

K&K Audio

RAKK dac

Mark III

Raleigh Audio

Active Differential Output

Assembly and Installation Manual

Kit version

Use this manual with RAKK dac Mark III Active Output

- Power Board version 1.2, which is marked on the board.
- Output Board version 1.0 or 1.1, which is marked on the board.
- Main Board version 1.0 or 1.1, which is marked on the board.
- Parts level F

Required Tools and Supplies

150 to 250 Watt soldering gun
35 to 50 Watt soldering iron
Potentiometer adjustment tool (supplied)
Volt-Ohm-Milliamp Meter
1/16" hex (Allen) wrench (supplied)
5/64" hex (Allen) wrench (supplied)
Diagonal cutting pliers
Long-nose pliers
Wire stripper
Solder

Use the soldering gun only to solder the heatsink pins. Use the soldering iron for all other components.

Warnings and Cautions

Warning – This power supply contains high electrical voltage. Such high voltage is capable of causing injury or even death. If you are not experienced in working with high voltages, seek the assistance of someone who is.

Caution – Use only solder that is intended for electrical circuits. Do not use acid or corrosive flux of any kind.

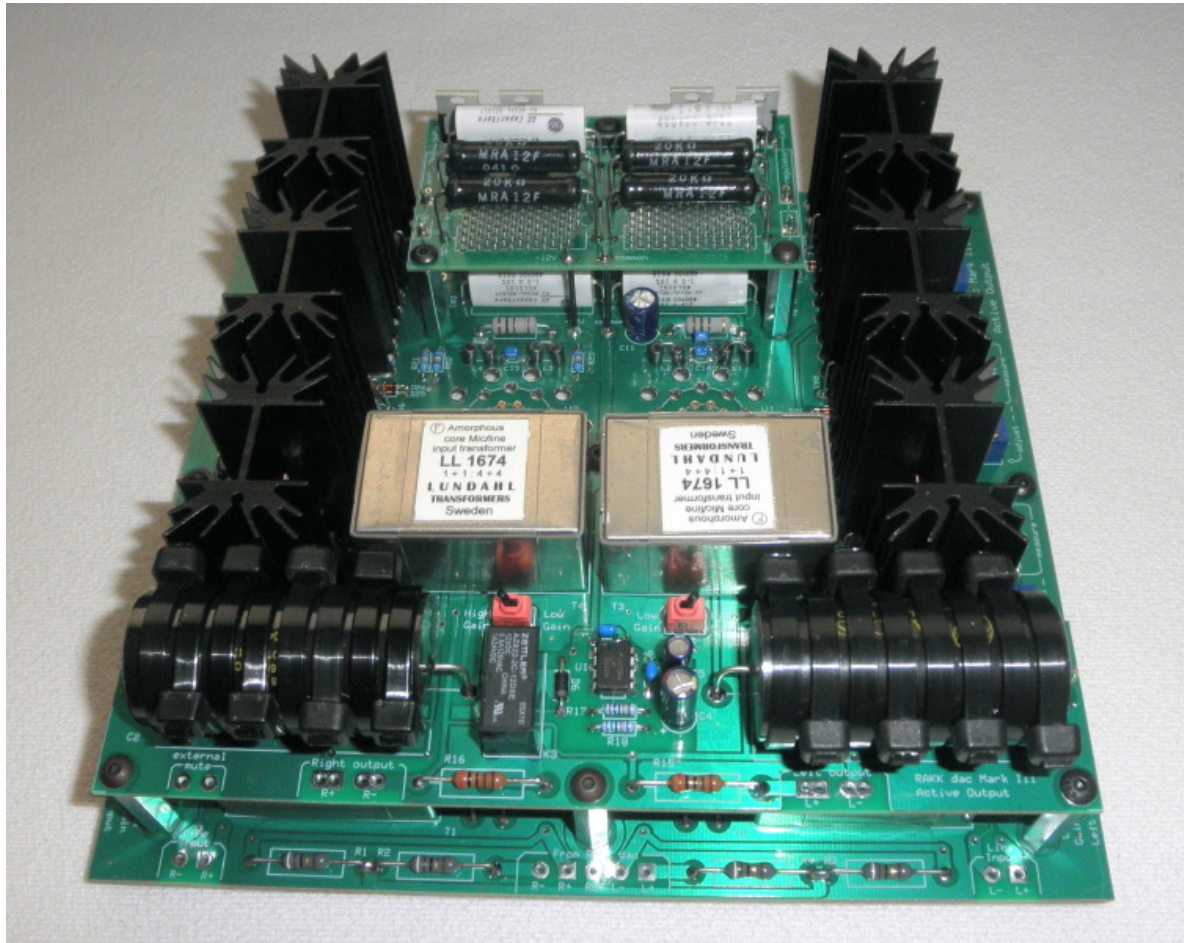
Support

RAKK dac and its associated components are produced through the joint cooperation of K&K Audio and Raleigh Audio. You may contact us with questions on constructing this kit by sending an e-mail message to david@raleighaudio.com or kevin@kandkaudio.com

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Assembly Instructions



In order to conserve area within a chassis, the Mark III Active Output has been partitioned into three parts, two of which are mounted on top of the third. The three parts of the Active Output are the main board, the output board and the power board. The power board and output board are mounted on the main board. You will first build the three boards and then assemble them together to complete the project. All of the components are mounted on the top of the boards, which have the components labeled with white silkscreen.

