3-Resonator Capacitively Coupled LC Band-Pass Filters

K 24 D 05
K 24 D 06

Design

This filter structure avoids the parallel resonant coupling circuits which result from the standard low-pass to band-pass transformation procedure as described in most texts. A step by step design procedure will be found in "Microwave Filters, Impedance Matching Circuits and Coupling Structures" by Matthaie, Young and Jones. (Artech House)

The order of this filter is equal to the number of shunt resonators. In general, filter orders greater than 3 are difficult to tune and best avoided.

For the special case of 50 Ohm terminations, 10 % bandwidth and a few particular response types, the element values for a given cut-off frequency are tabulated in Appendix 2. Element values for frequencies not listed in the tables may be found by simply scaling listed values with frequency.

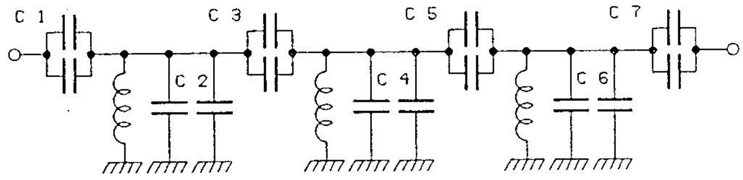
Successful performance requires inductors of suitably low loss, giving individual resonator unloaded Q values at least an order of magnitude greater than the Q required of the overall filter. Usually this demands the use of air-cored inductors for frequencies above 100 MHz or so. Physically deforming these inductors enables the filter to be tuned.

This type of filter is practical up to frequencies approaching 1 GHz. At such frequencies it is desireable to use high quality ceramic capacitors rather than the usual chip types.

PCB Versions

The two PCB versions together with the various input and output port locations provide a high degree of versatility in the application of this filter.

Circuit Diagram



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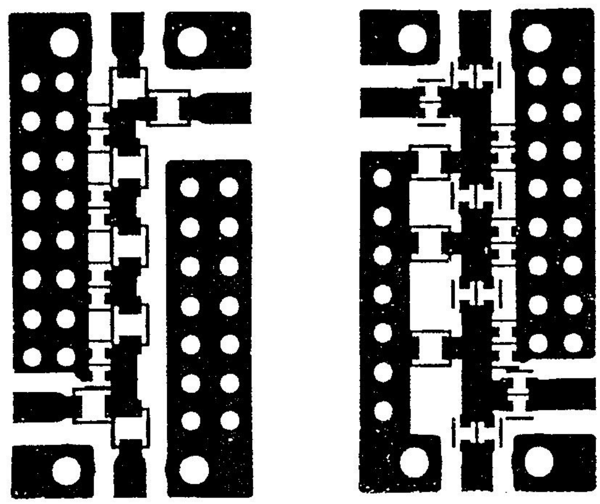
Component Placement (1.4 x Full-Size)



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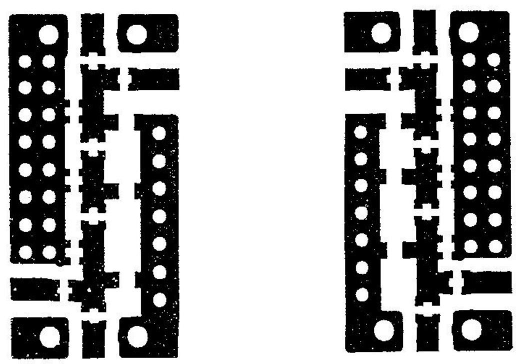
Track Patterns (Full-Size)



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Design Tables for 3-Pole Capacitively Coupled Band-Pass LC Ladder Filters

1 dB Tchebyscheff Response

This table lists element values for the filter shown opposite against centre frequency for the special case of 10% bandwidth and 50 Ohm source and load resistances. Values are tabulated for the Tchebyscheff Response function with 1 dB pass-band ripple.

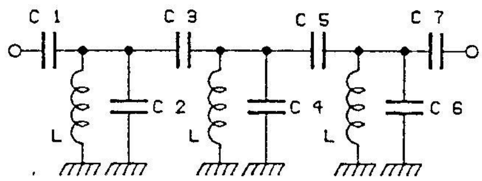
The bandwidth is defined as being between the upper and lower –1 dB ripple frequencies.

Element values for frequencies lying between those tabulated may be obtained to a reasonable degree of accuracy by linear interpolation.

Values for other terminations and response functions may be calculated by referring to the reference given on page 2.0.

Each filter has been designed for a resistance level of around 300 Ohms before adjusting the end sections to provide matching into 50 Ohms.

