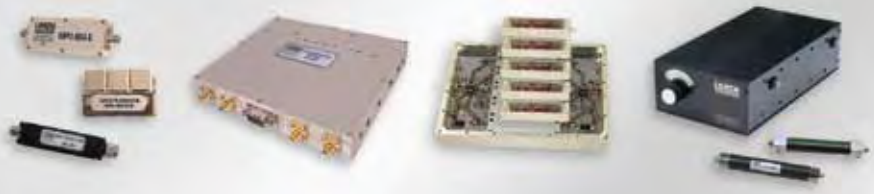
RF & Microwave Filter Products

smiths
bringing technology to life



LORCH MICROWAVE

Real World Solutions to Real World Problems

For four decades, Lorch Microwave has continuously supplied RF and Microwave components and systems to the leading military, industrial, and commercial manufacturers worldwide. This history is based on the fundamental principle that we supply solutions for the changing needs of our customers. Through continuous investment in engineering and manufacturing capabilities, Lorch is able to respond to our customer's unique custom requirements as though we are supplying "standard off-the-shelf product."

Lorch Microwave is committed to providing our customers with technically advanced, high quality products at competitive prices. As such, all products offered by Lorch Microwave are subject to the same rigorous design, manufacturing and inspection criteria. Manufacturing, testing and inspection facilities are located in our modern 37,000 square foot factory in Salisbury, Maryland. The company is MIL qualified and conforms to the principals set forth in ISO-9001 and ISO-14001. Regardless of application, the processes and procedures followed at Lorch help ensure that all products are fully compliant to all specifications and will perform as designed right out of the box.

The products described in this catalog have resulted from a combination of 40 years of design experience as well as the utilization of the latest computer aided design technology and manufacturing techniques. Further, Lorch's research and development activities are constantly evaluating new materials, plating techniques, and manufacturing processes to ensure that the company offers the highest performing components available today.

Lorch Microwave's designs are developed for ease of manufacturing and flexibility as a prime consideration. This, coupled with adequate inventories of raw materials and inventories of raw materials and in-house control of all critical process from design through manufacturing and testing yields deliveries that are quoted in weeks rather than months.

At Lorch Microwave, we believe that putting our trademark on the product is our commitment to you of quality, service and satisfaction. We understand that our product includes not just the component or system purchase, but rather, the entire purchasing experience. You have our commitment that Lorch will continue our tradition of unparalleled service to the microwave industry.

How To Order

Part numbers are assigned at time of order. If you have generated a part number, give the name of the component and the frequency range as stated in the catalog. If special options or non-standard features are desired, they should be fully described and a unique part number will be assigned. Special modifications for unusual applications, custom components and adaptation of existing parts can be designed and developed by our engineering department. A qualified staff of experienced sales and design engineers is available to assist you in specifying components for your special requirements.

Ordering Address
Lorch Microwave
PO Box 2828
Salisbury, MD 21802

Ordering: 800-780-2169
Phone: 410-860-5100
Fax: 410-860-1949

Our CAGE code is 29971

Orders may be placed through our local sales representative in your area or directly with the factory. Final determination of price, terms, conditions, and acceptance of orders, however, may be made only by our staff in Salisbury, Maryland.

Payment Options
Lorch Microwave offers many convenient payment methods, including: Open Account (subject to credit approval), Mastercard/Visa, and Letters of Credit. Please specify payment method at time of order.

Delivery
If a carrier is not specified at the time of order, shipment will be made via UPS Ground or UPS Air depending on distance from the factory. For rush service, we will ship by air freight, air express, or others, as requested. Firm delivery dates are given at time of quotation. Lorch Microwave maintains complete inventory so that many items may be delivered within 24 hours when quoted by the factory.

Packing and Packaging
Packing and Packaging is normally supplied to "Best Commercial" standards. Packaging to military requirements, including Bar Coding is available on request.

Warranty
Products manufactured by Lorch Microwave are warranted against defective materials and workmanship for a period of one year from the date of shipment. Lorch Microwave's obligation for any defect shall be limited to the repair of the defective part. Lorch Microwave assumes no liability if defects result from improper use, operation above rated capacities, repairs not made by us, or misapplication of equipment. No other warranty is expressed or implied. Lorch Microwave neither makes nor authorizes any other person to make any other warranty concerning its products. Lorch Microwave is not liable for consequential damages. Warranty returns must first be authorized by our sales office prior to return and must be returned pre-paid.

Terms and Conditions
Please visit our website at www.lorch.com/terms for a complete listing.

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Specification Guide

In many cases it is important to know more about the passband of a filter around the transition region between the passband and the stopband. The information provided serves as a design aid where passband flatness is an important criteria.

The dissipative losses are greater at the bandedges than at center frequency. The passband of the filter becomes rounded at the bandedges. Since both the dissipative loss and the reflective losses are present in each filter, the ripple becomes superimposed on the rounded passband created by the dissipative losses. Because of this it is more useful to specify a relative bandwidth as shown than the equi-ripple bandwidth.

The relationship between center frequency insertion loss and the +/- 5 degree phase linearity bandwidth is shown. This bandwidth is defined as the maximum deviation from a best-fit line drawn between two points on either side of the passband.

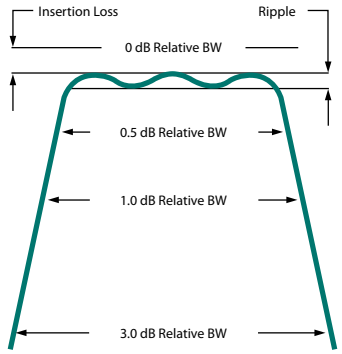
The relationship between center frequency insertion loss and the 1.5:1 VSWR bandwidth is also given. The VSWR corresponds to a 14 dB Return Loss in a 50 Ohm system.

Example:
A 4 pole filter with a 3 dB bandwidth of 60 MHz and 3.5 dB insertion loss:

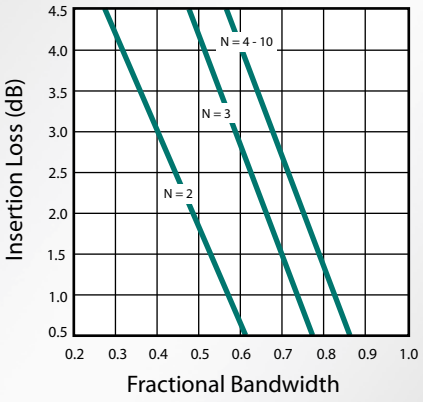
0.5 dB bandwidth is .64 x 60 = 38.4 MHz
1.0 dB bandwidth is .77 x 60 = 46.2 MHz
+/- 5° phase bandwidth is .62 x 60 = 37.2 MHz
1.5:1 VSWR bandwidth is .85 x 60 = 51 MHz

Note: When out-of-band attenuation is not specified, a 3 dB bandwidth tolerance of -0 / + 10% nominal will be used.

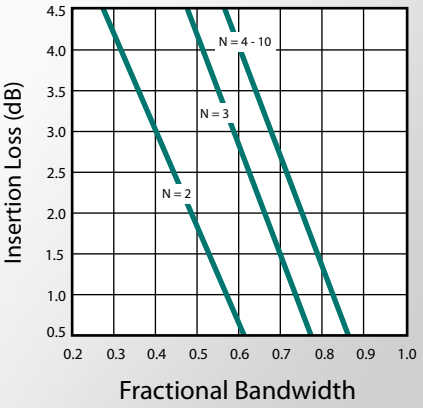
The (%) tolerance on bandwidth will be inversely proportional to an actual decrease in bandwidth (MHz) vs. frequency. If a maximum bandwidth is required, please specify.



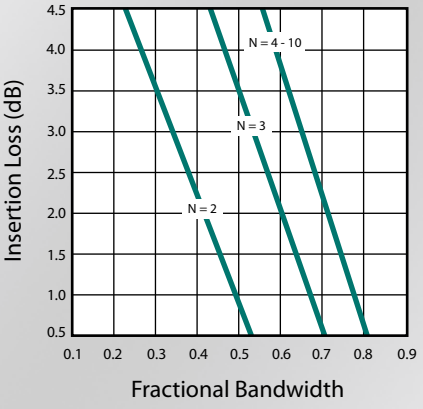
0.5 dB Relative Bandwidth



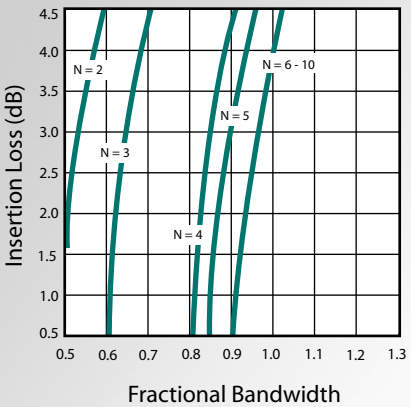
1.0 dB Relative Bandwidth



± 5° Relative Phase Bandwidth



1.5:1 VSWR Bandwidth



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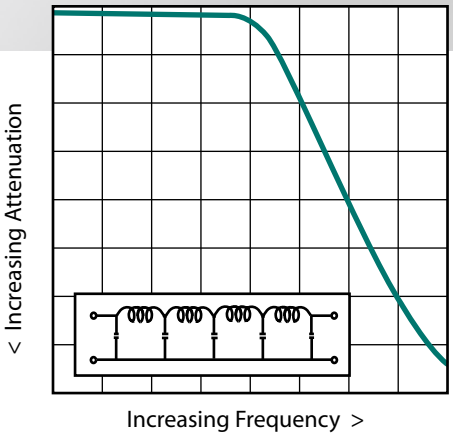
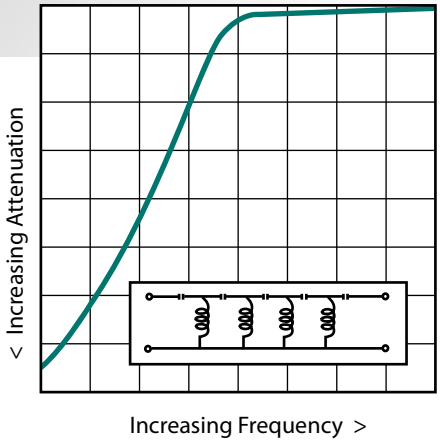
Filter Circuit Topology

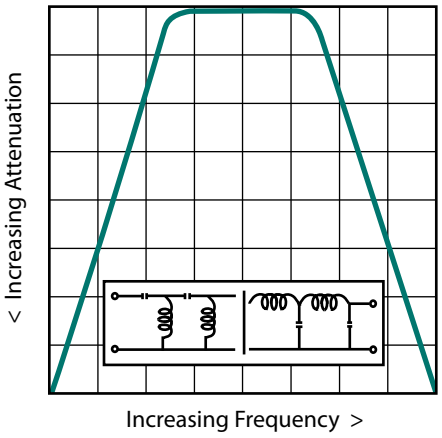
Modern filter synthesis allows the placement of transmission zeroes by the designer. Lorch Microwave incorporates the use of the latest software to design our filters to each unique application. Filters may be designed with asymmetrical responses to most efficiently attenuate low side or high side signals. Symmetrical responses are used where both lower and upper attenuations are important. Lorch Microwave utilizes elliptic or pole-placed functions where finite zeros are required. The schematics and response curves below show just a few of the filter networks used.



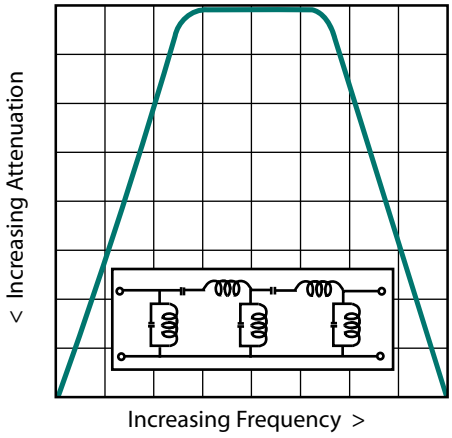
Lowpass Filter
This is the simplest form of a ladder network. The lowpass filter response extends from D.C. to a specified cutoff frequency. The passband insertion loss is measured at .90 times the 3 dB cutoff. Stopband response may extend to 100 times the cutoff frequency.



Hipass Filter
This is the inverse of the lowpass circuit shown. The highpass filter is specified with a 3 dB cutoff as well as an upper passband limit. Because of parasitic elements inherent in the design, the passband cannot extend to infinite frequencies. Responses are available to 20 times the specified cutoff frequency.

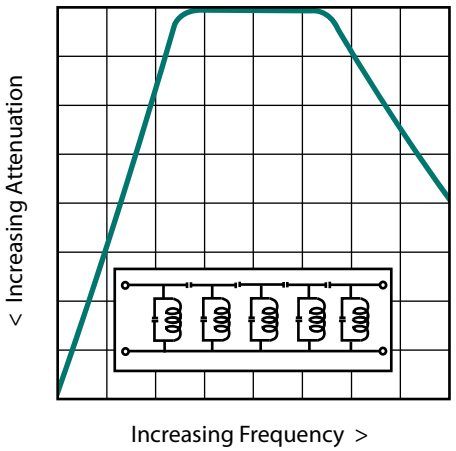


Lowpass/Highpass Filter
This is a cascade of the lowpass and highpass circuits shown above. This configuration is generally used for bandwidths of an octave or greater. The response may be tailored to meet the upper and lower stopband requirements as needed.

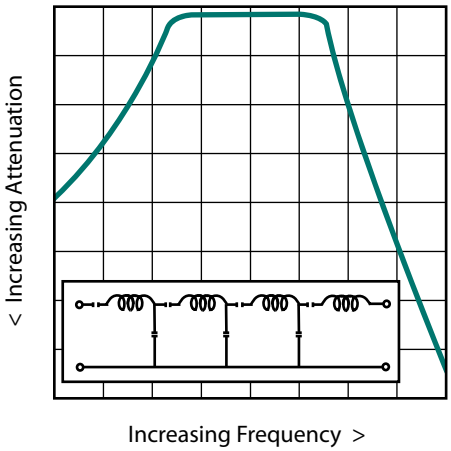


Direct Scaled Bandpass Filters
This is the classical "resonant ladder" used in wideband applications. The circuit is obtained by a lowpass to bandpass transform. Its advantages are geometric symmetry and a small spread of element values when used in circuit transforms.

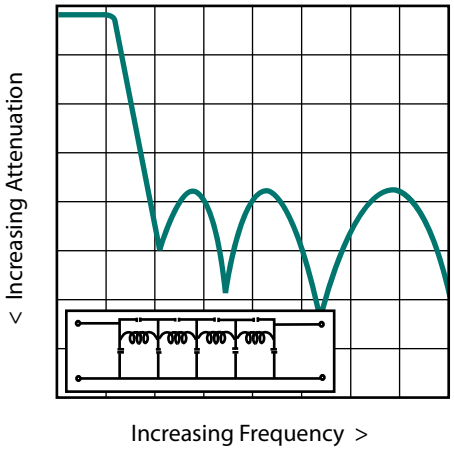
Filter Circuit Topology



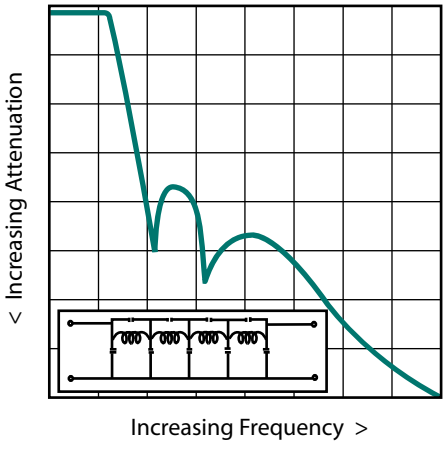
Nodal Circuit Bandpass Filters
The capacitively coupled nodal circuit provides an excellent configuration for narrowband use. The highside response may be sharpened by the use of a variety of transforming networks.



Mesh Circuit Bandpass Filter
This is the "dual" of the nodal circuit shown. It provides a steeper high side response due to the greater number of zeroes at infinity. This circuit may also use a variety of transforming networks to provide symmetry to the response.



Elliptic Filter
The Elliptic filter (also known as a Cauer response) provides the steepest out of band attenuation of any filter response. This is achieved by adding anti-resonance, or notch sections to the filter. These responses are available in Lowpass, Highpass, Bandpass and Bandstop.



Pole Placed Filter
Unlike the Elliptic filter where the finite attenuation poles are determined by the mathematical function, the Pole Placed filter allows the designer to specify where these points fall. This design is useful where there are specific single frequencies to remove.

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Environmental Specifications

The standard environmental conditions are listed throughout the catalog in the corresponding section for each product series.

Most products offered by Lorch Microwave may be designed to meet any of the extended environmental specifications shown in the following table. Conditions not listed may also be acceptable. Lorch Microwave has the capability to test our products in accordance with these or similar environmental test methods. Please contact the sales department for your specific requirements.

Rating or Test	MIL-STD-202F Method/Conditions
Temperature Operating, °C	-55 °C, +85 °C
Temperature Storage, °C	-55 °C, +125 °C
Gross Leak	Method 112
Fine Leak	Method 112
Moisture Resistance (Humidity)	Method 106
Thermal Shock	Method 107
Mechanical Shock	Method 213
Random Vibration	Method 214
Vibration High Frequency	Method 204
Solderability	Method 208
Terminal Strength and Fatigue	Method 211
Altitude	Method 105
Salt Spray	Method 101
Solvent Resistance	Method 215
Solder Heat	Method 210

Cavity Filters

- 30 MHz to 40 GHz
- 3 dB Bandwidths from <0.5 to >66%
- High "Q", Low Loss
- High Power
- Computer-Aided Designs
- Helical, Combline, Interdigital
- Waveguide
- 12 Stock Series

Lorch Microwave's cavity filter designs are available in the frequency range of 30 MHz to 40 GHz and with bandwidth options from less than 0.5% to over 66%. Cavity filters offer the user very low insertion loss, steep skirt selectivity, and narrower bandwidths than discrete component filters. Cavity filter performance is based on parts selection and physical layout of the helical coils, resonators, as well as the shape and size of the cavity housing. Lorch Microwave offers the user 12 unique stock designs to satisfy the majority of applications. At lower frequencies a helical coil is used to excite the electromagnetic field, while a 1/8 to 1/4 wave capacitively loaded design is used at higher frequencies. A cylindrical waveguide design is used to achieve narrow bandwidths and high power operation.