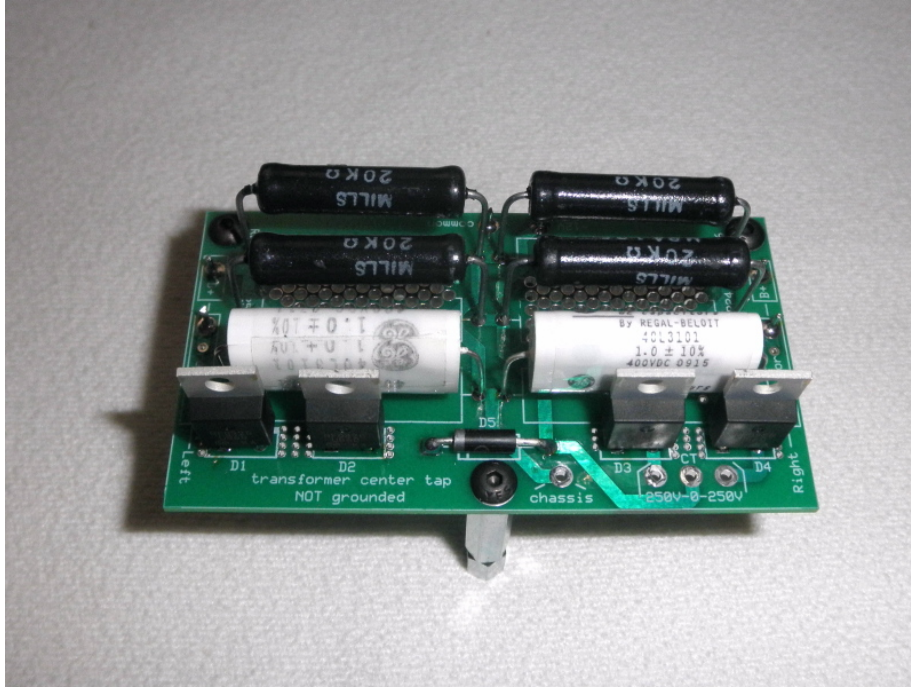
This kit may serve as an active output for the RAKK dac or line-level inputs. The main board has provisions for both types of inputs and while the circuitry for DAC support is always present, the input transformers to support line-level inputs are optional.

Before you start, read through the instructions completely to the end. Inventory the kit contents to become familiar with the parts and to make sure you have everything.

Steps preceded by a “note” (♫) deal with components which must be oriented properly.

Power Board Assembly

Locate the power board, which is the smallest of the three PC boards.



-
1. Install three 1" standoffs on the bottom of the board using 6-32 x 1/4" screws. The 1" standoffs were shipped mated with 3/8" standoffs to protect the threads. For now, leave the 3/8" standoffs in place.
-

TIP: you may find it convenient to solder the components with leads, like resistors and capacitors, from the top of the board.

♪

2. Insert the 1N5349B diode in location D5. Orient the diode such that the end of the diode with the stripe is closest to diode D2.

Solder and trim the leads.



3. Insert a MUR860 diode in the following four locations: D1, D2, D3 and D4. Orient the diodes such that the tabs are closest to capacitors C9 and C10.

Solder and trim the leads.

In the next two steps the components are raised off the board so as to be level with the tops of the diodes. This is not done for esthetics – rather it is done to facilitate ventilation which is important for cooling the components.

4. Insert a 1 μ F, 400V capacitor in the following two locations: C9 and C10. The capacitors should be raised off the board about $\frac{1}{8}$ " such that the top edge of the capacitors are level with the tops of diodes D1 – D4.

Raise the capacitors off the board $\frac{1}{8}$ " then solder and trim the leads.

5. Insert a 20K, 12W resistor in the following four locations: R24, R25, R26 and R27. The resistors should be raised off the board about $\frac{1}{2}$ " such that the top edge of the resistors are level with the tops of diodes D1-D4 and capacitors C9 and C10.

Raise the resistors off the board $\frac{1}{2}$ " then solder and trim the leads.

