BIRD®

TECHNOLOGIES GROUP

BIRD ELECTRONIC

TX RX SYSTEMS

Cavity Filters & Duplexers

CAVITY FILTERS
Introduction & Construction

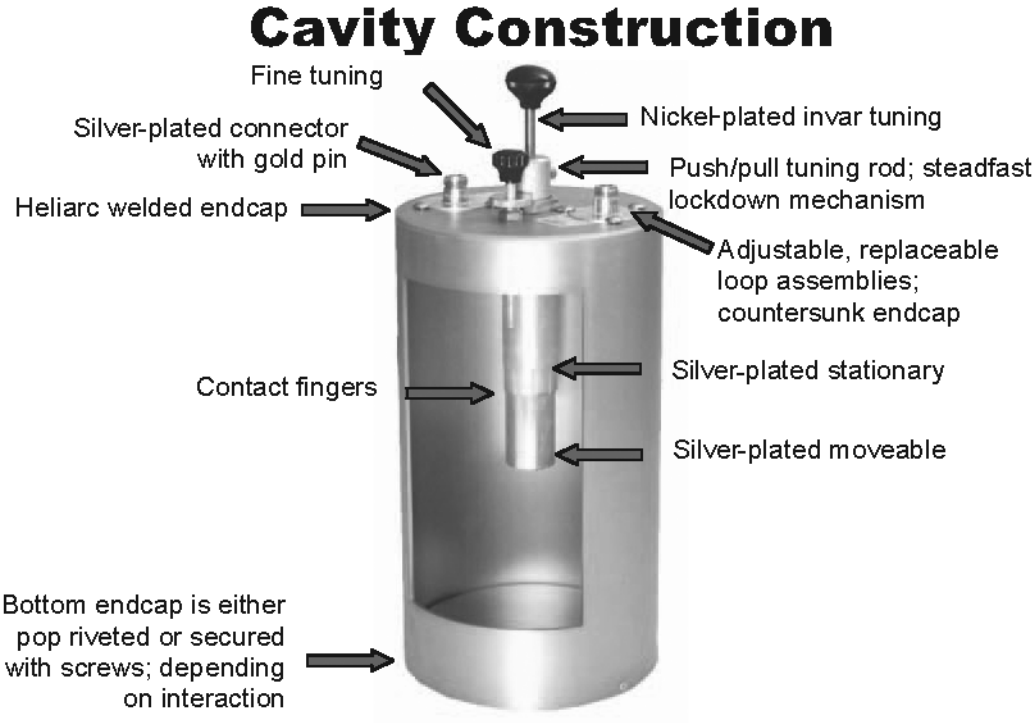
Cavity Filters

Resonant cavity filters are the primary building blocks of duplexers, multicouplers and preselectors. However, their use is not limited to these specific applications. Individual or cascaded cavities may be used for a variety of interference fighting chores, such as cleaning up the performance of existing filter systems that have inadequate isolation or off-channel interference rejection. At crowded antenna sites, cavity filters are ideal for quieting noisy transmitters or for preventing transmitter IM mixing. Receiver front-end selectivity can be greatly enhanced by the use of additional filtering, thus eliminating many desensitization, IM, and overload problems.

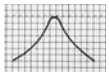
When used in conjunction with a spectrum analyzer or service monitor, cavity filters can allow a detailed analysis of lower-level transmitter noise. This lower-level noise is one of the major sources of interference at multi-transmitter sites. Cavity filters can stand alone as pieces of test equipment for analyzing many receiver IM problems and can also help determine the best type of filter to use for a permanent fix.

Four types of cavity filters are designed and manufactured by TX RX Systems: Bandpass, T-Pass®, Vari-Notch® and Series-Notch®. Each uses a specific type of loop assembly which provides the desired frequency response. The Vari-Notch® and Series-Notch® filters use one loop assembly per cavity and incorporates a tuning capacitor. The Bandpass and TPass® designs utilize 2 loop assemblies per cavity.

- Silver plated connectors with gold pins reduce the risk of intermod; especially at higher frequencies
- Silver plated probes insure conductivity even if corrosion occurs
- Nickel plated invar has high temperature coefficient and resists rust.
- Push/pull tuning (not threaded) mechanism stays on frequency when locked down.
- Temperature compensation stem keeps cavity on frequency
- Slotted probe fingers insure excellent contact between stationary and moveable probes
- Heliarc welded end cap = one piece construction which maximizes 'Q'
- Field adjustable loops allow changes in selectivity as well as circuit style
- Fine tuning rod provides an easy way to optimize tuning

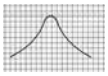


- Various Low-Loss High-Rejection Models to Choose From.
- All Loop Plate/connector assemblies are silver-or Alballoy®-plated for low IM.
- Welded cavity construction and silver-plated tunable probe and loops give superior pass and reject characteristics.



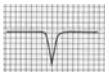
BANDPASS

The Bandpass cavity passes one narrow band of frequencies and attenuates all others with increasing attenuation above and below the pass frequency. It is equivalent to a parallel-tuned circuit and is most often used for general transmitter spurious clean-up or a sharpening of a single receiver front end selectivity with or without amplification. TX RX bandpass cavities (4", 6", 8" and 10") have adjustable selectivity characteristics (rotatable loops) to allow a trade-off between insertion loss (0.5--3.0 dB) and selectivity. Maximum power handling is typically determined by insertion loss setting.



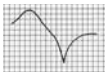
T-PASS®

T-Pass® is a variation of the Bandpass cavity used for our expandable multicoupler applications. Its general characteristics are nearly identical to a bandpass cavity but the output loop has a pair of N-connectors so it can easily be coupled to other channels.



SERIES NOTCH®

The Series-Notch® passes a relatively wide band of frequencies while rejecting a very narrow band of frequencies. It is equivalent to a series-tuned circuit. Notch depth is variable from 15 - 25 dB. Pass and notch frequencies must be known so that the optimum loop assembly can be used. This is the best filter for very close separations (200 KHz to 400 KHz) in UHF applications.



VARI-NOTCH®

The Vari-Notch® design passes a relatively narrow band of frequencies and rejects (notches out) a relatively wide frequency band. Equivalent to a combination series-tuned and parallel-tuned circuit, this filter has a greater notch depth than the Series-Notch® design. The notch depth is adjustable but varies with passband insertion loss (0.3dB or 0.6dB typical) and the difference between pass and notch frequencies. Vari-Notch® is ideal for moderately close to wide separations (400 KHz and greater) in UHF applications.

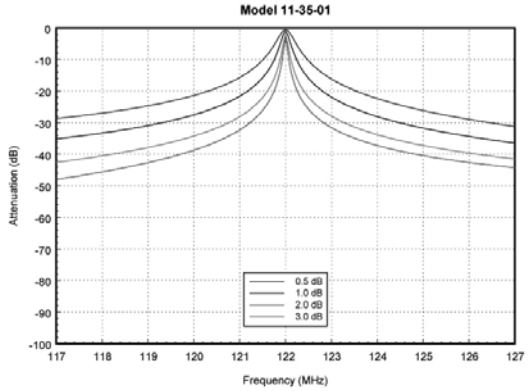
CASCADING FILTERS

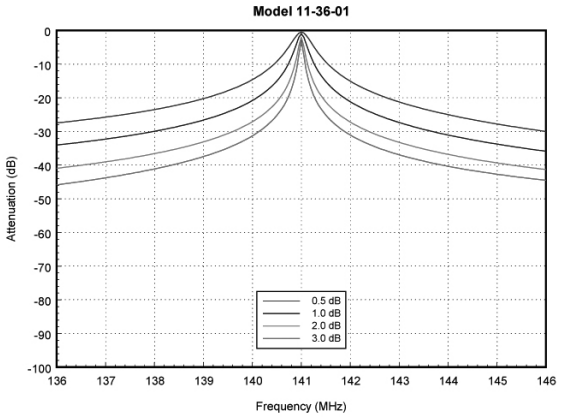
All cavity types mentioned above may be cascaded to achieve an arithmetic sum of individual filter attenuation. Up to 6 dB of additional attenuation can be achieved when the proper length of cable is used to interconnect the cavities. (This additional 6 dB does not occur in the filter passband but only at frequencies where moderate to high attenuation occurs.) A TX RX system specialist can assist you in ordering the proper length of interconnecting cable for your frequencies.

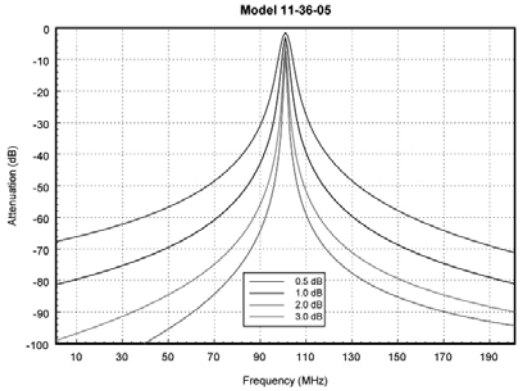
CAVITY FILTERS

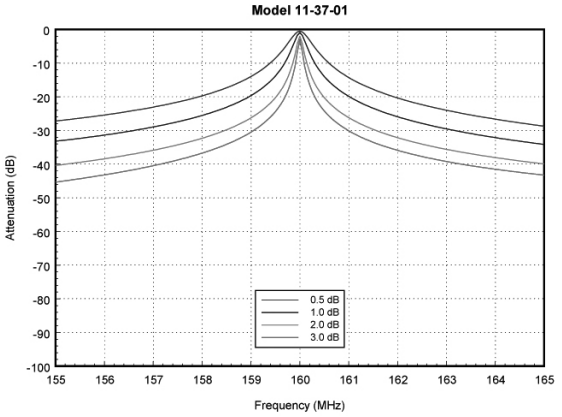
Bandpass

108-174 MHz









Model Number	11-35-01	11-35-02	11-35-05	11-35-06	11-36-01	11-36-02
Frequency Range (MHz)	108-136	108-136	108-136	108-136	132-150	132-150
Max. pwr., per cavity, @ 0.5 dB IL	270 Watts	270 Watts	270 Watts	270 Watts	270 Watts	270 Watts
Max. pwr., per cavity, @ 0.3 dB IL	60 Watts	60 Watts	60 Watts	60 Watts	60 Watts	60 Watts
Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
VSWR	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.
Cavity Length (electrical)	1/4λ	1/4λ	1/4λ	1/4λ	1/4λ	1/4λ
Temperature Range, °C	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60
Cavity Size, diameter (inches)	6.625	6.625	10	10	6.625	6.625
Number of Cavities	1	2	1	2	1	2
Connectors	N	N	N	N	N	N
Dimensions, HxWxD (inches)	31.5x6.625x6.625	31.5x6.625x6.625	33.5x10x10	33.5x10x10	26x6.625x6.625	26x6.625x6.625
Shipping Weight, lbs.	20	42	27	56	15	30