Each filter is custom designed to your exact specification so that you will receive the optimum performance at the lowest cost. Filter performance is easily predicted using our proprietary software, while CAD files are generated for our CNC machine and fabrication center. At Lorch Microwave, even complex designs and working drawings can be generated in a matter of a few hours…not weeks.

Standard cavity filters generally are designed using aluminum as the base metal. As most raw metals are inherently lossy, filter housings are silver plated for improved electrical characteristics and current flow. Brass, copper, aluminum or bi-metal resonators are used to minimize frequency drift over temperature.

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The tables, graphs and curves on the following pages have been prepared to enable you to determine an approximation of the electrical performance and physical size you can expect. If by chance your requirements cannot be met from the units described herein, please contact our technical marketing staff for assistance. With over 30 years of filter designs in our data bank, chances are good that we have successfully solved a similar problem in the past.

Narrowband - 0.5% to 4%

P/N	Frequency (MHz)	% 3 dB Bandwidth	VSWR (Typical)	Number of Sections	Avg. Power (Watts)	Operating Temp. (°C)	Relative Humidity
CP	30 - 2000	0.5 - 4	1.5:1	2 - 6	10	-55 to +85	95%
CF2	500 - 2000	0.5 - 4	1.5:1	2 - 8	10	-55 to +85	95%
CF3	500 - 2500	0.5 - 4	1.5:1	2 - 8	10	-55 to +85	95%
CF4	2000 - 3000	0.5 - 4	1.5:1	2 - 8	10	-55 to +85	95%
CF6	2000 - 8000	0.5 - 4	1.5:1	2 - 8	10	-55 to +85	95%
CF7	4000 - 26000	0.5 - 4	1.5:1	2 - 8	10	-55 to +85	95%

Narrowband (Combline) - 1% to 25%

P/N	Frequency (MHz)	% 3 dB Bandwidth	VSWR (Typical)	Number of Sections	Avg. Power (Watts)	Operating Temp. (°C)	Relative Humidity
EZ3	500 - 6000	1 - 25	1.5:1	2 - 17	10	-55 to +85	95%
EZ4	1000 - 8000	1 - 25	1.5:1	2 - 17	10	-55 to +85	95%
EZ5	2000 - 12000	1 - 25	1.5:1	2 - 17	10	-55 to +85	95%
EZ6	4000 - 18000	1 - 25	1.5:1	2 - 17	10	-55 to +85	95%
EZ7	6000 - 26000	1 - 25	1.5:1	2 - 17	10	-55 to +85	95%

Wideband (Interdigital) -25% to 66%

P/N	Frequency (MHz)	% 3 dB Bandwidth	VSWR (Typical)	Number of Sections	Avg. Power (Watts)	Operating Temp. (°C)	Relative Humidity
IZ3	500 - 6000	25 - 66	2.0:1	2 - 17	10	-55 to +85	95%
IZ4	1000 - 8000	25 - 66	2.0:1	2 - 17	10	-55 to +85	95%
IZ5	2000 - 12000	25 - 66	2.0:1	2 - 17	10	-55 to +85	95%
IZ6	4000 - 18000	25 - 66	2.0:1	2 - 17	10	-55 to +85	95%
IZ7	6000 - 26000	25 - 66	2.0:1	2 - 17	10	-55 to +85	95%

Shock 10G
Vibration 20G

See pages 12-14 for mechanical outlines and dimensions.
Contact factory for specific requirements not listed above.

Specifying Cavity Filters

Cavity Filter Part Number Description

4 CF2 - 1200 / A15 - S / SM
1 2 3 4 5 6

1. Number of Sections
2. Series and Package Size
3. Center Frequency, MHz
4. Bandwidth and Code (3 dB BW Standard)
5. Input Connector
6. Output Connector (if different from input)

Bandwidth	Designator
3 dB	/(blank)
1 dB	/A
equi-ripple	/R
special	/X

CONNECTORS

Connector Type	Designator
BNC Female (1)	B
BNC Male (1)	BM
Blind Mate	BP
N Female (1)	N
N Male (1)	NM
RF Pin (2)	P
SMA Female	S
SMA Male	SM
SMA Removable	SR
Special	X
TNC Female (1)	T
TNC Male (1)	TM

(1) Requires Minimum Cross Section of 0.88"

(2) Requires SMA Removable Connectors at High Frequencies

Calculating Number of Sections

The following curves show the stopband frequencies normalized to the 3 dB bandwidth for filters with 2 to 13 sections. A ratio of stopband frequency to 3 dB bandwidth is used.

The curve on the next page shows a slightly asymmetric frequency response resulting from the circuit used. Other schematics may be utilized to yield different attenuation characteristics (i.e. steeper on the high frequency side of the passband and shallower on the low side).

Example:
A CF-Series filter has a center frequency of 1000 MHz and a 3 dB bandwidth of 10 MHz. A stopband attenuation of 60 dB is required at 980 MHz and 1030 MHz.

The percentage bandwidth is 1%, calculated as follows:

$$\frac{\text{3 dB BW (MHz)}}{F_O\text{ (MHz)}} \times 100 = \frac{10}{1000} \times 100 = 1\%$$

For the first stopband requirement: Number of 3 dB bandwidths from center frequency = $\frac{(1000 - 980)}{10} = 2.0$

From the CP/CF series attenuation curve, we find that a minimum of 7 sections are required.

The second stopband requirement is: Number of 3 dB bandwidths from center frequency = $\frac{(1030 - 1000)}{10} = 3.0$

From the CP/CF series attenuation curve, we find that 5 sections minimum are required.

The greater number of sections must always be used to insure full specification compliance; therefore, a 7 section should be used.

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Insertion Loss Calculation

Knowing the number of sections, center frequency and bandwidth of the filter, insertion loss may be calculated using the following formula:

$$\text{Loss} = \frac{N - 1.5}{Q \times \%3\text{dB BW}} + 0.2$$

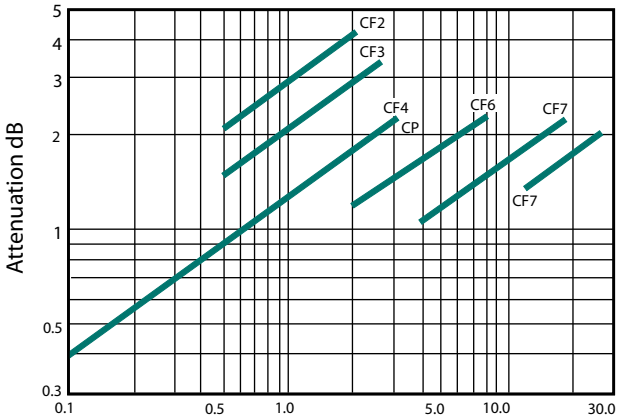
Example: 5CF2-915/25-N

1. Percentage BW = 25 / 915 x 100 = 2.7%
2. Q from CF series curves = 2.9
3. Number of Sections = 5
4. $\text{Loss} = \frac{5 - 1.5}{2.9 \times 2.7} + 0.2$

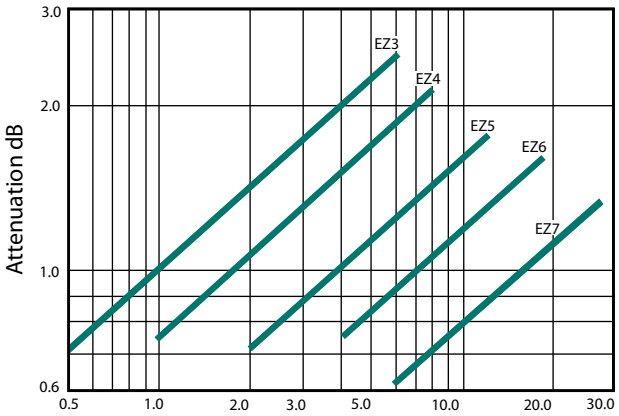
Example: 9EZ6-8725/1375-S

1. Percentage BW = 1375/8725 x 100 = 15.8%
2. Q from EZ series curves = 1.1
3. Number of Sections = 9
4. $\text{Loss} = \frac{9 - 1.5}{1.1 \times 15.8} + 0.2 = 0.63$ dB

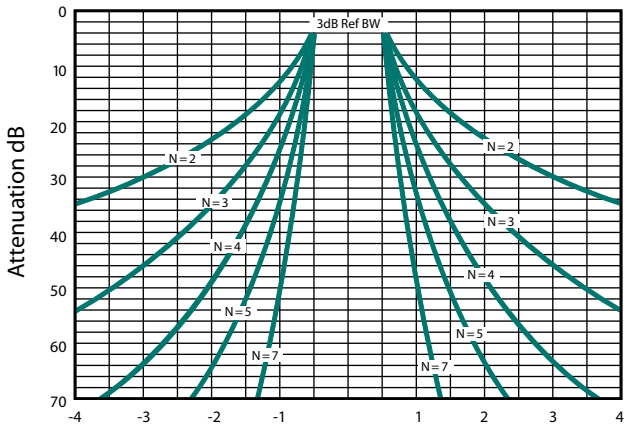
"Q"-CF, CP Series, Narrowband Cavities



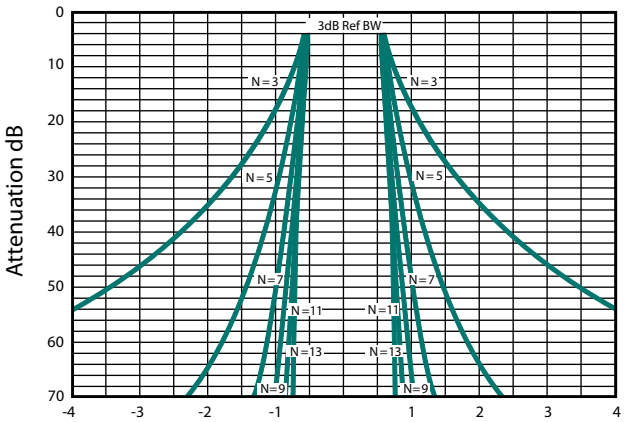
"Q"-EZ, IZ Series, Wideband Cavities



CP and CF Series Attenuation Characteristics



EZ and IZ Series Attenuation Characteristics



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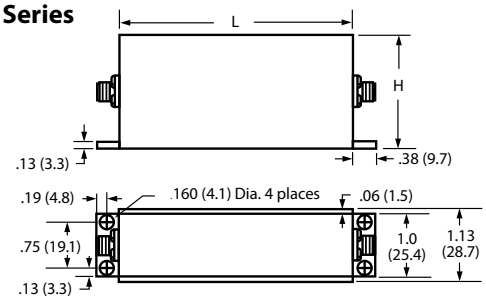
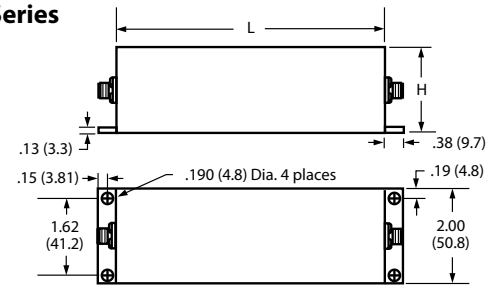
Cavity Filter Outline Drawings

CP, BRP Series



CF2 Series



CP Series

Frequency (MHz)	Width Inches (mm)	Height Inches (mm)	Length vs. Number of Sections — Inches (mm) 2	3	4	5	6
30 - 50	1.13 (28.7)	3.88 (98.6)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
51 - 65	1.13 (28.7)	2.88 (73.2)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
66 - 100	1.13 (28.7)	2.38 (60.5)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
101 - 500	1.13 (28.7)	1.88 (47.8)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
501 - 600	1.13 (28.7)	4.88 (124.0)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
601 - 900	1.13 (28.7)	3.88 (98.6)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
901 - 1300	1.13 (28.7)	2.88 (73.2)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
1301 - 1800	1.13 (28.7)	2.38 (60.5)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
1801 - 2000	1.13 (28.7)	1.88 (47.8)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)

BRH Series

Frequency (MHz)	Width Inches (mm)	Height Inches (mm)	Length vs. Number of Sections — Inches (mm) 2	3	4	5	6
30 - 50	1.13 (28.7)	4.88 (124.0)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
51 - 65	1.13 (28.7)	3.88 (98.6)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
66 - 100	1.13 (28.7)	3.38 (85.9)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
101 - 500	1.13 (28.7)	2.88 (73.2)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
501 - 600	1.13 (28.7)	5.88 (149.4)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)
601 - 900	1.13 (28.7)	4.88 (124.0)	2.50 (63.5)	3.63 (92.2)	4.75 (120.7)	5.88 (149.4)	7.00 (177.8)

CF2 Series

Frequency (MHz)	Width Inches (mm)	Height Inches (mm)	Length vs. Number of Sections — Inches (mm) 2	3	4	5	6
500 - 750	2.0 (50.8)	6.6 (167.6)	3.9 (99.1)	5.7 (145)	7.6 (193.1)	9.4 (238.8)	11.2 (285)
751 - 1000	2.0 (50.8)	4.6 (116.8)	3.9 (99.1)	5.7 (145)	7.6 (193.1)	9.4 (238.8)	11.2 (285)
1001 - 1500	2.0 (50.8)	3.7 (94.0)	3.9 (99.1)	5.7 (145)	7.6 (193.1)	9.4 (238.8)	11.2 (285)
1501 - 2000	2.0 (50.8)	2.7 (68.6)	3.9 (99.1)	5.7 (145)	7.6 (193.1)	9.4 (238.8)	11.2 (285)

All dimensions are approximate. Contact factory for actual sizes. All length dimensions are excluding connectors.

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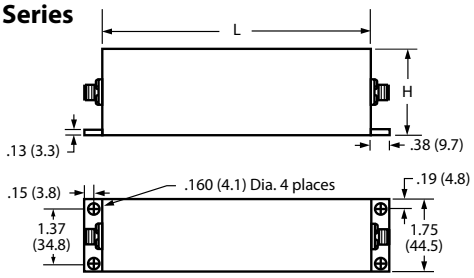
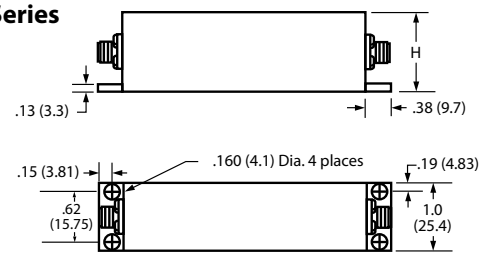
CF3 Series



CF4 Series



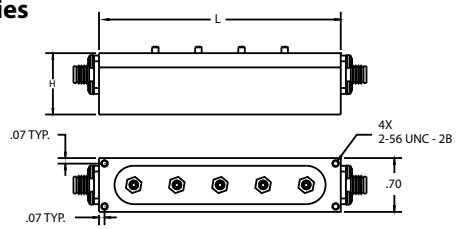
CF3 Series

Frequency (MHz)	Width Inches (mm)	Height Inches (mm)	Length vs. Number of Sections — Inches (mm) 2	3	4	5	6
500 - 750	1.75 (44.45)	6.6 (167.6)	3.00 (76.2)	4.3 (109.5)	5.6 (142.25)	6.9 (175.26)	8.3 (210.82)
751 - 1000	1.75 (44.45)	4.6 (116.8)	3.00 (76.2)	4.3 (109.5)	5.6 (142.25)	6.9 (175.26)	8.3 (210.82)
1001 - 1500	1.75 (44.45)	3.7 (94.0)	3.00 (76.2)	4.3 (109.5)	5.6 (142.25)	6.9 (175.26)	8.3 (210.82)
1501 - 2000	1.75 (44.45)	2.7 (68.6)	3.00 (76.2)	4.3 (109.5)	5.6 (142.25)	6.9 (175.26)	8.3 (210.82)

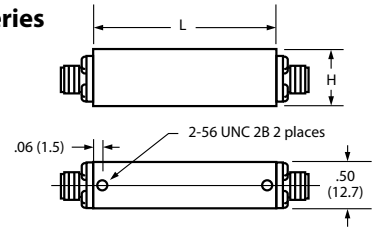
CF4 Series

Frequency (MHz)	Width Inches (mm)	Height Inches (mm)	Length vs. Number of Sections — Inches (mm) 2	3	4	5	6
2001-3000	1.0 (25.4)	2.1 (53.4)	2.00 (50.8)	2.80 (71.1)	3.60 (91.4)	4.40 (111.8)	5.20 (132.1)

CF6 Series



CF7 Series



CF6 Series

Frequency (MHz)	Width Inches (mm)	Height Inches (mm)	Length vs. Number of Sections — Inches (mm) 2	3	4	5	6
2000 - 4000	0.7 (17.8)	1.9 (48.3)	1.50 (38.1)	2.0 (50.8)	2.6 (66.1)	3.2 (81.3)	3.7 (94.0)
4001 - 6000	0.7 (17.8)	1.2 (30.5)	1.50 (38.1)	2.0 (50.8)	2.6 (66.1)	3.2 (81.3)	3.7 (94.0)
6001 - 8000	0.7 (17.8)	0.9 (22.9)	1.50 (38.1)	2.0 (50.8)	2.6 (66.1)	3.2 (81.3)	3.7 (94.0)