6. Cut six pieces of wire, each 1.375" long. 1.375" is the length of the two standoffs, which may be used as a gauge. Strip $\frac{1}{4}$ " of insulation from each end of the wires and tin the ends by melting a little solder onto the stripped ends.
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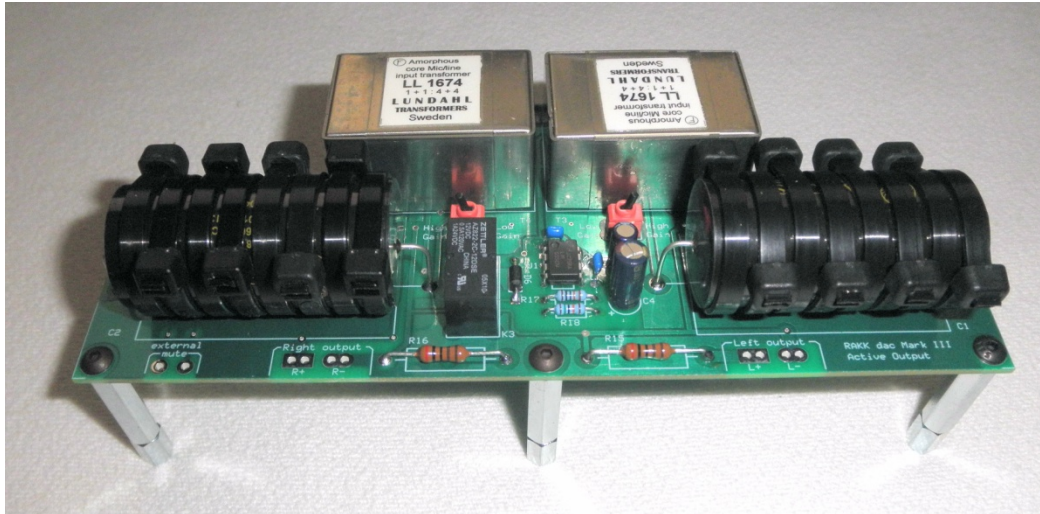
7. Insert the six wires from the bottom of the board into the following six locations:

- Right regulator
- Left regulator
- Right B+
- Left B+
- common
- -12V

Solder and trim the leads.

Output Board Assembly

Set the power board aside for now and locate the T-shaped output board.



-
1. Install six 1" standoffs with 3/8" standoffs on the bottom of the board using 6-32 x 1/4" screws.
-

2. Insert a 100K (brown, black, black, orange, brown) resistor in location R17.

Solder and trim the leads.

3. Insert a 150K (brown, green, black, orange, brown) resistor in location R18.

Solder and trim the leads.



4. Insert a 1N4007 (marked on body) diode in location D6. Orient the diode such that the end of the diode with the stripe is closest to resistor, R17.

Solder and trim the leads.

5. Insert a 2K (red, black, black, brown, brown) tantalum resistor in the following two locations: R15 and R16.

Solder and trim the leads.

TIP: When soldering a multi-pin component from the solder side of the board, first solder only one pin. Then pick up the board and holding the component, ensure that it is mounted straight while heating that one pin. Then solder the remaining pins.



6. Insert the LM555 timer in the location U1. Orient the timer such that the end of the timer with a notch is closest to capacitor C3.

Solder the leads.

7. Insert a 0.1 μ F (tiny blue) capacitor in each of the following two locations: C3 and C6.

Solder and trim the leads.

8. Insert a toggle switch in the following two locations: SW3 and SW4.

Solder the leads.



9. Insert the 1 μ F, 50V capacitor in location C5. Orient the capacitor such that the negative lead (marked on side) is closest to switch SW3.

Solder and trim the leads.

10. Insert a relay in location K3.

Solder the leads.



11. Insert the 180 μ F, 16V capacitor in location C4. Orient the capacitor such that the negative lead (marked on side) is closest to capacitor C1.

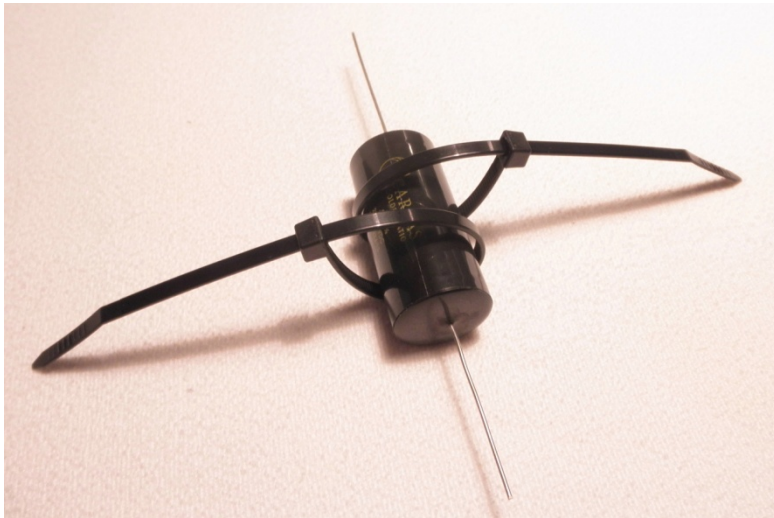
Solder and trim the leads.

12. Insert one of the LL1674 transformers in location T3.

Solder all of the transformer pins.