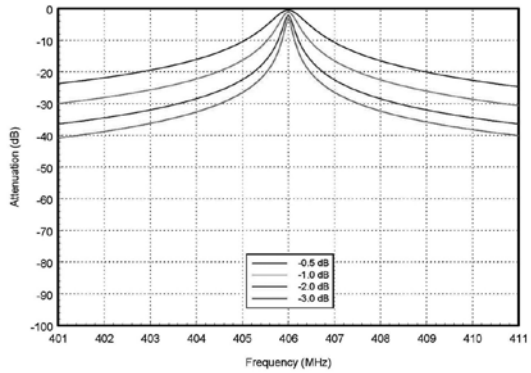
Model Number	11-36-05	11-36-06	11-37-01	11-37-02	11-37-05	11-37-06	11-37-09
Frequency Range (MHz)	132-150	132-150	144-174	144-174	144-174	144-174	144-174
Max. pwr., per cavity, @ 0.5 dB IL	270 Watts	270 Watts	270 Watts	270 Watts	270 Watts	270 Watts	100 Watts
Max. pwr., per cavity, @ 0.3 dB IL	60 Watts	60 Watts	60 Watts	60 Watts	60 Watts	60 Watts	N/A
Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
VSWR	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.
Cavity Length (electrical)	1/4λ	1/4λ	1/4λ	1/4λ	1/4λ	1/4λ	1/4λ
Temperature Range, °C	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60
Cavity Size, diameter (inches)	10	10	6.625	6.625	10	10	4
Number of Cavities	1	2	1	2	1	2	1
Connectors	N	N	N	N	N	N	N
Dimensions, HxWxD (inches)	26x10x10	26x10x10	26x6.625x6.625	26x6.625x6.625	26x10x10	26x10x10	15x4x4
Shipping Weight, lbs.	21	44	15	30	21	44	5

CAVITY FILTERS

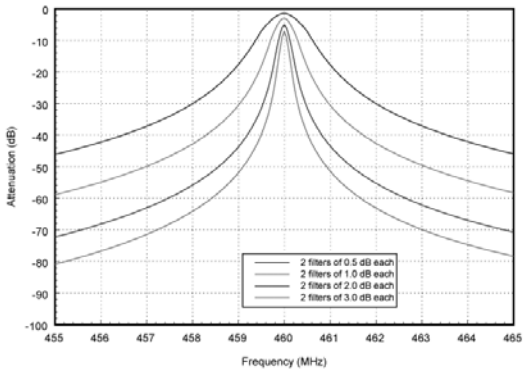
Bandpass

225-400 / 406-512 MHz

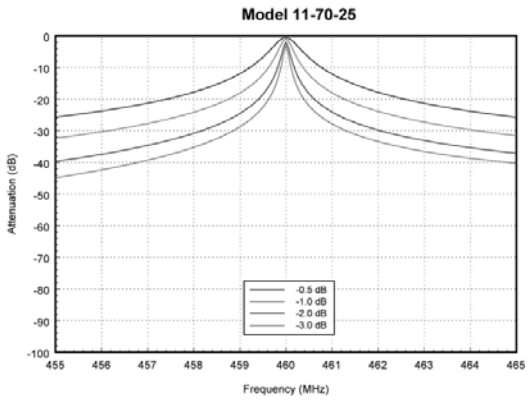
Model 11-70-11



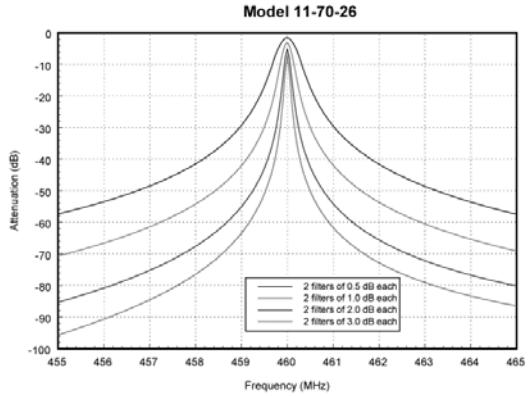
Model 11-70-12



Model 11-70-25



Model 11-70-26



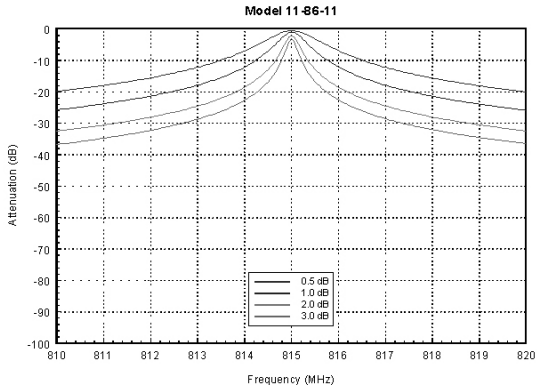
Model Number	11-53-01	11-65-26	11-70-01	11-70-02	11-70-05	11-70-06	11-70-09	11-70-11	11-70-12
Frequency Range (MHz)	225-400	406-420	450-470	450-470	450-470	450-470	450-470	450-470	450-470
Max. pwr., per cavity, @ 0.5 dB IL	100 Watts	270 Watts	270 Watts	270 Watts	270 Watts	270 Watts	100 Watts	270 Watts	270 Watts
Max. pwr., per cavity, @ 0.3 dB IL	100 Watts	60 Watts	60 Watts	60 Watts	60 Watts	60 Watts	N/A	60 Watts	60 Watts
Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
VSWR	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.
Cavity Length (electrical)	3/4λ	3/4λ	1/4λ	1/4λ	1/4λ	1/4λ	1/4λ	3/4λ	3/4λ
Temperature Range, °C	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60
Cavity Size, diameter (inches)	8	10	6.625	6.625	10	10	4	6.625	6.625
Number of Cavities	1	2	1	2	1	2	1	1	2
Connectors	N	N	N	N	N	N	BNC	N	N
Dimensions, HxWxD (inches)	25x8x8	26x10x10	11.5x6.625x 6.625	11.5x6.625x 6.625	12.5x10x10	12.5x10x10	9x4x4	26x6.625x 6.625	26x6.625x 6.625
Shipping Weight, lbs.	8.6	43	8	16	11	23	4	12	25

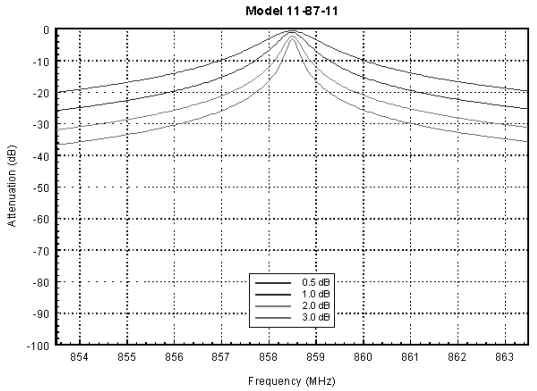
Model Number	11-70-25	11-70-26	11-69-01	11-69-02	11-69-05	11-69-06	11-69-09	11-69-25	11-69-26
Frequency Range (MHz)	450-470	450-470	470-512	470-512	470-512	470-512	470-512	470-512	470-512
Max. pwr., per cavity, @ 0.5 dB IL	270 Watts	270 Watts	270 Watts	270 Watts	270 Watts	270 Watts	100 Watts	270 Watts	270 Watts
Max. pwr., per cavity, @ 0.3 dB IL	60 Watts	60 Watts	60 Watts	60 Watts	60 Watts	60 Watts	N/A	60 Watts	60 Watts
Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
VSWR	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.
Cavity Length (electrical)	3/4λ	3/4λ	1/4λ	1/4λ	1/4λ	1/4λ	1/4λ	3/4λ	3/4λ
Temperature Range, °C	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60
Cavity Size, diameter (inches)	10	10	6.625	6.625	10	10	4	10	10
Number of Cavities	1	2	1	2	1	2	1	1	2
Connectors	N	N	N	N	N	N	BNC	N	N
Dimensions, HxWxD (inches)	26x10x10	26x10x10	11.5x6.625 x6.625	11.5x6.625 x6.625	12.5x10x10	12.5x10x10	9x4x4	12.5x10x10	26x10x10
Shipping Weight, lbs.	21	43	8	16	11	23	4	21	43

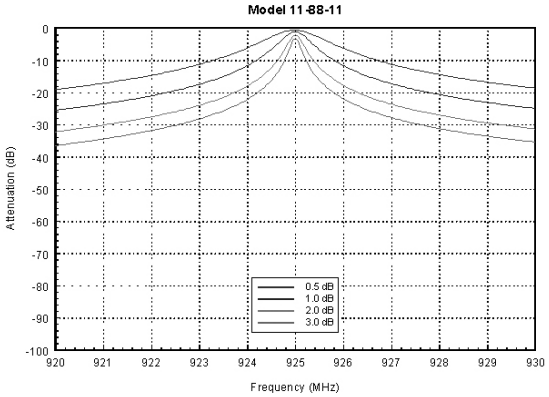
CAVITY FILTERS

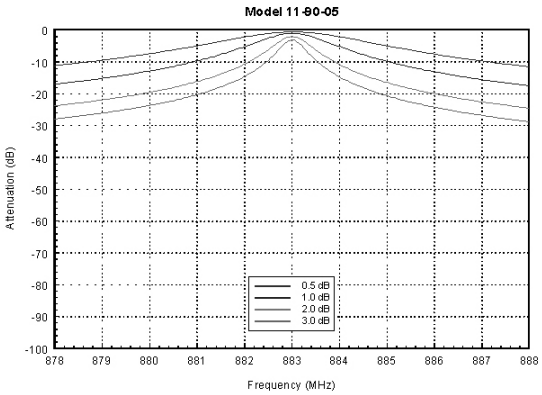
Bandpass

746-960 MHz









Model Number	11-83B-11	11-83B-12	11-86-11	11-86-12
Frequency Range (MHz)	746-869	746-869	806-821	806-821
Max. pwr., per cavity, @ 0.5 dB IL	270 Watts	270 Watts	270 Watts	270 Watts
Max. pwr., per cavity, @ 0.3 dB IL	60 Watts	60 Watts	60 Watts	60 Watts
Impedance	50 ohms	50 ohms	50 ohms	50 ohms
VSWR	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.
Cavity Length (electrical)	3/4λ	3/4λ	3/4λ	3/4λ
Temperature Range, °C	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60
Cavity Size, diameter (inches)	6.625	6.625	6.625	6.625
Number of Cavities	1	2	1	2
Connectors	N	N	N	N
Dimensions, HxWxD (inches)	14 x 6.625 x 6.625	14 x 6.625 x 6.625	13 x 6.625 x 6.625	13 x 6.625 x 6.625
Shipping Weight, lbs.	10	19	9	18

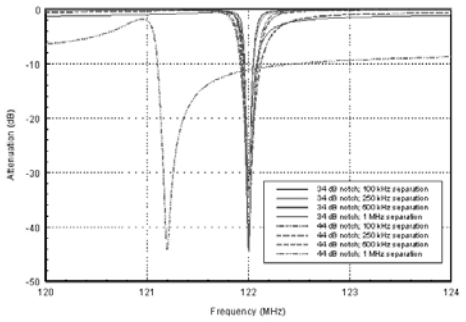
Model Number	11-87-11	11-87-12	11-88-11	11-88-12	11-90-05
Frequency Range (MHz)	851-866	851-866	806-960	806-960	806-960
Max. pwr., per cavity, @ 0.5 dB IL	270 Watts	270 Watts	270 Watts	270 Watts	100 Watts
Max. pwr., per cavity, @ 0.3 dB IL	60 Watts	60 Watts	60 Watts	60 Watts	N/A
Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
VSWR	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.	1.25:1 max.
Cavity Length (electrical)	3/4λ	3/4λ	3/4λ	3/4λ	1/4λ
Temperature Range, °C	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60	-30 to + 60
Cavity Size, diameter (inches)	6.625	6.625	6.625	6.625	4
Number of Cavities	1	2	1	2	1
Connectors	N	N	N	N	BNC
Dimensions, HxWxD (inches)	13 x 6.625 x 6.625	13 x 6.625 x 6.625	13 x 6.625 x 6.625	13 x 6.625 x 6.625	6.5 x 4 x 4
Shipping Weight, lbs.	9	18	9	18	3