CF7 Series

Frequency (MHz)	Width Inches (mm)	Height Inches (mm)	Length vs. Number of Sections — Inches (mm) 2	3	4	5	6
4000 - 7000	0.5 (12.7)	1.15 (29.2)	0.9 (22.8)	1.3 (33.1)	1.6 (40.7)	1.9 (48.3)	1.95 (49.6)
7001 - 13000	0.5 (12.7)	0.85 (21.6)	0.9 (22.8)	1.3 (33.1)	1.6 (40.7)	1.9 (48.3)	1.95 (49.6)
13000 - 26000	0.5 (12.7)	0.65 (16.6)	0.9 (22.8)	1.3 (33.1)	1.6 (40.7)	1.9 (48.3)	1.95 (49.6)

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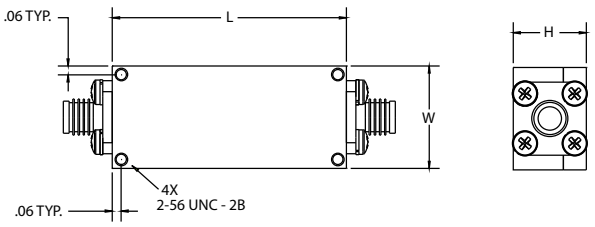
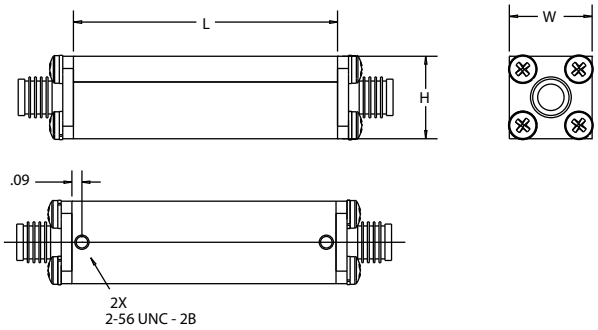
Cavity Filter Outline Drawings

EZ3, EZ4, EZ5 Series and IZ3, IZ4, IZ5 Series



EZ6, EZ7 Series and IZ6, IZ7 Series



EZ Series Length VS. Number of Sections, 1 - 25% BW

Series	Frequency (MHz)	Width In. (mm)	Height In. (mm)	Length vs. Number of Sections — Inches (mm) 3	4	5	6	7	8	9	10	11	12	13
EZ3	0.5-6.0	4.00 (101.6)	0.75 (19.1)	2.6 (66.0)	3.2 (81.3)	3.7 (94.0)	4.3 (109.2)	4.8 (121.9)	5.5 (139.7)	6.2 (157.5)	6.9 (175.3)	7.6 (193.0)	8.3 (210.8)	9.0 (228.6)
EZ4	1.0-8.0	2.1 (53.4)	0.59 (15.0)	1.9 (48.8)	2.4 (61.0)	2.8 (71.1)	3.2 (81.3)	3.6 (91.5)	4.1 (104.1)	4.6 (116.8)	5.1 (129.5)	5.6 (142.2)	6.1 (154.9)	6.6 (167.6)
EZ5	2.0-12.0	1.5 (38.1)	0.63 (16.0)	1.4 (35.6)	1.8 (45.7)	1.9 (48.8)	2.3 (58.4)	2.6 (66.0)	2.9 (73.7)	3.3 (83.8)	3.6 (91.5)	4.0 (101.6)	4.3 (109.2)	4.7 (119.4)
EZ6	4.0-18.0	0.9 (22.9)	0.50 (12.7)	1.1 (28.0)	1.2 (30.5)	1.5 (38.1)	1.8 (45.7)	2.1 (53.3)	2.4 (61.0)	2.7 (68.6)	3.0 (76.2)	3.3 (83.8)	3.6 (91.4)	3.9 (99.1)
EZ7	6.0-20.0	0.7 (17.8)	0.50 (12.7)	1.0 (25.4)	1.1 (28.0)	1.2 (30.5)	1.3 (33)	1.4 (35.6)	1.6 (40.6)	1.7 (43.2)	1.9 (48.3)	2.0 (50.8)	2.2 (55.9)	2.4 (61.0)

All dimensions are approximate, based on % BW. Contact factory for actual sizes. All length dimensions are excluding connectors. Dimensions for width are a maximum. The final width will vary with frequency.

IZ Series Length VS. Number of Sections, 25 - 66% BW

Series	Frequency (MHz)	Width In. (mm)	Height In. (mm)	Length vs. Number of Sections — Inches (mm) 3	4	5	6	7	8	9	10	11	12	13
IZ3	0.5-6.0	6.5 (165.1)	0.75 (19.1)	1.1 (28.0)	1.5 (38.1)	1.9 (48.3)	2.3 (58.4)	2.7 (68.6)	3.1 (78.7)	3.5 (88.9)	3.9 (99.1)	4.3 (109.2)	4.7 (119.4)	5.1 (129.5)
IZ4	1.0-8.0	3.5 (88.9)	0.59 (15.0)	1.0 (25.4)	1.2 (30.5)	1.5 (38.1)	1.8 (45.7)	2.1 (53.3)	2.5 (63.5)	2.8 (71.1)	3.2 (81.3)	3.5 (88.9)	3.9 (99.1)	4.2 (106.7)
IZ5	2.0-12.0	2.0 (50.8)	0.63 (16.0)	1.0 (25.4)	1.1 (28.0)	1.2 (30.5)	1.3 (33.0)	1.5 (38.1)	1.8 (45.7)	2.0 (50.8)	2.3 (58.4)	2.5 (63.5)	2.8 (71.1)	3.1 (78.7)
IZ6	4.0-18.0	1.25 (31.8)	0.50 (12.7)	0.9 (22.9)	1.0 (25.4)	1.1 (28.0)	1.2 (30.5)	1.3 (33.0)	1.5 (38.1)	1.6 (40.6)	1.8 (45.7)	2.0 (50.8)	2.2 (55.9)	2.3 (58.4)
IZ7	6.0-20.0	1.00 (25.4)	0.50 (12.7)	0.8 (20.3)	0.9 (22.9)	1.0 (25.4)	1.1 (28.0)	1.2 (30.5)	1.3 (33.0)	1.4 (35.6)	1.5 (38.1)	1.6 (40.6)	1.7 (43.2)	1.8 (45.7)

All dimensions are approximate, based on % BW. Contact factory for actual sizes. All length dimensions are excluding connectors. Dimensions for width are a maximum. The final width will vary with frequency.

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- **Frequency Range 2 - 40 GHz**
- **2 thru 8 Sections**
- **W/G Flange or Connectorized**
- **Stand Alone Filters or Diplexed**

Waveguide Part Number Description

4 WR62 - 12950 / R175 - C / CK
1 2 3 4 5 6

1. Number of Sections
2. Waveguide Size
3. Center Frequency, MHz
4. Bandwidth and Code
5. Input Connector
6. Output Connector

Bandwidth	Designator
3 dB	/(blank)
1 dB	/A
equi-ripple	/R
special	/X

CONNECTORS

Connector Type	Designator
Cover Flange	C
Choke Flange	CK
SMA Female	S
SMA Male	SM
SMA Removable	SR
K Female	K
K Male	KM
Special	X

Most standard connectors and flanges are available.

Lorch Microwave offers a complete line of waveguide filters, that cover the frequency range of 2-40 GHz. Lorch offers waveguide filters as single components or in a diplexed configuration. Typical applications for radio communications.

Waveguide Filter Electrical Performance

Parameter	Standard	Special
Frequency Range	4 - 40 GHz	2 - 40 GHz
Bandwidth	0.5 - 5%	Contact Factory
Number of Sections	2 - 8	2 - 13
Typical VSWR	1.5:1	<1.3:1
Power Handling	1 watt avg	>100 watts

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Discrete Components

- 5 MHz to 7.5 GHz
- 3 dB Bandwidths from 1% to >100%
- Computer-Aided Designs
- 10 Stock Series
- Custom & Dielectric Resonator Designs

Lorch Microwave's miniature discrete component filters are designed to give optimal performance where small size is critical. Electrical and mechanical requirements for each design are computer generated, taking into consideration realizable "Q" and environmental conditions, then analyzed using our unique software, thereby reducing the amount of trial and error alignment.

Lorch Microwave's filter designs are available to satisfy bandpass, lowpass, highpass, or bandreject applications. We have found through our years of service that one design does not fit all needs. In order to achieve today's required electrical performance, Lorch Microwave's engineers use a variety of electrical circuits ranging from coupled tank, mesh, resonant ladder, highpass/lowpass, or helical to achieve the desired performance. In some cases, a combination of circuit designs is used. This enables our engineers to provide you with the highest performance filters available.

Lorch Microwave has developed a series of package types to satisfy the majority of industry needs. These range from small TO packages to 1/4-wave designs. Actual package selection will depend upon your specific performance needs. All machining is done on computer-controlled machines, thereby reducing error and assuring repeatability of critical processes. Our designs incorporate high "Q" air wound or toroidal inductors and monolithic ceramic capacitors.

Discrete Component Bandpass Filters

P/N	Frequency Range (MHz)	% 3 dB Bandwidth	VSWR (Typical)	Number of Sections	Avg. Power (watts)	Operating Temp. (°C)	Relative Humidity
BP2	5 - 100	3 - 100	1.5:1	2 - 10	10	-55 to +85	95%
BP3	25 - 200	3 - 100	1.5:1	2 - 10	10	-55 to +85	95%
BP4	15 - 200	3 - 100	1.5:1	2 - 10	10	-55 to +85	95%
BP5	5 - 200	3 - 100	1.5:1	2 - 10	10	-55 to +85	95%
BP6	50 - 7500	3 - 100	1.5:1	2 - 10	1	-55 to +85	95%
BP7	50 - 7500	3 - 100	1.5:1	2 - 10	1	-55 to +85	95%
BP8	50 - 7500	3 - 100	1.5:1	2 - 10	1	-55 to +85	95%
BP9	25 - 5000	5 - 100	1.5:1	2 - 10	1	-55 to +85	95%
MH	60 - 3000	1 - 5	1.5:1	2 - 10	1	-55 to +85	95%
T8B	70 - 1000	5 - 30	1.5:1	2 - 4	1	-55 to +85	95%

Shock 10G
Vibration 20G

See pages 20-24 for mechanical outlines and dimensions.
Contact factory for specific requirements not listed above.

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Calculating Number of Sections

The following curves show the stopband frequencies normalized to the 3 dB bandwidth for filters with 2 to 8 sections. A ratio of stopband frequency to 3 dB bandwidth is used.

The curve given below shows an asymmetric frequency response resulting from the circuit used. Other schematics may be utilized to yield different attenuation characteristics (i.e. steeper on the high frequency side of the passband and shallower on the low side).

Example:
A BP-Series filter has a center frequency of 600 MHz and a 3 dB bandwidth of 120 MHz. Use the curve for 7-50% bandwidth filters. A stopband attenuation of 30 dB is required at 360 MHz and 50 dB is required at 960 MHz.

The percentage bandwidth is 20%, calculated as follows:

$$\frac{120}{600} \times 100 = 20\%$$

For the first stopband requirement: Number of 3 dB bandwidths from center frequency: $\frac{(600 - 360)}{120} = 2.0$

From the 7-50% bandwidth attenuation curve, we find that a minimum of 3 sections is required.

The second stopband requirement is: Number of 3 dB bandwidths from center frequency = $\frac{(900 - 600)}{120} = 3.0$

From the 7-50% bandwidth attenuation curve, we find that 5 sections minimum are required. The greater number of sections must be used to insure full specification compliance; therefore, a 5 section should be used.

Insertion Loss Calculation

Knowing the number of sections, center frequency and bandwidth of the filter, insertion loss may be calculated using the following formula: $IL = \frac{(\text{Loss Constant}) \times (N - 1.5)}{(\%3\text{dB BW})} + 0.2$

Example: 6BP8 - 725/145-S
1. Percentage BW = 145/725 x 100 = 20%
2. LC from table = 6.8
3. Number of Sections (from P/N) = 6
4. $IL = \frac{(6.8) \times (6 - 1.5)}{(20)} + 0.2 = 1.73$ dB

Bandpass Filter Electrical Performance

Series	Frequency (MHz)	Loss Constant
BP2-BP9, T8B	5 - 100	9.5
BP3-BP9, T8B	101 - 1000	6.8
BP6-BP9, T8B	1001 - 7500	5.0
MH	60 - 3000	4.0

Specifying Bandpass Filters

Bandpass Filter Part Number Description

4 BP3 - 260 / 26 - S / P
1 2 3 4 5 6

1. Number of Sections
2. Series and Package Size
3. Center Frequency, MHz
4. Bandwidth and Code (3 dB BW Standard)
5. Input Connector
6. Output Connector (if different from input)

Bandwidth	Designator
3 dB	/(blank)
1 dB	/A
equi-ripple	/R
special	/X

CONNECTORS

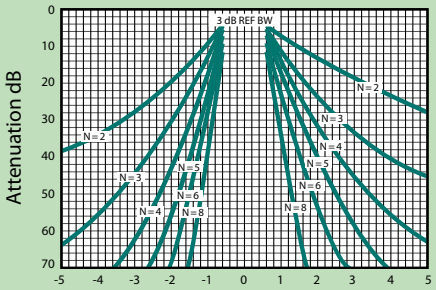
Connector Type	Designator
Blind Mate	BP
Cable (1)	C
RF Pin (2)	P
SMA Female	S
SMA Male	SM
SMB Female	SB
SMC Female	SC
SMA Removable	SR
Surface Mount	M
Surface Mount-Pins	MP
Special	X

(1) 6" RG 188 Standard

(2) Requires SMA Removable Connectors at High Frequencies

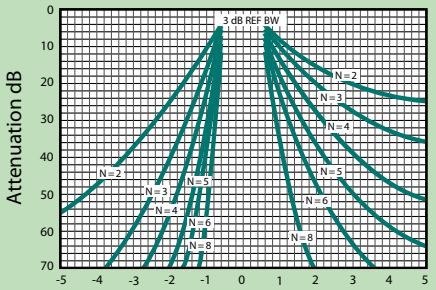
Please note that the Frequency Response Curves shown are based on a low ripple Chebyshev transfer function. Exact performance is related directly to the unloaded Q, component selection and package size. If you have a critical parameter please contact the factory so full compliance may be assured.

3-7% Bandwidth



Number of 3 dB Bandwidths From Center Frequency

7-50% Bandwidth



Number of 3 dB Bandwidths From Center Frequency

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LORCH MICROWAVE

Specifying Lowpass Filters

- 0.1 - 6000 MHz
- Microminiature Size
- Computer-Aided Designs
- 10 Stock Series

Lowpass Filter Part Number Description

4 LP7 - 650A - P / C

1 2 3 4 5

1. Number of Sections
2. Series and Package Size
3. Cutoff Frequency (3 dB C/O Standard)
4. Input Connector
5. Output Connector (if different from input)

Bandwidth	Designator
3 dB	/(blank)
1 dB	/A
equi-ripple	/R
special	/X

CONNECTORS

Connector Type	Designator
Blind Mate	BP
Cable (1)	C
RF Pin (2)	P
SMA Female	S
SMA Male	SM
SMB Female	SB
SMC Female	SC
SMA Removable	SR
Surface Mount	M
Surface Mount-Pins	MP
Special	X

(1) 6" RG 188 Standard

(2) Requires SMA Removable Connectors at High Frequencies

Note: For Lowpass filters, insertion loss is calculated at 0.9 times the cutoff frequency.

Calculating Number of Sections

The curves shown indicate the stopband frequencies normalized to the 3 dB cutoff for filters of 2 to 12 sections. A ratio of stopband frequency to 3 dB bandwidth is used.

The curve shown indicates the frequency response resulting from the circuit used.

Example:
A LP-Series filter has a cutoff frequency of 1000 MHz.
A stopband attenuation of 30 dB is required at 1250 MHz.

Calculate the number of sections as follows: Number of 3 dB bandwidths from cutoff frequency = $\frac{1250}{1000} = 1.25$

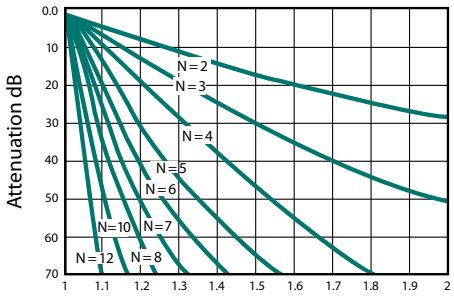
The curve indicates that a minimum of 5 sections is required.

Insertion Loss Calculation

Knowing the number of sections, and cutoff frequency of the filter, insertion loss may be calculated from the following formula: Loss = N x 0.2

Example: 7LP7 - 1275 - S
1. Number of Sections = 7
2. IL = 7 x 0.2 = 1.4 dB

Lowpass



Ratio of Stopband Frequency to Cutoff Frequency

Discrete Component Lowpass Filters

P/N	Frequency Range (MHz)	VSWR (Typical)	Number of Sections	Avg. Power (watts)	Operating Temp. (°C)	Relative Humidity
LP2	1 - 100	1.5:1	2 - 10	10	-55 to +85	95%
LP3	2.5 - 150	1.5:1	2 - 10	10	-55 to +85	95%
LP4	10 - 200	1.5:1	2 - 10	10	-55 to +85	95%
LP5	0.1 - 10	1.5:1	2 - 10	10	-55 to +85	95%
LP6	10 - 6000	1.5:1	2 - 10	1	-55 to +85	95%
LP7	10 - 6000	1.5:1	2 - 10	1	-55 to +85	95%
LP8	10 - 6000	1.5:1	2 - 10	1	-55 to +85	95%
LP9	10 - 6000	1.5:1	2 - 8	1	-55 to +85	95%
T8L	70 - 1000	1.5:1	2 - 4	1	-55 to +85	95%

Shock 10G
Vibration 20G

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Calculating Number of Sections

The following curves show the stopband frequencies normalized to the dB cutoff for filters of 2 to 12 sections. A ratio of stopband frequency to 3 dB bandwidth is used.