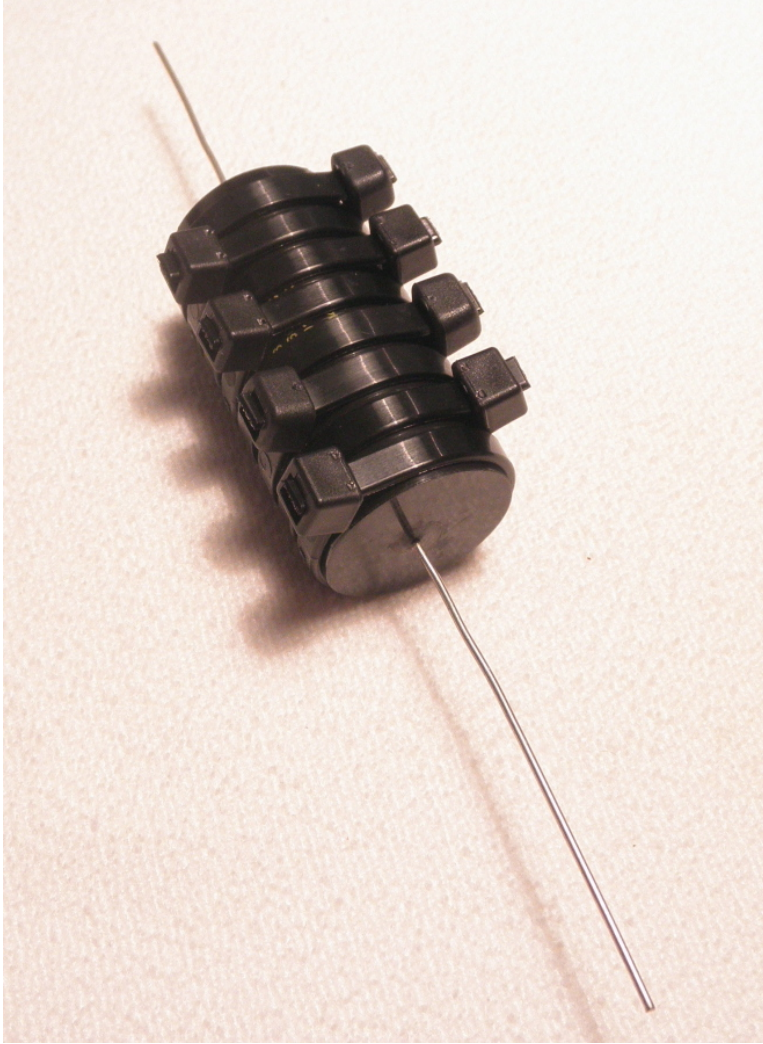
13. Insert the other LL1674 transformer in location T4.

Solder all of the transformer pins.



14. Wrap each of the 0.68 μ F, 600V (marked on body) Cardas capacitors with eight wire ties.

- Alternate the direction on alternate ties so that the wire tie ends do not interfere with each other.
 - Pull the wire ties moderately tight by hand and do not use a tool to tighten them. If a tie is too tight it will cut into the capacitor and cause an internal short circuit.
 - Think of tying a shoe – it should be snug enough so that it doesn't move easily on the foot, but not so tight as to cut off circulation. A tie should be tight enough so it will not move sideways easily, and loose enough so that you can rotate the tie without exerting much force.
-



15. Trim the ends of the wire ties.

16. Insert a $0.68\mu\text{F}$, 600V (marked on body) Cardas capacitor in the following two locations: C1 and C2.

Solder and trim the leads.

17. Prepare six, 1.375" long jumper wires as you did previously.

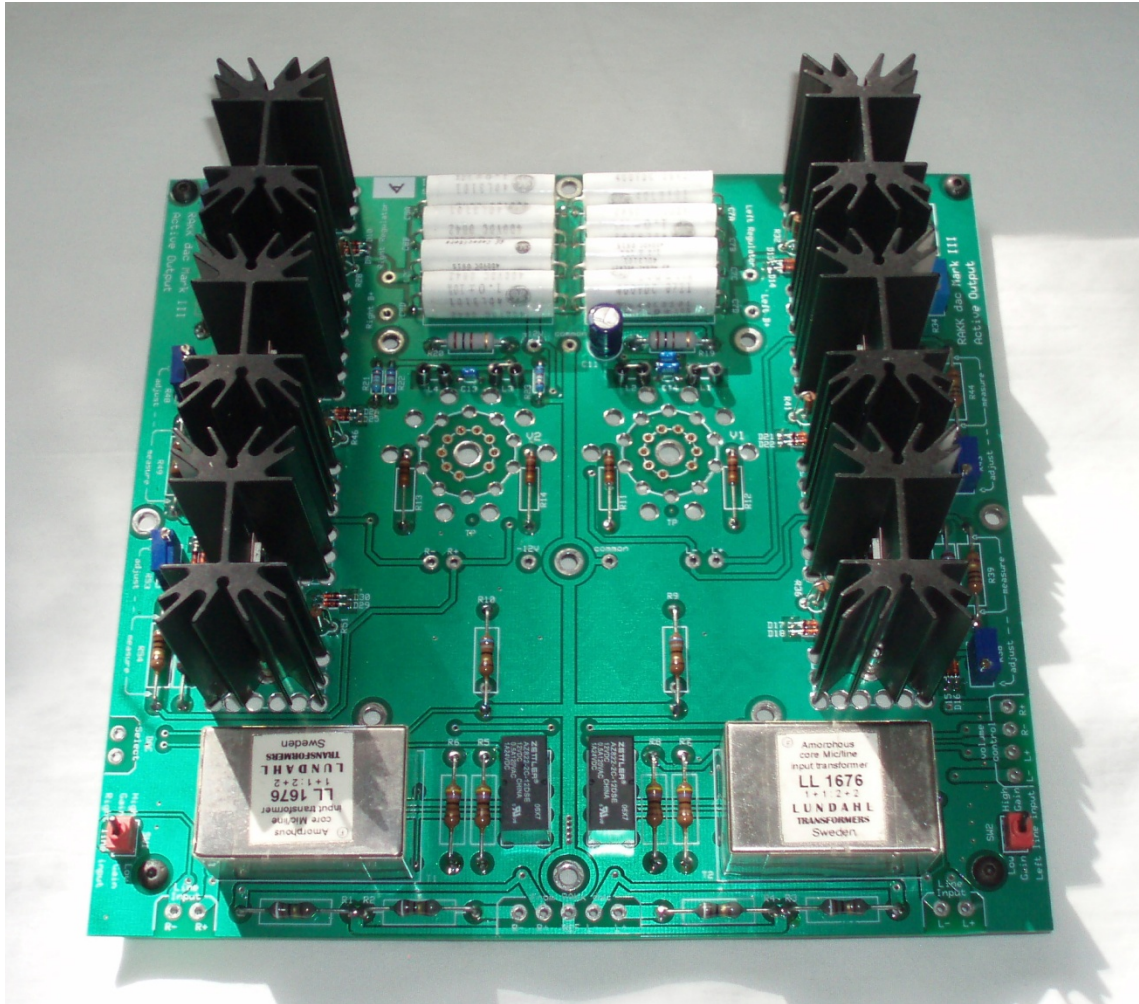
18. Insert the six wires from the bottom of the board into the following six locations:

