JBL 4300 Series
Charge-Coupled Crossover
User Manual

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Introduction

Thank you for your purchase of Echo Mountain Audio's charge-coupled crossover boards for the JBL 4300 series of studio monitors. The set of bare boards you have received are intended for DIY build and integration into your existing 4300 series monitor setup.

The scope of this user manual is to, as succinctly as possible, guide the build of the PCBs with the specific parts list for the model in question, and provide instructions for the connectivity of the boards to the loudspeaker system with the proper polarity.

The parts list for the finished crossovers consists of high-quality metallized polypropylene capacitors, air-core inductors, and non-inductive wirewound resistors. Due to the large size of these modern, high-performance components and the board space required to accommodate them, the boards are not physically a 'plug-and-play' replacement for the factory crossovers. Custom mounting or external enclosures will be required.

Any comments, questions, technical support requests, etc. are welcomed and encouraged, and can be sent to echomountainaudio@gmail.com.

Supported Models

The models supported by this crossover system are listed below. Any models not found in the list below are not supported.

- 4315A/4315B
- 4340*
- 4341
- 4343/4343B
- 4344
- 4345
- 4350/4350B*
- 4355*

Note: models above marked with an asterisk are bi-amp only systems. See Hardware Overview section for more details.

The Charge-Coupled Topology

The "charge-coupling" technique was first employed on JBL's K2 S5500 loudspeaker system by Chief Engineer Greg Timbers and was used subsequently on all high-end JBL Synthesis models, including the top-of-the-line Everest DD66000. The technique involves replacing a given capacitor in a crossover topology with two series capacitors of twice that value (this series combination is equivalent to the original value), with a DC bias injected between the two capacitors through a large value resistor. This DC-biased topology mitigates the effects of dielectric absorption and the distortion associated with a change in the direction of current as the input signal transitions from positive to negative (i.e., zero crossing). The theory of operation is explained in detail in the following excerpts from the K2 S5500 product overview:

http://www.lansingheritage.org/images/jbl/specs/home-speakers/1993-k2-s5500/page10.jpg
http://www.lansingheritage.org/images/jbl/specs/home-speakers/1993-k2-s5500/page11.jpg
https://www.lansingheritage.org/images/jbl/specs/home-speakers/1993-k2-s5500/page12.jpg

In 2006, Greg Timbers (who also designed the 4343, 4345, 4355, and many other legendary JBL systems) made a post on the Lansing Heritage audio forums about modifications he would pursue on the 4345 and other similar legacy 4-way systems, including the charge-coupled modification:

https://www.audioheritage.org/vbulletin/showthread.php?10490-The-JBL-4345-Club&p=110075&viewfull=1#post110075

This led to many DIY efforts, mostly hand-wired, to bring the charge-coupled topology to the 4345 system over the years. Echo Mountain Audio's goal with this product is to carry this effort forward and produce a set of high-quality printed circuit boards that allow users to upgrade a wide variety of legacy JBL 4-way systems with this modern topology, without the hassle of hand-wiring.

Hardware Overview

The JBL 4300 series charge-coupled crossover system consists of two boards: a 'Main' board, shown in Figure 1, which contains filters for the mid-frequency (MF), high-frequency (HF), and ultra-high-frequency (UHF) drivers, and an 'Auxiliary' (Aux) board, shown in Figure 2, that contains filters for the MF and low-frequency (LF) drivers.

