Bird Technologies®

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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.

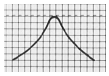
Four types of cavity filters are designed and manufactured by TX RX Systems: Bandpass, T-Pass®, Vari-Notch® and Series-Notch®. Each uses a specific type of loop assembly which provides the desired frequency response. The Vari-Notch® and Series-Notch® filters use one loop assembly per cavity and incorporates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

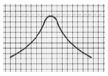
All Loop Plate/connector assemblies are silver-or Alballoy®-plated for low IM

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.

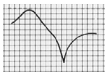


T-PASS®

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®

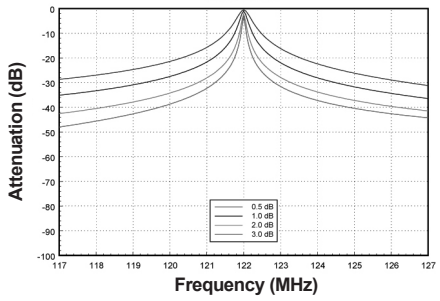
The Vari-Notch® design passes a relatively narrow band of frequencies and rejects (notches out) a relatively wide frequency band. Equivalent to a combination series-tuned and parallel-tuned circuit, this filter has a greater notch depth than the Series-Notch® design. The notch depth is adjustable but 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

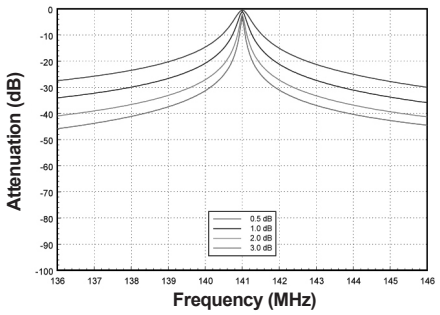
All cavity types mentioned above may be cascaded to achieve an arithmetic sum of individual filter attenuation. Up to 6 dB of additional attenuation can be achieved when the proper length of cable is used to interconnect the cavities. (This additional 6 dB does not occur in the filter passband but only 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

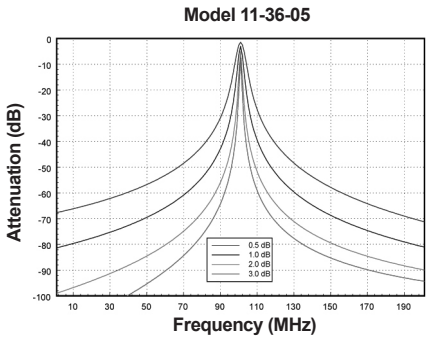
Model 11-35-01



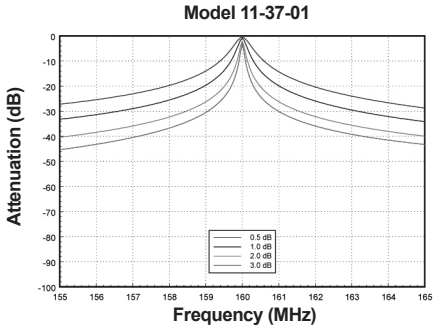
Model 11-36-01



Model 11-36-05



Model 11-37-01



SPECIFICATIONS, ELECTRICAL

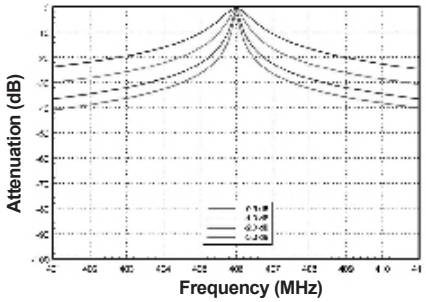
Model Number/ Frequency Range	11-35-01	108-136 MHz
	11-35-02	108-136 MHz
	11-35-05	108-136 MHz
	11-35-06	108-136 MHz
	11-36-01	132-150 MHz
	11-36-02	132-150 MHz
Max. pwr., per cavity, @ 0.5 dB IL		270 Watts
Max. pwr., per cavity, @ 3.0 dB IL		60 Watts
Impedance		50 ohms
VSWR		1.25:1 max.
Cavity Length (electrical)		1/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter (inches)	11-35-01	6.625
	11-35-02	6.625
	11-35-05	10
	11-35-06	10
	11-36-01	6.625
	11-36-02	6.625
Number of Cavities	11-35-01	1
	11-35-02	2
	11-35-05	1
	11-35-06	2
	11-36-01	1
	11-36-02	2
Connectors		N
Dimensions, HxWxD (inches)	11-35-01	31.5x6.625x6.625
	11-35-02	31.5x6.625x6.625
	11-35-05	33.5x10x10
	11-35-06	33.5x10x10
	11-36-01	26x6.625x6.625
	11-36-02	26x6.625x6.625
Shipping Weight	11-35-01	20 lbs
	11-35-02	42 lbs
	11-35-05	27 lbs
	11-35-06	56 lbs
	11-36-01	15 lbs
	11-36-02	30 lbs

SPECIFICATIONS, ELECTRICAL

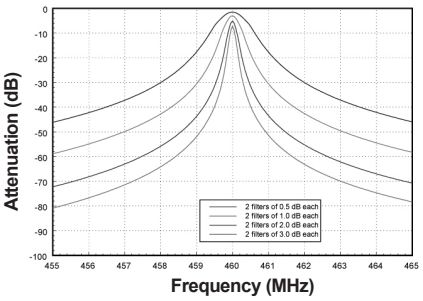
Model Number/ Frequency Range	11-36-05	132-150 MHz
	11-36-06	132-150 MHz
	11-37-01	144-174 MHz
	11-37-02	144-174 MHz
	11-37-05	144-174 MHz
	11-37-06	144-174 MHz
	11-37-09	144-174 MHz
Max. pwr., per cavity, @ 0.5 dB IL		270 Watts
	11-37-09	100 Watts
Max. pwr., per cavity, @ 3.0 dB IL		60 Watts
	11-37-09	N/A
Impedance		50 ohms
VSWR		1.25:1 max.
Cavity Length (electrical)		1/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter (inches)	11-36-05	10
	11-36-06	10
	11-37-01	6.25
	11-37-02	6.25
	11-37-05	10
	11-37-06	10
	11-37-09	4
Number of Cavities	11-36-05	1
	11-36-06	2
	11-37-01	1
	11-37-02	2
	11-37-05	1
	11-37-06	2
	11-37-09	1
Connectors		N
Dimensions, HxWxD (inches)	11-36-05	26x10x10
	11-36-06	26x10x10
	11-37-01	26x6.625x6.625
	11-37-02	26x6.625x6.625
	11-37-05	26x10x10
	11-37-06	26x10x10
	11-37-09	15 x 4 x 4
Shipping Weight	11-36-05	21 lbs
	11-36-06	44 lbs
	11-37-01	15 lbs
	11-37-02	30 lbs
	11-37-05	21 lbs
	11-37-06	44 lbs
	11-37-09	5 lbs