The curve shown indicates the frequency response resulting from the circuit used.

Example:
A HP-Series filter has a cutoff frequency of 300 MHz.
A stopband attenuation of 60 dB is required at 200 MHz.

Calculate the number of sections by:
Number of 3 dB bandwidths from cutoff frequency = $\frac{300}{200} = 1.5$

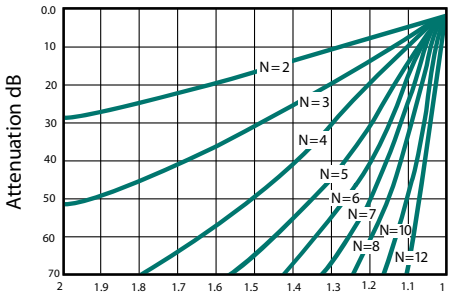
The curve indicates that a minimum of 5 sections are required.

Insertion Loss Calculation

Knowing the number of sections, and cutoff frequency of the filter, insertion loss may be calculated from the following formula: Loss = N x 0.2

Example: 5HP2-98-S
1. Number of Sections = 5
2. IL = 5 x 0.2 = 1.0 dB

Highpass



Ratio of Stopband Frequency to Cutoff Frequency

- **0.1 - 4000 MHz**
- **Broad Passband Range**
- **Computer-Aided Designs**
- **9 Stock Series**

Highpass Filter Part Number Description

3 HPD - 2000 - SR / SRM
1 2 3 4 5

1. Number of Sections
2. Series and Package Size
3. Cutoff Frequency (3 dB BW Standard)
4. Input Connector
5. Output Connector (if different from input)

Bandwidth	Designator
3 dB	/(blank)
1 dB	/A
equi-ripple	/R
special	/X

CONNECTORS

Connector Type	Designator
Blind Mate	BP
Cable (1)	C
RF Pin (2)	P
SMA Female	S
SMA Male	SM
SMB Female	SB
SMC Female	SC
SMA Removable	SR
Surface Mount	M
Surface Mount-Pins	MP
Special	X

(1) 6" RG 188 Standard

(2) Requires SMA Removable Connectors at High Frequencies

Note: For Highpass filters, insertion loss is calculated at 1.1 times the cutoff frequency.

Discrete Component Highpass Filters

P/N	Frequency Range (MHz)	Number of Sections	Upper Bandpass Limit*	VSWR (Typical)	Avg. Power (watts)	Operating Temp. (°C)	Relative Humidity
HP2	0.1 - 200	2 - 6	3-5 x Fc	1.5:1	10	-55 to +85	95%
HP3	3 - 500	2 - 6	3-5 x Fc	1.5:1	10	-55 to +85	95%
HP4	50 - 1000	2 - 6	3-5 x Fc	1.5:1	10	-55 to +85	95%
HP5	0.1 - 200	2 - 6	3-5 x Fc	1.5:1	10	-55 to +85	95%
HPD	550 - 4000	2 - 6	3-5 x Fc	1.5:1	1	-55 to +85	95%
HP6	300 - 1000	2 - 6	3-5 x Fc	1.5:1	1	-55 to +85	95%
HP7	500 - 1000	2 - 6	3-5 x Fc	1.5:1	1	-55 to +85	95%
HP8	10 - 500	2 - 6	3-5 x Fc	1.5:1	1	-55 to +85	95%
HP9	100 - 1000	2 - 6	3-5 x Fc	1.5:1	1	-55 to +85	95%

Shock 10G
Vibration 20G

See pages 20-24 for mechanical outlines and dimensions. Contact factory for specific requirements not listed above.

* Note: This is an approximation and may vary depending on transfer function and/or packaging. If a specific requirement is desired please check with the factory.

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Discrete Components — Outline Drawings

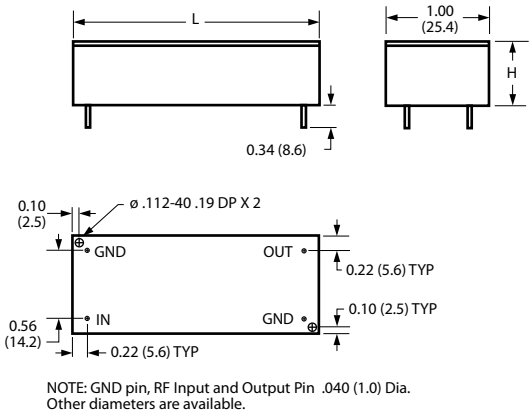
Connectors for Discrete Components Series

Connector Type	Designator	Length (in)
Blind Mate	BP	0.38
Cable (1)	C	NOTE (1)
RF PIN (2)	P	NOTE (2)
SMA Female	S	0.38
SMA Male	SM	0.50
SMB Female	SB	0.38
SMC Female	SC	0.38
SMA Removable	SR	0.38
Surface Mount	M	-
Surface Mount - Pins	MP	-
Special	X	-

(1) 6" RG 188 Standard
(2) Requires SMA Removable Connectors at High Frequencies

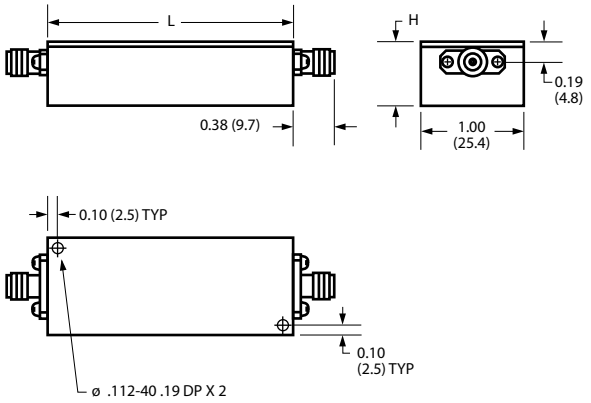
Package 2,3,4

PC Style



NOTE: GND pin, RF Input and Output Pin .040 (1.0) Dia.
Other diameters are available.

SMA Style



Series	No. of Sections	H	L
BP2, BR2, HP2, LP2	2 - 6	1.0 (25.4)	2.38 (60.5)
BP2, BR2, HP2, LP2	7 - 10	1.0 (25.4)	3.58 (90.9)
BP3, BR3, HP3, LP3	2 - 6	.75 (19.1)	2.38 (60.5)
BP3, BR3, HP3, LP3	7 - 10	.75 (19.1)	3.58 (90.9)
BP4, BR4, HP4, LP4	2 - 6	.50 (12.7)	2.38 (60.5)
BP4, BR4, HP4, LP4	7 - 10	.50 (12.7)	3.38 (90.9)

All length dimensions are excluding connectors.

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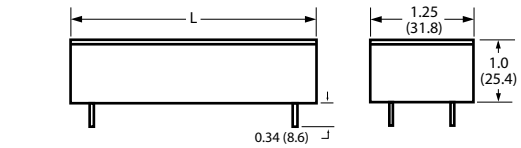
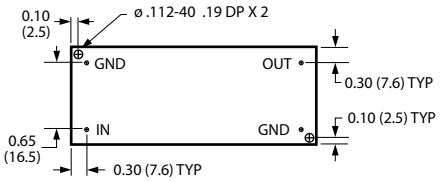
Package 5

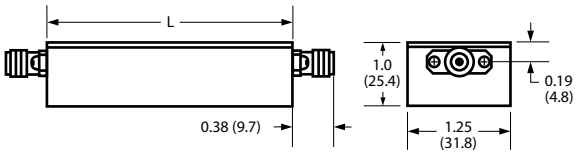
PC Style

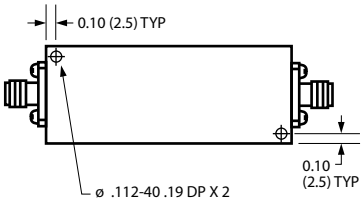




NOTE: GND pin, RF Input and Output Pin .040 (1.0) Dia.
Other diameters are available.

SMA Style

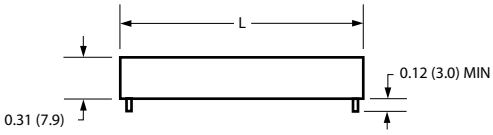


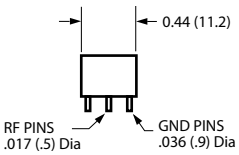


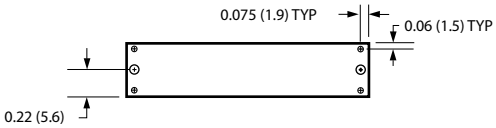
Series	No. of Sections	L
BP5, BR5, LP5, HP5	2 - 6	3.0 (76.2)
BP5, BR5, LP5	7 - 10	4.5 (114.3)

All length dimensions are excluding connectors.

Package 6







Series	Length in.)
2 - 3	.75 (19.0)
4 - 5	1.0 (25.4)
6 - 7	1.5 (38.1)
8 - 9	1.75 (44.5)
10	2.0 (50.8)

All length dimensions are excluding connectors.

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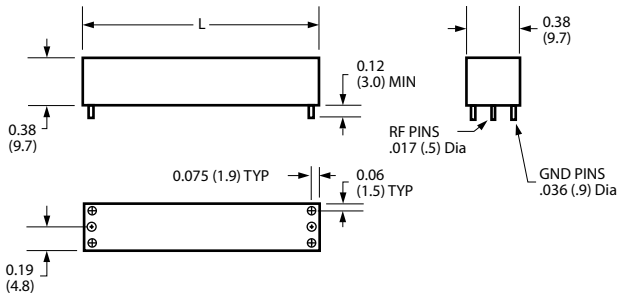
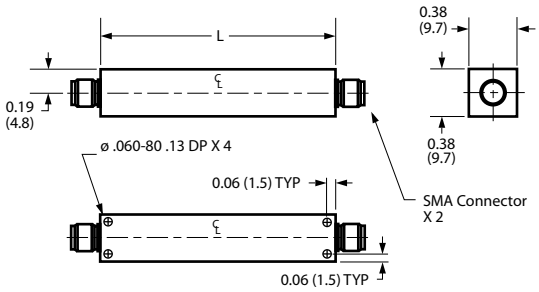
Package 7

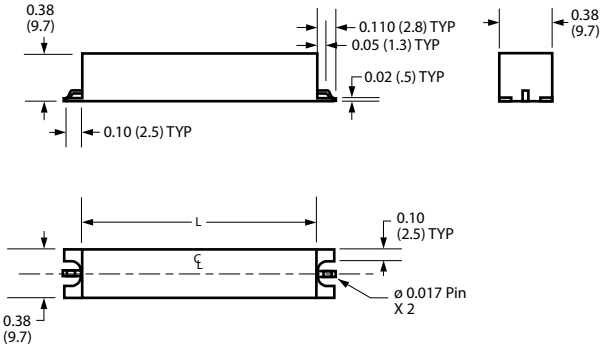
PC Board Mount - P



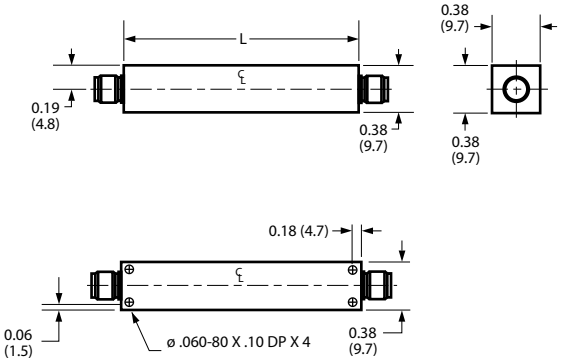
SMA Connectors - S



Surface Mount - MP



High Frequency with Field Replaceable Connector - SR



Sections	Length (in.)
2 - 3	.75 (19.0)
4 - 5	1.0 (25.4)
6 - 7	1.5 (38.1)
8 - 9	1.75 (44.5)
10	2.0 (50.8)

All length dimensions are excluding connectors.

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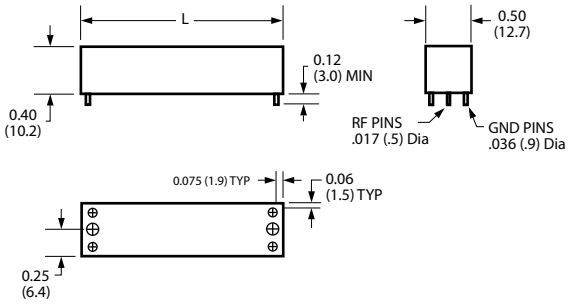
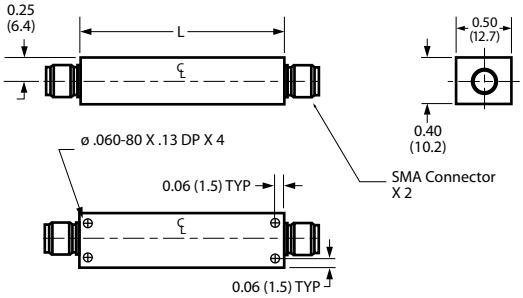
Package 8

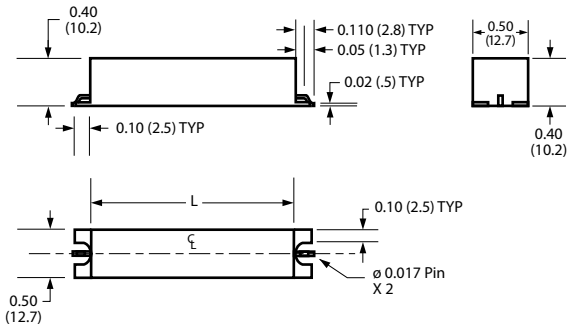
PC Board Mount - P



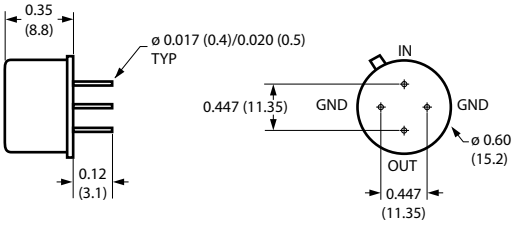
SMA Connectors - S



Surface Mount - MP



Series T8B, T8L

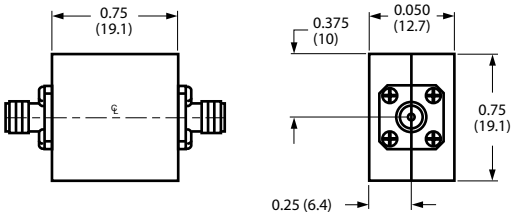


Sections	Length (in.)
2 - 3	.75 (19.0)
4 - 5	1.0 (25.4)
6 - 7	1.5 (38.1)
8 - 9	1.75 (44.5)
10	2.0 (50.8)

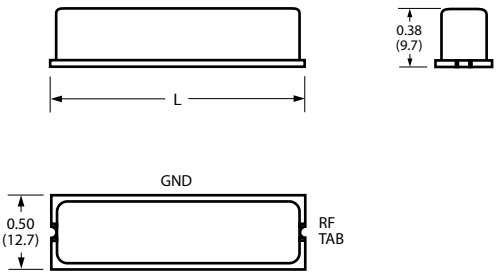
All length dimensions are excluding connectors.

Package 9

Series HPD (Highpass) - S



Surface Mount - M

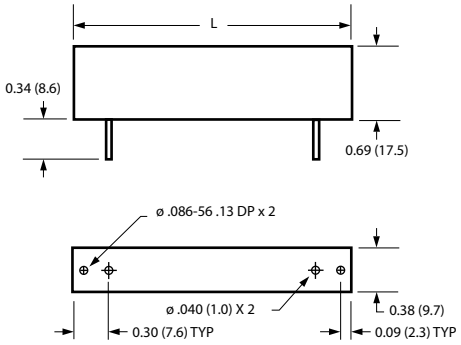


Package 9 (Surface Mount)

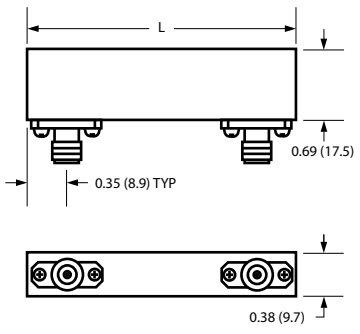
Sections	Length (in.)
2 - 3	.75 (19.0)
4 - 5	1.0 (25.4)
6 - 7	1.5 (38.1)

All length dimensions are excluding connectors.

