

Four-Way, Second-Order Crossover

****Optimal Crossover****

The four-way, second-order crossover is arguably one of the most effective crossover types.

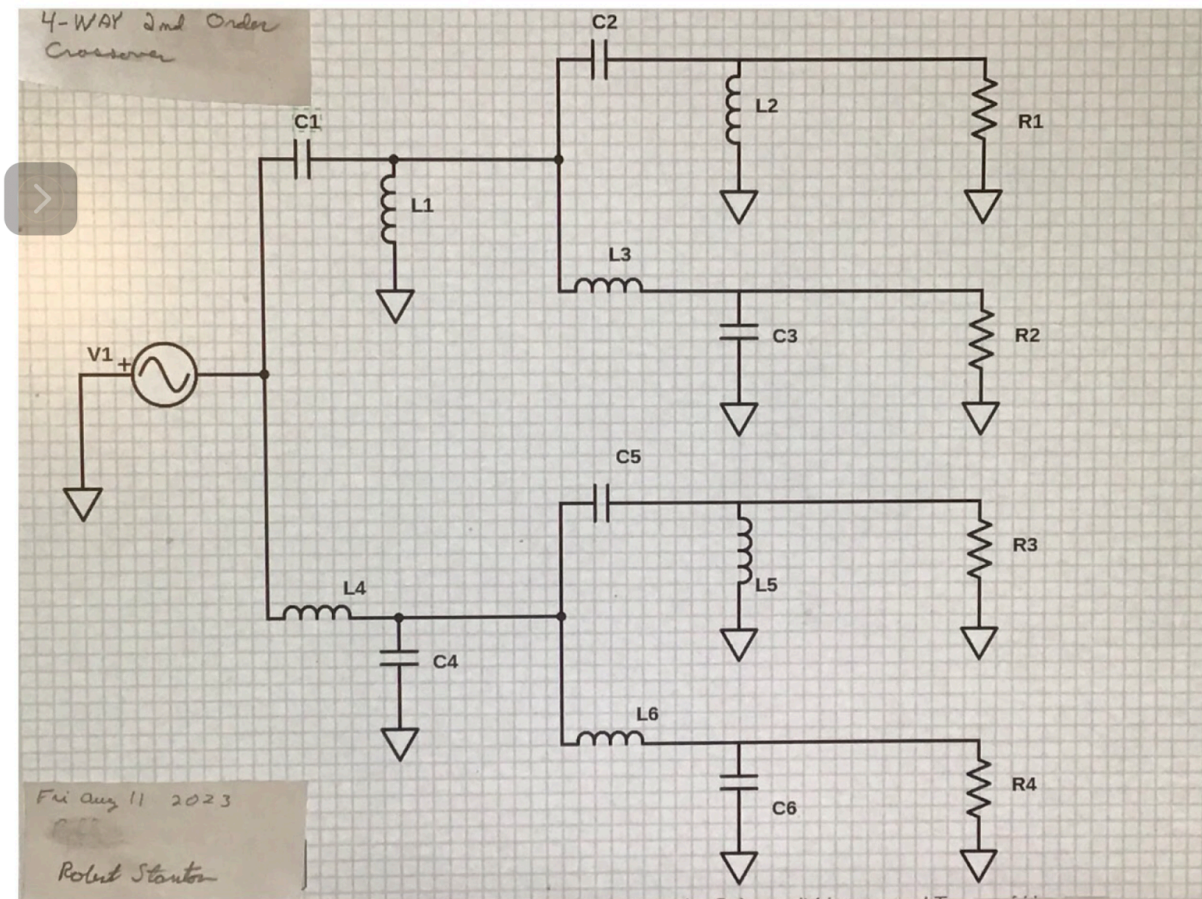
This design aims for the flattest possible frequency response. It has an S11 (input reflection coefficient) that exceeds 38 dB and accurate phase matching of the drivers, giving it a flat frequency response.

****The Speaker Architect****

Some DIY audio enthusiasts lack access to sophisticated computer-aided design (CAD) software required to create precision crossovers customized for particular drivers. A resourceful speaker builder can still construct an exceptional four-way speaker system by starting with an ideal crossover and selecting drivers and equalization networks to align with this crossover.