CAVITY FILTERS
Bandpass
225-400 / 406-512 MHz

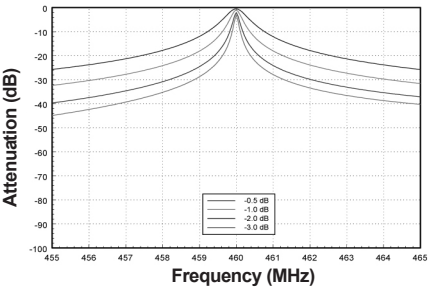
Model 11-70-11



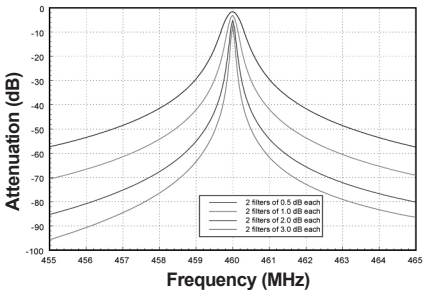
Model 11-70-12



Model 11-70-25



Model 11-70-26



SPECIFICATIONS, ELECTRICAL

Model Number/ Frequency Range	11-53-01	225-400 MHz
	11-65-26	406-420 MHz
	11-69-01	470-512 MHz
	11-69-02	470-512 MHz
	11-69-05	470-512 MHz
	11-69-06	470-512 MHz
	11-69-09	470-512 MHz
	11-69-11	470-512 MHz
	11-69-12	470-512 MHz
Max. pwr., per cavity, @ 0.5 dB IL	11-53-01	100 Watts
	11-69-09	100 Watts
		270 Watts
Max. pwr., per cavity, @ 3.0 dB IL	11-53-01	100 Watts
		60 Watts
	11-69-09	N/A
Impedance		50 ohms
VSWR		1.25:1 max.
Cavity Length (electrical)	11-53-01	3/4λ
	11-65-26	3/4λ
	11-69-01	1/4λ
	11-69-02	1/4λ
	11-69-05	1/4λ
	11-69-06	1/4λ
	11-69-09	1/4λ
	11-69-11	3/4λ
	11-69-12	3/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter (inches)	11-53-01	8
	11-65-26	10
	11-69-01	6.25
	11-69-02	6.25
	11-69-05	10
	11-69-06	10
	11-69-09	4
	11-69-11	10
	11-69-12	10
Number of Cavities	11-53-01	1
	11-65-26	2
	11-69-01	1
	11-69-02	2
	11-69-05	1
	11-69-06	2
	11-69-09	1
	11-69-11	1
	11-69-12	2
Connectors		N
	11-69-09	BNC
Dimensions, HxWxD (inches)	11-53-01	25x8x8
	11-65-26	26x10x10
	11-69-01	11.5x6.625x6.625
	11-69-02	11.5x6.625x6.625
	11-69-05	12.5x10x10
	11-69-06	12.5x10x10
	11-69-09	9x4x4
	11-69-11	12.5x10x10
	11-69-12	26x10x10
Shipping Weight	11-53-01	8.6 lbs
	11-65-26	43 lbs
	11-69-01	8 lbs
	11-69-02	16 lbs
	11-69-05	11 lbs
	11-69-06	23 lbs
	11-69-09	4 lbs
	11-69-11	21 lbs
	11-69-12	43 lbs

SPECIFICATIONS, ELECTRICAL

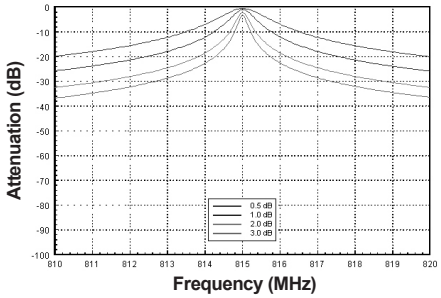
Model Number/ Frequency Range	11-70-01	450-470 MHz
	11-70-02	450-470 MHz
	11-70-05	450-470 MHz
	11-70-06	450-470 MHz
	11-70-09	450-470 MHz
	11-70-11	450-470 MHz
	11-70-12	450-470 MHz
	11-70-25	450-470 MHz
	11-70-26	450-470 MHz
Max. pwr., per cavity, @ 0.5 dB IL	11-70-01	100 Watts
Max. pwr., per cavity, @ 3.0 dB IL		60 Watts
	11-70-09	N/A
Impedance		50 ohms
VSWR		1.25:1 max.
Cavity Length (electrical)	11-70-01	1/4λ
	11-70-02	1/4λ
	11-70-05	1/4λ
	11-70-06	1/4λ
	11-70-09	1/4λ
	11-70-11	3/4λ
	11-70-12	3/4λ
	11-70-25	3/4λ
	11-70-26	3/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter (inches)	11-70-01	6.25
	11-70-02	6.25
	11-70-05	10
	11-70-06	10
	11-70-09	4
	11-70-11	6.25
	11-70-12	6.25
	11-70-25	10
	11-70-26	10
Number of Cavities	11-70-01	1
	11-70-02	2
	11-70-05	1
	11-70-06	2
	11-70-09	1
	11-70-11	1
	11-70-12	2
	11-70-25	1
	11-70-26	2
Connectors		N
	11-70-09	BNC
Dimensions, HxWxD (inches)	11-70-01	11.5x6.625x6.625
	11-70-02	11.5x6.625x6.625
	11-70-05	12.5x10x10
	11-70-06	12.5x10x10
	11-70-09	9x4x4
	11-70-11	26x6.625x6.625
	11-70-12	26x6.625x6.625
	11-70-25	26x10x10
	11-70-26	26 x10x10
Shipping Weight	11-70-01	8 lbs
	11-70-02	16 lbs
	11-70-05	11 lbs
	11-70-06	23 lbs
	11-70-09	4 lbs
	11-70-11	12 lbs
	11-70-12	25 lbs
	11-70-25	21 lbs
	11-70-26	43 lbs