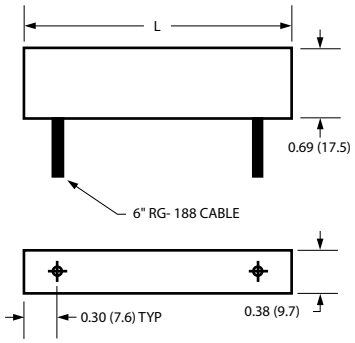
MH Series PC Pins



MH Series SMA Female Connector



MH Series RG-188 Cable



MH Series PC Pins

Sections	2	3	4	5	6	7	8	9	10
Length, L	1.75 (44.5)	2.0 (50.8)	2.25 (57.2)	2.50 (63.5)	2.75 (69.9)	3.0 (76.2)	3.25 (82.6)	3.50 (88.9)	3.75 (95.3)

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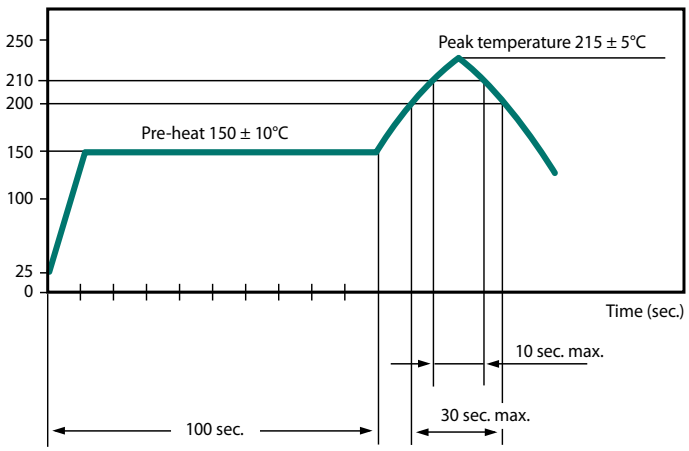
- 400 MHz to 6000 MHz
- Bandwidths: 0.5 to 10%
- Surface Mount, PC Mount, Connectorized Options
- Custom Configurations Available
- 2 to 6 Poles in Single, Diplexed or Triplexed Configurations
- Low Cost, High Performance
- Fast Delivery
- Low to High Volume Production Quantities

Lorch Microwave's Ceramic Filters are manufactured in two basic styles for both commercial and military applications. The high volume, low cost units in open frame, non-hermetic packages are most often used in commercial applications. The lower volume, custom designed hermetic packages find wide usages in military applications. Both styles are available in various mounting configurations. In both instances the same high "Q" coaxial resonators are used which yield low insertion loss and excellent stability over temperature. A low ripple Chebyshev transfer function is standard with bandpass filters and diplxers available.

Ceramic Electrical Performance

Parameter	Standard	Special
Frequency Range	400 - 5000 MHz	400 - 6000 MHz
Bandwidth	0.5 - 5%	0.1 - 25%
Number of Sections	2 - 6	2 - 8
Typical VSWR	2.0:1	<1.5:1
Power Handling	1 watt average	Contact Factory
Temperature Range	-20 to + 70° C	-55 to + 125° C

Reflow Profile



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Specifying Ceramic Filters

Insertion Loss Calculation

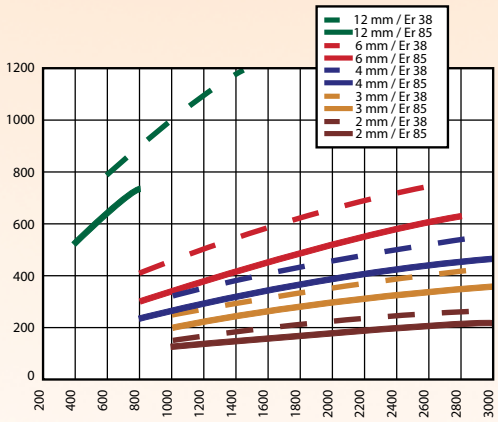
Parameters needed:
1) Number of Sections (N)
2) Typical Resonator Qu (Qu)
3) Center Frequency (F_O)
4) 3 dB Bandwidth (BW)

$Ql = F_O/BW$
$K = Qu/Ql$

The formula is as follows:
I.L. = N*.63*20*LOG10(1+(1/(K-1)))

Example:
CF = 1910
3 dB BW = 25
Qu = 625 (6MM/Er38.6)
N = 4

I.L. = 4*.63*20*LOG10(1+(1/(8.18-1)))-2.85 dB



Filter Attenuation

The attenuation curve below shows the typical shape for the coaxial resonators for n=2 thru n=6. Use the formula below to determine the number of sections needed for the required attenuation.

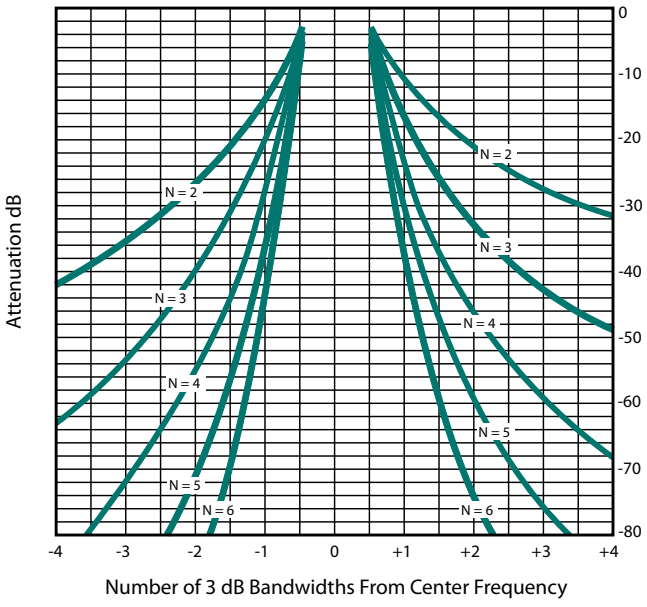
$$\frac{\text{Stopband Frequency - Center Frequency}}{\text{3 dB Bandwidth}}$$

Example:
Center frequency = 1910 MHz
3 dB BW = 25 MHz
Stopband Frequency = 2000 MHz
Attenuation = >50 dB

$$\frac{2000 - 1910}{25} = +3.6$$

It is determined that 4 sections are required to meet >50 dB attenuation at 2000 MHz

Ceramic Attenuation



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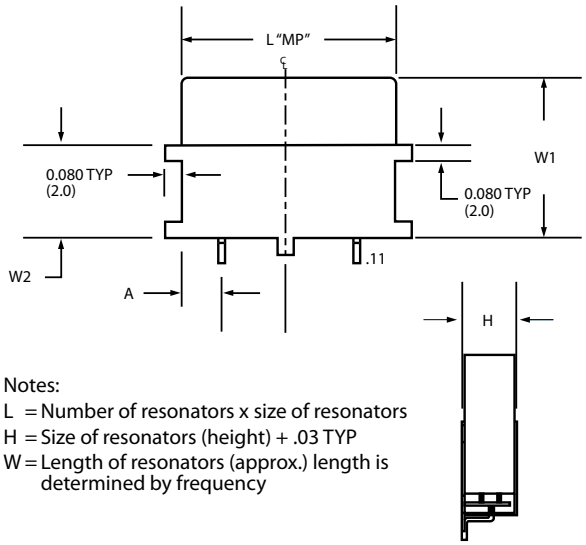
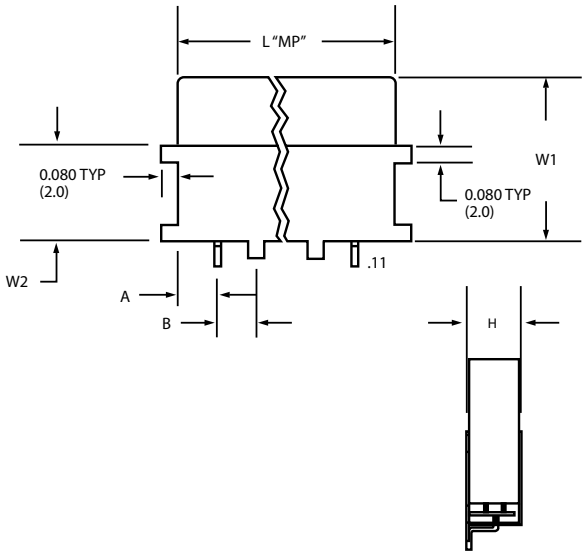
Ceramic "MP" Series (Sections 2 + 3)



Notes:
L = Number of resonators x size of resonators
H = Size of resonators (height) + .03 TYP
W = Length of resonators (approx.) length is determined by frequency

Ceramic "MP" Series (Sections 4, 5 + 6)



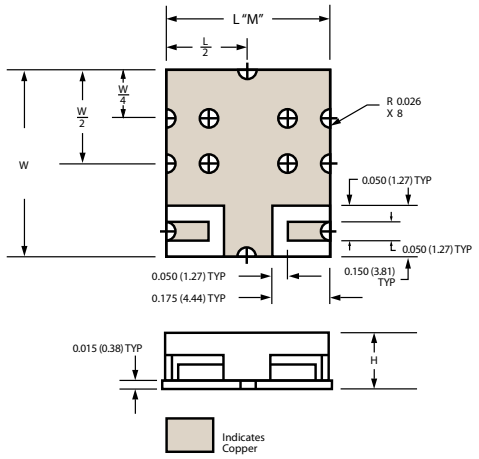
Ceramic Electrical Performance

Profile	Width 1 Inches (mm)	Width 2 Inches (mm)	Height Inches (mm)	Length vs. No. of Sections, Inches (mm) 2	3	A
12 mm	*See Notes	*See Notes	.51 (12.5)	.96 (24.4)	1.44 (36.6)	.24
6 & 7 mm			.28 (7.1)	.56 (14.2)	.84 (21.3)	.14
4 mm			.19 (4.8)	.32 (8)	0.48 (12.2)	.08

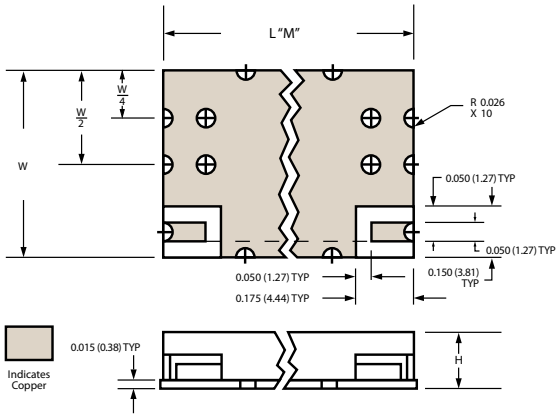
Profile	Width 1 Inches (mm)	Width 2 Inches (mm)	Height Inches (mm)	Length vs. No. of Sections, Inches (mm) 4	5	6	A	B
12 mm	*See Notes	*See Notes	.51 (12.5)	1.92 (48.8)	2.40 (61)	2.88 (73.1)	.24	.28
6 & 7mm			.28 (7.1)	1.12 (28.4)	1.49 (37.8)	1.68 (42.7)	.14	.28
4 mm			.19 (4.8)	0.64 (16.2)	0.80 (20.3)	0.96 (24.3)	.08	.20

*W1= Frequency Dependent; *W2= .250 over 1.1 GHz, .500 under 1.1 GHz

Ceramic "M" Series (Sections 2 + 3)



Ceramic "M" Series (Sections 4, 5 + 6)



Note:
The tables shown for the "MP" series may be used as an approximation in determining the dimensions for the "M" series. The exact dimensions for the "M" series can be determined by using the "Lorch Filter Select Plus" (LFSP) filter selection program on the Lorch Microwave website.

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Z-Pack Series™

- 30 - 5000 MHz
- Leaded Surface Mount Package
- Low Profile
- Ceramic/Discrete Technology
- 2–8 Sections
- 3 dB Bandwidth (BPF) 2-100%
- Average Power 1 Watt
- Temperature Range -55 to +85°C
- Bandpass, Lowpass, Highpass & Band Reject Models Available
- Transfer Functions:
  - Chebyshev
  - Bessel
  - Elliptical
  - Gaussian

Lorch Microwave Z-Pack Series™ of leaded surface mount filters provide the designer with an alternative to traditional axial leads and "gull wing" RF Pin configurations. In addition to ease of installation the Z-Pack Series™ filters exhibit extremely good impedance matching characteristics and very good isolation.

The Z-Pack Series™ filters cover the frequency range of 30 MHz to 5000 MHz and is available in bandpass, lowpass, high-pass and band reject models with various transfer functions. Several package configurations are available with low profile (.25" height), a primary feature. Package sizes have been chosen to accept discrete filter or ceramic technology design and are primarily used in performance based military or commercial applications.

DFM Series Packages

Series	Height (H)	Width (W)
DFM45	.25	.50
DFM47	.25	.75
DFM65	.38	.50
DFM67	.38	.75

Length (L) vs. Number of Sections

DFM4 1.0 L = 2-3 Sections
1.5 L = 4-6 Sections
2.0 L = 7-8 Sections

DFM6 1.0 L = 2 Sections
1.75 L = 3-4 Sections
2.25 L = 5-6 Sections

MF Series Packages

Series	Height (H)	Width (W)
MF25	.25	.50
MF27	.25	.75
MF35	.38	.50
MF37	.38	.75

Length (L) vs. Number of Sections

MF Series 1.0 L = 2-4 Sections
1.5 L = 4-6 Sections
2.0 L = 7-8 Sections

Notes:
- RF Pins are 0.015 diameter
- Grounding tabs on side of unit optional
- Tab thickness - 0.020 std.

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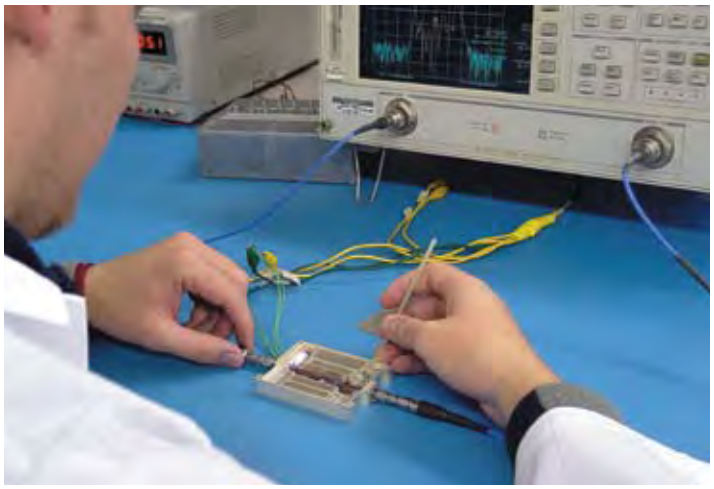


Integrated products are available for a wide variety of applications including RF preselection and LO selection for converters, harmonic rejection and signal leveling in multi-band transmitters and general purpose multi-band signal separation functions. The frequency range for switched filters is as low as 10 MHz and as high as 20 GHz.

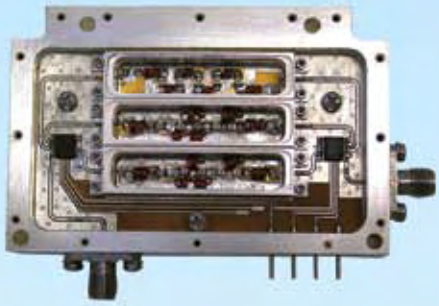
The utilization of multiple switch and filter technologies can be combined to address a wide range of requirements and to provide optimized electrical, mechanical and cost performance for each application. To achieve critical filter performance requirements, Lorch will use combline or interdigital structures for high-Q and lumped element structures for moderate-Q depending on size constraints. Lumped element filters are ideal where small packages are required.

With innovative filter technology and custom packaging, switched filters are an ideal integrated microwave component for the design engineer looking to minimize size and weight. By integrating both filter and switch components we can achieve small size and eliminate transitions between circuit elements. This allows a more optimum impedance match between components and provides passband insertion loss, flatness and VSWR close to that of individual components in a module. The elimination of interfaces and the use of internal channelization allow optimum rejection and isolation.

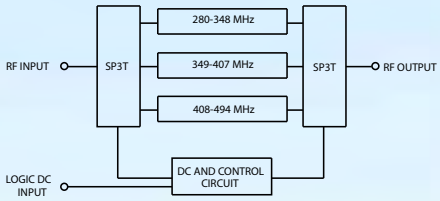
Multi-channel switched filter designs are available with profiles as low as 0.3 inches. Additional functions can be incorporated into switch banks. Power dividers or coupled output ports, separate switch inputs and/or outputs, isolators, BIT functions, amplifiers, and attenuators all can be integrated into single package configurations, with a minimal increase in size.

VHF Switch Bank

Lumped element filters are combined with two SP3T MMIC switches in an integrated aluminum package to provide a custom 3-channel switched filter. The switch bank covers the VHF frequency range. The bank utilizes a +5V power supply and two TTL control lines for switching. The filter bandwidths are 1.5 dB with stop bands of 45, 50, and 60 dB. This unit has been designed to meet stringent military environment of -55 to +85 degree operating temperature.



Performance



Insertion Loss	5.0 dB max.
VSWR	1.5:1
Rejection	40 dBc
	50 dBc
	60 dBc
Switching Speed	250 nS
DC Power	+5V @ 40 mA
Operating Temp.	-55 to +85°C

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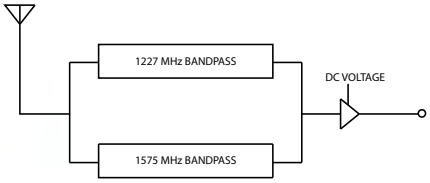
Integrated Assemblies

GPS-Preamplifiers

The Lorch GPS pre-amplifier is a modern high performance preamplifier. It incorporates a pair of three pole dielectric filters to select only the desired GPS signals, while rejecting unwanted out-of-band signals. The low noise gain stage maintains the receiver sensitivity to guard against loss of GPS signal, typical specifications are 26 dB gain and 2.0 dB maximum noise figure. The unit is powered by DC applied to the center conductor of the output connector. The pre-amp may also be powered by an external DC bias.