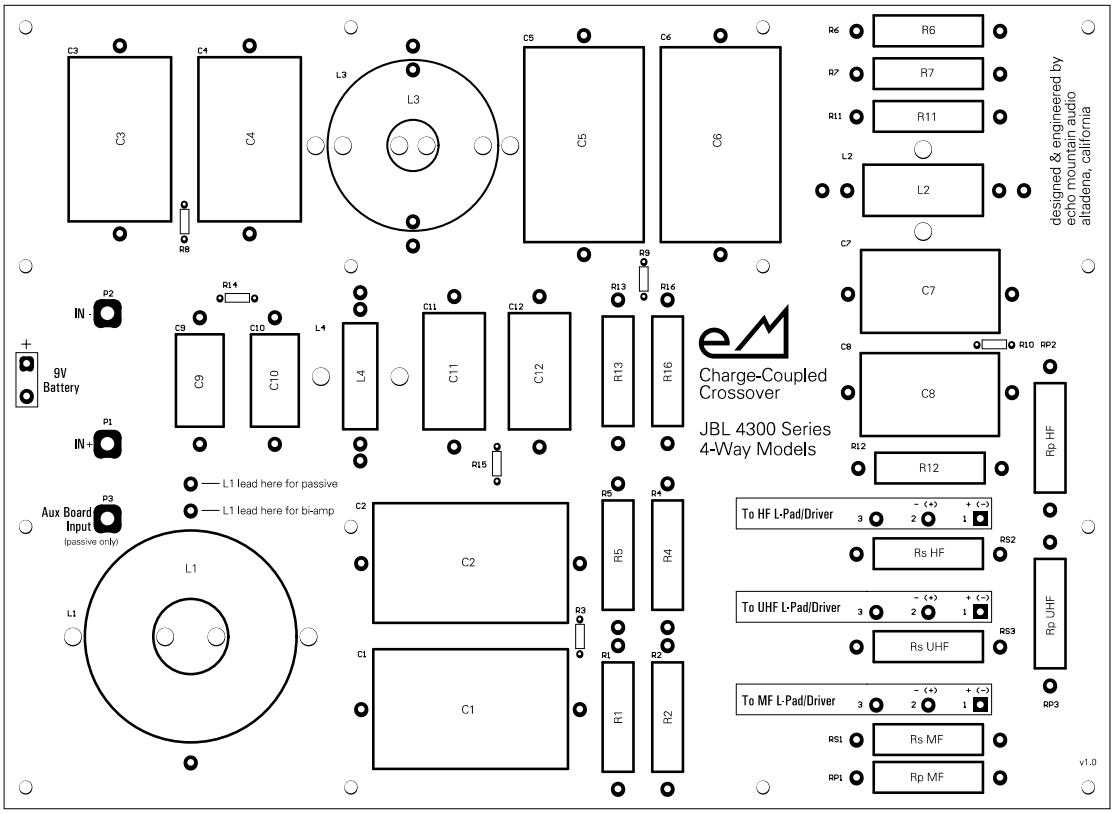

Figure 1: Main Board (top view)