CAVITY FILTERS

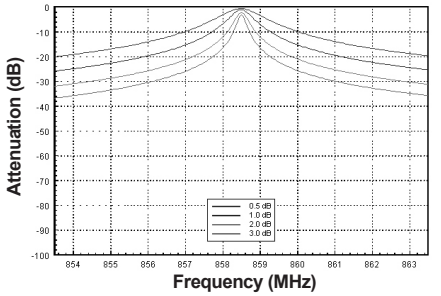
Bandpass

746-960 MHz

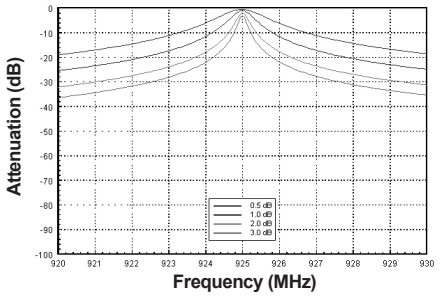
Model 11-86-11



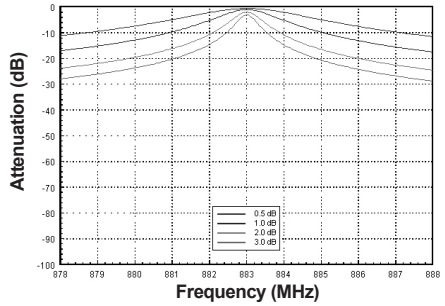
Model 11-87-11



Model 11-88-11



Model 11-90-05



SPECIFICATIONS, ELECTRICAL

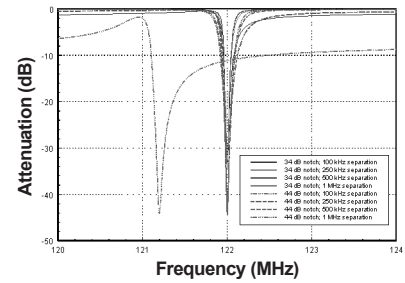
Model Number/ Frequency Range	11-83B-11	746-869 MHz
	11-83B-12	746-869 MHz
	11-86-11	806-821 MHz
	11-86-12	806-821 MHz
Max. pwr., per cavity, @ 0.5 dB IL		270 Watts
Max. pwr., per cavity, @ 3.0 dB IL		60 Watts
Impedance		50 ohms
VSWR		1.25:1 max.
Cavity Length (electrical)		3/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter (inches)		6.625
Number of Cavities	11-83B-11	1
	11-83B-12	2
	11-86-11	1
	11-86-12	2
Connectors		N
Dimensions, HxWxD (inches)	11-83B-11	14x6.625x6.625
	11-83B-12	14x6.625x6.625
	11-86-11	13x6.625x6.625
	11-86-12	13x6.625x6.625
Shipping Weight	11-83B-11	10 lbs
	11-83B-12	19 lbs
	11-86-11	9 lbs
	11-86-12	18 lbs

SPECIFICATIONS, ELECTRICAL

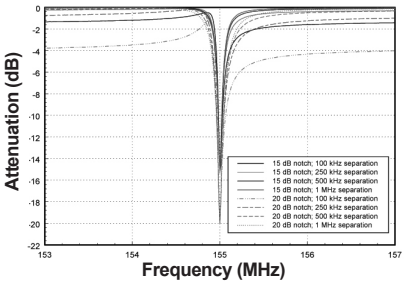
Model Number/ Frequency Range	11-87-11	851-866 MHz
	11-87-12	851-866 MHz
	11-88-11	806-960 MHz
	11-88-12	806-960 MHz
	11-90-05	806-960 MHz
Max. pwr., per cavity, @ 0.5 dB IL		270 Watts
	11-90-05	100 Watts
Max. pwr., per cavity, @ 3.0 dB IL		60 Watts
	11-90-05	N/A
Impedance		50 ohms
VSWR		1.25:1 max.
Cavity Length (electrical)		3/4λ
	11-90-05	1/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter (inches)		6.625
	11-90-05	4
Number of Cavities	11-87-11	1
	11-87-12	2
	11-88-11	1
	11-90-05	1
Connectors		N
	11-90-05	BNC
Dimensions, HxWxD (inches)	11-87-11	13x6.625x6.625
	11-87-12	13x6.625x6.625
	11-88-11	13x6.625x6.625
	11-90-05	6.5x4x4
Shipping Weight	11-87-11	9 lbs
	11-87-12	18 lbs
	11-88-11	9 lbs
	11-90-05	3 lbs

CAVITY FILTERS
Series Notch
108-174 MHz

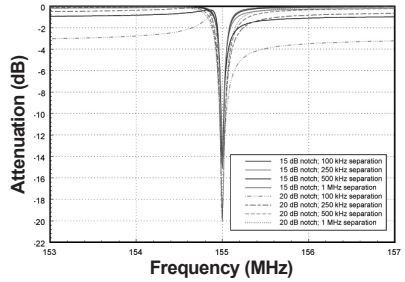
Model 20-35-02



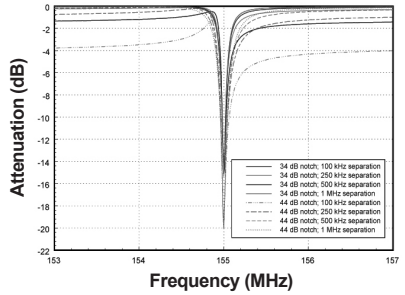
Model 20-37-01



Model 20-37-05



Model 20-37-06



Model Number/ Frequency Range	20-35-01	108-136 MHz
	20-35-02	108-136 MHz
	20-36-01	132-150 MHz
	20-36-02	132-150 MHz
Insertion Loss vs. Frequency Separations / with single cavity, notch depth @ 15 dB / with single cavity, notch depth @ 20 dB	20-35-01	<1.0 dB / <1.5 dB @ 100 kHz <0.2 dB / <0.3 dB @ 250 kHz <0.2 dB / <0.2 dB @ 500 kHz <0.2 dB / <0.2 dB @ 1 MHz
	20-35-02	N/A
	20-36-01	<1.0 dB / <1.5 dB @ 100 kHz <0.2 dB / <0.3 dB @ 250 kHz <0.2 dB / <0.2 dB @ 500 kHz <0.2 dB / <0.2 dB @ 1 MHz
	20-36-02	N/A
Insertion Loss vs. Frequency Separations / with single cavity, notch depth @ 34 dB / with single cavity, notch depth @ 44 dB	20-35-01	N/A
	20-35-02	<0.2 dB / <0.3 dB @ 100 kHz <0.6 dB / <0.8 dB @ 250 kHz <0.5 dB / <0.5 dB @ 500 kHz <0.4 dB / <0.4 dB @ 1 MHz
	20-36-01	N/A
	20-36-02	<0.2 dB / <0.3 dB @ 100 kHz <0.6 dB / <0.8 dB @ 250 kHz <0.5 dB / <0.5 dB @ 500 kHz <0.4 dB / <0.4 dB @ 1 MHz
Impedance		50 ohms
VSWR		1.5:1 max.
Max. pwr. (Watts) @ stated separation	20-35-01	60W @ 100 kHz 250W @ 250 kHz 350W @ 500 kHz 350W @ 1 MHz
	20-35-02	N/A
	20-36-01	60 W @ 100 kHz 250W @ 250 kHz 350 W @ 500 kHz 350 W @ 1 MHz
	20-36-02	N/A
Cavity Length (electrical)		1/4λ
Temperature Range, °C		-30 to + 60
Cavity Size, diameter		6.625”
Number of Cavities	20-35-01	1
	20-35-02	2
	20-36-01	1
	20-36-02	2
Cavity Height (inches)	20-35-01	31.5; w / tuning rod extended, 43 max.
	20-35-02	31.5; w / tuning rod extended, 43 max.
	20-36-01	26, w / tuning rod extended, 38 max.
	20-36-02	26, w / tuning rod extended, 38 max.
Width		6.625”
	20-37-05	10”
Depth		6.625”
	20-37-05	10”
Connectors		N
Weight, lbs.	20-35-01	18
	20-35-02	36
	20-36-01	17
	20-36-02	34