This inverted methodology presents greater challenges than contemporary practices, where digital tools automatically optimize crossover networks around existing driver specifications. By prioritizing the ideal crossover as the foundation, the builder can achieve excellent results.

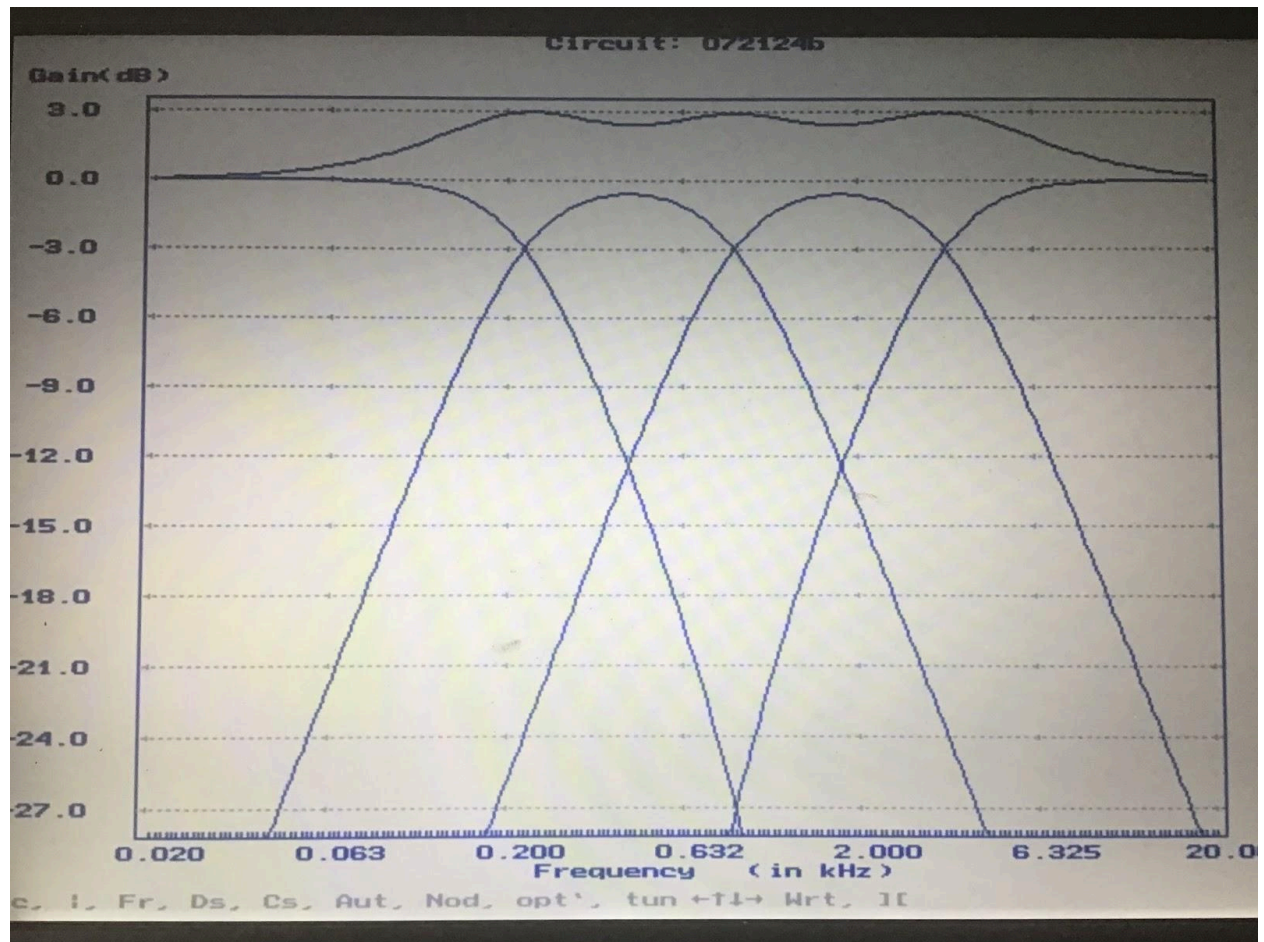
****Schematic****



Please note that speakers R1 and R3 must be phase-inverted.