CAVITY FILTERS

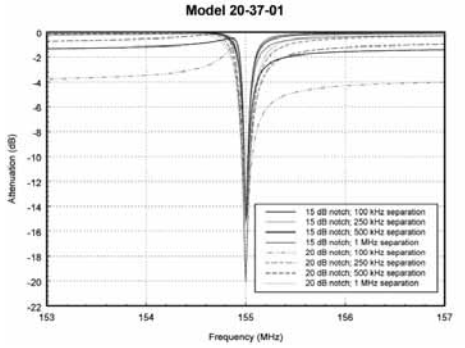
Series Notch

108-174 MHz

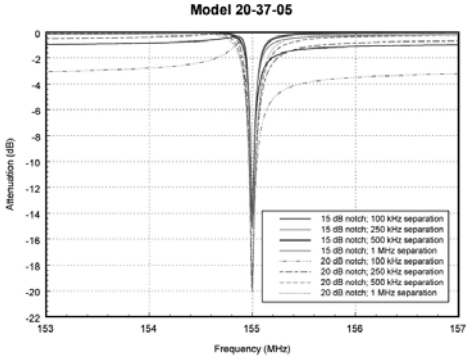
Model 20-35-02



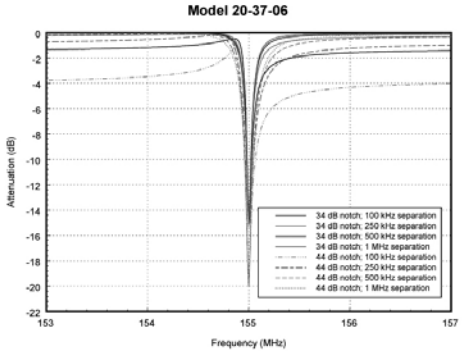
Model 20-37-01



Model 20-37-05



Model 20-37-06



Model Number	20-35-01				20-36-01				20-37-01				20-37-05				
Frequency Range (MHz)	108-136				132-150				144-174				144-174				
Insertion Loss vs. Frequency Separations	100 kHz	250 kHz	500 kHz	1 MHz	100 kHz	250 kHz	500 kHz	1 MHz	100 kHz	250 kHz	500 kHz	1 MHz	50 kHz	100 kHz	250 kHz	500 kHz	1 MHz
with single cavity, notch depth @ 15 dB	<1.0 dB	<0.2 dB	<0.2 dB	<0.2 dB	<1.0 dB	<0.2 dB	<0.2 dB	<0.2 dB	<1.0 dB	<0.2 dB	<0.2 dB	<0.2 dB	<0.2 dB	-	<0.2 dB	<0.2 dB	<0.2 dB
with single cavity, notch depth @ 20 dB	<1.5 dB	<0.3 dB	<0.2 dB	<0.2 dB	<1.5 dB	<0.3 dB	<0.2 dB	<0.2 dB	<1.8 dB	<0.3 dB	<0.2 dB	<0.2 dB	-	<1.0 dB	<0.2 dB	<0.2 dB	<0.2 dB
Impedance	50 ohms				50 ohms				50 ohms				50 ohms				
VSWR	1.5:1 max.				1.5:1 max.				1.5:1 max.				1.5:1 max.				
Max. pwr. (Watts) @ stated separation	60	250	350	350	60	250	350	350	60	250	350	350	80	150	350	350	350
Cavity Length (electrical)	1/4λ				1/4λ				1/4λ				1/4λ				
Temperature Range, °C	-30 to + 60				-30 to + 60				-30 to + 60				-30 to + 60				
Cavity Size, diameter (inches)	6.625				6.625				6.625				10				
Number of Cavities	1				1				1				1				
Cavity Height (inches)	31.5; w /tuning rod extended, 43 max.				26, w /tuning rod extended, 38 max.				26, w /tuning rod extended, 38 max.				26, w /tuning rod extended, 38 max.				
Width (inches)	6.625				6.625				6.625				10				
Depth (inches)	6.625				6.625				6.625				10				
Connectors	N				N				N				N				
Weight, lbs.	18				17				17				22				

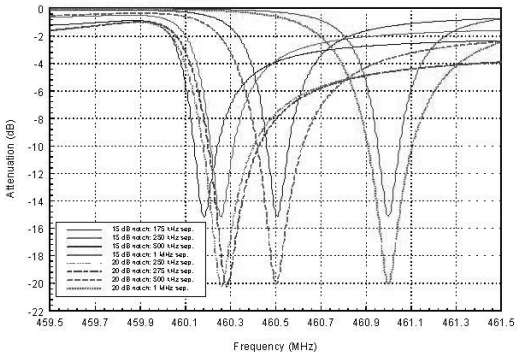
Model Number	20-35-02				20-36-02				20-37-02				20-37-06				
Frequency Range (MHz)	108-136				132-150				144-174				144-174				
Insertion Loss vs. Frequency Separations	100 kHz	250 kHz	500 kHz	1 MHz	100 kHz	250 kHz	500 kHz	1 MHz	100kHz	250 kHz	500 kHz	1 MHz	50 kHz	100 kHz	250 kHz	500 kHz	1 MHz
with dual cavity, notch depth @ 34 dB	<2.0 dB	<0.6 dB	<0.5 dB	<0.4 dB	<2.0 dB	<0.6 dB	<0.5 dB	<0.4 dB	<2.0 dB	<0.6 dB	<0.5 dB	<0.4 dB	<3.5 dB	-	<0.5 dB	<0.5 dB	<0.4 dB
with dual cavity, notch depth @ 44 dB	<3.0 dB	<0.8 dB	<0.5 dB	<0.4 dB	<3.0 dB	<0.8 dB	<0.5 dB	<0.4 dB	<3.6 dB	<0.8 dB	<0.5 dB	<0.4 dB	-	<2.0 dB	<0.6 dB	<0.5 dB	<0.4 dB
Impedance	50 ohms				50 ohms				50 ohms				50 ohms				
VSWR	1.5:1 max.				1.5:1 max.				1.5:1 max.				1.5:1 max.				
Max. pwr. (Watts) @ stated separation	60	250	350	350	60	250	350	350	60	250	350	350	80	150	350	350	350
Cavity Length (electrical)	1/4λ				1/4λ				1/4λ				1/4λ				
Temperature Range, °C	-30 to + 60				-30 to + 60				-30 to + 60				-30 to + 60				
Cavity Size, diameter (inches)	6.625				6.625				6.625				10				
Number of Cavities	2				2				2				2				
Cavity Height (inches)	31.5; w /tuning rod extended, 43 max.				26, w /tuning rod extended, 38 max.				26, w /tuning rod extended, 38 max.				26, w /tuning rod extended, 38 max.				
Width (inches)	6.625				6.625				6.625				10				
Depth (inches)	6.625				6.625				6.625				10				
Connectors	N				N				N				N				
Weight, lbs.	36				34				34				45				

CAVITY FILTERS

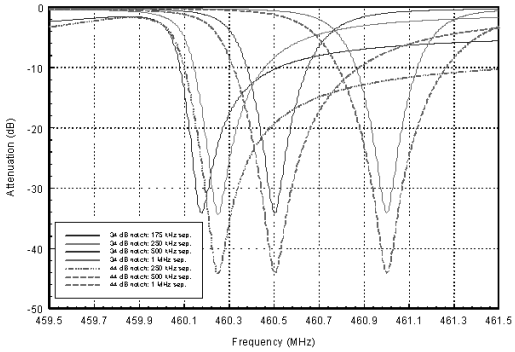
Series Notch

450-470 MHz

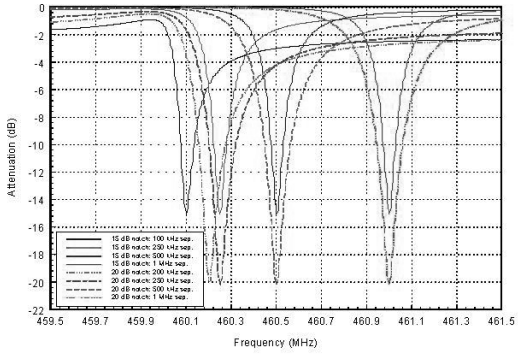
Model 20-70-01



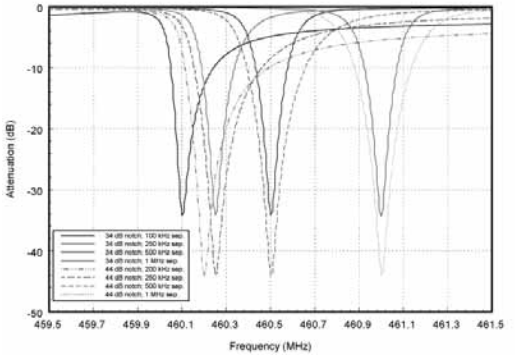
Model 20-70-02



Model 20-70-25



Model 20-70-26



Model Number	20-70-01					20-70-25				
Frequency Range (MHz)	450-470					450-470				
Insertion Loss vs. Frequency Separations	175 kHz	250 kHz	275 kHz	500 kHz	1 MHz	100 kHz	200 kHz	250 kHz	500 kHz	1 MHz
with single cavity, notch depth @ 15 dB	1.5 dB	0.7 dB	-	0.2 dB	0.1 dB	1.2 dB	-	0.4 dB	<0.1 dB	<0.1 dB
with single cavity, notch depth @ 20 dB	-	1.5 dB	1.2 dB	0.4 dB	0.1 dB	-	0.6 dB	0.4 dB	0.1 dB	<0.1 dB
Impedance	50 ohms					50 ohms				
VSWR	1.5:1 max.					1.5:1 max.				
Max. pwr. (Watts) @ stated separation	35	35	40	120	350	55	100	180	350	350
Cavity Length (electrical)	1/4λ					3/4λ				
Temperature Range, °C	-30 to + 60					-30 to + 60				
Cavity Size, diameter (inches)	6.625					10				
Number of Cavities	1					1				
Cavity Height (inches)	11.5, w /tuning rod extended, 16.5 max.					26, w /tuning rod extended, 37 max.				
Width (inches)	6.625					10				
Depth (inches)	6.625					10				
Connectors	N					N				
Weight, lbs.	11					21				

