

Butterworth and Chebyshev crystal ladder filter calculator, Dan Halbert, KB1RT

See May 1982 QST, "A unified approach to the design of crystal ladder filters", by Wes H  
 This spreadsheet is initially loaded with data from the example in that article.

The May 1982 QST article has one typo in it, for Butterworth N=4, k\_23. The correct value

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To use, fill in the crystal and filter characteristics in the cells below pointed to by "=="

Given crystal characteristics

- ==> 294 delta\_f (Hz): crystal bandwidth ==>
- ==> 23 R\_s (ohms): crystal series-loss resistance ==>
- ==> 3.577 F\_0 (MHz): crystal center frequency
- 5 C\_p (assumption, not used in these calculations)

Calculated crystal characteristics

N= number of filter sections

- 63478.261 Q\_u: unloaded Q
- 3.0468633E-14 C\_m (F) value is possible with the given characteristics
- 0.064965986 L\_m (H)

Calculated Butterworth crystal filter component values (R in ohms, C in pF)

N	R_end	C_end	C_12	C_23	C_34
2	49.2	384.3	606.5		
3	79.0	269.9	606.5	606.5	
4	110.3	195.4	508.4	795.5	508.4
5	142.1	136.8	425.9	774.2	774.2
6	174.1	80.6	363.0	710.6	832.2
7	206.3	Err:502	314.8	643.5	817.5
8	238.5	Err:502	277.1	582.6	777.3

Calculated Chebyshev 0.1 dB ripple crystal filter component values (R in ohms, C in pF)

N	R_end	C_end	C_12	C_23	C_34
2	39.3	444.5	603.5		
3	48.2	389.3	648.7	648.7	
4	52.9	365.8	626.4	794.2	626.4
5	55.4	354.0	610.3	804.1	804.1
6	56.9	347.4	600.1	799.6	831.6
7	57.9	343.2	593.6	794.2	835.7

8	58.5	340.5	589.2	789.8	834.9
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Butterworth filter tables (do not change) (These tables are from Zverev's Handbook of Filt

N	q	k_12	k_23	k_34
2	1.4142	0.7071		
3	1.0000	0.7071	0.7071	
4	0.7654	0.8409	0.5412	0.8409
5	0.6180	1.0000	0.5559	0.5559
6	0.5176	1.1688	0.6050	0.5176
7	0.4450	1.3424	0.6671	0.5268
8	0.3902	1.5187	0.7357	0.5537

Chebyshev 0.1 dB ripple filter tables (do not change)

N	q	k_12	k_23	k_34
2	1.6382	0.7106		
3	1.4328	0.6618	0.6618	
4	1.3451	0.6850	0.5421	0.6850
5	1.3013	0.7028	0.5355	0.5355
6	1.2767	0.7145	0.5385	0.5180
7	1.2615	0.7223	0.5421	0.5155
8	1.2515	0.7276	0.5451	0.5160

ayward, W7ZOI, p. 21.

ie is used here.

#### Required filter characteristics

250 filter\_bw (Hz): filter bandwidth

200 R\_0 (must be greater than R\_end)

C_45	C_56	C_67	C_78
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425.9			
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710.6			
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	363.0		
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817.5			
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	643.5		
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		314.8	
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845.1			
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	777.3		
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		582.6	
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			277.1
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C_45	C_56	C_67	C_78
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610.3			
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799.6			
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	600.1		
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835.7			
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	794.2		
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		593.6	
--	--	-------	--

844.8	834.9	789.8	589.2
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er Synthesis)

k_45	k_56	k_67	k_78
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1.0000

0.6050

0.5268

0.5098

1.1688

0.6671

0.5537

1.3424

0.7357

1.5187

k\_45

k\_56

k\_67

k\_78

0.7028

0.5385

0.5155

0.5100

0.7145

0.5421

0.5160

0.7223

0.5451

0.7276