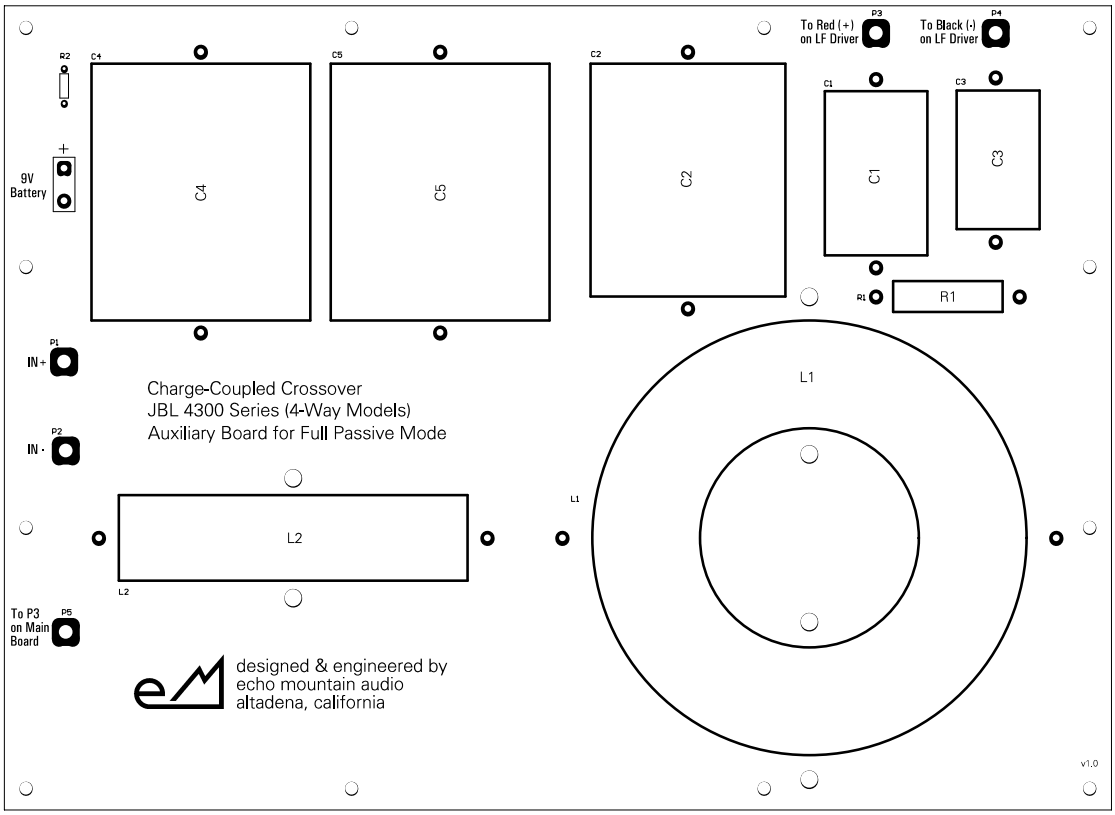

Figure 2: Auxiliary (Aux) Board (top view)

Parts Information

Detailed parts lists for all supported system configurations can be found in Appendix A (Main Board) and Appendix B (Aux Board).

Note that the tables shown each represent the parts required for a single channel (i.e., one board). Once you've entered all the parts from the table into the vendor website when creating an order, you will need to double the quantities to have the total number of parts required for four boards. Also note that if pursuing a bi-amp configuration, only the parts on the Main boards are needed, since the Aux board is not used for bi-amping. In order to have full passive capability (via jumpered connections; details to follow), procure all the parts and populate both pairs of boards per the instructions in the subsequent sections.

While some system configurations make use of all the part footprints on the board, others use a reduced set of parts as indicated by two markings in the Component Value column:

- "DNI" – Do Not Install
- "(short)" – indicates that this part's leads should be shorted with a length of wire. For example, in the case of the 4355 system, Main Board component R1's value is listed as "short;" therefore, a short length of wire should be soldered between the two pads on footprint R1 on the PCB.

The footprints on the boards have been sized to accommodate the parts shown in the tables. Parts of the same type and rating from other manufacturers may be substituted at the user's discretion, but it is the responsibility of the user to measure the board footprints and ensure a proper fit, as well as ensuring that any user-substituted parts are properly rated for the application. Echo Mountain Audio does not support or provide specific info on custom or user-selected parts that are not on the official parts list.

Board Assembly and Integration

Once parts have been procured, follow the steps in this section to assemble the Main boards and integrate them into your system. Note that details about mounting of the boards into the speakers or custom enclosures are not included and are left to the user's discretion; as previously mentioned, the boards require custom mounting and do not make use of the stock mounting features on any of the supported loudspeaker systems.

Main Board Assembly

1. Solder all parts to the Main Boards according to the parts list in Appendix A.
   Note: holes in the inductor footprints are included for placing zip-ties to secure the coils tightly to the board in two places each. If mounting the boards vertically, consider using hot glue to stake the inductors and capacitors in place as well.
2. If you are using the boards in a bi-amp configuration, be sure to insert the lead on the top side of inductor L1 into the plated through-hole (PTH) marked "L1 lead here for bi-amp." For full passive configurations, insert the lead on the top side of L1 into the PTH marked "L1 lead here for passive." These two features of the board are outlined in blue in Figure 3 and Figure 5.
3. If you are installing the boards into a bi-amp system, skip ahead to the Main Board Integration steps. If installing into a full passive system, proceed to the Aux Board Assembly steps.

Aux Board Assembly

1. Solder all parts to the Aux Boards according to the parts list in Appendix B. See notes above about the use of zip ties, etc.
2. Proceed to the subsequent integration steps in order to connect the Aux Board and Main Board for full passive mode and integrate into the system.

Main Board Integration

1. Connect the 9V battery holder to the terminals on footprint BT1 (labeled '9V Battery'). Ensure the positive lead from the battery holder connects to the pad marked "+".
2. Solder speaker wire to the "IN+" and "IN-" PCB terminals, and connect these wires to the positive and negative output terminals of the amplifier (actual cable path is user's choice – through connectors to speaker cables, etc.). This amplifier will either be the high-frequency amp in a bi-amped configuration (see Figure 3), or the single amp in a full passive configuration (see Figure 5).