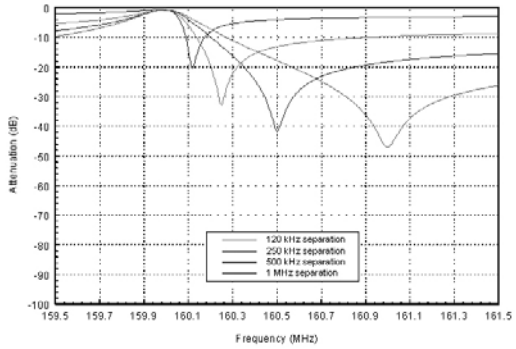
Model Number	20-70-02					20-70-26				
Frequency Range (MHz)	450-470					450-470				
Insertion Loss vs. Frequency Separations	175 kHz	250 kHz	275 kHz	500 kHz	1 MHz	100 kHz	200 kHz	250 kHz	500 kHz	1 MHz
with dual cavity, notch depth @ 34 dB	3.0 dB	1.5 dB	-	0.5 dB	0.4 dB	2.6 dB	-	1.0 dB	0.3 dB	0.3 dB
with dual cavity, notch depth @ 44 dB	-	3.1 dB	2.6 dB	1.0 dB	0.4 dB	-	1.5 dB	1.0 dB	0.4 dB	0.3 dB
Impedance	50 ohms					50 ohms				
VSWR	1.5:1 max.					1.5:1 max.				
Max. pwr. (Watts) @ stated separation	35	35	40	120	350	55	100	180	350	350
Cavity Length (electrical)	1/4λ					3/4λ				
Temperature Range, °C	-30 to + 60					-30 to + 60				
Cavity Size, diameter (inches)	6.625					10				
Number of Cavities	2					2				
Cavity Height (inches)	11.5, w /tuning rod extended, 16.5 max.					26, w /tuning rod extended, 37 max.				
Width (inches)	6.625					10				
Depth (inches)	6.625					10				
Connectors	N					N				
Weight, lbs.	23					44				

CAVITY FILTERS

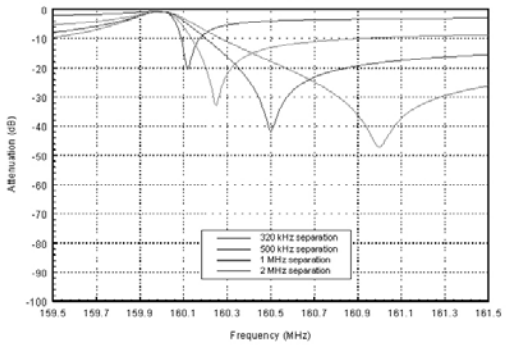
Vari-Notch

108-174 MHz

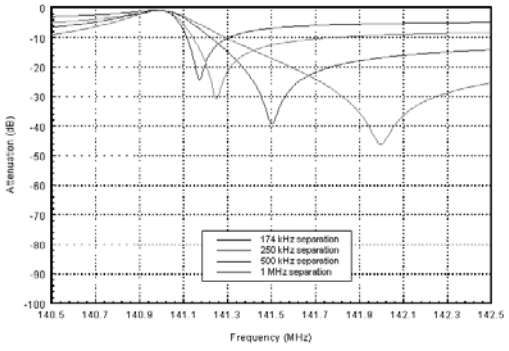
Model 15-37-05



Model 15-37-09



Model 15-36-01



Model Number	15-35-01				15-35-05				15-36-01			
Frequency Range (MHz)	108-136				108-136				132-150			
Minimum Separation (Pass-to-Notch):	174 kHz				130 kHz				140 kHz			
Frequency Separation	174 kHz	250 kHz	500 kHz	1 MHz	130 kHz	250 kHz	500 kHz	1 MHz	140 kHz	250 kHz	500 kHz	1 MHz
Attenuation vs. Pass-to-Notch	24 dB	30 dB	39 dB	46 dB	24 dB	34 dB	43 dB	47 dB	19 dB	27 dB	37 dB	45 dB
Power Rating	300 Watts				300 Watts				300 Watts			
Impedance	50 ohms				50 ohms				50 ohms			
VSWR	1.25:1 max.				1.25:1 max.				1.25:1 max.			
Cavity Length (electrical)	1/4λ				1/4λ				1/4λ			
Temperature Range, °C	-30 to + 60				-30 to + 60				-30 to + 60			
Cavity Size, (diameter) inches	6.625				10				6.625			
Number of Cavities	1				1				1			
Connectors	N				N				BNC			
Cavity Height (inches)	31.5, w /tuning rod extended, 44 max.				33.5, w /tuning rod extended, 48 max.				26, w /tuning rod extended, 38 max.			
Width (inches)	6.625				10				6.625			
Depth (inches)	6.625				10				6.625			
Shipping Weight, lbs.	20				27				17			

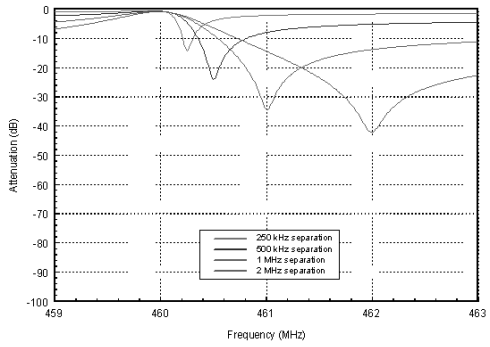
Model Number	15-36-05				15-37-01				15-37-05				15-37-09			
Frequency Range (MHz)	132-150				144-174				144-174				144-174			
Minimum Separation (Pass-to-Notch):	100 kHz				170 kHz				120 kHz				320 kHz			
Frequency Separation	100 kHz	250 kHz	500 kHz	1 MHz	170 kHz	250 kHz	500 kHz	1 MHz	120 kHz	250 kHz	500 kHz	1 MHz	320 kHz	500 kHz	1 MHz	2 MHz
Attenuation vs. Pass-to-Notch	19 dB	33 dB	42 dB	47 dB	22 dB	27 dB	37 dB	45 dB	20 dB	32 dB	41 dB	47 dB	18 dB	24 dB	35 dB	44 dB
Power Rating	300 Watts				300 Watts				300 Watts				150 Watts			
Impedance	50 ohms				50 ohms				50 ohms				50 ohms			
VSWR	1.25:1 max.				1.25:1 max.				1.25:1 max.				1.25:1 max.			
Cavity Length (electrical)	1/4λ				1/4λ				1/4λ				1/4λ Low Pass			
Temperature Range, °C	-30 to + 60				-30 to + 60				-30 to + 60				-30 to + 60			
Cavity Size, diameter (inches)	10				6.625				10				4			
Number of Cavities	1				1				1				1			
Connectors	N				N				N				N			
Cavity Height (inches)	26, w /tuning rod extended, 38 max.				26, w /tuning rod extended, 38 max.				26, w /tuning rod extended, 38 max.				15, w /tuning rod extended, 20 max			
Width (inches)	10				6.625				10				4			
Depth (inches)	10				6.625				10				4			
Shipping Weight, lbs.	23				17				23				5			

CAVITY FILTERS

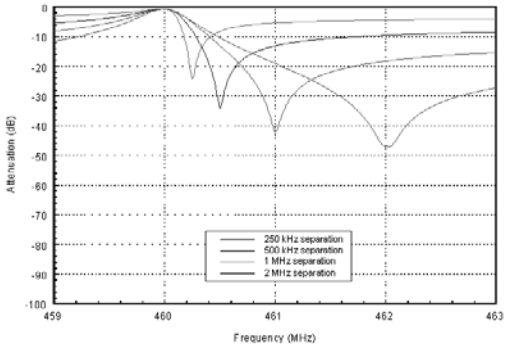
Vari-Notch

406-512 MHz

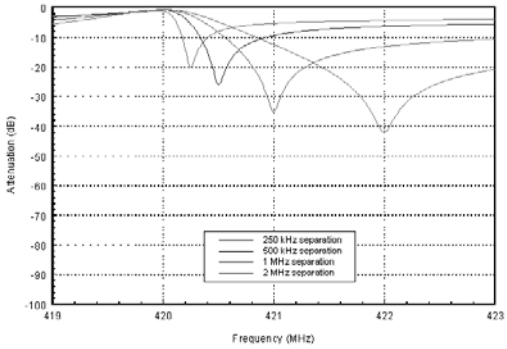
Model 15-70-01



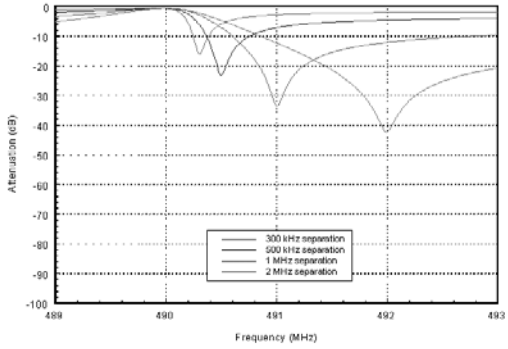
Model 15-70-25



Model 15-65-01



Model 15-69-01



Model Number	15-65-01				15-65-21			15-65-22				15-69-01				15-69-21		
Frequency Range (MHz)	406-430				406-430			406-430				470-512				470-512		
Minimum Separation (Pass-to-Notch):	250 kHz				1 MHz			500 kHz				300 kHz				1 MHz		
Frequency Separation	250 kHz	500 kHz	1 MHz	2 MHz	1 MHz	2 MHz	3 MHz	500 kHz	1 MHz	2 MHz	5 MHz	300 kHz	500 kHz	1 MHz	2 MHz	1 MHz	2 MHz	3 MHz
Attenuation vs. Pass-to-Notch	20 dB	26 dB	35 dB	42 dB	23 dB	32 dB	48 dB	19 dB	26 dB	38 dB	47 dB	16 dB	23 dB	33 dB	42 dB	23 dB	32 dB	48 dB
Power Rating	300 Watts				150 Watts			150 Watts				300 Watts				150 Watts		
Impedance	50 ohms				50 ohms			50 ohms				50 ohms				50 ohms		
VSWR	1.25:1 max.				1.25:1 max.			1.25:1 max.				1.25:1 max.				1.25:1 max.		
Cavity Length (electrical)	1/4λ				1/4λ			1/4λ High Selectivity				1/4λ				1/4λ		
Temperature Range, °C	-30 to + 60				-30 to + 60			-30 to + 60				-30 to + 60				-30 to + 60		
Cavity Size, diameter (inches)	6.625				4			4				6.625				4		
Number of Cavities	1				1			1				1				1		
Connectors	N				BNC			BNC				N				BNC		
Cavity Height (inches)	11.5, w /tuning rod extended, 16.5 max.				10, w /tuning rod extended, 13 max.			10, w /tuning rod extended, 13 max.				11.5, w /tuning rod extended, 16.5 max.				9, w /tuning rod extended, 13 max.		
Width (inches)	6.625				4			4				6.625				4		
Depth (inches)	6.625				4			4				6.625				4		
Shipping Weight, lbs.	6				4			4				8				4		