- R+
- R-
- L+
- L-
- common
- -12V

Solder and trim the leads.

Main Board Assembly

Set the output board aside for now and locate the main PC board.



1. Install four 3/8" standoffs, one in each corner, on the bottom of the board using 6-32 x 1/4" screws.

In the following steps you will form tube sockets by installing the tube pin connectors. The connectors are designed such that when the tube is fully seated it is held a short distance above the board. There are two reasons for this arrangement: First, it allows for better ventilation and cooling of the tube. Second, it alleviates stress where the pins join with the glass, thus preventing hairline cracks that can damage the tube.

2. Insert a pin connector on each of the nine pins of tube V1.
-

3. Insert tube V1 with the connectors into its location. You might find it convenient to hold the tube in place with an elastic rubber band looped around the board with its ends hooked onto the top of the tube.

Solder all nine pin connectors.

4. Likewise, install the pin connectors for tube V2.
-

5. Set the two tubes aside for now.
You will install them in their locations during final assembly.
-



6. Insert a 1N5248B diode in the following 24 locations: D7 through D30.
Notice that the component outlines indicate where the band on the diode should be.

Solder and trim the leads.

7. Insert a 499K (yellow, white, white, orange, brown) resistor in location R21.

Solder and trim the leads.

8. Insert a 249K (red, yellow, white, orange, brown) resistor in each of the following two locations: R22 and R23.

Solder and trim the leads.

Note that there are two different kinds of 10Ω resistors.

9. Insert a 10Ω (brown, black, black, gold) carbon composition resistor in the following four locations: R11, R12, R13 and R14.

Solder and trim the leads.

10. Insert a 150Ω (brown, green, black, black, brown) tantalum resistor in the following four locations: R37, R42, R47 and R52.

Solder and trim the leads.

11. Insert a 91Ω (white, brown, black, gold, brown) tantalum resistor in the following four locations: R1, R2, R3 and R4.

Solder and trim the leads.

12. Insert a 4.7K (yellow, violet, black, brown, brown) tantalum resistor in the following four locations: R5, R6, R7 and R8.

Solder and trim the leads.

13. Insert a 75Ω (violet, green, black, gold, brown) tantalum resistor in the following two locations: R9 and R10.

Solder and trim the leads.

14. Insert a 56Ω (green, blue, black, gold, brown) tantalum resistor in the following two locations: R29 and R33.

Solder and trim the leads.

15. Insert a 100 Ω (brown, black, brown, gold) 1W resistor in the following two locations: R19 and R20.

Solder and trim the leads.

16. Insert a 0.1 μ F (tiny blue) capacitor in each of the following three locations: C12, C13 and C14.

Solder and trim the leads.

17. Insert an EMI bead in each of the following four locations: L1—L4.

Solder the leads.

18. Insert a 10 Ω (brown, black, black, gold, brown) tantalum resistor in the following four locations: R39, R44, R49 and R54. Raise these resistors about $\frac{1}{8}$ " off of the board so as to facilitate attaching meter leads to the resistors when making current measurements.

Solder and trim the leads.



19. Insert a transistor socket in each of the following two locations: Q1 and Q2. Orient the two sockets such that the edges with the transistor pin holes are closest together and facing each other. Notice that there are two sets of three holes under each socket. The socket pins should be inserted in the outermost holes such that the transistor pins can extend into the innermost holes.

