

Tubular Filters



- 50 MHz to 20 GHz
- Chebyshev Response Standard
- 4 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 (1/2 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	Average 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 10 G
Vibration 20 G

Contact factory for specific requirements not listed above.

Bandpass Filter Loss Constant

Series	Frequencies						
	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 (Nominal)	Number of Sections	Average 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 10 G
Vibration 20 G

Contact factory for specific requirements not listed above.

Specifying Bandpass Filters

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)

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

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

Insertion Loss Calculation

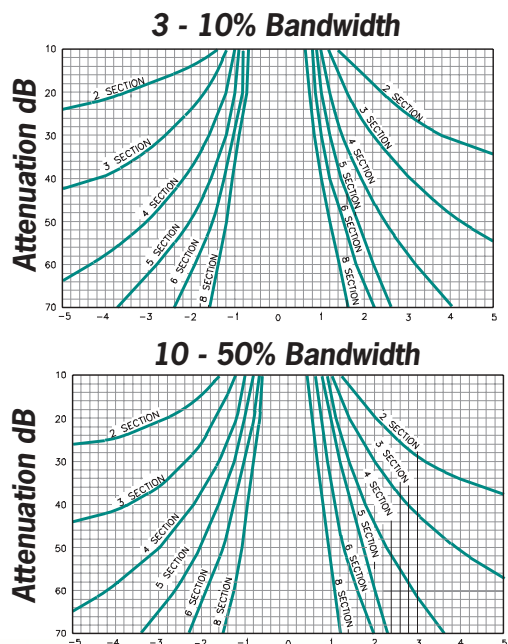
Knowing the number of sections, center frequency and bandwidth of the filter, insertion loss may be calculated using the following formula:

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

Example:

4BC - 1000/150-S

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



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.

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
6. Output Connector
(if different from input)

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

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



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 stopband 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:

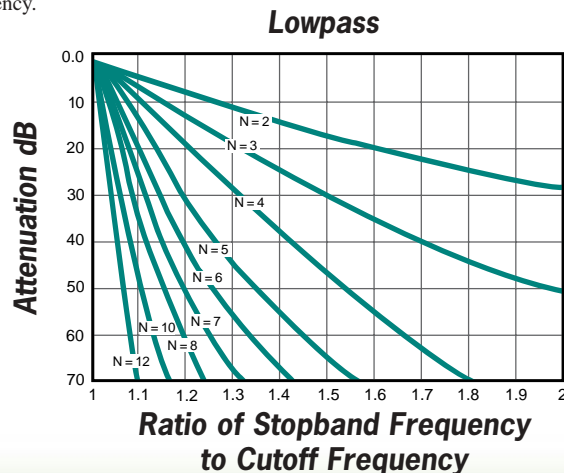
$$\text{Loss} = N \times 0.2$$

Example:

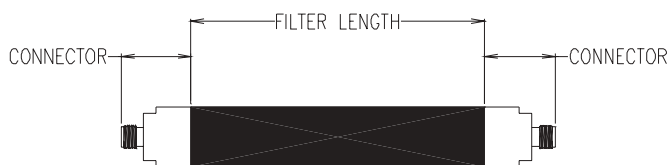
4LC - 650-S

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.



Tubular Filters — 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 Code	.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)

# 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

BD - Filter Length vs. Frequency (MHz)

# 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

BC - Filter Length vs. Frequency (MHz)

# 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

BE - Filter Length vs. Frequency (MHz)

# 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.

Tubular Filters — Dimensions

LA - Filter Length vs. Frequency (MHz)

# of Sections	300-600	600-1000	1000-1300	1300-1700	1700-2300	2300-3000	3000-5000	5000-20000
2	.65	.55	.40	.50	.45	4.0	4.0	
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)

# 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)

# 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)

Number 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.