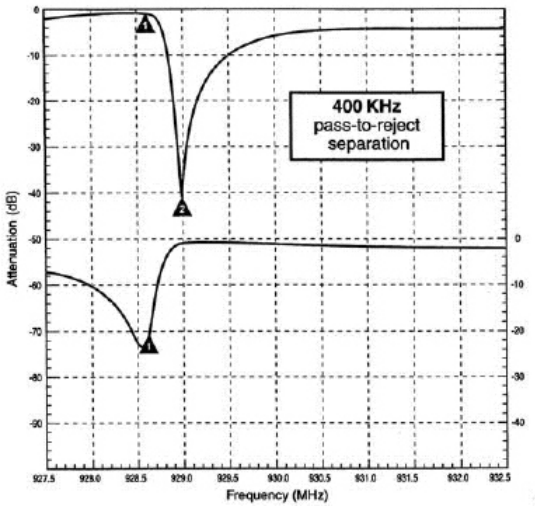
Model Number	15-69-22				15-70-01				15-70-11				15-70-21			15-70-22				15-70-25			
Frequency Range (MHz)	470-512				450-470				450-470				450-470			450-470				450-470			
Minimum Separation (Pass-to-Notch):	500 kHz				250 kHz				250 kHz				1 MHz			500 kHz				250 kHz			
Frequency Separation	500 kHz	1 MHz	2 MHz	5 MHz	250 kHz	500 kHz	1 MHz	2 MHz	250 kHz	500 kHz	1 MHz	2 MHz	1 MHz	2 MHz	3 MHz	250 kHz	500 kHz	1 MHz	2 MHz	250 kHz	500 kHz	1 MHz	2 MHz
Attenuation vs. Pass-to-Notch	19 dB	26 dB	38 dB	47 dB	14 dB	24 dB	34 dB	42 dB	19 dB	29 dB	38 dB	45 dB	23 dB	32 dB	48 dB	19 dB	26 dB	38 dB	47 dB	24 dB	34 dB	42 dB	47 dB
Power Rating	150 Watts				300 Watts				300 Watts				150 Watts			150 Watts				300 Watts			
Impedance	50 ohms				50 ohms				50 ohms				50 ohms			50 ohms				50 ohms			
VSWR	1.25:1 max.				1.25:1 max.				1.25:1 max.				1.25:1 max.			1.25:1 max.				1.25:1 max.			
Cavity Length (electrical)	1/4λ High Selectivity				1/4λ				3/4λ				1/4λ			1/4λ High Selectivity				3/4λ			
Temperature Range, °C	-30° to + 60				-30 to + 60				-30 to + 60				-30 to + 60			-30 to + 60				-30 to + 60			
Cavity Size, diameter (inches)	4				6.625				6.625				4			4				10			
Number of Cavities	1				1				1				1			1				1			
Connectors	BNC				N				N				BNC			BNC				N			
Cavity Height (inches)	9, w /tuning rod extended, 13 max.				11.5, w /tuning rod extended, 16.5 max.				26, w /tuning rod extended, 37 max.				10.5, w /tuning rod extended, 13 max.			10.5, w /tuning rod extended, 13 max.				26, w /tuning rod extended, 37 max.			
Width (inches)	4				6.625				6.625				4			4				10			
Depth (inches)	4				6.625				6.625				4			4				10			
Shipping Weight, lbs.	4				8				11				4			4				21			

CAVITY FILTERS

Vari-Notch

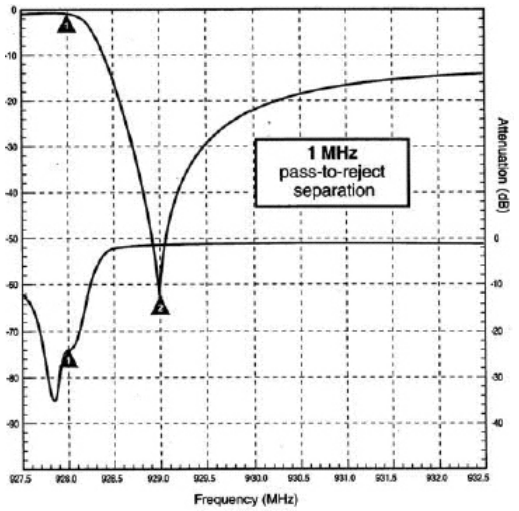
890-960 MHz

15-88-12-DM



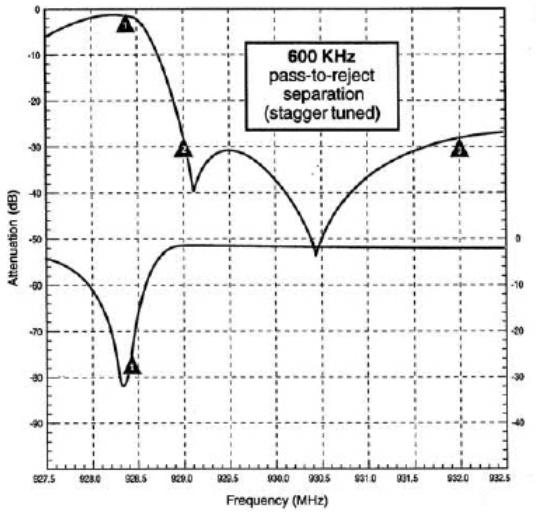
← Markers
1: 928.600 MHz
1.4 dB Insertion Loss
23.0 dB Return Loss
2: 929.000 MHz
40.8 dB Reject

15-88-12-DM



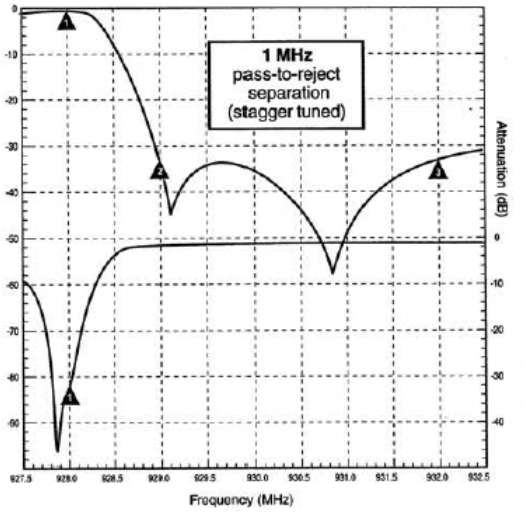
Markers →
1: 928.000 MHz
1.4 dB Insertion Loss
24.8 dB Return Loss
2: 929.000 MHz
63.0 dB Reject

15-88-12-DM



← Markers
1: 928.400 MHz
1.4 dB Insertion Loss
29.0 dB Return Loss
2: 929.000 MHz
28.0 dB Reject
3: 932.000 MHz
28.0 dB Reject

15-88-12-DM



Markers →
1: 928.000 MHz
1.0 dB Insertion Loss
32.5 dB Return Loss
2: 929.000 MHz
33.0 dB Reject
3: 932.000 MHz
33.5 dB Reject

Model Number	15-88-01				15-88-02			15-88-11				15-88-12				15-88-12-DM			
Frequency Range (MHz)	890-960				890-960			890-960				890-960				890-960			
Minimum Separation (Pass-to-Notch):	500 kHz				1.45 MHz			500 kHz				400 kHz				400 kHz			
Frequency Separation	500 kHz	1 MHz	2 MHz	10 MHz	1.45 MHz	2 MHz	10 MHz	500 kHz	1 MHz	2 MHz	10 MHz	500 kHz	1 MHz	2 MHz	10 MHz	400 kHz	500 kHz	600 kHz	1 MHz
Attenuation vs. Pass-to-Notch	15 dB	23 dB	31 dB	48 dB	24 dB	29 dB	51 dB	22 dB	32 dB	40 dB	45 dB	50 dB	70 dB	86 dB	96 dB	39 dB	45 dB	50 dB	60 dB
Pow er Rating	150 Watts				150 Watts			300 Watts				300 Watts				250 Watts		400 Watts	
Impedance	50 ohms				50 ohms			50 ohms				50 ohms				50 ohms			
VSWR	1.25:1 max.				1.25:1 max.			1.25:1 max.				1.25:1 max.				1.25:1 max.			
Cavity Length (electrical)	1/4 λ Low Pass				1/4 λ High Pass			3/4 λ				3/4 λ				3/4 λ			
Temperature Range, ° C	-30 to +60				-30 to +60			-30 to +60				-30 to +60				-30 to +60			
Cavity Size, (diameter) inches	4				4			6.625				6.625				6.625			
Number of Cavities	1				1			1				2				2			
Connectors	BNC				BNC			N				N				N			
Cavity Height (inches)	6.5, w /tuning rod extended, 10 max.				6.5, w /tuning rod extended, 10 max.			13,w/tuning rod extended, 19 max.				13, w/tuning rod extended, 19 max.				17.5, w/tuning rod extended, 23 max.			
Width (inches)	4				4			4				4				6.625			
Depth (inches)	4				4			4				4				6.625			
Shipping Weight, lbs.	3				3			9				18				17			

CAVITY FILTERS
Loop Kits

Cavity filter loop kits allow the same cavity shells to be configured for different responses in order to suit different application needs. See page 2 of this section on descriptions of the various filter configurations.

Model	Frequency Range	Type
76-28-01	66-88 MHz	Bandpass
76-28-02	66-88 MHz	Vari Notch Low Pass
76-28-03	66-88 MHz	Vari Notch High Pass
76-28-04	66-88 MHz	Series Notch Low Pass
76-28-05	66-88 MHz	Series Notch High Pass
76-28-08	66-88 MHz	T-Pass
76-28-09	66-88 MHz	Bandpass
76-29-01	88-108 MHz	Bandpass
76-29-04	88-108 MHz	Series Notch Low Pass
76-29-05	88-108 MHz	Series Notch High Pass
76-35-01	108-136 MHz	Bandpass
76-35-02	108-136 MHz	Vari Notch Low Pass
76-35-03	108-136 MHz	Vari Notch High Pass
76-35-04	108-136 MHz	Series Notch Low Pass
76-35-05	108-136 MHz	Series Notch High Pass
76-35-07	108-136 MHz	T-Pass
76-36-03	132-150 MHz	Vari Notch Low Pass
76-36-04	132-150 MHz	Vari Notch High Pass
76-36-05	132-150 MHz	Series Notch Low Pass
76-36-06	132-150 MHz	Series Notch High Pass
76-37-01	144-174 MHz	Bandpass
76-37-03	144-174 MHz	Vari Notch Low Pass
76-37-04	144-174 MHz	Vari Notch High Pass
76-37-05	144-174 MHz	Series Notch Low Pass
76-37-06	144-174 MHz	Series Notch High Pass
76-38-01	132-174 MHz	T-Pass
76-38-02	132-174 MHz	Bandpass
76-38-03	132-174 MHz	Vari Notch Low Pass
76-38-04	132-174 MHz	Vari Notch High Pass
76-38-05	132-174 MHz	Series Notch Low Pass
76-38-06	132-174 MHz	Series Notch High Pass
76-38-07	132-174 MHz	T-Pass
76-38-08	132-174 MHz	Bandpass
76-54-02	220-300 MHz	Vari Notch Low Pass
76-54-03	220-300 MHz	Vari Notch High Pass
76-55-02	300-400 MHz	Vari Notch Low Pass
76-55-03	300-400 MHz	Vari Notch High Pass
76-65-01	406-420 MHz	Bandpass
76-67-01	406-512 MHz	T-Pass
76-67-02	406-512 MHz	Bandpass pair
76-67-03	406-512 MHz	Vari Notch
76-67-04	406-512 MHz	Series Notch Low Pass
76-67-05	406-512 MHz	Series Notch High Pass
76-67-06	406-512 MHz	T-Pass
76-67-07	406-512 MHz	Bandpass
76-70-01	450-470 MHz	Bandpass
76-70-03	450-470 MHz	Vari Notch
76-70-05	450-470 MHz	Series Notch High Pass
76-90-01	806-960 MHz	Bandpass
76-90-03	806-960 MHz	T-Pass

Bandpass Loops

T-Pass® Loops

Vari Notch® Loops

Series Notch loops

DUPLEXERS
30-960 MHz

A Duplexer (or diplexer as they are sometimes called) is a 3-port device most commonly used to allow a transmitter and receiver, operating on different frequencies, to share a common antenna while operating simultaneously. The filters that make up the duplexer isolate the transmitter from the receiver by doing two important functions - the most important is filtering out any transmitter noise sidebands that are being generated on the receive frequency. The second function is protecting the receiver from transmitter carrier overload. The amount of isolation necessary is dependent upon the TX to RX frequency spacing. As the frequencies get closer, a higher value of isolation is required.