Solder the leads.



20. Likewise, insert a transistor socket in each of the following ten locations: Q3—Q12. Orient each pair of sockets the same as with Q1 and Q2.

Solder the leads.

21. Insert a 500 Ω (marked Y501 on body) potentiometer in each of the following four locations: R38, R43, R48 and R53.

Solder and trim the leads.

22. Insert a 100 Ω (marked Y101 on body) potentiometer in each of the following two locations: R30 and R34.

Solder and trim the leads.

23. Insert a toggle switch in the following two locations: SW1 and SW2.

Solder the leads.

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24. Insert a 1 μ F 450V (marked on body) capacitor in location C11.
Orient the capacitor such that the negative side (-) (marked on body) is closest to resistor R23.

Solder and trim the leads.

25. Insert a relay in the following two locations K1 and K2.

Solder the leads.

In the following step the resistors will be mounted vertically on end. Form one lead back along the body of the resistor such that the two leads are parallel. Insert the resistor in its location and hold the body of the resistor about 0.1" off the board as you solder it.

26. Insert a 1K (brown, black, red, gold) carbon composition resistor in the following 12 locations: R28, R31, R32, RR35, R36, R40, R41, R45, R46, R50, R51 and R55.

Solder and trim the leads.

27. Insert a 1 μ F, 400V GE capacitor in each of the following eight locations: C7A, C7B, C7C, C7D, C8A, C8B, C8C, and C8D.

Solder and trim the leads.

Perform the next two steps only if you have chosen to have line-level inputs.

28. Insert one of the LL1676 transformers in location T1.

Solder all of the transformer pins.

29. Insert the other LL1676 transformer in location T2.

Solder all of the transformer pins.

30. Insert a heatsink adjacent to MOSFET locations Q1 and Q2.

Using a soldering gun, solder the two pins of the heatsink.

Tip: Solder only one pin and seat the heatsink even and vertical while the solder is molten, and then solder the second pin.

31. In a like manner, install heatsinks in the other five locations.

Caution: A MOSFET is immune from damage due to static electricity if its leads are shorted together or it is installed in a circuit. To protect the MOSFETs during shipment they are packaged in an anti-static bag. Make sure to discharge any static electrical charge from your body before handling the MOSFETs. You can discharge your body by touching a water faucet or grounded electrical appliance. Handle a MOSFET by its tab and try not to touch its pins.

In the following steps, the MOSFET pins should protrude through the holes under the sockets. This will allow the hole in the MOSFET tabs to properly align with the hole in the heatsink. You may have to maneuver the devices and socket a tiny amount to get the pins aligned with the holes.

Note that there are two different kinds of MOSFETs: 08N100D2 and 01N100D



32. Install two MOSFETs as follows:

Plug a 01N100D MOSFET into location Q1.
Plug a 08N100D2 MOSFET into location Q2.

Align the MOSFETs such that their tabs are against the heatsink.

Insert an insulator between each MOSFET and the heatsink. Secure with a screw, lock washer and a nut, using two insulating bushings (one for each tab) on the screw, and tighten moderately.



33. In a like manner, install
a 01N100D MOSFET in location Q3, and
a 08N100D2 MOSFET in location Q4.



34. In a like manner, install
a 01N100D MOSFET in location Q5, and
a 08N100D2 MOSFET in location Q6.



35. In a like manner, install
a 01N100D MOSFET in location Q7, and
a 08N100D2 MOSFET in location Q8.



36. In a like manner, install
a 01N100D MOSFET in location Q9, and
a 08N100D2 MOSFET in location Q10.
-



37. In a like manner, install
a 01N100D MOSFET in location Q11, and
a 08N100D2 MOSFET in location Q12.
-

38. Using your VOM, measure continuity between the body of the heatsinks and the tabs on each of the twelve MOSFETs, Q1—Q12. There should be NO continuity. If continuity exists, check that the insulators and insulating bushings are installed correctly.
-

Final Assembly

All components should now be installed on the three boards.

Check that all leads are soldered and that there are no “solder bridges” that connect things that should not be connected.

Carefully clean the boards with alcohol, removing ALL traces of residual solder flux, especially around the tube pins and other high-voltage points.

-
1. On the power board, remove the three, 3/8” standoffs from the 1” standoffs.
-

2. Place the power board in its position over capacitors C7 and C8 on the main board such that the standoffs fit into the holes provided. Make sure that the six jumper wires fit down into the pads provided for them.

Secure the board in place using the three 3/8” standoffs as nuts.

3. Solder and trim the six jumper wires to the main board.
-

4. On the main board, move the standoff from the hole next to SW2 to the hole that is next to R43.
-

5. On the main board, move the standoff from the hole next to SW1 to the hole that is next to R53.
-

6. On the output board, remove the six, 3/8” standoffs from the 1” standoffs.
-

7. Place the output board in its position over transformers T1 and T2 on the main board such that the standoffs fit into the holes provided. Make sure that the six jumper wires fit down into the pads provided for them.

Secure the board in place using the six 3/8" standoffs as nuts.