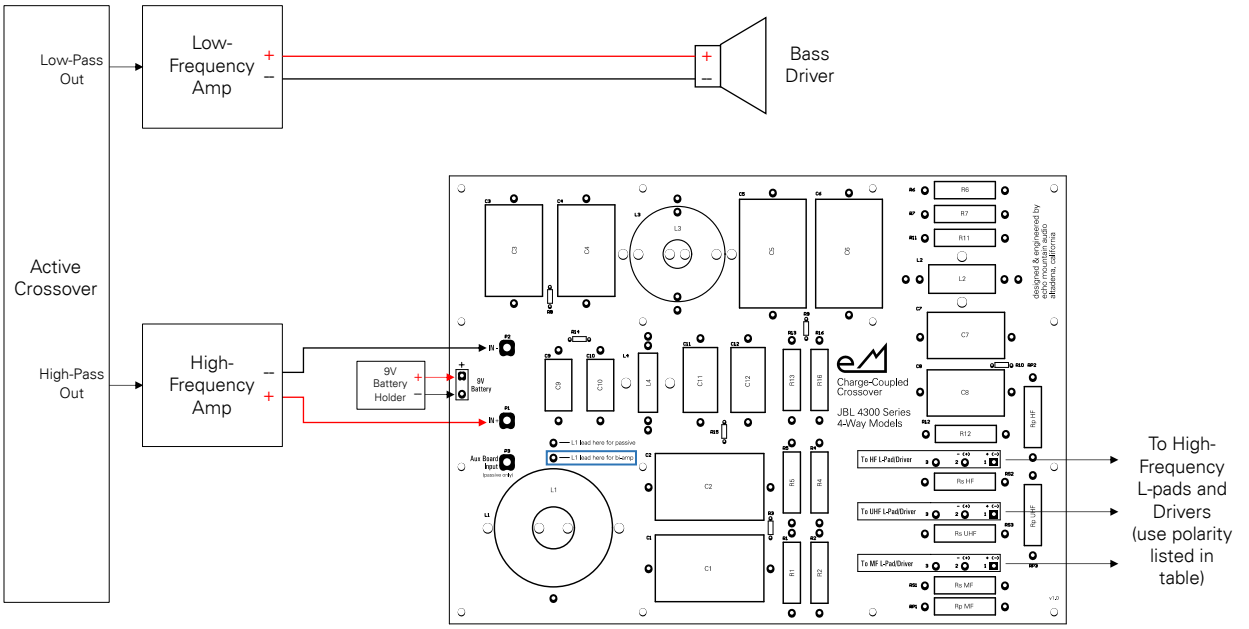

Figure 3: Bi-amp configuration diagram (single channel shown)

3. **[IMPORTANT STEP - Read carefully]** The next step is to connect the three sets of L-Pad/Driver terminals (MF, HF, UHF) to their respective L-Pads and/or drivers. The wires will need to connect from the board to the L-pad (if applicable), and then from the L-pad to the driver. This concept is illustrated in Figure 4, where the connections between the L-pad and speakers are represented with blue dotted lines. The connections between L-pad and the Main Board are one-to-one, as shown in the diagram (i.e. pad 1 on the board goes to L-pad pin 2, pad 2 on the board goes to L-pad pin 2, etc.). The blue dotted lines in the diagram between the L-pads and the driver are meant to signify the variable polarity required for different models of the supported loudspeaker systems. Use the table below to determine the proper polarity for your system. Note that the 4350 and 4355 models are special cases: the 4350 only has one L-pad (on the UHF driver), and the 4355 only has two L-pads (on the HF and UHF drivers). In these two cases, the polarity still needs to be followed per the table between the board and the drivers that do not use L-pads.

Model	Driver	L-Pad/PCB Terminal	Driver Terminal
4340, 4341, 4343, 4344, 4345	MF, UHF, HF	1	Red
		2	Black
4355	MF, UHF, HF	1	Black
		2	Red
4350	MF, UHF	1	Black
		2	Red
	HF	1	Red
		2	Black

4. In the case of a bi-amp system, the crossover boards have now been fully integrated in the system. The low-frequency amp can be connected to the bass driver as shown in Figure 3. If you are setting up a full passive system, proceed to the next section.