At high-band VHF and UHF, the TX RX Vari-Notch® design is the most commonly used. Vari-Notch® provides a low-loss pseudo-bandpass characteristic that can exist very close to a deep notch. Proven low-loss and low-noise construction techniques are used such as welded cavity construction; silver-plated loops, Alballoy®-plated integrated loop plates and connectors; as well as a unique fingerstock-free high-conductivity silver-plated tuning probe. Our 4" and 6.625" diameter cavities are constructed of hardened aluminum which, unlike most copper cavities, resists denting and associated detuning.

At 700/800/900 MHz where there are large guard bands and multiple frequencies per system, the Bandpass duplexer fills the bill nicely. The combline filter design is both low-loss and space-efficient. For duplexing a single repeater, the TX RX Vari-Notch® design is still the product of choice. Vari-Notch® provides a low-loss pseudo-bandpass characteristic that can exist very close to a deep notch. Proven low-loss and low-noise construction techniques are used such as welded cavity construction; silver-plated loops, Alballoy®-plated integrated loop plates and connectors; as well as a unique fingerstock-free high-conductivity silver-plated tuning probe. Our cavities are constructed of hardened aluminum which, unlike most copper cavities, resists denting and associated detuning.

28-52-02A
28-56C-02A

38-36-01A
38-37-01A

28-70-15H

DUPLEXERS

Technical Specifications

30-512 MHz

Electrical: Temperature Range: -30° to +60° C
Impedance: 50 ohms
VSWR: 1.3:1

ELECTRICAL								MECHANICAL					
Frequency Range (MHz)	Model Number	Minimum Freq. Separation (MHz)	Power Rating (W)	Isolation (dB)*	Insertion Loss (dB)	No. of Cavities	Cavity Size	H (in)	W (in)	D (in)	Tx & Rx Port Connectors	Antenna Connectors	Shipping Weight (lbs)
30-40	28-13-01F	0.3	400	90	1.5	4	6.625" DIA.	132	19	15	N	N	250
38-50	28-14-01F	0.3	400	90	1.5	4	6.625" DIA.	101	19	15	N	N	260
50-54	28-25-92358	0.5			1.5/1.0			76/193	19	15		N(F)	185
	38-36-01A	4.5	100	70	0.9	4	2" SQ.	5.25	19	7.25	BNC	N	10
Tx High	30-36-01A	3.0	100	100	1.4/1.5	6	2" SQ.	5.25	19	7.25	BNC	N	14
Tx Low	30-36-02A	3.0	100	100	1.4/1.5	6	2" SQ.	5.25	19	7.25	BNC	N	14
132-150	74-36-02A	3.0	400	57	1.35	4	6.625" DIA.	33	19	±7.5	N	N	50
Tx High	30-36-03A	1.5	100	80/90	1.4/2.2	6	2" SQ.	5.25	19	7.25	BNC	N	14
Tx Low	30-36-04A	1.5	100	80/90	1.4/2.2	6	2" SQ.	5.25	19	7.25	BNC	N	14
	28-36-02A	0.5	400	85	1.5	4	6.625" DIA.	33	19	±7.5	N	N	50
	28-36-11E	0.3	400	100	2.2	6	6.625" DIA.	33	24	±7.5	N	N	75
	38-37-01A	4.5	100	70	0.9	4	2" SQ.	5.25	19	7.25	BNC	N	10
Tx High	30-37-01A	3.0	100	100	1.4/1.5	6	2" SQ.	5.25	19	7.25	BNC	N	14
Tx Low	30-37-02A	3.0	100	100	1.4/1.5	6	2" SQ.	5.25	19	7.25	BNC	N	14
	28-37-07A	3.0	400	85	0.7	4	4" DIA.	5.25	19	+4.5 -15.5	N	N	22
144-174	28-37-07C	3.0	400	85	0.7	4	4" DIA.	9.5	19	10.50	N	N	24
	74-37-02A	3.0	400	57	1.35	4	6.625" DIA.	33	19	±7.5	N	N	50
Tx High	30-37-03A	1.5	100	80/90	1.4/2.2	6	2" SQ.	5.25	19	7.25	BNC	N	14
Tx Low	30-37-04A	1.5	100	80/90	1.4/2.2	6	2" SQ.	5.25	19	7.25	BNC	N	14
	28-37-06A	1.0	125	75	1.2	4	4" DIA.	5.25	19	+4.5 -15.5	N	N	22
	28-37-06C	1.0	125	75	1.2	4	4" DIA.	9.5	19	10.5	N	N	24
	28-37-04A	0.5	125	65	1.8	4	4" DIA.	5.25	19	+4.5 -15.5	N	N	22
	28-37-04C	0.5	125	65	1.8	4	4" DIA.	9.5	19	10.5	N	N	24
	28-37-02A	0.5	400	85	1.5	4	6.625" DIA.	33	19	±7.5	N	N	50
	28-37-02A-DIN	0.5	400	85	1.5	4	6.625" DIA.	33	19	±7.5	N	7/16 DIN	50
	28-37-11E	0.3	400	100	2.2	6	6.625" DIA.	33	24	±7.5	N	N	75
215-250	28-52-02A	1.6	250	90	1.2	4	4" DIA.	5.25	19	+3 -15	N	N	19
380-420	28-56C-02A	3.0	350	80	0.8	4	4" DIA.	5.25	19	+3-9	N	N	19
	28-65-01A	1.5	350	90	1.5	4	6.625" DIA.	17	19	±7.5	N	N	37
	28-65-02A	3.0	350	80	0.8	4	4" DIA.	5.25	19	+3-9	N	N	14
	28-65-02B	3.0	350	80	0.8	4	4" DIA.	5.25	19	12	N	N	16
406-430	28-65-05A	0.7	350	100	2.2	6	6.625" DIA.	34	19	±7.5	N	N	75
	28-65-07A	3.0	250	85	1.25	4	4" DIA.	5.25	19	+3-9	N	N	14
	28-65-07B	3.0	250	85	1.25	4	4" DIA.	5.25	19	12	N	N	16
	28-65-08A	4.5	100	80	1.2	4	1.25" x 2" RECT.	1.75	19	±2.5	BNC	N	5
	28-65-09A	2.5	100	80	1.8	6	1.25" x 2" RECT.	3.5	19	±2.5	BNC	N	7
	28-65-10H	4.5	100	80	1.2	4	1.25" x 2" RECT.	2.7	5.12	7.4	BNC	UHF	5
	26-66-01A	6.0	100	70	1.2	2	COMBLINE	10	21.5	7.5	N	N	12
442-450	28-66-02A	5.0	350	100	0.6	4	4" DIA.	5.25	19	+3-9	N	N	14
	28-66-02B	5.0	350	100	0.6	4	4" DIA.	5.25	19	12	N	N	16
	28-66-04H	5.0	100	80	1.2	4	1.25" x 2" RECT.	2.7	5.12	7.4	N	UHF	5
	28-70-01A	1.5	350	90	1.5	4	6.625" DIA.	17	19	±7.5	N	N	37
	28-70-02A	5.0	350	100	0.6	4	4" DIA.	5.25	19	+3-9	N	N	14
	28-70-02B	5.0	350	100	0.6	4	4" DIA.	5.25	19	12	N	N	16
450-470	28-70-07A	0.7	350	100	2.2	6	6.625" DIA.	34	19	±7.5	N	N	55
	28-70-09A	5.0	250	100	1.25	4	4" DIA.	5.25	19	+3-9	N	N	14
	28-70-09B	5.0	250	100	1.25	4	4" DIA.	5.25	19	12	N	N	16
	28-70-14A	5.0	100	80	1.2	4	1.25" x 2" RECT.	1.75	19	±2.5	BNC	N	5
	28-70-15H	5.0	100	80	1.2	4	1.25" x 2" RECT.	2.7	5.12	7.4	BNC	UHF	5

*Specifications for duplexers of unsymmetrical construction or response are listed as follows:
Isolation: Noise Suppression/Carrier Suppression
Insertion Loss: Tx Loss/Rx Loss

DUPLEXERS
Technical Specifications
764-1300 MHz

General Specifications
Electrical: Temperature Range: -30° to + 60° C
Impedance: 50 ohms, VSWR: 1.3:1

ELECTRICAL								MECHANICAL					
Frequency Range (MHz)	Model Number	Minimum Freq. Separation (MHz)	Power Rating (Watts)	Isolation (dB)*	Insertion Loss (dB)	No. of Cavities	Cavity Size	H"	W"	D"	Tx & Rx Port Connectors	Antenna Connectors	Shipping Weight (lbs.)
470-512	28-69-01A	1.5	350	90	1.5	4	6.625" DIA.	17	19	±7.5	N	N	37
	28-69-02A	3.0	350	80	0.8	4	4" DIA.	5.25	19	+3-9	N	N	14
	28-69-02B	3.0	350	80	0.8	4	4" DIA.	5.25	19	12	N	N	16
	28-69-04A	0.7	350	100	2.2	6	6.625" DIA.	34	19	±7.5	N	N	55
764-806	28-83E-01A	30	125	60/90	0.8/0.8	4	4" DIA.	5.25	19	+3-6.5	N	N	10
	28-83E-01B	30	125	60/90	0.8/0.8	4	4" DIA.	5.25	19	10	N	N	10
	26-83B-10A		100	80	1.5								
806-869	26-83G-10A		50	70	1.5								
	26-89A-10A		100	80	1.5								
	26-89-03A	45	600	45/77	0.5/1.0	N/A	COMBLINE	5.25	19	+7-2	N	N	14
	26-89A-01A	45	600	35/90	0.5/1.5	N/A	COMBLINE	5.25	19	+7-2	N	N	15
	26-89A-05A	45	600	35/110	0.5/1.0	N/A	COMBLINE	5.25	19	+7-2	N	N	16
	28-89-01A	45	125	90/90	0.8/0.8	4	4" DIA.	5.25	19	+3-6.5	N	N	10
	28-89-01B	45	125	90/90	0.8/0.8	4	4" DIA.	5.25	19	10	N	N	12
890-960	26-88-01A	39	600	55/100	0.6/1.2	4	COMBLINE & 4" DIA.	5.25	19	+7-6.5	N	N	15
	28-88-01A	3.6	125	90/90	1.25/1.25	4	4" DIA.	5.25	19	+3-6.5	N	N	10
	28-88-01B	3.6	125	90/90	1.25/1.25	4	4" DIA.	5.25	19	10	N	N	12
	28-88-04A	39	125	90/90	0.8/0.8	4	4" DIA.	5.25	19	+3-6.5	N	N	10
	28-88-04B	39	125	90/90	0.8/0.8	4	4" DIA.	5.25	19	10	N	N	12
1215-1300	28-97-01A	12	125	100	1.0	4	4" DIA.	5.25	19	+3-6.5	N	N	13
	28-97-01B	12	125	100	1.0	4	4" DIA.	5.25	19	10	N	N	13
1.2 -1.3 GHz	36-97-07053-A	12	100	50	1.3/1.3			10.5	19	8.9	N	N	13

*Specifications for duplexers of unsymmetrical construction or response are listed as follows:
Isolation: Noise Suppression/Carrier Suppression
Insertion Loss: Tx Loss/Rx Loss

REFERENCE

Duplexer Trouble Shooting Aid

Duplexer Problems and Remedies

Duplexers are passive devices requiring little or no service once installed in a system. The proper design and application of a given Duplexer will give years of trouble free service. When problems do occur in a duplex system it is necessary to identify as many abnormal conditions as possible to zero in on the specific cause of the problem. Unfortunately, there are only a few measurable or observable performance indicators at the disposal of the field serviceman, and any number of conditions may exist, even simultaneously, which are responsible for the observed phenomena. Most Duplexer installation problems fall into three categories. Each of these three conditions will be treated separately, using the typical cause and remedy approach.