8. Solder and trim the six jumper wires to the main board.
-

9. Set the four gain switches, SW1 – SW4, to the high gain position.
-

Install the Active Output

If you are building the Active Output as part of one of the Extreme kits, use the installation instructions that are in that assembly manual rather than these instructions.

We have found that the vast majority of problems experienced with the RAKK dac and its associated components are traced back to incorrect installation, particularly ground loops and faulty grounding. Do not trust your intuition—rather, follow these instructions—we know that they work.

The combination of high plate current and high heater current causes the tubes and heatsinks to be quite warm. Therefore, sufficient natural air convection must be provided for the tubes and heatsinks.

The power supply is a full wave rectifier and intended to be used with a transformer such as the Lundahl LL1683 that provides a center tapped high voltage winding. These instructions assume a Lundahl LL1683 power transformer and should be adapted if you are using a different transformer.

The Lundahl LL1683 data sheet, showing its pins, is [here](#).

You should use a 500 mA fuse on your power input for 120VAC.
You should use a 315 mA fuse on your power input for 230VAC.

Power Wiring

1. Wire the transformer for your mains line voltage.

For 120VAC:

Connect pin 2 to pin 12 and connect pin 4 to pin 10.

For 230VAC:

Connect pin 4 to pin 12.

-
2. Wire the transformer to provide 250VAC-0-250VAC.

Connect pin 22 to pin 24

3. Install a wire from the “**chassis**” pad (next to the high-voltage inputs) to the chassis at the point where the Mains safety ground is connected to the chassis.
-

4. Connect a wire from the middle pad of the “**250V-0-250V**” pads to the center tap of the high voltage winding on the power transformer (pins 22 and 24).
-

5. Connect a twisted pair of wires from the two outer pads of the “**250V-0-250V**” pads to the high voltage winding on the power transformer (pins 15 and 17).
-

6. Run a twisted-pair of wires from the power switch and AC connector to the primary of the transformer (pins 2 and 12).
-

7. Connect a twisted pair of wires from the “**6.3 VAC**” pads to the 6.3VAC winding on the power transformer (pins B1 and B6).
-

Wire the Outputs

8. If you are using RCA output jacks, connect the center pin from the right output jack to the Right output “+” pad.

If you are using XLR output jacks, connect pin 2 of the right output jack to the Right output “+” pad.

9. If you are using RCA output jacks, connect the outer tab from the right output jack to the Right output “-” pad.

If you are using XLR output jacks, connect pin 3 of the right output jack to the Right output “-” pad.

10. If you are using RCA output jacks, connect the center pin from the left output jack to the Left output “+” pad.

If you are using XLR output jacks, connect pin 2 of the left output jack to the Left output “+” pad.

11. If you are using RCA output jacks, connect the outer tab from the left output jack to the Left output “-” pad.

If you are using XLR output jacks, connect pin 3 of the left output jack to the Left output “-” pad.

12. If you are using RCA output jacks, you may or may not choose to ground the outer tabs of the jacks to the system chassis. Depending on your ground layout, this may be the single-point ground. One option may provide lower noise.

If you are using XLR jacks, connect pin 1 of each output jack to the system chassis. Depending on your ground layout, this may be the single-point ground.

Wire the Volume Control

Skip this section if you do not have a volume control.

The special stepped attenuator available from K&K audio has two connections per channel. Polarity of these connections is not important. A standard volume control potentiometer or stepped attenuator has three pins for each channel: high, low and wiper. With the potentiometer turned maximum counter-clockwise the wiper is at the low end, and when the potentiometer turned maximum clockwise the wiper is at the high end. For use in this circuit, the wiper pin should be connected to the high pin on each channel.

13. Connect a wire from the Active Output board volume control L+ pad to both the high and wiper pins on the left channel of the volume control potentiometer.
-

14. Connect a wire from the Active Output board volume control L- pad to the low pin on the left channel of the volume control potentiometer.
-

15. Connect a wire from the Active Output board volume control R+ pad to both the high and wiper pins on the right channel of the volume control potentiometer.
-

16. Connect a wire from the Active Output board volume control R- pad to the low pin on the right channel of the volume control potentiometer.
-

Wire the Line Level Inputs

Skip this section if you do not have line level inputs.

17. If you are using RCA jacks, connect the center pin from the right input jack to the “Line Input” R+ pad on the Active Output board.

If you are using XLR jacks, connect pin 2 of the right input jack to the “Line Input” R+ pad on the Active Output board.

18. If you are using RCA jacks, connect the shell tab from the right input jack to the “Line Inputs” R- pad on the Active Output board.

If you are using XLR jacks, connect pin 3 of the right input jack to the “Line Inputs” R- pad on the Active Output board.

19. If you are using RCA jacks, connect the center pin from the left input jack to the “Line Inputs” L+ pad on the Active Output board.

If you are using XLR jacks, connect pin 2 of the left input jack to the “Line Inputs” L+ pad on the Active Output board.

20. If you are using RCA jacks, connect the shell tab from the left input jack to the “Line Inputs” L- pad on the Active Output board.

If you are using XLR jacks, connect pin 3 of the left input jack to the “Line Inputs” L- pad on the Active Output board.