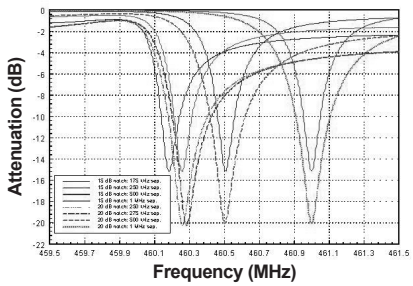
Model Number / Frequency Range	20-37-01	144-174 MHz
	20-37-02	
	20-37-05	
	20-37-06	
Insertion Loss vs. Frequency Separations with single cavity, notch depth @ 15 dB / with single cavity, notch depth @ 20 dB	20-37-01	<1.0 dB / <1.8 dB @ 100 kHz <0.2 dB / <0.3 dB @ 250 kHz <0.2 dB / <0.2 dB @ 500 kHz <0.2 dB / <0.2 dB @ 1 MHz
	20-37-02	N/A
	20-37-05	<2.0 dB @ 50 kHz / <1.0 dB @ 100 kHz <0.2 dB / <0.2 dB @ 250 kHz <0.2 dB / <0.2 dB @ 500 kHz <0.2 dB / <0.2 dB @ 1 MHz
	20-37-06	N/A
Insertion Loss vs. Frequency Separations / with single cavity, notch depth @ 34 dB / with single cavity, notch depth @ 44 dB	20-37-01	N/A
	20-37-02	<2.0 dB / <3.6 dB @ 100 kHz <0.6 dB / <0.8 dB @ 250 kHz <0.5 dB / <0.5 dB @ 500 kHz <0.4 dB / <0.4 dB @ 1 MHz
	20-37-05	N/A
	20-37-06	<3.5 dB @ 50 kHz / <2.0 dB @ 100 kHz <0.5 dB / <0.6 dB @ 250 kHz <0.5 dB / <0.5 dB @ 500 kHz <0.4 dB / <0.4 dB @ 1 MHz
Impedance		50 ohms
VSWR		1.5:1 max.
Max. pwr. (Watts) @ stated separation	20-37-01	60 W @ 100 kHz 250 W @ 250 kHz 350 W @ 500 kHz 350 W @ 1 MHz
	20-37-02	N/A
	20-37-05	80 W @ 50 kHz 150 W @ 100 kHz 350 W @ 250 kHz 350 W @ 500 kHz 350 W @ 1 MHz
	20-37-06	N/A
Cavity Length (electrical)		1/4λ
Temperature Range, °C		-30 to + 60
Cavity Size, diameter	20-37-01	6.625”
	20-37-02	6.625”
	20-37-05	10”
	20-37-06	10”
Number of Cavities	20-37-01	1
	20-37-02	2
	20-37-05	1
	20-37-06	2
Cavity Height (inches)		26, w/ tuning rod extended, 38 max.
Width	20-37-01	6.625”
	20-37-02	6.625”
	20-37-05	10”
	20-37-06	10”
Depth		6.625”
	20-37-06	10”
Connectors		N
Weight, lbs.	20-37-01	17
	20-37-02	34
	20-37-05	22
	20-37-06	45

CAVITY FILTERS

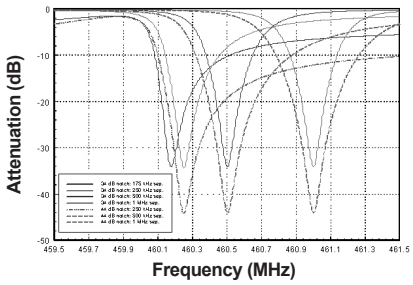
Series Notch

450-470 MHz

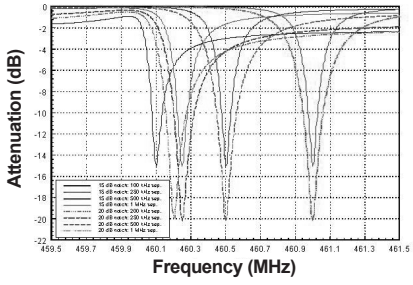
Model 20-70-01



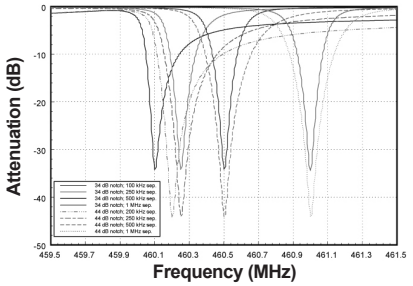
Model 20-70-02



Model 20-70-25



Model 20-70-26



SPECIFICATIONS, ELECTRICAL

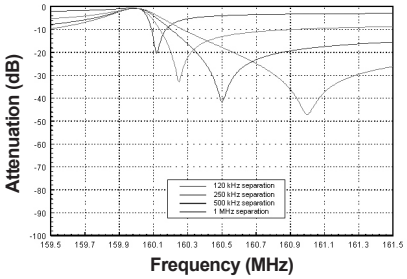
Model Number / Frequency Range	20-70-01 20-70-02	450-470 MHz
Frequency Separations vs. Insertion Loss **With single cavity, notch depth @ 15 dB /** **With single cavity, notch depth @ 20 dB**	20-70-01 20-70-02	1.5 dB @ 175 kHz / 1.5 dB @ 250 kHz 0.7 dB @ 250 kHz / 1.2 dB @ 275 kHz 0.2 dB / 0.4 dB @ 500 kHz 0.1 dB / 0.1 dB @ 1 MHz N/A
Frequency Separations vs. Insertion Loss **With single cavity, notch depth @ 34 dB /** **With single cavity, notch depth @ 44 dB**	20-70-01 20-70-02	N/A 3.0 dB @ 175 kHz / 3.1 dB @ 250 kHz 1.5 dB @ 250 kHz / 2.6 dB @ 275 kHz 0.5 dB / 1.0 dB @ 500 kHz 0.4 dB / 0.4 dB @ 1 MHz
Impedance		50 ohms
VSWR		1:5:1 max.
Max. pwr. (Watts) @ stated separation		35W @ 175 kHz 35W @ 250 kHz 40W @ 275 kHz 120W @ 500 kHz 350W @ 1 MHz
Cavity Length (electrical)		1/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter		6.625”
Number of Cavities	20-70-01 20-70-02	1 2
Cavity Height (inches)		11.5, w/tuning rod extended, 16.5 max.
Width x Depth		6.625” x 6.625”
Connectors		N
Weight lbs.	20-70-01 20-70-02	11 23