- | | | |
|-------------------|-------------|-------------|
| - C1 = 16 μ F | L1 = 2.0 mH | R1 = 8 Ohms |
| - C2 = 4 μ F | L2 = 0.5 mH | R2 = 8 Ohms |
| - C3 = 4 μ F | L3 = 0.5 mH | R3 = 8 Ohms |
| - C4 = 16 μ F | L4 = 2.0 mH | R4 = 8 Ohms |
| - C5 = 64 μ F | L5 = 8.0 mH | |
| - C6 = 64 μ F | L6 = 8.0 mH | |

****Frequency Response****



****The top curve represents SPL (Sound Pressure Level)**..**

****Frequency Bands and Rolloff Rates****

- 20 Hz to 220 Hz: 12 dB per octave
- 220 Hz to 880 Hz: 12 dB per octave
- 880 Hz to 3520 Hz: 12 dB per octave
- 3520 Hz to 20 kHz: 12 dB per octave

****SPL Response, Group Delay, Input Impedance, Data****

Frequency		Volts (at node11)	Phase deg.	Gain db	Delay usec	Z (in)		
						R	+ -	J
20.00	Hz	1.0028	-9.0	0.02		7.997	-j	0.029
28.25	Hz	1.0101	-12.8	0.09	1265.3	7.995	-j	0.041
39.91	Hz	1.0247	-18.2	0.21	1279.8	7.990	-j	0.058
56.37	Hz	1.0534	-25.9	0.45	1307.5	7.976	-j	0.079
79.62	Hz	1.1079	-37.3	0.89	1358.1	7.948	-j	0.102
112.5	Hz	1.2025	-54.3	1.60	1439.2	7.897	-j	0.112
158.9	Hz	1.3304	-79.7	2.48	1522.1	7.831	-j	0.073
224.4	Hz	1.4081	-114.2	2.97	1463.0	7.827	+j	0.025
317.0	Hz	1.3689	-152.2	2.73	1140.6	7.924	+j	0.067
447.7	Hz	1.3256	170.8	2.45	784.77	7.991	-j	0.010
632.5	Hz	1.3586	132.3	2.66	578.97	7.931	-j	0.093
893.4	Hz	1.3985	89.6	2.91	454.85	7.838	-j	0.034
1262	Hz	1.3592	46.9	2.67	322.09	7.900	+j	0.055
1783	Hz	1.3257	8.4	2.45	205.45	7.988	+j	0.003
2518	Hz	1.3676	-28.5	2.72	139.35	7.958	-j	0.093
3557	Hz	1.4055	-66.4	2.96	101.24	7.852	-j	0.094
5024	Hz	1.3290	-100.7	2.47	64.984	7.816	-j	0.003
7096	Hz	1.2027	-126.0	1.60	33.899	7.859	+j	0.059
10.02	kHz	1.1089	-142.9	0.90	16.073	7.910	+j	0.071
14.16	kHz	1.0545	-154.3	0.46	7.6003	7.945	+j	0.063
20.00	kHz	1.0257	-162.0	0.22	3.6652	7.966	+j	0.050

The data in the fourth column is the Sound Pressure Level (SPL). You will observe a 3 dB increase in Sound Pressure Level within the midband range.

Sound Pressure Level

It's important to recognize that it is not feasible to achieve a flat SPL response while keeping a flat Sound Power Output. If you were to retune this crossover for a nearly flat SPL response, you will face an undesirable 3 dB power dip at the three crossover frequencies.

Theoretical Crossover

It is important to point out that it is only a theoretical crossover.

Physical Crossover

The cost of components is quite high. With twelve components priced at around ten to eleven dollars each, the total comes to approximately \$130. There may be additional components if Zobel equalizers are needed.

This crossover is exactly optimized for the standard component values shown. That should make it easier for success in transforming this theoretical concept into a functional reality. Good luck.