Performance

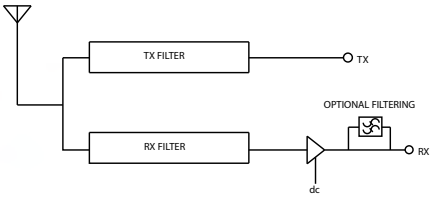


Frequency	1575 MHz (L1)
	1227 MHz (L2)
Bandwidth	30 MHz min.
Noise Figure	< 2.0 dB
VSWR	1.5:1
Gain	26 dB
DC Power	5-15 V @ 75 mA

C-Band Diplexer/LNA

High Q combline cavities combined with a low noise amplifier make up this C-Band diplexer. This assembly features high performance electrical specifications in a small rugged configuration for airborne environments. The diplexer features 85 dB TX to RX isolation while maintaining a 1.0 dB maximum pass band insertion loss. This assembly also provides the option for additional filtering with an external filter option.

Performance

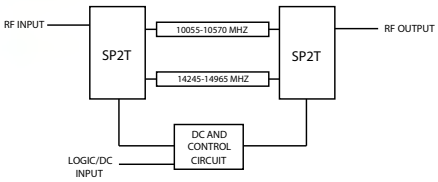


Insertion Loss	1.0 dB max.
VSWR	1.5:1
Isolation	85 dB
Ripple	.5 dB
DC Power	+12V
Gain	20 dB

X-Band Switch Bank

Low profile combline cavity filters are combined with series/shunt pin diode switches to provide low loss and high isolation in this X-band switch bank. This unit features 60 dB isolation along with 4.5 dB insertion loss. Typical switching speeds are 400ns using standard TTL control logic. This device is assembled for a full mil-spec. environment.

Performance



Frequency	X-Band
Insertion Loss	4.5 dB max.
Isolation	60 dB
VSWR	1.5:1
DC Power	+5V @ 60 mA
	-5V @ 50 mA
Switching Speed	400 ns

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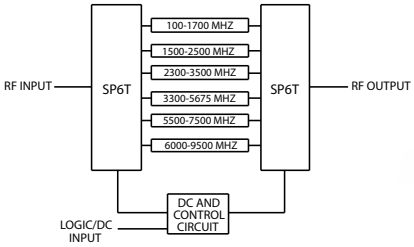
Performance

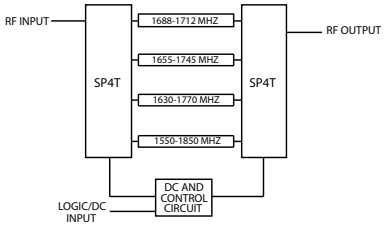


Insertion Loss	8.0 dB max.
1 dB BW	6.8 MHz
VSWR	1.7:1
Rejection	60 dBc
Operating Temp.	-55 to +85 ºC
Phase Noise	-148 dBc/Hz

6-Channel Switched Filter

High-Q lumped element filters are combined with MMIC switches to provide low loss narrow band filter selectivity. The RF band is split into 6 narrow, overlapping channels. Filter components are selected to provide a minimum frequency drift over an operating temperature of -55 to +85 °C. This unit features a phase noise specification of -148 dBc/Hz at four different offset frequencies. DC control for this device is provided thru a nine pin D-sub connector.

Performance

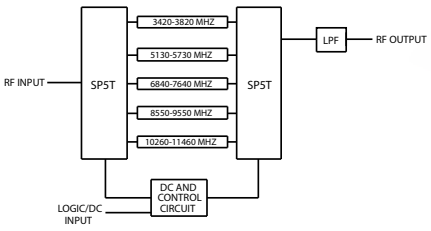


Insertion Loss	8.0 dB max.
Amplitude Match	1.0 dB
Rejection	80 dBc
VSWR	1.4:1
Control	2 bit TTL
Power Supply	+5V @ 50 mA
Package	1.6 x 1.6 x .3

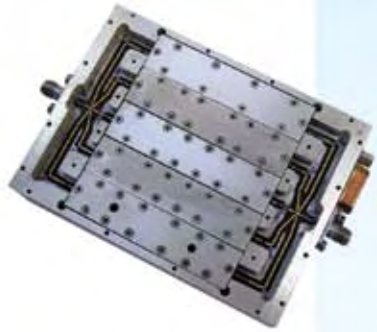
Low Profile Switch Bank

Four channel switch filter bank utilizing modern switch technology in a .30 tall package. The low profile switch bank features four bandpass filters in a package that is 1.6 x 1.6 x .3 tall. The bank contains four bandpass filters that have a common center frequency and four independent bandwidths. The insertion loss is amplitude matched to provide constant amplitude. The filters feature 80 dB stopbands with symmetrical skirt attenuation. The mechanical configuration is designed to meet Mil-Std-202 environmental conditions.

Performance



Insertion Loss	6.0 dB max.
VSWR	2.0:1
Rejection	60 dBc
Control	3 bit TTL
Amplitude Var.	+/- 1 dB
Switching Speed	1 us



5-Channel Switched Filter

The Lorch Microwave five channel switch filter bank features mixed filter technology combined with high performance pin diode switches. The bank features one high Q lumped element filter and four combline cavities. The control circuitry features a 3 to 8 decoder that provides standard 3 bit TTL logic and utilizes a single +5 V power supply.

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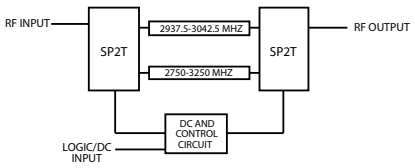
S-Band Switch Bank

The 2IFA-3000/85-500-SR is a two channel switch filter bank centered at 3 GHz. This bank features a narrow band channel and one broadband channel. The broad band channel features Lorch Microwave chip and wire filter technology while the narrow channel features cavity technology. This bank also features ultimate rejection to 20 GHz.

Performance

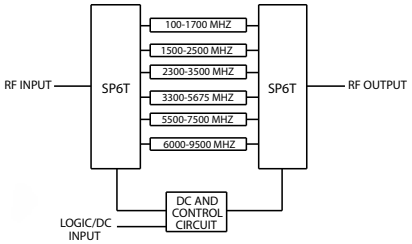


Frequency	S-Band
Shape Factor	6/60 2/5:1
Switching Speed	400 ns
Input Power	+15 dBm
1 dB Compression	+20 dBm
Ultimate Rejection	30 dBc to 20 GHz

6-Channel Broadband Switch Bank

This broad band filter bank features six channels that cover VHF thru X-Band frequencies. This bank utilizes low profile discrete filters up to 9500 MHz. The bank maintains a maximum insertion loss of 5 dB and 60 dB ultimate rejections. Typical switching speed is specified at 400 ns maximum using standard TTL control logic. The mechanical configuration features a .490 maximum package height suitable for ground or airborne applications.

Performance

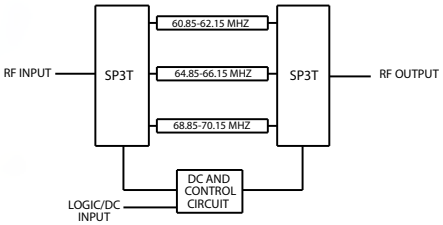


Insertion Loss	6.0 dB max.
VSWR	2.0:1
Rejection	60 dBc
Switching Speed	400 ns
Amplitude Var.	+/- 1 dBc
Package	3.5 x 3.0 x .5

3-Channel Switched Filter

Narrow band LC filters and MMIC switches combine to make up the VHF switch bank. This bank features three bandpass filters with 2% bandwidths and 65, 75, and 90 dB stopbands. Control is done thru two TTL control lines and +5V power supply voltage. Design considerations for this bank was maximum phase noise requirements under vibration and Mil-Std -202 environmental conditions.

Performance



Insertion Loss	9.0 dB max.
3 dB BW	1.5 MHz
VSWR	1.5:1
Power Supply	+5V @ 50 mA
Phase Noise	-148 dBc/Hz

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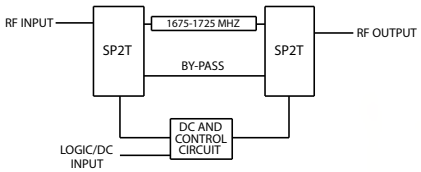
Performance

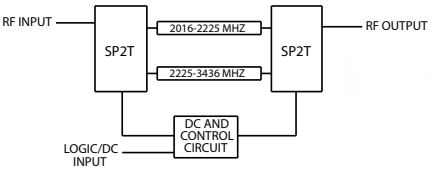


Insertion Loss	7.0 dB max.
Rejection	60 dBc
Control	TTL
Operating Temp.	0 to +70 ºC

Switch Bank / By-Pass

The two channel switch bank features a bandpass filter and by-pass channel. The by-pass channel is designed into the device as part of the RF board. This provides a wider bandwidth and lower insertion loss. The bandpass is designed as an LC filter and potted to provide maximum performance under Mil-Std-202 vibration profiles. The bank provides a single voltage supply and low current consumption to support modern design techniques.

Performance

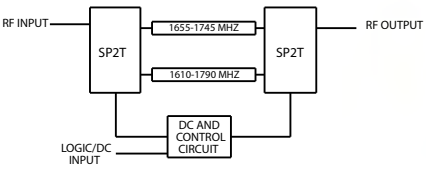


Insertion Loss	6.5 dB max.
Rejection	80 dBc
VSWR	1.7:1
Switching Speed	100 ns
Power Supply	+5V @ 50 mA
Package	3.25 x 1.25 x .3

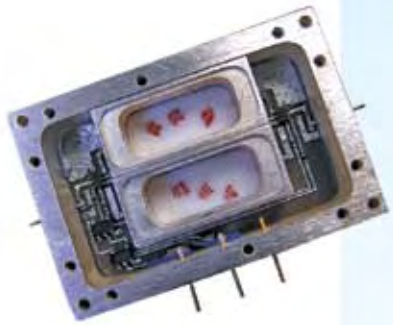
2-Channel Switch Bank

The 2IFA-2016/2436 is a two channel high isolation switch filter bank. This unit features 80 dB stopbands, 6.5 dB maximum insertion loss and 2.0:1 VSWR. The control and voltage lines feature decoupling to reduce RF pick-up. The switching speed is specified as 100 ns maximum and this includes the delay thru the filters. The mechanical housing includes RF pins for surface mounting and .300 tall maximum height to fit low profile cards.

Performance



Frequency	1700 MHz
Ripple	.4 dB
Input Power	+10 dBm
Operating Temp.	-54 to +95 ºC
Group Delay Var.	4 ns
Package	1.5 x 1.0 x .4



Miniature 2-Channel Switch Bank

Small size, low profile and high end performance are featured in this two channel switch filter bank. The bandpass filters are centered at 1700 MHz with bandwidths of 150 and 300 MHz. The operating temperature is -54 to +95°C. The filters are temperature compensated to meet the extreme operating conditions. Switching speeds are specified as 100 ns maximum. The total package size is 1.5L x 1.0W x .4T excluding RF pins for the input and output.

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LORCH MICROWAVE

Tunable Filters

- 24 MHz to 3000 MHz
- Direct Readout
- Octave Tuning
- High Power
- Digital and Manual Tuning Available
- Diplexer Configuration
- Ruggedized Applications

Lorch Microwave's tunable filter products are designed to provide high performance in a single package. While typically used in test and measurement applications, these products can also be ruggedized for mobile and remote applications.

Lorch Microwave offers several standard Bandpass and Bandreject Tuners covering the frequency range of 24 MHz to 3000 MHz in octave bands. Cellular and PCS units cover less than full octaves, however they feature greater dial resolution. All standard units offer direct frequency read-out, high power, and narrow bandwidth.

Lorch Microwave's standard products may be customized to meet specific requirements; including Digitally Controlled, Diplexed, and Ruggedized options. Contact the factory for your specific requirements.

An additional feature of Lorch Microwave's Tunable Filter Product Line is the ability to ship standard bandpass and bandreject filters overnight from stock.

Tunable Filter Part Number Description

5	TF	-	200 / 400	-	5	S
1	2		3		4	5

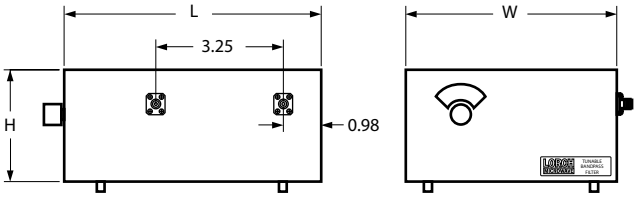
1. Number of Sections
2. Series (TF)
3. Frequency Range, MHz
4. Percent Bandwidth 3 dB (3 dB BW Standard)
5. Connectors

Bandwidth	Designator
3 dB	/(blank)
special	/X

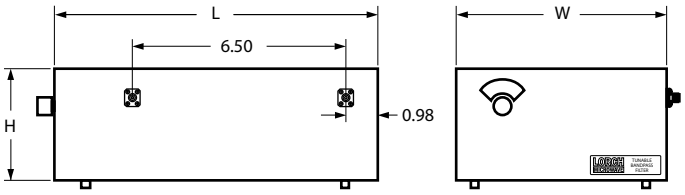
CONNECTORS

Connector Type	Designator
BNC Female	B
F	F
N Female	N
SMA - Female	S
TNC - Female	T

3-Section Tunable Bandpass



5-Section Tunable Bandpass



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Standard Cellular and PCS Tunable Bandpass Filters

Part No.	No. of Sec.	Freq. Range (MHz)	Insert. Loss dB (Typ.)	Nominal Bandwidth	VSWR (Typ.)	Avg. Power (watts)	Dial Acc.	30 dB/ 3 dB Ratio	50 dB/ 3 dB Ratio	Length Inches (mm)	Width Inches (mm)	Height Inches (mm)
Cellular Bandpass												
3BT-800/1000-1S	3	800-1000	1.25	1%	1.5:1	50 W	±0.5%	3.5:1	N/A	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
5BT-800/1000-1S	5	800-1000	2	1%	1.5:1	50 W	±0.5%	2.2:1	3.5:1	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
PCS Bandpass												
3BT-1800/2200-1S	3	1800-2200	1	1%	1.5:1	50 W	±0.5%	3.5:1	N/A	6.57 (166.9)	2.0 (50.8)	2.0 (50.8)
5BT-1800/2200-1S	5	1800-2200	1.5	1%	1.5:1	50 W	±0.5%	2.2:1	3.5:1	9.86 (250.4)	2.0 (50.8)	2.0 (50.8)

Standard Tunable Bandpass Specifications

No. of Sections	Freq. Range (MHz)	Nominal Bandwidth	VSWR (Typical)	Avg. Power (watts)	Dial Accuracy	30 dB/3 dB Ration	50 dB/3 dB Ration
3	30 - 3000	5%	1.5:1	50 W	±1%	3.5:1	N/A
5	30 - 3000	5%	1.5:1	50 W	±1%	2.2:1	3.5:1

3-Section Tunable Bandpass

Stock 3 Section Units	Insertion Loss dB (Typical)	Length Inches (mm)	Width Inches (mm)	Height Inches (mm)
3TF-24/48-5S	1.0	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-30/76-5S	1.0	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-32/64-5S	0.8	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-48/95-5S	0.8	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-63/125-5S	0.8	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-95/190-5S	0.8	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-125/250-5S	0.8	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-200/400-5S	0.8	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-225/400-5S	0.8	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-250/500-5S	0.7	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-375/750-5S	0.7	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-500/1000-5S	0.7	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-750/1500-5S	0.7	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3TF-1000/2000-5S	0.7	5.0 (127.0)	2.9 (73.7)	2.8 (71.1)
3TF-1500/3000-5S	0.7	5.0 (127.0)	2.9 (73.7)	2.8 (71.1)

5-Section Tunable Bandpass

Stock 3 Section Units	Insertion Loss dB (Typical)	Length Inches (mm)	Width Inches (mm)	Height Inches (mm)
5TF-24/48-5S	1.3	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-30/76-5S	1.3	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-32/64-5S	1.3	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-48/95-5S	1.3	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-63/125-5S	1.3	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-95/190-5S	1.3	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-125/250-5S	1.3	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-200/400-5S	1.3	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-225/400-5S	1.0	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-250/500-5S	1.0	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-375/750-5S	1.0	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-500/1000-5S	1.0	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-750/1500-5S	1.0	9.8 (248.9)	5.4 (137.2)	2.8 (71.1)
5TF-1000/2000-5S	1.0	7.4 (188.0)	2.9 (73.7)	2.8 (71.1)
5TF-1500/3000-5S	1.0	7.4 (188.0)	2.9 (73.7)	2.8 (71.1)

All width dimensions are excluding connectors.

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Tunable Bandreject Filters

- 24 MHz to 2000 MHz
- Direct Readout
- Octave Tuning
- Digital and Manual Tuning Available
- Extended Passband
- High Power Application
- Custom Bandwidths
- Ruggedized Applications

Tunable Filter Part Number Description

3 NF - 200 / 400 - S
1 2 3 4

1. Number of Sections
2. Series (NF)
3. Frequency Range, MHz
4. Connectors

Bandwidth	Designator
3 dB	/(blank)
special	/X

CONNECTORS

Connector Type	Designator
BNC Female	B
F	F
N Female	N
SMA - Female	S
TNC - Female	T

Digital Filter Options

Lorch Microwave can provide a wide selection of tunable bandpass and bandreject options, including digitally controlled filters. Standard bandpass and bandreject tuners can be configured to provide digital frequency control. Tuning is accomplished by utilizing a servo-type stepping motor to drive the gear assembly.

A programmable microprocessor-based system is used. Many control logic options exist including serial, RS-232, RS-422, IEEE-488, and BCD.

Note: Outline drawings for Bandreject Filters are the same as Tunable Filters. See page 36.