KEY

A. High Input VSWR
B. Excessive Loss
C. Desensitization of the receiver when transmitter is keyed.

PROBLEM			POTENTIAL CAUSE	REMEDY
A	B	C	*The number at right corresponds to the remedy paragraph on the next page.*	
•	•		Reverse labeling of Tx and Rx terminals.	1
•	•		Unit tuned to wrong frequencies.	2
•			Bad antenna or interconnect cables.	3
•	•		Use of between series adapters, especially UHF types.	4
•	•	•	Duplexer detuned in shipment.	5
•	•		Water has entered the Duplexer antenna connector from the antenna feed line.	6
•	•		Spurious Tx output is being reflected by the selective Duplexer input terminal and observed on the wattmeter, the wattmeter being unable to discriminate between on-frequency and off-frequency energy.	7
		•	Bad joint in a cable or antenna system beyond the antenna terminal of the Duplexer. All lines may show zero reflected power, but noise can still be produced when a corroded or indefinite metal-to-metal contact is exposed to RF energy. When this occurs beyond the Duplexer, it cannot be filtered out, and the noise backs up into the receiver.	8
		•	Adverse cable length between Duplexer and transmitter using varactor or broadband hybrid combining type transmitter outputs. Even though the Duplexer VSWR is flat on frequency, the reflected impedance of the Duplexer off resonance, transformed by changing cable lengths, can cause parasitics to be generated.	9
		•	Duplexer transmitter mixing with another outside transmitter, producing intermodulation on or near the receiver frequency.	10
		•	Transmitter cable leading to Duplexer in close proximity to Duplexer antenna or receiver cable. This is usually only a problem on close separation Duplexers, (1.0 MHz or less) where the 85 to 100 dB isolation is decreased by adverse coupling, created by running these cables too close together for too great a distance.	11
		•	Inadequate shielding of transmitter and receiver modules in the repeater.	12
		•	Insufficient duplex isolation for the application.	13
		•	A spurious transmitter response outside of the normal Duplexer isolation band or inadequacy of notch filter type Duplexers to suppress a wide enough band of Tx noise to protect the receiver.	14
		•	Impedance change in antenna due to icing. VSWR increase may be sufficient to reflect back through the Duplexer and upset transmitter tuning, causing parasitics, which are not suppressed sufficiently by the Duplexer.	15
		•	The addition of a broadband power amplifier to a low power transmitter. The noise floor of the low power radio is raised by an amount equal to the gain of the power amplifier, and in addition, the power amplifier will contribute its own noise. Power amplifiers are just as prone to the generation of parasitics as transmitters, and may be triggered by an adverse cable length between power amplifier and Duplexer, a problem covered above.	16
		•	Excessive loss with changing temperature and apparent Duplexer detuning.	17

FIELD SERVICE REMEDIES for problems listed on previous page

1. Tune a signal generator to the receive frequency and inject it into the antenna terminal, sampling for the signal at each equipment terminal. Reverse the labels if necessary. It may be that the unit was ordered to the reverse frequencies. If so, the label will indicate this. If the duplexer is symmetrical in design (usually indicated by the same number of Tx and Rx filter sections) just reverse 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, contact 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 termaline wattmeter, or a thruline wattmeter into a known good load. Check the antenna line input for reflected power.

4. To eliminate high input VSWR reduce the number of between series adapters by making up proper interconnect cables. UHF connectors are non-constant impedance, and certain combinations can transform a 1.1:1 VSWR into a 2.0:1, or vice versa.

5. Consult the instruction manual for field tuning procedures, or the factory, if the 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 spurious, 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 duplex 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 back into the antenna 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 half wave in increments of between 1 and 2 inches until the desensitization ceases or is minimal. A ferrite isolator will also cure this condition when it is installed between the transmitter and duplexer. However, this is a much more expensive remedy.

10. If the IM is in the duplex transmitter, a ferrite isolator in the duplex transmitter line (NOT antenna line) will show this by either reducing or eliminating it. More isolation can be obtained by cascading isolators if needed. However, IM of this magnitude indicates the system should be studied for possible revision to reduce the production of this IM.

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

12. Consult the radio manufacturer. This 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 repeater operation.

13. If this problem is suspected, contact the radio manufacturer for recommended duplex isolation for Tx noise suppression and carrier suppression. Duplexer isolation should be measured first per instruction manual to verify rated specifications are present. If more duplex isolation is required, contact 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 de-ice the antenna, or use an antenna less sensitive to ice. 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 Rx signals.

16. A mismatch may possibly be reduced by lengthening the cable which runs between the power amplifier output and the duplexer input until the receiver desensitization disappears, as follows:
30 MHz to 512 MHz RANGE
BNC or N type adapters may be inserted in the original cable, one at a time and not to exceed a total of 1/2 wavelength, until desensitization disappears.
800 MHz to 1.3 GHz RANGE
Prepare a cable length 3/4” longer than the original cable and insert. If desensitization does not disappear, repeat with cables each 3/4” longer than the previous length, not to exceed 1/2 wavelength.

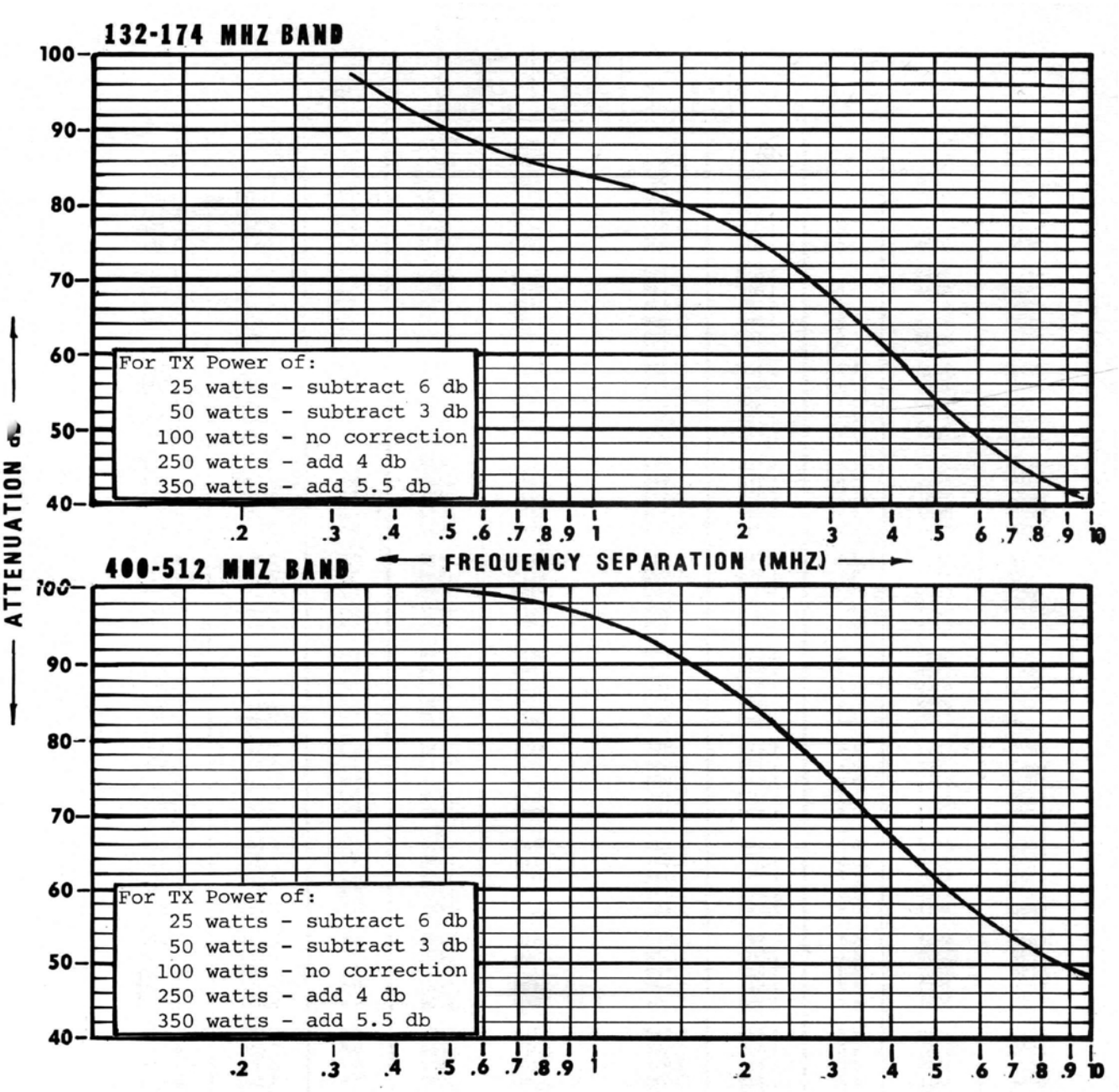
17. We find that this cause most commonly relates to shifting impedance of the transmitter or power amplifier with temperature. The duplexer appears detuned, since a “conjugate match” (canceling reactance, and matching resistance component) is approached by shifting the duplexer passband above or below the 50 ohm 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.

REFERENCE

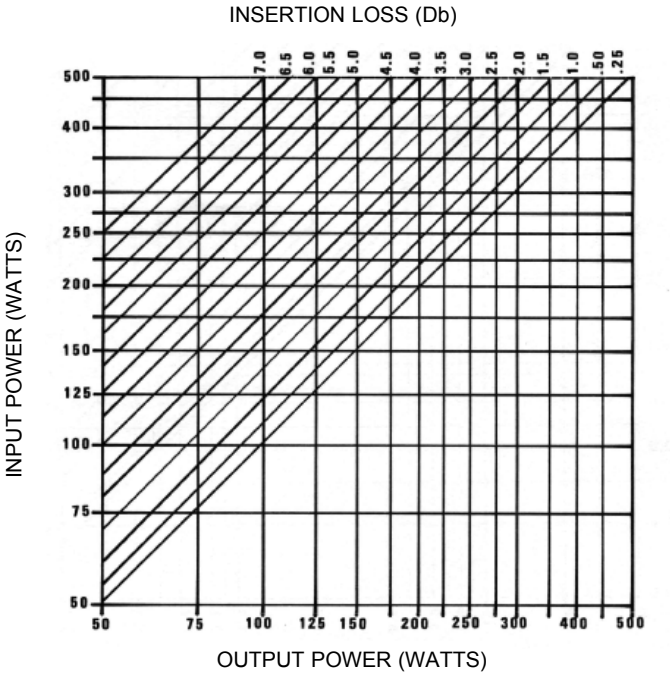
TNRD Curves

Isolation curves for data reference Transmitter/Receiver

The curves shown below for use with filters, duplexers, and multicouplers, 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 SINAD sensitivity.