SPECIFICATIONS, ELECTRICAL

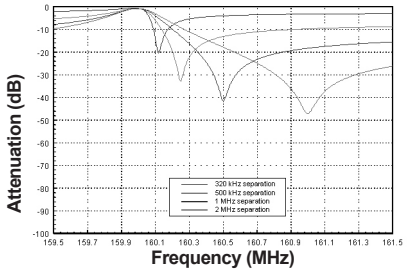
Model Number / Frequency Range	20-70-25 20-70-26	450-470 MHz
Frequency Separations vs. Insertion Loss **With dual cavity, notch depth @ 15 dB /** **With dual cavity, notch depth @ 20 dB**	20-70-25 20-70-26	1.2 dB @ 100 kHz / 0.6 dB @ 200 kHz 0.4 dB / 0.4 dB @ 250 kHz <0.1 dB / 0.1 dB @ 500 kHz <0.1 dB / <0.1 dB @ 1 MHz N/A
Frequency Separations vs. Insertion Loss **With single cavity, notch depth @ 34 dB /** **With single cavity, notch depth @ 44 dB**	20-70-25 20-70-26	N/A 2.6 dB @ 100 kHz / 1.5 dB @ 200 kHz 1.0 dB / 1.0 dB @ 250 kHz 0.3 dB / 0.4 dB @ 500 kHz 0.3 dB / 0.3 dB @ 1 MHz
Impedance		50 ohms
VSWR		1:5:1 max.
Max. pwr. (Watts) @ stated separation		55W @ 100 kHz 100W @ 200 kHz 180W @ 250 kHz 350W @ 500 kHz 350W @ 1 MHz
Cavity Length (electrical)		3/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter		10”
Number of Cavities	20-70-25 20-70-26	1 2
Cavity Height (inches)		26, w/tuning rod extended, 37 max.
Width x Depth		10” x 10”
Connectors		N
Weight lbs.	20-70-25 20-70-26	21 44

CAVITY FILTERS
Vari-Notch
108-174 MHz

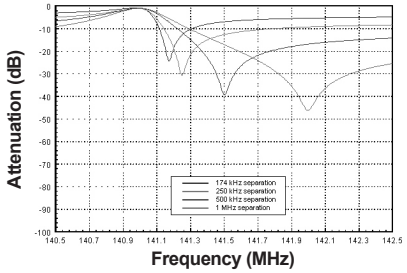
Model 15-37-05



Model 15-37-09



Model 15-36-01



SPECIFICATIONS, ELECTRICAL

Model Number / Frequency Range	15-35-01	108-136 MHz
	15-35-05	108-136 MHz
	15-36-01	132-150 MHz
	15-36-05	132-150 MHz
Minimum Separation (Pass-to-Notch)	15-35-01	174 kHz
	15-35-05	130 kHz
	15-36-01	140 kHz
	15-36-05	100 kHz
Frequency Separation / Attenuation vs. Pass-to-Notch	15-35-01	24 dB @ 174 kHz 30 dB @ 250 kHz 39 dB @ 500 kHz 46 dB @ 1 MHz
	15-35-05	24 dB @ 130 kHz 34 dB @ 250 kHz 43 dB @ 500 kHz 47 dB @ 1 MHz
	15-36-01	19 dB @ 140 kHz 27 dB @ 250 kHz 37 dB @ 500 kHz 45 dB @ 1 MHz
	15-36-05	19 dB @ 100 kHz 33 dB @ 250 kHz 42 dB @ 500 kHz 47 dB @ 1 MHz
Power Rating		300 Watts
Impedance		50 ohms
VSWR		1:25:1 max.
Cavity Length (electrical)		1/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter	15-35-01	6.625”
	15-35-05	10”
	15-36-01	6.625”
	15-36-05	10”
Number of Cavities		1
Connectors	15-35-01	N
	15-35-05	N
	15-36-01	BNC
	15-36-05	N
Cavity Height (inches)	15-35-01	31.5, w/tuning rod extended, 44 max.
	15-35-05	33.5, w/tuning rod extended, 48 max.
	15-36-01	26, w/tuning rod extended, 38 max
	15-36-05	26, w/tuning rod extended, 38 max
Width x Depth	15-35-01	6.625” x 6.625”
	15-35-05	10” x 10”
	15-36-01	6.625” x 6.625”
	15-36-05	10” x 10”
Shipping Weight lbs.	15-35-01	20
	15-35-05	27
	15-36-01	17
	15-36-05	23

SPECIFICATIONS, ELECTRICAL

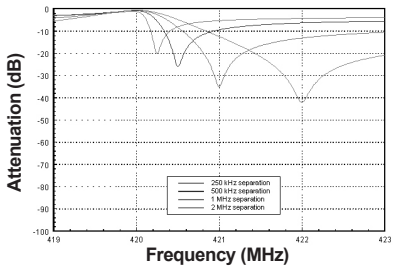
Model Number / Frequency Range	15-37-01 15-37-05 15-37-09	144-174 MHz
Minimum Separation (Pass-to-Notch)	15-37-01	170 kHz
	15-37-05	120 kHz
	15-37-09	320 kHz
Frequency Separation / Attenuation vs. Pass-to-Notch	15-37-01	22 dB @ 170 kHz 27 dB @ 250 kHz 37 dB @ 500 kHz 45 dB @ 1 MHz
	15-37-05	20 dB @ 120 kHz 32 dB @ 250 kHz 41 dB @ 500 kHz 47 dB @ 1 MHz
	15-37-09	18 dB @ 320 kHz 24 dB @ 500 kHz 35 dB @ 1 MHz 44 dB @ 2 MHz
Power Rating		300 Watts
	15-37-09	150 Watts
Impedance		50 ohms
VSWR		1:25:1 max.
Cavity Length (electrical)		1/4λ
	15-37-09	1/4λ Low Pass
Temperature Range		-30 to + 60 C°
Cavity Size, diameter	15-37-01	6.625”
	15-37-05	10”
	15-37-09	4”
Number of Cavities		1
Connectors		N
Cavity Height (inches)		26, w/tuning rod extended, 38 max.
	15-37-09	15, w/tuning rod extended, 20 max.
Width x Depth	15-37-01	6.625” x 6.625”
	15-37-05	10” x 10”
	15-37-09	4” x 4”
Shipping Weight lbs.	15-37-01	17
	15-37-05	23
	15-37-09	5