Standard Cellular and PCS Tunable Bandreject Filters

Part No.	No. of Sections	Freq. Range (MHz)	Insert. Loss dB (Typ.)	Nominal Bandwidth	VSWR (Typ.)	Avg. Power (watts)	Dial Acc.	Notch Depth	Length Inches (mm)	Width Inches (mm)	Height Inches (mm)
Cellular Bandreject											
3NF-800/1000-1S	3	800-1000	1	1%	1.5:1	50 W	±0.5%	50 DB	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
5NF-800/1000-1S	5	800-1000	1	1%	1.5:1	50 W	±0.5%	75 DB	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
PCS Bandreject											
3NF-1800/2200-1S	3	1800-2200	1	1%	1.5:1	50 W	±0.5%	50 DB	6.57 (166.9)	2.0 (50.8)	2.0 (50.8)
5NF-1800/2200-1S	5	1800-2200	1	1%	1.5:1	50 W	±0.5%	75 DB	9.86 (250.4)	2.0(50.8)	2.0 (50.8)

Standard 3-Section Tunable Bandreject Filters

Stock 3 Section Units	Insertion Loss dB (Typical)	3 dB BW (MHz)	40 dB BW min. (KHz)	Notch Depth (dB)	Length Inches (mm)	Width Inches (mm)	Height Inches (mm)
3NF-25/50-S	1.0	1-2.5	100	50	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3NF-30/76-S	1.0	1-2.5	100	50	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3NF-50/100-S	1.0	3-6	300	50	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3NF-100/200-S	1.0	3-6	300	50	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3NF-200/400-S	1.0	3-7	300	50	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3NF-250/500-S	1.0	3-7	300	50	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3NF-375/750-S	1.0	6-16	400	50	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3NF-500/1000-S	1.0	6-16	400	50	6.6 (167.6)	5.4 (137.2)	2.8 (71.1)
3NF-1000/2000-S	1.0	9-24	400	50	5.2 (132.1)	2.9 (73.7)	2.8 (71.1)

All width dimensions are excluding connectors.

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Lorch's Standard Digitally Controlled Bandpass Filters are available with 3 or 5 sections in the frequency range of 25 MHz to 3000 MHz. The typical insertion loss at center frequency ranges from 0.7 dB to 1.0 dB and standard tuners have a 3 dB passband bandwidth of 5%. Digitally Controlled Bandreject Filters are also available. Standard Bandreject Filters have 3 or 5 sections with a center frequency between 25 MHz to 2200 MHz and a notch depth of 50 dB to 75 dB. The rejection bandwidth is typically 1%. All Standard Digitally Controlled Filters have a dial accuracy of better than 0.5%. The filter is controlled by sending commands as ASCII strings to the RS232 port.

- **24 MHz to 3000 MHz**
- **Octave Tuning**
- **High Position Resolution**
- **Built in Backlash Compensation**
- **Simple Command Structure**

Communications

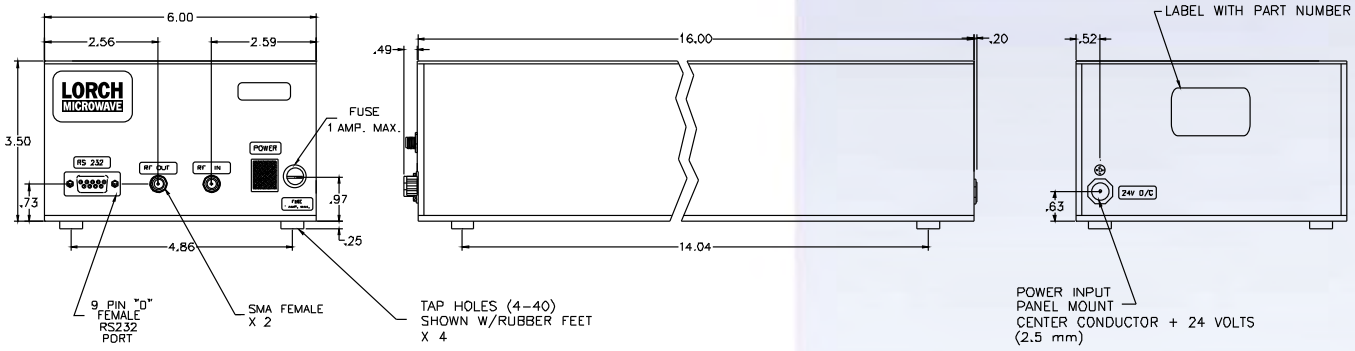
The controller communicates via a RS232-C port with the following settings: 9600 BAUD, 8 Bits/Byte, No parity, 1 stop bit. If a PC us used to send commands to the controller, a standard serial cable must be connected to the RS232 port of the filter.

Power Supply

The digitally controlled filter is supplied with a 24 VDC, 0.625 mA, universal power supply. Typically a filter draws about 250 mA of current.

Lifetime Expectancy & Servicing

Lorch's Digitally Controlled Filters do not require servicing. The meantime to failure is calculated at approximately 1,000,000 tune commands (based on 1 tune command every 30 seconds over 1 year) and is mainly determined by the limited number of write cycles to EEPROM to keep track of the current frequency setting.



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LORCH MICROWAVE

Tubular Filters

- 50 MHz to 20 GHz
- Chebyshev Response Standard
- Four Convenient Sizes
- Reliable Sturdy Construction

Lorch Microwave tubular filters are available in bandpass and lowpass configurations. A low ripple Chebyshev transfer function is standard for both models. These units are available with up to a 10 section response. The bandpass units exhibit high side sharp attenuation characteristics. All tubular filters are available in diameters of .25, .5, .75, and 1.25 inches respectively.

Tubular filters are an excellent choice when the designer has space available and needs a cost effective approach. The BC series (½ inch) diameter is the model most often selected as the best compromise between performance and cost with the fastest delivery. Units are of rugged construction and may be found in a variety of military and commercial applications.

Tubular Filter Dimensions

BPF Model	LPF Model	Diameter - Inches / mm
BA	LA	.25/6.35
BC	LC	.50/12.70
BD	LD	.75/19.05
BE	LE	1.25/31.70

Tubular Bandpass Filters

P/N	Freq. Range (MHz)	% 3 dB Bandwidth	VSWR (Typical)	Number of Sections	Avg. Power (Watts)	Operating Temp. (°C)	Impedance	Relative Humidity
BA	200-5000	5 - 50	1.5:1	2 - 10	2	-40 to +85	50	0 - 95%
BC	75-2500	5 - 50	1.5:1	2 - 10	15	-40 to +85	50	0 - 95%
BD	50-1500	5 - 50	1.5:1	2 - 10	40	-40 to +85	50	0 - 95%
BE	50-500	5 - 50	1.5:1	2 - 10	200	-40 to +85	50	0 - 95%

Shock 10G
Vibration 20G

Contact factory for specific requirements not listed above.

Bandpass Filter Loss Constant

	Frequencies						
Series	50-74	75-199	200-499	500-1000	1001-1499	1500-2499	2500-5000
BA	-	-	4.5	4.0	3.5	3.0	2.5
BC	-	3.0	2.75	2.5	2.0	1.8	-
BD	2.5	2.0	1.6	1.4	1.2	-	-
BE	2.2	1.8	1.3	1.2	-	-	-

Tubular Lowpass Filters

P/N	Freq. Range (MHz)	VSWR (Typical)	Number of Sections	Avg. Power (Watts)	Operating Temp. (°C)	Impedance	Relative Humidity
LA	300-20000	1.5:1	2-10	2	-40 to +85	50	0-95%
LC	60-3000	1.5:1	2-10	15	-40 to +85	50	0-95%
LD	50-2000	1.5:1	2-10	40	-40 to +85	50	0-95%
LE	50-1000	1.5:1	2-10	200	-40 to +85	50	0-95%

Shock 10G
Vibration 20G

Contact factory for specific requirements not listed above.

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Calculating Number of Sections

The following curves show the stopband frequencies normalized to the 3 dB bandwidth for filters with 2 to 8 sections. A ratio of stopband frequency to 3 dB bandwidth is used.

The curve given below shows an asymmetric frequency response resulting from the circuit used. Other schematics may be utilized to yield different attenuation characteristics (i.e. steeper on the high frequency side of the passband and shallower on the low side).

When considering the use of a tubular bandpass filter the following "Rule of Thumb" is useful: "For a given bandwidth, the larger the diameter of the tubular…a) the lower the frequency of operation; b) the lower the insertion loss; c) the greater the selectivity. The inverse is true when decreasing the diameter."

Example:
A BC-Series filter has a center frequency of 1000 MHz and a 3 dB bandwidth of 50 MHz. Use the curve for 3-10% bandwidth filters. A stopband attenuation of 40 dB is required at 760 MHz and 50 dB is required at 1140 MHz.

The percentage bandwidth is 5%, calculated as follows:

$$\frac{50}{1000} \times 100 = 5\%$$

For the first stopband requirement: $\frac{(1000 - 760)}{50} = 4.8$

Number of 3 dB bandwidths from center frequency:

$$\frac{(1140 - 1000)}{50} = 2.8$$

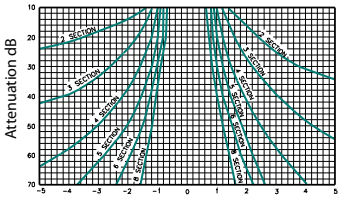
From the 3-10% bandwidth attenuation curve, we find that a minimum of 3 sections is required.

The second stopband requirement is: Number of 3 dB bandwidths from center frequency: $\frac{(1140 - 1000)}{50} = 2.8$

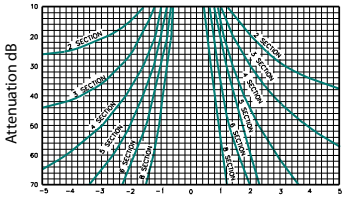
From the 10-50% bandwidth attenuation curve, we find that 4 sections minimum are required.

The greater number of sections must be used to insure full specification compliance; therefore, a 4 section should be used.

3-10% Bandwidth



10-50% Bandwidth



Bandpass Filter Part Number Description

4 BC - 1000 / 50 - S S
1 2 3 4 5 6

1. Number of Sections
2. Series and package size
3. Center Frequency, MHz
4. Bandwidth and Designator (3 dB BW Standard)
5. Input Connector
6. Output Connector (if different from input)

Bandwidth	Designator
3 dB	/(blank)
1 dB	/A
equi-ripple	/R
special	/X

CONNECTORS

Connector Type	Designator
BNC - M	BM
BNC - F	B
Type N - Male	NM
Type N - Female	N
TNC - Male	TM
TNC - Female	T
SMA - Male	SM
SMA - Female	S

(1) 6" RG 188 Standard

(2) Requires SMA RemovableConnectors at High Frequencies

Insertion Loss Calculation

Knowing the number of sections, center frequency and bandwidth of the filter, insertion loss may be calculated using the following formula:

$$IL = \frac{(\text{Loss Constant}) \times (N - 1.5)}{(\%3\text{dB BW})} + 0.2$$

Example:
4BC - 1000/150-S
1. Percentage BW = 50/1000 x 100 = 5%
2. LC from table = 2.5
3. Number of Sections (from P/N) = 4
4. $IL = \frac{(2.5) \times (4 - 1.5)}{(5)} + 0.2 = 1.45$ dB

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Specifying Lowpass Filters

Lowpass Filter Part Number Description

4 LC - 650 - S / S
1 2 3 4 5

1. Number of Sections
2. Series and package size
3. Cutoff Frequency, MHz (3 dB C/O Standard)
4. Input Connector
5. Output Connector (if different from input)

Bandwidth	Designator
3 dB	/(blank)
1 dB	/A
equi-ripple	/R
special	/X

CONNECTORS

Connector Type	Designator
BNC - M	BM
BNC - F	B
Type N - Male	NM
Type N - Female	N
TNC - Male	TM
TNC - Female	T
SMA - Male	SM
SMA - Female	S

(1) 6" RG 188 Standard

(2) Requires SMA Removable Connectors at High Frequencies

Calculating Number of Sections

The following curves show the stopband frequencies normalized to the 3 dB bandwidth for filters with 2 to 12 sections. A ratio of stopband frequency to 3 dB bandwidth is used.

The curve given below indicates the frequency response resulting from the circuit used.

When considering the use of a tubular lowpass filter the following "Rule of Thumb" is useful: "The larger the diameter of the tubular…a) the lower the insertion loss; b) the greater the selectivity; c) the greater the power handling capability. The inverse is true when decreasing the diameter."

Example:
A LC-Series filter has a cutoff frequency of 650 MHz. A stop-band attenuation of 30 dB is required at 900 MHz.

Calculate the number of sections as follows:

$$\frac{900}{650} = 1.38$$

Number of 3 dB bandwidths from cutoff frequency = The curve indicates that a minimum of 4 sections is required.

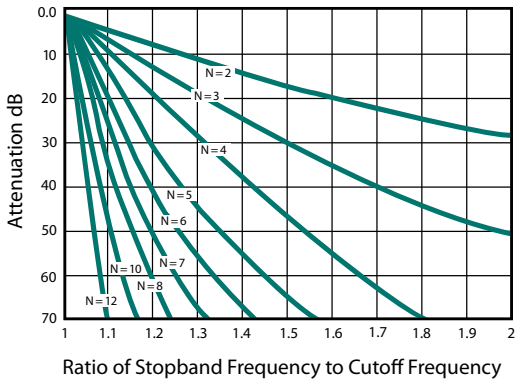
Insertion Loss Calculation

Knowing the number of sections, center frequency and bandwidth of the filter, insertion loss may be calculated using the following formula: Loss = N x 0.2

Example:
4LC - 650-S
1. Number of Sections
2. IL= 4 x 0.2 = 0.8 dB

Note: For Lowpass filters, insertion loss is calculated at 0.9 times the cutoff frequency.

Lowpass



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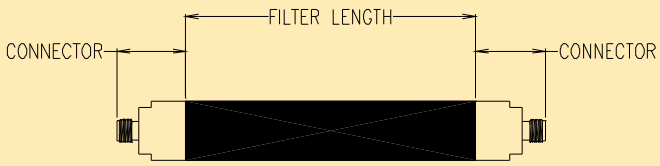
Tubular Filter Dimensions



The length of a tubular filter is determined by adding the connector dimensions from the table below. The filter length is obtained from the Length vs. Frequency tables.

Example:
A 5-section bandpass filter Model BC with a center frequency of 300 MHz and with SMA connectors has a filter dimension of 3.4 inches and a connector dimension of 0.8 inches. The total length is 5.0 inches.

Connector Dimensions (inches)

Connector Style	Connector Cod	.25 Diameter	.50 Diameter	.75 Diameter	1.25 Diameter	Figure
"N" Female	N	NR*	1.28	1.4	1.7	-
"N" Male	NM	NR*	1.23	1.31	1.65	-
BNC Female	B	NR*	1.0	1.35	1.42	-
BNC Male	BM	NR*	.93	1.45	1.35	-
TNC Female	T	NR*	1.0	1.35	1.42	-
TNC Male	TM	NR*	.93	1.45	1.35	-
SMA Female (standard)	S	.6	.8	.8	.8	1
SMA Male (standard	SM	.73	.85	.85	.85	1
SMA Male (right angle square)	EP	.55	.65	.65	.65	2

NR- Not recommended for PC mount. Contact factory with specific requirements.

Standard connector dimensions are in inches, please use 25.4 to convert to metric.

BA - Filter Length vs. Frequency (MHz)

No. of Sections	200-300	300-400	400-1000	1000-3000	3000-4000	4000-5000
2	1.10	1.00	.90	.80	.70	.50
3	2.00	1.90	1.40	1.20	1.00	.70
4	2.90	2.80	1.90	1.70	1.30	.90
5	3.80	3.60	2.40	2.10	1.60	1.10
6	4.70	4.40	2.90	2.50	1.90	1.30
7	5.60	5.20	3.40	2.90	2.20	1.60
8	6.50	6.00	3.90	3.30	2.50	1.90

BC - Filter Length vs. Frequency (MHz)

No. of Sections	75-130	130-180	180-350	350-700	700-2500
2	2.00	1.60	1.30	1.10	.90
3	3.15	2.60	2.00	1.65	1.40
4	4.30	3.60	2.70	2.20	1.95
5	5.45	4.55	3.40	2.70	2.45
6	6.60	5.55	4.10	3.25	3.00
7	7.75	6.55	4.80	3.80	3.50
8	8.90	7.55	5.50	4.35	4.00
9	-	8.55	6.20	4.90	4.55
10	-	9.50	6.90	5.40	5.00

BD - Filter Length vs. Frequency (MHz)

No. of Sections	50-140	140-230	230-500	500-1500
2	2.00	1.50	1.30	1.10
3	3.00	2.25	1.85	1.60
4	3.95	3.00	2.40	2.10
5	4.90	3.75	2.95	2.60
6	5.90	4.50	3.50	3.10
7	6.85	5.25	4.10	3.60
8	7.80	6.00	4.60	4.10
9	8.80	6.75	5.15	4.60
10	-	7.50	5.70	5.10

BE - Filter Length vs. Frequency (MHz)

No. of Sections	50-80	80-200	200-400	400-500
2	2.80	2.40	2.00	1.60
3	3.80	3.20	2.80	2.30
4	4.80	4.00	3.60	3.00
5	6.00	5.20	4.40	3.80
6	7.20	5.60	5.20	4.60
7	8.40	6.40	6.00	5.40
8	9.60	7.20	6.80	6.20
9	-	8.60	7.60	7.00
10	-	-	8.50	7.80

All dimensions are approximate. Contact factory for actual sizes.
All length dimensions are excluding connectors.