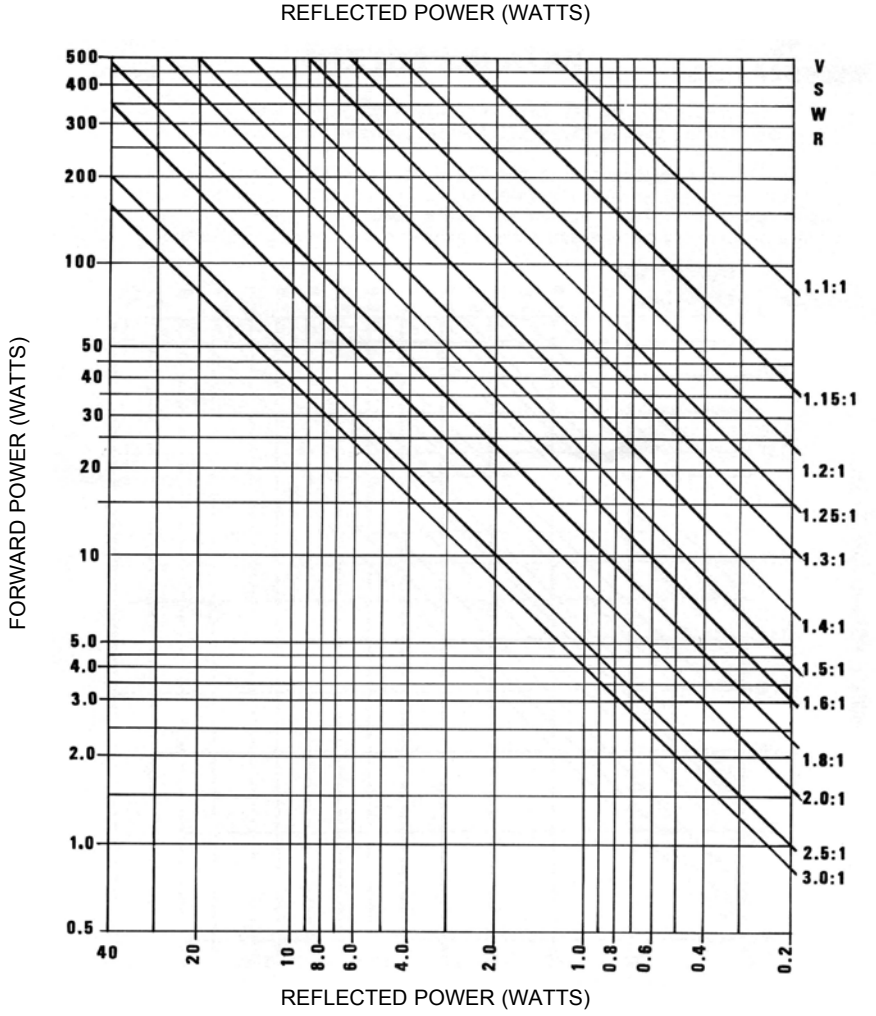
Note: These are only “typical curves. When accuracy is required, consult the radio manufacturer.



TX TX Systems, Inc. offers this convenient means of determining ten 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)

For other power levels, multiply both scales by the same multiplier



CONVERSION TABLE

POWER AND VOLTAGE RATIOS TO dB

TO ACCOUNT FOR THE SIGN OF THE DECIBEL

For positive (+) values of the decibel - Both voltage and power ratios are greater than unity. Use the two right hand columns.

For negative (-) values of the decibel - Both voltage and power ratios are less than unity. Use the two left hand columns.

Voltage Ratio	Power Ratio	<-- - dB + -->	Voltage Ratio	Power Ratio
1.0000	1.0000	0	1.0000	1.0000
0.9886	0.9772	0.1	1.0116	1.0233
0.9772	0.9550	0.2	1.0233	1.0471
0.9661	0.9333	0.3	1.0351	1.0715
0.9550	0.9120	0.4	1.0471	1.0965
0.9441	0.8913	0.5	1.0593	1.1220
0.9333	0.8710	0.6	1.0715	1.1482
0.9226	0.8511	0.7	1.0839	1.1749
0.9120	0.8318	0.8	1.0965	1.2023
0.9016	0.8128	0.9	1.1092	1.2303
0.8913	0.7943	1	1.1220	1.2589
0.8810	0.7762	1.1	1.1350	1.2882
0.8710	0.7586	1.2	1.1482	1.3183
0.8610	0.7413	1.3	1.1614	1.3490
0.8511	0.7244	1.4	1.1749	1.3804
0.8414	0.7079	1.5	1.1885	1.4125
0.8318	0.6918	1.6	1.2023	1.4454
0.8222	0.6761	1.7	1.2162	1.4791
0.8128	0.6607	1.8	1.2303	1.5136
0.8035	0.6457	1.9	1.2445	1.5488
0.7943	0.6310	2	1.2589	1.5849
0.7852	0.6166	2.1	1.2735	1.6218
0.7762	0.6026	2.2	1.2882	1.6596
0.7674	0.5888	2.3	1.3032	1.6982
0.7586	0.5754	2.4	1.3183	1.7378
0.7499	0.5623	2.5	1.3335	1.7783
0.7413	0.5495	2.6	1.3490	1.8197
0.7328	0.5370	2.7	1.3646	1.8621
0.7244	0.5248	2.8	1.3804	1.9055
0.7161	0.5129	2.9	1.3964	1.9498
0.7079	0.5012	3	1.4125	1.9953
0.6998	0.4898	3.1	1.4289	2.0417
0.6918	0.4786	3.2	1.4454	2.0893
0.6839	0.4677	3.3	1.4622	2.1380

Voltage Ratio	Power Ratio	<-- - dB + -->	Voltage Ratio	Power Ratio
0.6761	0.4571	3.4	1.4791	2.1878
0.6683	0.4467	3.5	1.4962	2.2387
0.6607	0.4365	3.6	1.5136	2.2909
0.6531	0.4266	3.7	1.5311	2.3442
0.6457	0.4169	3.8	1.5488	2.3988
0.6383	0.4074	3.9	1.5668	2.4547
0.6310	0.3981	4	1.5849	2.5119
0.6237	0.3890	4.1	1.6032	2.5704
0.6166	0.3802	4.2	1.6218	2.6303
0.6095	0.3715	4.3	1.6406	2.6915
0.6026	0.3631	4.4	1.6596	2.7542
0.5957	0.3548	4.5	1.6788	2.8184
0.5888	0.3467	4.6	1.6982	2.8840
0.5821	0.3388	4.7	1.7179	2.9512
0.5754	0.3311	4.8	1.7378	3.0200
0.5689	0.3236	4.9	1.7579	3.0903
0.5623	0.3162	5	1.7783	3.1623
0.5559	0.3090	5.1	1.7989	3.2359
0.5495	0.3020	5.2	1.8197	3.3113
0.5433	0.2951	5.3	1.8408	3.3884
0.5370	0.2884	5.4	1.8621	3.4674
0.5309	0.2818	5.5	1.8836	3.5481
0.5248	0.2754	5.6	1.9055	3.6308
0.5188	0.2692	5.7	1.9275	3.7154
0.5129	0.2630	5.8	1.9498	3.8019
0.5070	0.2570	5.9	1.9724	3.8905
0.5012	0.2512	6	1.9953	3.9811
0.4955	0.2455	6.1	2.0184	4.0738
0.4898	0.2399	6.2	2.0417	4.1687
0.4842	0.2344	6.3	2.0654	4.2658
0.4786	0.2291	6.4	2.0893	4.3652
0.4732	0.2239	6.5	2.1135	4.4668
0.4677	0.2188	6.6	2.1380	4.5709
0.4624	0.2138	6.7	2.1627	4.6774

Voltage Ratio	Power Ratio	<-- - dB + -->	Voltage Ratio	Power Ratio
0.4571	0.2089	6.8	2.1878	4.7863
0.4519	0.2042	6.9	2.2131	4.8978
0.4467	0.1995	7	2.2387	5.0119
0.4416	0.1950	7.1	2.2646	5.1286
0.4365	0.1905	7.2	2.2909	5.2481
0.4315	0.1862	7.3	2.3174	5.3703
0.4266	0.1820	7.4	2.3442	5.4954
0.4217	0.1778	7.5	2.3714	5.6234
0.4169	0.1738	7.6	2.3988	5.7544
0.4121	0.1698	7.7	2.4266	5.8884
0.4074	0.1660	7.8	2.4547	6.0256
0.4027	0.1622	7.9	2.4831	6.1660
0.3981	0.1585	8	2.5119	6.3096
0.3936	0.1549	8.1	2.5410	6.4565
0.3890	0.1514	8.2	2.5704	6.6069
0.3846	0.1479	8.3	2.6002	6.7608
0.3802	0.1445	8.4	2.6303	6.9183
0.3758	0.1413	8.5	2.6607	7.0795
0.3715	0.1380	8.6	2.6915	7.2444
0.3673	0.1349	8.7	2.7227	7.4131
0.3631	0.1318	8.8	2.7542	7.5858
0.3589	0.1288	8.9	2.7861	7.7625
0.3548	0.1259	9	2.8184	7.9433
0.3508	0.1230	9.1	2.8510	8.1283
0.3467	0.1202	9.2	2.8840	8.3176
0.3428	0.1175	9.3	2.9174	8.5114
0.3388	0.1148	9.4	2.9512	8.7096
0.3350	0.1122	9.5	2.9854	8.9125
0.3311	0.1096	9.6	3.0200	9.1201
0.3273	0.1072	9.7	3.0549	9.3325
0.3236	0.1047	9.8	3.0903	9.5499
0.3199	0.1023	9.9	3.1261	9.7724
0.3162	0.1000	10	3.1623	10.0000
0.1778	0.0316	11	5.6234	31.6228

Power Conversion Chart dBm to dBw to Watts to Volts			
dBm	dBw	Watts	Volts (50 Ohm)
80	50	100 kW	2236
75	45	31.6 kW	1257
70	40	10.0 kW	707
65	35	3.16 kW	398
60	30	1000	224
55	25	316	126
50	20	100	70.7
45	15	31.6	39.8
40	10	10.0	22.4
38	8	6.31	17.8
36	6	3.98	14.1
34	4	2.51	11.2
32	2	1.58	8.90
30	0	1.00	7.07
29	-1	0.79	6.30
28	-2	0.63	5.62
27	-3	0.50	5.01
26	-4	0.40	4.46
25	-5	0.32	3.98
24	-6	0.25	3.54
23	-7	0.20	3.16
22	-8	0.16	2.82
21	-9	0.13	2.51
20	-10	0.10	2.24
19	-11	79 mW	1.99

Power Conversion Chart dBm to dBw to Watts to Volts			
dBm	dBm	Watts	Volts (50 Ohm)
18	-12	63 mW	1.78
17	-13	50 mW	1.58
16	-14	40 mW	1.41
15	-15	32 mW	1.26
14	-16	25 mW	1.12
13	-17	20 mW	1.00
12	-18	16 mW	0.890
11	-19	13 mW	0.793
10	-20	10 mW	0.707
9	-21	7.9 mW	0.630
8	-22	6.3 mW	0.562
7	-23	5.0 mW	0.501
6	-24	4.0 mW	0.446
5	-25	3.2 mW	0.398
4	-26	2.5 mW	0.354
3	-27	2.0 mW	0.316
2	-28	1.6 mW	0.282
1	-29	1.3 mW	0.251
0	-30	1.0 mW	0.224
-5	-35	316 uW	0.126
-10	-40	100 uW	0.071
-15	-45	31.6 uW	0.040
-20	-50	10 uW	0.022
-25	-55	3.16 uW	0.013
-30	-60	1 uW	0.007

Free Space Path Loss Estimator

Path Length (miles)	Path Loss in dB: 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)

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