CAVITY FILTERS

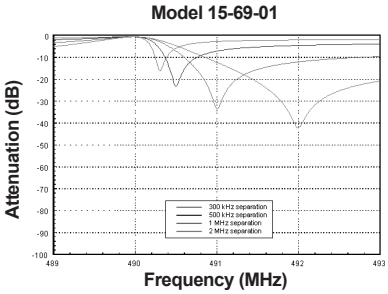
Vari-Notch

406-512 MHz

Model 15-65-01



Model 15-69-01

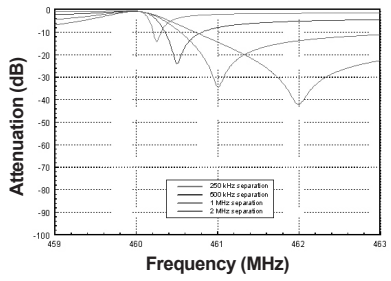


SPECIFICATIONS, ELECTRICAL

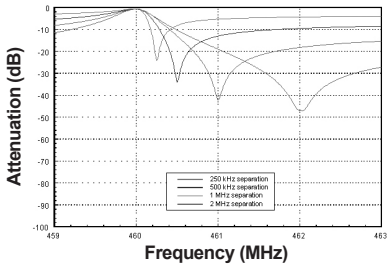
Model Number /Frequency Range	15-65-01	406-430 MHz
	15-65-21	406-430 MHz
	15-65-22	406-430 MHz
	15-69-01	470-512 MHz
	15-69-21	470-512 MHz
	15-69-22	470-512 MHz
Minimum Separation (Pass-to-Notch)	15-65-01	250 kHz
	15-65-21	1 MHz
	15-65-22	500 kHz
	15-69-01	300 kHz
	15-69-21	1 MHz
	15-69-22	500 kHz
Frequency Separation / Attenuation vs. Pass-to-Notch	15-65-01	20 dB @ 250 kHz
		26 dB @ 500 kHz
		35 dB @ 1 MHz
		42 dB @ 2 MHz
	15-65-21	23 dB @ 1 MHz
		32 dB @ 2 MHz
		48 dB @ 3 MHz
	15-65-22	19 dB @ 500 kHz
		26 dB @ 1 MHz
		38 dB @ 2 Mhz
		47 dB @ 5 MHz
	15-69-01	16 dB @ 300 kHz
		23 dB @ 500 kHz
		33 dB @ 1 Mhz
		42 dB @ 2 MHz
	15-69-21	23 dB @ 1 MHz
		32 dB @ 2 MHz
		48 dB @ 3 MHz
	15-69-22	19 dB @ 500 kHz
		26 dB @ 1 MHz
		38 dB @ 2 Mhz
		47 dB @ 5 MHz
Power Rating	15-65-01	300 Watts
	15-65-21	150 Watts
	15-65-22	150 Watts
	15-69-01	300 Watts
	15-69-21	150 Watts
	15-69-22	150 Watts
Impedance		50 ohms
VSWR		1:25:1 max.
Cavity Length (electrical)		1/4λ
	15-65-22	1/4λ High Selectivity
	15-69-22	1/4λ High Selectivity
Temp. Range		-30 to + 60 C°
Cavity Size, diameter	15-65-01	6.625”
	15-65-21	4”
	15-65-22	4”
	15-69-01	6.625”
	15-69-21	4”
	15-69-22	4”
Number of Cavities		1
Connectors	15-65-01	N
	15-65-21	BNC
	15-65-22	BNC
	15-69-01	N
	15-69-21	BNC
	15-69-22	BNC
Cavity Height (inches)	15-65-01	11.5, w/tuning rod extended, 16.5 max
	15-65-21	10, w/tuning rod extended, 13 max.
	15-65-22	10, w/tuning rod extended, 13 max.
	15-69-01	11.5, w/tuning rod extended, 16.5 max.
	15-69-21	9, w/tuning rod extended, 13 max.
	15-69-22	9, w/tuning rod extended, 13 max.
Width x Depth	15-65-01	6.625 x 6.625
	15-65-21	4 x 4
	15-65-22	4 x 4
	15-69-01	6.625 x 6.625
	15-69-21	4 x 4
	15-69-22	4 x 4
Shipping Weight lbs.	15-65-01	6
	15-65-21	4
	15-65-22	4
	15-69-01	8
	15-69-21	4
	15-69-22	4

CAVITY FILTERS
Vari-Notch
470-512 MHz

Model 15-70-01



Model 15-70-25



SPECIFICATIONS, ELECTRICAL

Model Number /Frequency Range	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	450-470 MHz
Minimum Separation (Pass-to-Notch)	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	250 kHz 250 kHz 1 MHz 500 kHz 250 kHz
Frequency Separation / Attenuation vs. Pass-to-Notch	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25 	14 dB @ 250 kHz 24 dB @ 500 kHz 34 dB @ 1 MHz 42 dB @ 2 MHz 19 dB @ 250 kHz 29 dB @ 500 kHz 38 dB @ 1 MHz 45 dB @ 2 Mhz 23 dB @ 1 MHz 32 dB @ 2 MHz 48 dB @ 3 MHz 19 dB @ 250 kHz 26 dB @ 500 kHz 38 dB @ 1 MHz 47 dB @ 2 MHz 24 dB @ 250 kHz 34 dB @ 500 kHz 42 dB @ 1 MHz 47 dB @ 2 MHz
Power Rating	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	300 Watts 300 Watts 150 Watts 150 Watts 300 Watts
Impedance		50 ohms
VSWR		1:25:1 max.
Cavity Length (electrical)	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	1/4λ 3/4λ 1/4λ 1/4λ High Selectivity 3/4λ
Temp. Range		-30 to + 60 C°

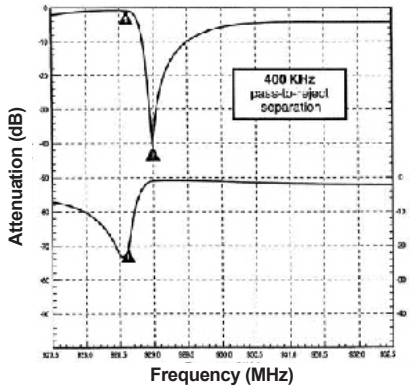
Cavity Size, diameter	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	6.625” 6.625” 4” 4” 10”
Number of Cavities		1
Connectors	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	N N BNC BNC N
Cavity Height (inches)	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	11.15, w/tuning rod extended, 16.5 max 26, w/tuning 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 x Depth	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	6.625 x 6.625 6.625 x 6.625 4 x 4 4 x 4 10 x 10
Shipping Weight lbs.	15-70-01 15-70-11 15-70-21 15-70-22 15-70-25	8 11 4 4 21

CAVITY FILTERS

Vari-Notch

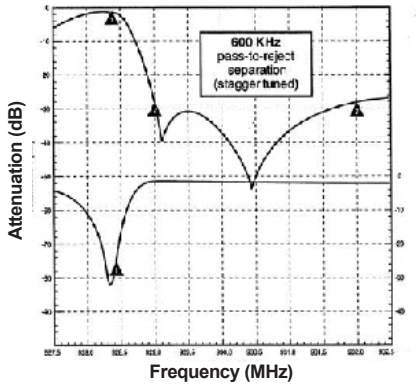
890-960 MHz

15-88-12-DM



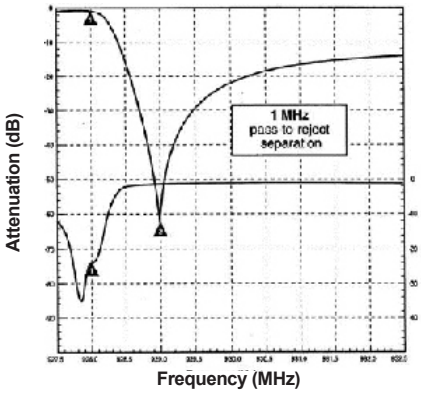
← **Markers**
1: 928.600 MHz
1.4 dB Insertion Loss
23.0 dB Return Loss
2: 929.000 MHz
40.8 dB Reject