Circuit Diagram



Centre Freq. fc (MHz)	L (nH)	C1 = C7 (pF)	C3 = C5 (pF)	C2 = C6 (pF)	C4 (pF)
10	220	142	81	954	991
15	150	94	53	621	646
20	100	76	45	538	545
25	82	60	35	412	426
30	68	50	29	345	356
40	56	35	20	234	243
50	39	31	18	217	234
60	33	25	15	178	184
70	27	22	14	160	160
80	27	18	10	122	126
90	22	17	10	119	122
100	22	14	8.2	95	99
150	15	9.4	5.31	62	65
200	10	7.6	4.48	53	54
250	8.2	6.0	3.50	41	43
300	6.8	5.0	2.93	35	36
350	5.6	3.5	2.00	23	24
400	5.6	4.4	2.61	31	32
450	4.7	3.2	1.88	22	23
500	3.9	3.1	1.84	22	22

Basic Feedback Pair

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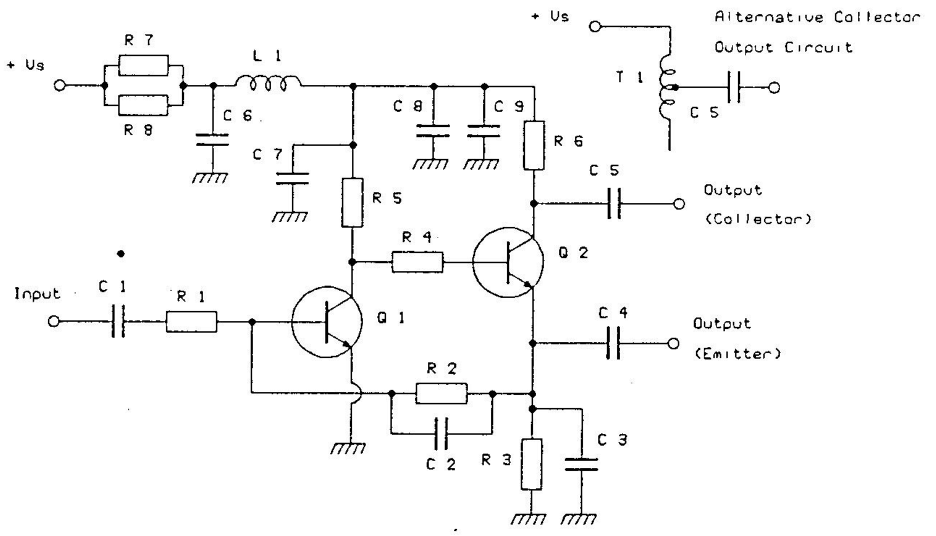
Design

This circuit is based on a high gain inverting amplifier consisting of common emitter stage Q 1 followed by emitter follower Q 2. The common emitter stage is operated with no emitter degeneration, Q 1 emitter being directly grounded.

Resistors R 1 and R 2 provide feedback in a similar manner to that employed in an inverting operational amplifier circuit. This results in a constant and stable gain over a wide bandwidth.

Circuit Diagram



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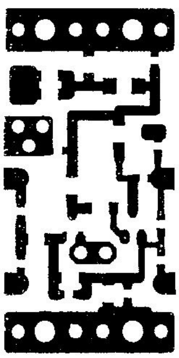
The gain from the input to Q 2 emitter is given by R 2 / R 1. A useful measure of additional gain may be obtained by taking the output from a load inserted in Q 2 collector circuit, in which case the gain becomes (R 6 / R 3) x (R 2 / R 1). Driving the load through autotransformer T 1 is beneficial when a low value of load such as 50 Ohms must be driven. Assuming a 2:1 step-down ratio, the 50 Ohm load appears in Q2 collector as 200 Ohms, increasing the gain by 4 x relative to 50 Ohms. The step-down ratio, however, reduces the net increase in gain to 2 x or 6 dB. For broadband performance, T1 should be made a transmission line or “Ruthroff” transformer consisting of a twisted wire line on a small toroidal core.

The feedback pair provides a simple low noise amplifier design capable of 20 to 30 dB of gain over a few hundred MHz of bandwidth. The frequency response may be optimised by choice of C2 and C3.

Care should be taken to remember that the signal source impedance forms part of the feedback network, hence instability may result under certain source conditions.

Track Pattern (Full-Size)



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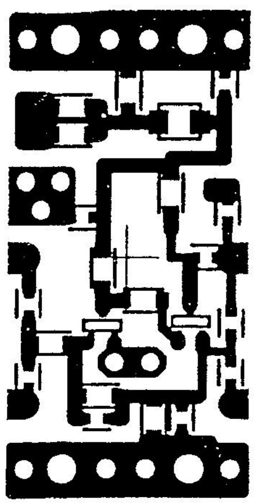
Component Placement (1.4 x Full-Size)



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