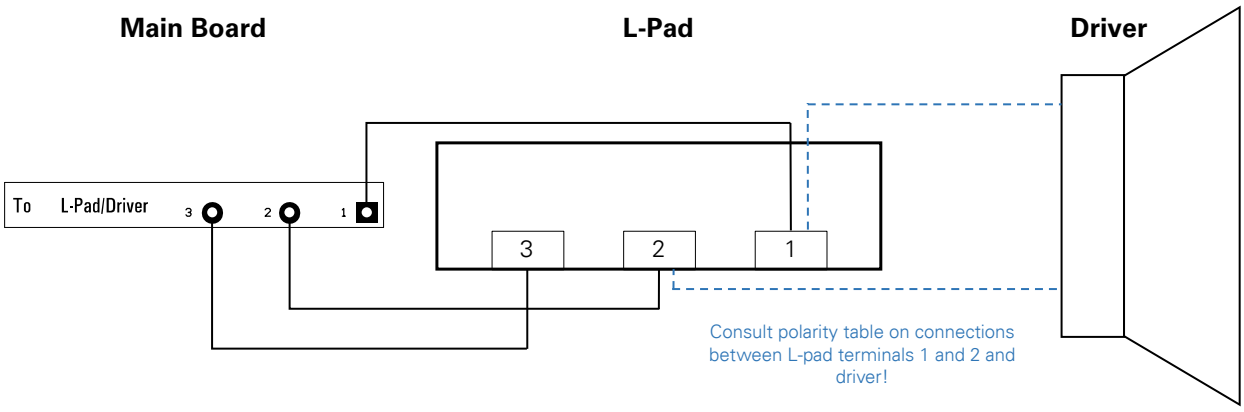

Figure 4: Connections from Main Board to L-Pad to Driver

Aux Board Integration

1. Connect the 9V battery holder to the terminals on footprint BT1 (labeled "9V Battery"). Ensure the positive lead from the battery holder connects to the pad marked "+". Note that the battery holder will now have two parallel connections: one to the Main Board, and one to the Aux Board.
2. Solder speaker wire to the "IN+" and "IN-" PCB terminals, and connect these wires to the positive and negative output terminals of the amplifier (actual cable path is user's choice – through connectors to speaker cables, etc.). This amplifier will either be the low-frequency amp in a bi-amped configuration, or the single amp in a full passive configuration. In a full passive configuration, the amplifier will now be connected in parallel to the inputs of the Main and Aux boards.
3. Solder a wire between P5 on the Aux Board (labeled "To P3 on Main Board") to P3 on the Main Board. Terminals P5 and P3 are sized to accommodate a variety of wire gauges; speaker wire is recommended.
4. Solder speaker wire from terminal P3 (labeled "To Red (+) on LF Driver") and connect the wire to the red terminal on the low-frequency driver.
5. Solder speaker wire from terminal P4 (labeled "To Black (-) on LF Driver") and connect the wire to the black terminal on the low-frequency driver.
6. At this point, the system should be configured for full passive operation.