15-88-12-DM



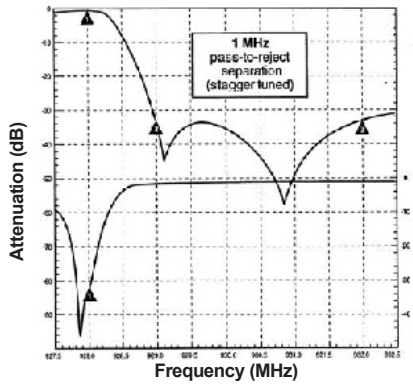
← **Markers**
1: 928.400 MHz
1.4 dB Insertion Loss
29.0 dB Return Loss
2: 929.000 MHz
28.0 dB Reject
3: 932.000 MHz
28.0 dB Reject

15-88-12-DM



← **Markers**
1: 928.000 MHz
1.4 dB Insertion Loss
24.8 dB Return Loss
2: 929.000 MHz
63.0 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

SPECIFICATIONS, ELECTRICAL

Model Number /Frequency Range	15-88-01	890-960 MHz
	15-88-02	
	15-88-11	
	15-88-12	
	15-88-12DM	
Minimum Separation (Pass-to-Notch)	15-88-01	500 kHz
	15-88-02	1.45 MHz
	15-88-11	500 kHz
	15-88-12	400 kHz
	15-88-12DM	400 kHz
Frequency Separation / Attenuation vs. Pass-to-Notch	15-88-01	15 dB @ 500 kHz
		23 dB @ 1 MHz
		31 dB @ 2 MHz
		48 dB @ 10 MHz
	15-88-02	24 dB @ 1.45 MHz
		29 dB @ 2 MHz
		51 dB @ 10 MHz
	15-88-11	22 dB @ 500 kHz
		32 dB @ 1 MHz
		40 dB @ 2 Mhz
		45 dB @ 10 MHz
	15-88-12	50 dB @ 500 kHz
		70 dB @ 1 MHz
		86 dB @ 2 Mhz
		96 dB @ 10 MHz
	15-88-12DM	39 dB @ 400 kHz
		45 dB @ 500 kHz
		50 dB @ 600 kHz
		60 dB @ 1 MHz
Power Rating	15-88-01	150 Watts
	15-88-02	150 Watts
	15-88-11	300 Watts
	15-88-12	300 Watts
	15-88-12DM	250 Watts, 400 Watts*
Impedance		50 ohms
VSWR		1:25:1 max.
Cavity Length (electrical)	15-88-01	1/4λ Low Pass
	15-88-02	1/4λ High Pass
	15-88-11	3/4λ
	15-88-12	3/4λ
	15-88-12DM	3/4λ
Temperature Range		-30 to + 60 C°
Cavity Size, diameter	15-88-01	4”
	15-88-02	4”
	15-88-11	6.625”
	15-88-12	6.625”
	15-88-12DM	6.625”
Number of Cavities	15-88-01	1
	15-88-02	1
	15-88-11	1
	15-88-12	2
	15-88-12DM	2
Connectors	15-88-01	BNC
	15-88-02	BNC
	15-88-11	N
	15-88-12	N
	15-88-12DM	N
Cavity Height (inches)	15-88-01	6.5, w/tuning rod extended, 10 max
	15-88-02	6.5, w/tuning rod extended, 10 max
	15-88-11	13, w/tuning rod extended, 19 max
	15-88-12	13, w/tuning rod extended, 19 max
	15-88-12DM	17.5, w/tuning rod extended, 23 max
Width x Depth		4 x 4
	15-88-12DM	6.625 x 6.625
Shipping Weight lbs.	15-88-01	3
	15-88-02	3
	15-88-11	9
	15-88-12	18
	15-88-12DM	17

BTG, TX RX Systems 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

Series Notch® Loops

Vari Notch® Loops

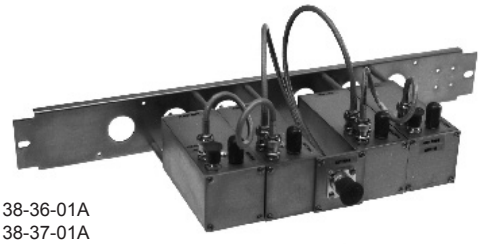
DUPLEXERS
30-960 MHz

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.

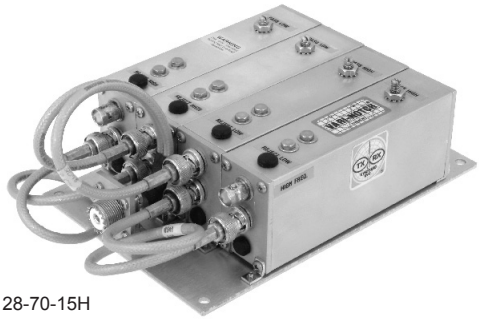
At high-band VHF and UHF, the TX RX Vari-Notch® design is the most commonly used. Vari-Notch® provides a low-loss pseudo-bandpass characteristic that can exist very close to a deep notch. Proven low-loss and low-noise construction techniques are used such as welded cavity construction; silver-plated 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
		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
		28-65-05A	0.7	350	100	2.2	6	6.625" DIA.	34	19	±7.5	N	N	75
406-430		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
		28-70-07A	0.7	350	100	2.2	6	6.625" DIA.	34	19	±7.5	N	N	55
450-470		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
806-869	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	4	4" DIA.	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

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

REFERENCE
Duplexer Trouble Shooting Aid

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.

