25	121.71	122.62	126.70	127.73
50	104.56	114.10	115.19	123.64	124.56	128.64	129.66

Formula: Path Loss (dB) = 36.6 + 20 log (MHz) + 20 log (miles)

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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