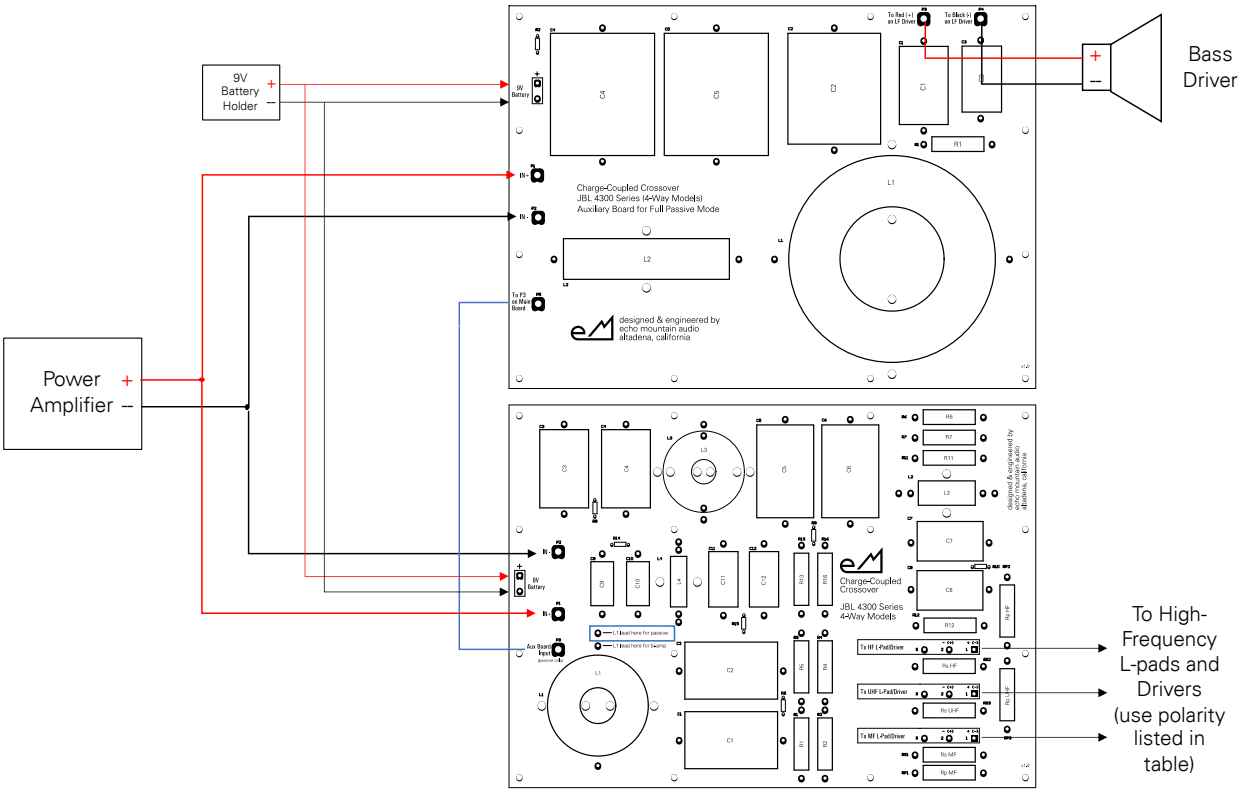

Figure 5: Full passive configuration diagram (single channel shown)

Additional Notes and Options

There is much information (and misinformation) published about the "reversed" polarity of JBL drivers on many of the online DIY audio forums. Like the factory JBL crossovers, the correct polarity convention is accounted for in the crossover PCB routing. If the directions in this manual are followed explicitly, audio signal will arrive at the drivers with the correct polarity.

Once the system is configured and working, and you have found a desired balance of the drivers with the L-pad knob settings, you have the option to replace the L-pads with fixed resistor attenuator pads; the footprints for these are marked 'Rs' and 'Rp' for the various drivers (MF, UHF, HF) on the board. To accomplish this, follow these steps:

1. Disconnect the L-pad from the system for a given driver.
2. With a multimeter set to resistance mode, measure the resistance between terminals 2 and 3 on the L-pad. This is the value of the series resistor Rs for the equivalent fixed resistor attenuator pad – note it down.
3. Measure the resistance between terminals 1 and 2 on the L-pad. This is the value of the parallel resistor Rp for the equivalent fixed attenuator pad – note it down.
4. Obtain the nearest standard resistor values for Rs and Rp using the same resistor type found in the parts list for the other power resistors (Mills 12W or equivalent) and install them in the proper locations on the board.
5. Repeat steps 1 through 4 for the remaining L-pads in the system.