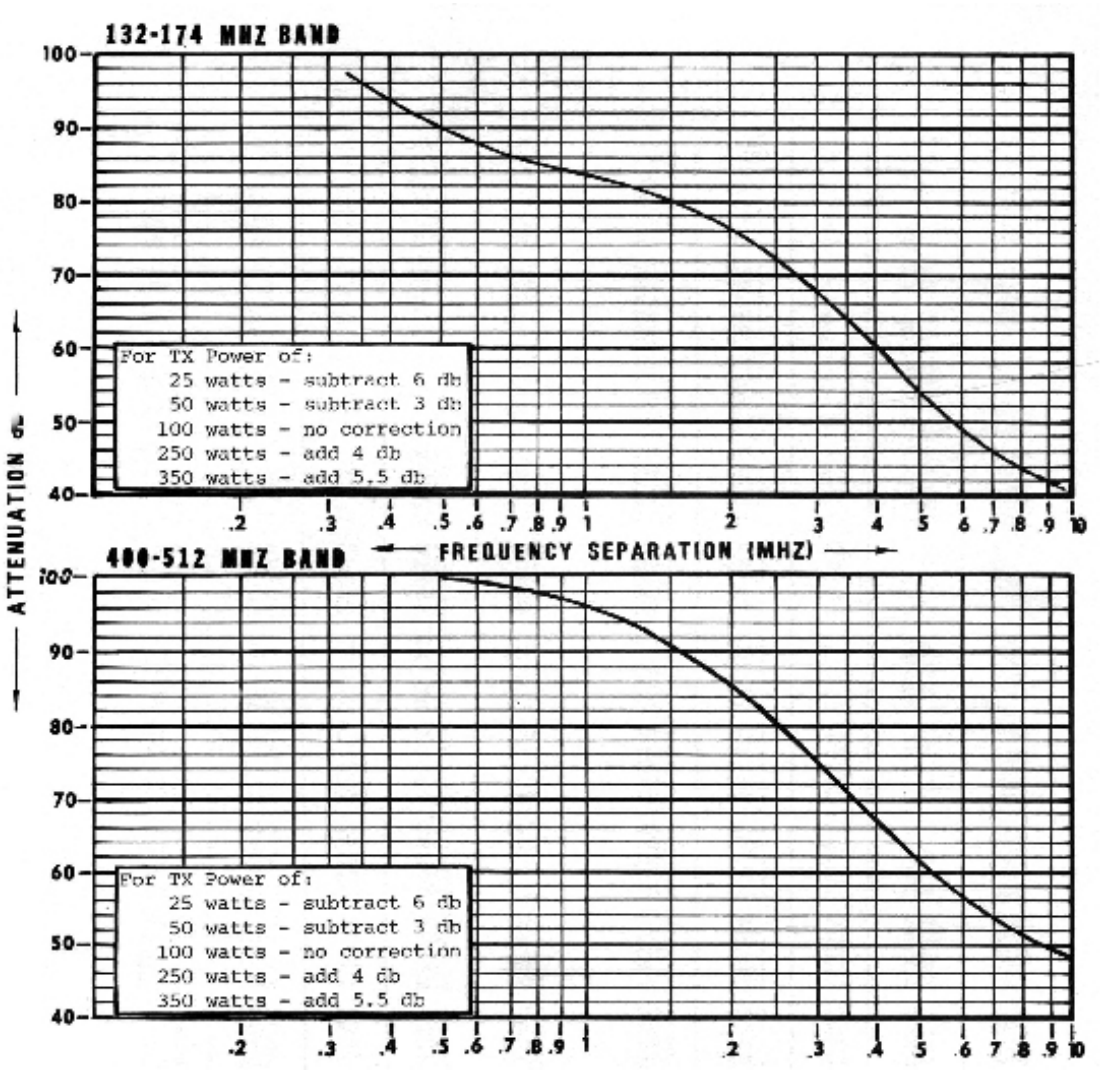
15. Either de-ice the antenna, or use an antenna less sensitive to ice. A ferrite isolator can also be put at the transmitter output to improve the impedance match. Ferrite isolators cannot be put in antenna lines, as they will attenuate Rx signals.

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.

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.



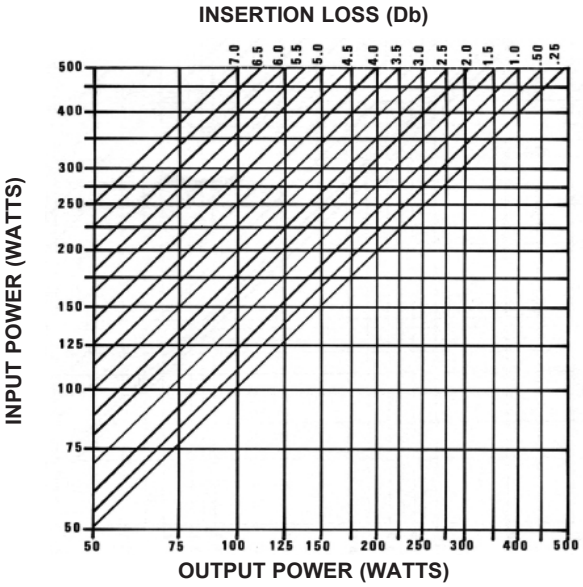
Note: These are only “typical curves. When accuracy is required, consult the radio manufacturer.

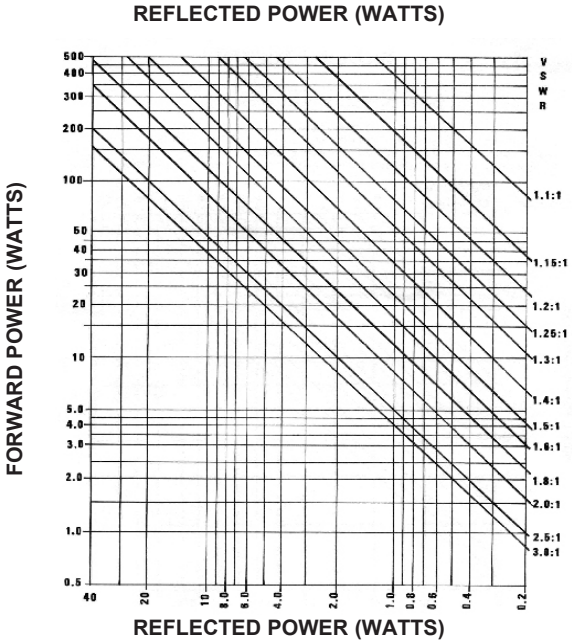
REFERENCE
Loss Nomographs

BTG, TX RX Systems 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

REFERENCE
Power Conversion Chart & Free Space Path Loss

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

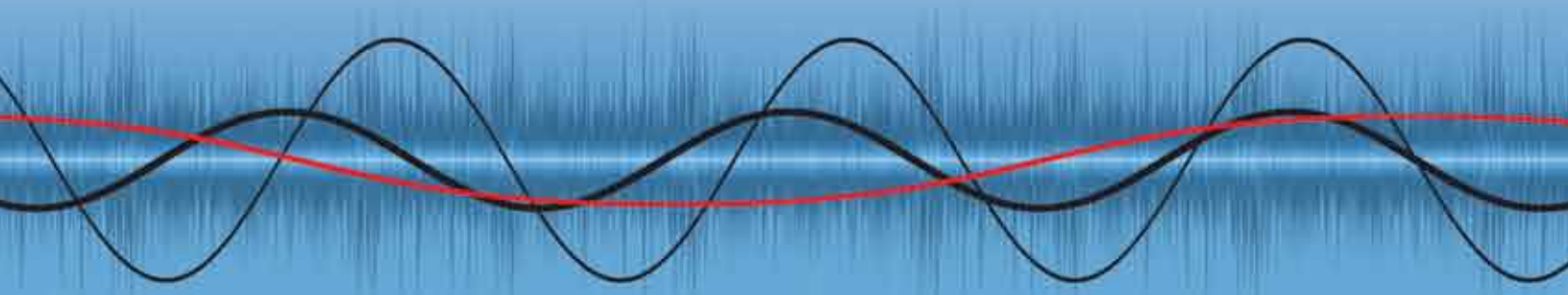
Power Conversion Chart
dBm to dBw to Watts to Volts

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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