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Tubular Filter Dimensions

LA - Filter Length vs. Frequency (MHz)

No. of Sections	300-600	600-1000	1000-1300	1300-1700	1700-2300	2300-3000	3000-5000	5000-20000
2	.65	.55	.40	.50	.45	.40	.40	
3	1.00	.90	.70	.85	.75	.70	.75	
4	1.45	1.25	1.00	1.20	1.10	1.00	1.50	
5	1.90	1.65	1.30	1.55	1.40	1.30	1.40	
6	2.30	2.00	1.60	1.95	1.70	1.55	1.75	*
7	2.75	2.40	1.90	2.30	2.00	1.85	2.10	
8	3.20	2.75	2.20	2.65	2.35	2.15	2.45	
9	3.65	3.10	2.50	3.00	2.70	2.45	2.80	
10	4.10	3.50	2.80	3.35	3.00	2.75	3.10	

*Contact factory for exact size at higher frequencies.

LD - Filter Length vs. Frequency (MHz)

No. of Sections	50-100	100-200	200-400	400-600	600-1000	1000-2000
2	2.20	2.00	1.20	1.00	.90	.80
3	3.50	3.15	2.00	1.60	1.35	1.25
4	4.75	4.30	2.70	2.15	1.80	1.65
5	6.00	5.40	3.40	2.70	2.25	2.00
6	7.30	6.50	4.10	3.25	2.70	2.45
7	8.60	7.65	4.90	3.85	3.15	2.85
8	-	8.75	5.55	4.40	3.60	3.30
9	-	-	6.40	5.00	4.00	3.70
10	-	-	7.00	5.50	4.50	4.10

LC - Filter Length vs. Frequency (MHz)

No. of Sections	60-90	90-150	150-200	200-400	400-800	800-3000
2	2.10	1.80	1.55	1.10	.75	.65
3	3.15	2.80	2.45	1.80	1.20	1.10
4	4.20	3.85	3.40	2.55	1.70	1.50
5	5.60	4.85	4.30	3.25	2.15	1.95
6	6.90	5.90	5.20	3.95	2.60	2.40
7	8.30	6.95	6.15	4.70	3.00	2.80
8	9.60	7.95	7.00	5.40	3.50	3.25
9	10.88	8.95	8.00	6.10	3.95	3.70
10	-	-	8.90	6.80	4.40	4.10

LE - Filter Length vs. Frequency (MHz)

No. of Sections	50-80	80-200	200-600	600-1000
2	2.40	2.00	1.30	1.00
3	3.55	2.85	2.00	1.55
4	4.75	3.70	2.60	2.00
5	6.00	4.55	3.25	2.60
6	7.15	5.40	3.90	3.10
7	8.35	6.25	4.55	3.65
8	9.50	7.10	5.20	4.20
9	-	7.95	5.85	4.70
10	-	8.80	6.50	5.20

All dimensions are approximate. Contact factory for actual sizes.
All length dimensions are excluding connectors.

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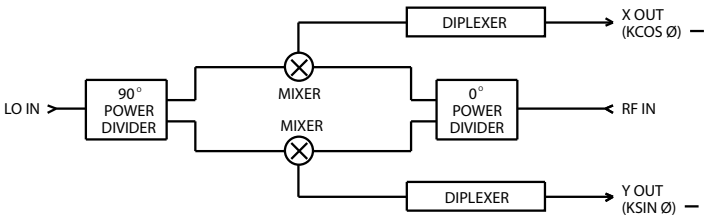
Lorch Microwave began manufacturing custom RF and Microwave signal processing components more than 30 years ago. Today, they comprise a portion of a broad product line which includes RF and Microwave filters and Integrated Assemblies.

- 0.2 - 1000 MHz Frequency Range
- Up to 33% Bandwidth
- Wide Dynamic Range
- High Phase Stability
- High Accuracy
- PC Mount and Connectorized

Schematic, Phase Comparator



Phase Accuracy

Center Frequency (MHz)	Phase Error (°)		Zero Crossing
	@ F_O	@ F_O +/-5%	@ F_O (°)
0.2-10	+/- 1.0	+/- 3.0	+/- 1.0
10-100	+/- 1.5	+/- 3.5	+/- 1.0
100-200	+/- 1.7	+/- 4.0	+/- 1.5
200-300	+/- 2.0	+/- 4.5	+/- 1.5
300-400	+/- 2.5	+/- 5.0	+/- 1.7
400-500	+/- 2.5	+/- 5.0	+/- 2.0

LO/RF Characteristics

	LO/RF Frequency, F_O	Bandwith	LO Input Level	RF Input Level	Nominal Impedance	VSWR
Low-Level Comparators	0.2-500 MHz	@ F_O +/- 5%	+13 +/- 2 dBm	+3 dBm max.	50 Ohms	1.4:1 typ. (1.6:1 max.)
High-Level Comparators	0.2-500 MHz	@ F_O +/- 5%	+20 +/- 2 dBm	+10 dBm max.	50 Ohms	1.4:1 typ. (1.6:1 max.)

X/Y Video Output Characteristics

	"X" Output	"Y" Output	Bandwidth	Nominal Impedance	X/Y Amplitude Balance	Conversion Loss	DC Offset Voltage
Low-Level Comparators	k Cos Ø	k Sin Ø	DC-10% RF	50 Ohms	+/- 5 mV max.	11 dB max.	+/- 2 mV typ.
High-Level Comparators	k Cos Ø	k Sin Ø	DC-10% RF	50 Ohms	+/- 5 mV max.	11 dB max.	+/- 2 mV typ.
Low-Level Comparators	Peak Amplitude: 85 mV min. into 50 Ohms, for 0 dBm input at Port RF						
High-Level Comparators	Peak Amplitude: 190 mV min. into 50 Ohms, for +7 dBm input at Port RF						

Lorch Microwave's CP-13 Series, Low-Level Phase Comparators, are designed to accept RF input signal levels of up to +3 dBm.
The CP-20 Series, High-Level Phase Comparators, are designed to accept RF input signal levels of up to + 10 dBm.

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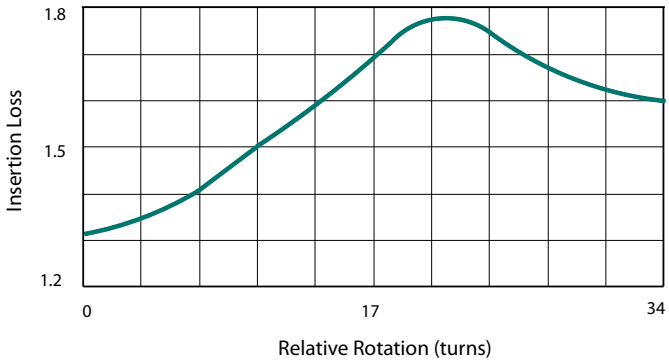
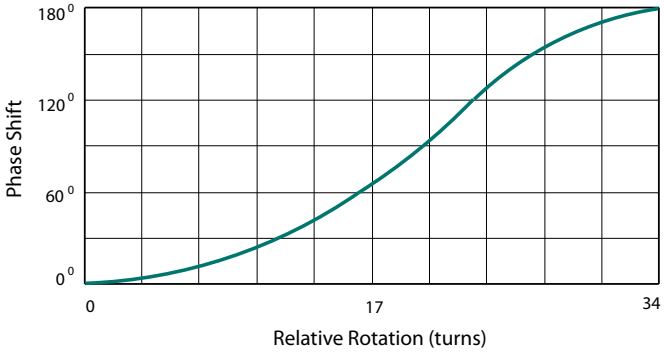
- 10 - 1000 MHz Frequency Range
- 10% Standard Bandwidth
- 0-90°, 0-180° and 0-360° Phase Shift Ranges
- Multi-Turn, Infinite Resolution
- Low Loss, High Phase Stability
- PC Mount and Connectorized

Typical Insertion Loss vs. Relative Rotation



Typical Phase Shift vs. Relative Rotation



Typical Performance Specifications

Frequency (MHz)	Usable Bandwidth (%)	Phase Shift @F_o (°)	Insertion Loss	VSWR
10-250	10	0-90	1.3	1.6:1
10-250	10	0-180	1.7	1.6:1
250-500	10	0-90	1.4	1.6:1
250-500	10	0-180	1.8	1.8:1

Notes:
1) Nominal impedance is 50 Ohms.
2) All units rated at 0.5 Watts average, 2 Watts peak.

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Phone 800.780.2169, 410.860.5100 · Fax 410.860.1949
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- 1 - 1000 MHz Frequency Range
- Up to a Full Octave Bandwidth
- 0-360° Phase Shift
- Integral TTL Driver
- 1-8 Bit Control
- Accuracy to 1/2 Least Significant Bit
- Time Shifter or Frequency Independence

Characteristics

Parameter	Type 1	Type 2
Phase Shift	Independence of Frequency	Proportional to Frequency
Group Delay	Constant with Frequency	Proportional to Phase Shift

Typical Performance Specifications

Part Number	Type	#Bits	Center Frequency (MHz)	Bandwidth (MHz)	VSWR Typ.	Insertion Loss (dB) Typ.	Phase Error/Bit (°) Typ.
DP-1-6-70-10-75	1	6	70	10	1.6:1	8	+/- 1.5
DP-1-6-305-30-75	1	6	305	30	1.6:1	8	+/- 2
DP-1-8-80-8-77	1	8	80	8	1.6:1	9	+/- 2
DP-1-8-370-5-77	1	8	370	5	1.6:1	9	+/- 2
DP-2-4-295-10-73	2	4	295	10	1.6:1	5.5	+/- 1.5
DP-2-6-255-30-75	2	6	255	30	1.6:1	7	+/- 1.5
DP-2-8-350-3-77	2	8	350	3	1.8:1	9	+/- 2
DP-2-8-860-80-77	2	8	860	80	2.0:1	9.5	+/- 3.5

Notes:
1) DC power supply requirements: +5VDC @ 20 mA, -5VDC @ 20 mA;
   RF input power: +16 dBm max.;
   Switching time: 100 ns max.
2) Please specify bit sequence, if other than standards

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RF Products — Voltage Controlled Phase Shifters

- 1 - 4000 MHz Frequency Range
- 10%, 20% and 30% Bandwidths
- 0-90°, 0-180° and 0-360° Phase Shift Range
- Low Insertion Loss
- High Phase Stability
- Surface Mount, PC-Mount, Flatpack and Connectorized

Typical Performance Specifications

Center Frequency (MHz)	% Bandwidth	Phase Shift (°)	Insertion Loss (dB)	VSWR	Max. Input Power (dBm)	Control Voltage (VDC)
0.5-50	10	0-90	1.0	1.4:1	0	0-15
0.5-50	10	0-180	1.5	1.5:1	0	0-15
0.5-50	10	0-360	3.0	1.6:1	0	0-15
0.5-50	20-30	0-90	1.2	1.5:1	0	0-15
0.5-50	20-30	0-180	1.6	1.6:1	0	0-15
0.5-50	20-30	0-360	3.2	1.7:1	0	0-15
50-500	10	0-90	1.0	1.4:1	+5	0-15
50-500	10	0-180	1.5	1.5:1	+5	0-15
50-500	10	0-360	3.0	1.6:1	+5	0-15
50-500	20-30	0-90	1.2	1.5:1	+5	0-15
50-500	20-30	0-180	1.6	1.6:1	+5	0-15
50-500	20-30	0-360	3.2	1.7:1	+5	0-15
500-2000	10	0-90	1.5	1.6:1	+10	0-10
500-2000	10	0-180	2.0	1.8:1	+10	0-10
500-2000	10	0-360	4.0	1.8:1	+10	0-10
500-2000	20-30	0-90	1.7	1.6:1	+10	0-10
500-2000	20-30	0-180	2.2	1.8:1	+10	0-10
500-2000	20-30	0-360	4.0	2.0:1	+10	0-10
2000-3000	10	0-90	1.8	1.7:1	+10	0-10
2000-3000	10	0-180	2.3	1.8:1	+10	0-10
2000-3000	10	0-360	4.5	2.0:1	+10	0-10
2000-3000	20-30	0-90	2.0	1.8:1	+10	0-10
2000-3000	20-30	0-180	2.6	1.8:1	+10	0-10
2000-3000	20-30	0-360	5..0	2.0:1	+10	0-10

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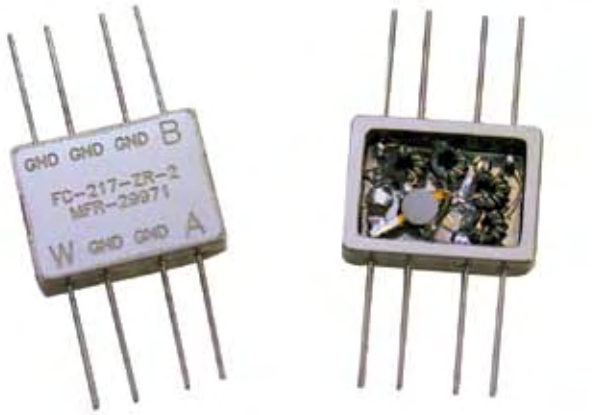
- 1 - 3000 MHz Frequency Range
- Single Control Voltage
- Low Signal Distortion
- Low Insertion Loss
- Wide Attenuation Range
- Surface Mount, PC-Mount, Connectorized

Typical Performance Specifications

Center Frequency (MHz)	% Bandwidth	Attenuation Range (dB)	Insertion Loss (dB) @ Vc = OVDC	VSWR @ Vc = OVDC	Max. Input Power (dBm)	Control Voltage VC @ 10 mA max. (VDC)
0.5-50	10	0-20	0.6	1.4:1	+15	0-5
0.5-50	10	0-40	1.2	1.4:1	+15	0-5
0.5-50	20-30	0-20	0.8	1.4:1	+15	0-5
0.5-50	20-30	0-40	1.6	1.4:1	+15	0-5
50-1000	10	0-18	0.8	1.5:1	+20	0-5
50-1000	10	0-35	1.6	1.5:1	+20	0-5
50-1000	20-30	0-18	0.9	1.6:1	+20	0-5
50-1000	20-30	0-35	1.8	1.6:1	+20	0-5
1000-2000	10	0-18	1.2	1.6:1	+20	0-5
1000-2000	10	0-35	2.4	1.6:1	+20	0-5
1000-2000	20-30	0-18	1.5	1.8:1	+20	0-5
1000-2000	20-30	0-35	3.0	1.8:1	+20	0-5
2000-3000	10	0-15	1.5	1.8:1	+20	0-5
2000-3000	10	0-30	3.0	2.0:1	+20	0-5
2000-3000	20-30	0-15	1.7	2.0:1	+20	0-5
2000-3000	20-30	0-30	3.5	2.0:1	+20	0-5

RF Products — Broad Band Mixers

- 50 kHz - 4000 MHz Frequency Range
- Wide Range and Optimized Bands
- High Dynamic Range
- Low Insertion Loss
- High Isolation
- PC Mount, Flatpack and Connectorized



Typical Performance Specifications

Part Number	LO Power	Freq. Range (MHz)		Performance Bandwidth, MHz Ports LO & RF	Conversion Loss dB (max)	Isolation		1-dB Input Comp Level (typ)	3rd Order Intercept Point (typ)
		Ports LO & RF	Port IF			LO-RF dB (min)	LO-IF dB (min)		
FC-7-0.05-100	+7 dBm	0.05-100	DC-100	0.05-0.1	7.5	50	50	0 dBm	+13 dBm
				0.1-10	6.0	50	5		
				10-60	6.0	35	30		
				60-100	7.5	35	30		
FC-7-0.2-600	+7 dBm	0.2-600	DC-600	0.2-0.4	8.0	50	50	0 dBm	+13 dB
				0.4-40	6.0	50	45		
				40-150	6.0	50	35		
				150-600	8.0	40	30		
FC-7-2-1200	+7 dBm	2-1200	DC-1200	2-500	8.0	35	30	0 dBm	+13 dB
				500-1000	8.0	30	30		
				1000-1200	8.5	25	25		
FC-10-10-2000	+10 dBm	10-2000	10-2000	10-50	7.5	40	30	+3 dBm	+15 dBm
				50-500	7.5	35	25		
				500-1000	8.0	30	20		
				1000-2000	9.0	25	20		
FC-10-10-3000	+10 dBm	10-3000	10-2000	10-500	8.0	25	20	+3 dBm	+15 dBm
				500-1000	9.0	30	25		
				1000-3000	10.0	25	18		
FC-20-0.05-100	+20 dBm	0.05-100	DC-100	0.05-10	6.5	45	40	+13 dBm	+27 dBm
				10-60	6.5	35	25		
				60-100	7.5	35	25		
FC-20-0.2-500	+20 dBm	0.2-500	DC-500	0.2-25	7.0	50	40	+13 dBm	+27 dBm
				25-50	7.0	45	35		
				50-150	7.0	30	25		
				150-500	8.0	30	25		

Notes:
1) Nominal impedance is 50 Ohms.
2) DC polarity is negative

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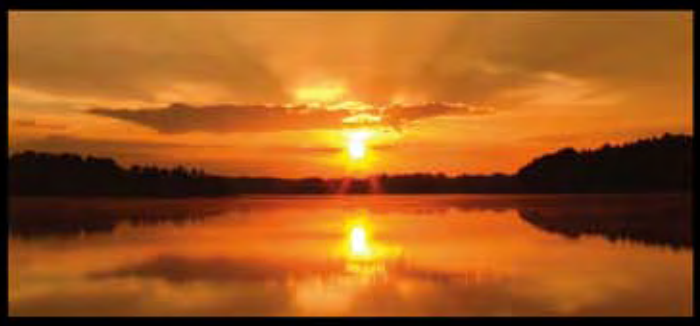

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