Appendix A: Main Board Detailed Parts List

Component Designator	Component Value					Part Type	Rating	Manufacturer	Manufacturer Part Number					Vendor
	4315A/ 4315B	4340/4341/ 4343/4343B	4344/4345	4350/4350B	4355				4315A/ 4315B	4343/4343B	4344/4345	4350/4350B	4355	
C1	16 µF	36 µF	27 µF	36 µF	36 µF	Metallized PP	400 V	Solen	PB1600	PB3600	PB2700	PB3600	PB3600	Solen or Parts Express
C2	16 µF	36 µF	27 µF	36 µF	36 µF	Metallized PP	400 V		PB1600	PB3600	PB2700	PB3600	PB3600	
C3	16 µF	11 µF	12 µF	16 µF	16 µF	Metallized PP	400 V		PB1600	PB1100	PB1200	PB1600	PB1600	
C4	16 µF	20 µF	15 µF	16 µF	16 µF	Metallized PP	400 V		PB1600	PB2000	PB1500	PB1600	PB1600	
C5	(short)	33 µF	30 µF	(short)	(short)	Metallized PP	400 V		N/A	PB3300	PB3000	N/A	N/A	
C6	(short)	33 µF	30 µF	(short)	(short)	Metallized PP	400 V		N/A	PB3300	PB3000	N/A	N/A	
C7	3.0 µF	DNI	8.2 µF	DNI	3.3 µF	Metallized PP	400 V		PB300	N/A	PB820	N/A	PB330	
C8	3.0 µF	DNI	8.2 µF	DNI	3.3 µF	Metallized PP	400 V		PB300	N/A	PB820	N/A	PB330	
C9	2.2 µF	2.0 µF	2.0 µF	2.0 µF	2.0 µF	Metallized PP	400 V		PB220	PB200	PB200	PB200	PB200	
C10	2.2 µF	2.0 µF	2.0 µF	2.0 µF	2.0 µF	Metallized PP	400 V		PB220	PB200	PB200	PB200	PB200	
C11	2.7 µF	3.0 µF	3.9 µF	3.0 µF	3.6 µF	Metallized PP	400 V		PB270	PB300	PB390	PB300	PB360	
C12	3.0 µF	3.0 µF	4.3 µF	3.0 µF	3.6 µF	Metallized PP	400 V		PB300	PB300	PB430	PB300	PB360	
L1	1.2 mH	1.8 mH	1.8 mH	2.4 mH[1,2]	2.4 mH[1]	Air Core	500 W	Jantzen	000-1899	000-1484	000-1484	000-1802	000-1802	Parts Express
L2	0.37 mH	0.2 mH	0.3 mH	(short)	0.47 mH	Air Core	300 W		000-1117	000-1822	000-1313	N/A	000-1031	
L3	1.2 mH	0.8 mH	0.6 mH	1.75 mH[3]	1.0 mH	Air Core	200 W		000-1864	000-1394	000-1850	000-0819	000-1056	
L4	0.15 mH	0.15 mH	0.1 mH	0.15 mH	0.15 mH	Air Core	300 W		000-1130	000-1130	000-1002	000-1130	000-1130	
R1	(short)	8 Ω	5.1 Ω	(short)	(short)	Non-inductive WW	12 W	Mills / Vishay-Mills	No specific manufacturer part numbers listed on most vendor websites for the Mills parts. Search by power rating and value. * If replacing L-pads with fixed resistor attenuator pad, see Additional Notes and Options section for information on determining an equivalent value for series resistor Rs ** If replacing L-pads with fixed resistor attenuator pad, see Additional Notes and Options section for information on determining a value for parallel resistor value Rp					Sonic Craft or Parts Connexion
R2	(short)	8 Ω	5.1 Ω	(short)	(short)	Non-inductive WW	12 W	Mills / Vishay-Mills						
R3	2.2 MΩ	2.2 MΩ	2.2 MΩ	2.2 MΩ	2.2 MΩ	Metal Film	1/4 W	PRP or similar						
R4	39 Ω	68 Ω	39 Ω	DNI	DNI	Non-inductive WW	12 W	Mills / Vishay-Mills						
R5	39 Ω	68 Ω	39 Ω	DNI	DNI	Non-inductive WW	12 W	Mills / Vishay-Mills						
R6	(short)	14 Ω	6.2 Ω	20 Ω	8.2 Ω	Non-inductive WW	12 W	Mills / Vishay-Mills						
R7	(short)	14 Ω	6.2 Ω	20 Ω	8.2 Ω	Non-inductive WW	12 W	Mills / Vishay-Mills						
R8	2.2 MΩ	2.2 MΩ	2.2 MΩ	2.2 MΩ	2.2 MΩ	Metal Film	1/4 W	PRP or similar						
R9	DNI	2.2 MΩ	2.2 MΩ	DNI	DNI	Metal Film	1/4 W	PRP or similar						
R10	2.2 MΩ	DNI	2.2 MΩ	DNI	2.2 MΩ	Metal Film	1/4 W	PRP or similar						
R11	DNI	DNI	9.1 Ω	20 Ω	18 Ω	Non-inductive WW	12 W	Mills / Vishay-Mills						
R12	DNI	5.6 Ω	20 Ω	DNI	DNI	Non-inductive WW	12 W	Mills / Vishay-Mills						
R13	1.75 Ω	(short)	5.6 Ω	(short)	4.3 Ω	Non-inductive WW	12 W	Mills / Vishay-Mills						
R14	2.2 MΩ	2.2 MΩ	2.2 MΩ	2.2 MΩ	2.2 MΩ	Metal Film	1/4 W	PRP or similar						
R15	2.2 MΩ	2.2 MΩ	2.2 MΩ	2.2 MΩ	2.2 MΩ	Metal Film	1/4 W	PRP or similar						
R16	27 Ω	10 Ω	8.2 Ω	DNI	36 Ω	Non-inductive WW	12 W	Mills / Vishay-Mills						
RP1	**	**	**	DNI	DNI	Non-inductive WW	12 W	Mills / Vishay-Mills						
RP2	**	**	**	DNI	**	Non-inductive WW	12 W	Mills / Vishay-Mills						
RP3	**	**	**	**	**	Non-inductive WW	12 W	Mills / Vishay-Mills						
RS1	*	*	*	DNI	DNI	Non-inductive WW	12 W	Mills / Vishay-Mills						
RS2	*	*	*	DNI	*	Non-inductive WW	12 W	Mills / Vishay-Mills						
RS3	*	*	*	*	*	Non-inductive WW	12 W	Mills / Vishay-Mills						
LPAD1	16 Ω	8 Ω	8 Ω	DNI	DNI	Mono L-Pad	50 W	Dayton Audio or Similar	Search by impedance and power rating.					Parts Express
LPAD2	8 Ω	8 Ω	8 Ω	DNI	16 Ω	Mono L-Pad	50 W							
LPAD3	8 Ω	8 Ω	8 Ω	8 Ω	8 Ω	Mono L-Pad	50 W							

Note 1: The part number specified for this inductor is 2.7 mH (the ideal value of 2.4 mH is not a standard value). Inserting the 2.7 mH is acceptable and still will work properly, but unwinding the inductor until it measures 2.4 mH (with an LCR meter) and removing the excess wire will result in a slightly more accurate filter response.

Note 2: The 4350 used a special high-DCR coil in this inductor location. Add a 3.5 ohm resistor (Mills 12W) in series with one of the inductor leads to achieve the correct filter response.

Note 3: The 4350 used a special high-DCR coil in this inductor location. Add a 3.7 ohm resistor (Mills 12W) in series with one of the inductor leads to achieve the correct filter response.

Appendix B: Auxiliary Board Detailed Parts List

Component Designator	Component Value					Part Type	Rating	Manufacturer	Manufacturer Part Number					Vendor
	4315A/ 4315B	4341/4343/ 4343B	4344/4345	4350/4350B	4355				4315A/ 4315B	4343/4343B	4344/4345	4350/4350B	4355	
C1	20 µF	DNI	20 µF	Aux Board not used in these models		Metallized PP	400 V	Solen	PB2000	N/A	PB2000	Aux Board not used in these models		Solen or Parts Express
C2	68 µF	68 µF	82 µF			Metallized PP	400 V	Solen	PB6800	PB6800	PB8200			
C3	DNI	DNI	10 µF			Metallized PP	400 V	Solen	N/A	N/A	PB1000			
C4	100 µF	100 µF	120 µF			Metallized PP	400 V	Solen	PB10000	PB10000	PB12000			
C5	110 µF	100 µF	120 µF			Metallized PP	400 V	Solen	PB11000	PB10000	PB12000			
L1	3.9 mH	5.6 mH	5.6 mH			Air Core	500 W	Solen	S143.9	S125.6	S125.6			Solen
L2	2.2 mH	3.0 mH	4.7 mH			Air Core	500 W	Solen	S142.2	S143.0	S144.7			
R1	10 Ω	DNI	7.5 Ω			Non-inductive WW	12 W	Mills / Vishay-Mills	No specific manufacturer part numbers listed on most vendor websites. Search by power rating and value.					Sonic Craft or Parts Connexion
R2	2.2 MΩ	2.2 MΩ	2.2 MΩ			Metal Film	1/4 W	Mills / Vishay-Mills						