21. If you are using RCA input jacks, you may or may not choose to ground the outer tabs of the jacks to the system chassis. Depending on your ground layout, this may be the single-point ground. One option may provide lower noise.

If you are using XLR jacks, connect pin 1 of each input jack to the system chassis. Depending on your ground layout, this may be the single-point ground.

RAKK dac Wiring

If you do not have a DAC input, skip the next step.

22. Connect a wire from each of the five “From RAKK dac” pads, L+, L-, REF, R+ and R-, on the Active Output board to the same five pads on the RAKK dac.
-

Input Selection Wiring

The Active Output board has the circuitry for both line-level input and DAC input. Selection between the two is provided with the “DAC Select” pads on the board.

When the two pads are connected together, the DAC is selected. When the two pads are not connected, the line-level inputs are selected.

Note that it is **not** necessary to provide any external voltage to the pads for selection.

23. If you have **only** line-level inputs, make no connection to the DAC Select pads.
-

24. If you have **only** a DAC input, solder a jumper wire between the two DAC Select pads.
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25. If you have both line-level inputs and a DAC input, connect a pair of wires between the two DAC Select pads and the select switch. Wire the switch such that the DAC Select pads are connected when the switch is in the DAC position.
-

External Mute

There is provision for the mute circuit to be controlled by an external mute switch. To use an external switch, first cut the trace connecting the two “external mute” pads on the Active Output board, then connect the two pads to the mute switch. An open switch contact will mute the output.

Adjust the Constant Current Sources

The adjustments that you are about to make interact. Therefore, the first time you may have to alternate adjustments to get them in range.

1. Install a 6N6P tube in locations V1 and V2.

2. Power on the Active Output and allow it to warm up for about one minute.

3. Measure the voltage across the 20K Ω resistor, R27 and adjust potentiometer R34 for 200V across R27.

4. Measure the voltage across the 20K Ω resistor, R26 and adjust potentiometer R30 for 200V across R26.

5. Measure the voltage across each of the four CCS current sense resistors and adjust the associated potentiometers for 240mV across its resistor.

Measure	Adjust	Voltage
R39	R38	0.240V
R44	R43	0.240V
R49	R48	0.240V
R54	R53	0.240V

6. Allow the unit to warm up for about 15 minutes and then check and re-adjust the above six adjustments.

Congratulations! You have finished the assembly and installation.

Enjoy the music and be aware that the character and quality of the sound will improve with time. The first 100 hours are most noticeable so hold off making evaluations until after that.

Parts List (Level F)

Designator	Part	Description	Qty
	Schematic diagram set	Four schematic diagrams	1
	Hex wrench, 5/64"	For 6-32 screw	1
	Hex wrench, 1/16"	For 4-40 screw	1
	Adjustment tool	For potentiometers	1
	Wire, #20		18"
	Set of three PC boards	one small square, (version 1.2) one large square, (version 1.1) one medium T-shaped (version 1.1)	1
	Heatsink	Black, with fins, 2" tall	6
	Transistor socket	White, square, with three pins	12
	Tube pin socket	Tiny silver cylinder	18
	Bushing, insulator	Small black cylinder	12
	Insulator, heatsink	Thin pink rectangle	12
	Lock washer, 4-40		6
	Nut, 4-40		6
	Screw, 4-40 x 1/2"		6
	Screw, 6-32 x 1/4"		26
	Standoff, 6-32 x 3/8"	Female-female	13
	Standoff, 6-32 x 1"	Male-female	9
	Wire tie	black plastic strip	16

Designator	Part	Description	Qty
Q1, Q3, Q5, Q7, Q9, Q11	MOSFET, 01N100D	3-pin TO-220	6
Q2, Q4, Q6, Q8, Q10, Q12	MOSFET, 08N100D2	3-pin TO-220	6
D1 – D4	Diode, MUR860	2-pin TO-220	4
D5	Diode, 1N5349B	Black cylinder	1
D6	Diode, 1N4007	Black cylinder	1
D7 – D30	Diode, 1N5248B	Small brown glass cylinder with a black band on one end.	24
U1	Timer, LM555	8-pin DIP	1
C1, C2	Capacitor, .68 μ F, 600VDC	Cardas, black cylinder	2
C3, C6, C12, C13, C14	Capacitor, 100nF, 50V	Tiny blue	5
C4	Capacitor, 180 μ F, 16V	Dark blue cylinder	1
C5	Capacitor, 1 μ F, 50V	Dark blue cylinder	1
C7 – C10	Capacitor, 1 μ F, 400VDC	White oval	10
C11	Capacitor, 1 μ F, 450V	Dark blue cylinder	1
V1, V2	Tube, 6N6P	Glass cylinder, 9-pin	2
L1 – L4	EMI bead	Wire with two beads	4
SW1 – SW4	Switch, DPDT	Tiny toggle switch	4
K1 – K3	Relay, DPDT	Black rectangle	3

Designator	Part	Description	Qty
R11 – R14	Resistor, 10 Ω , ¼W carbon composition	Brown, black, black, gold bands	4
R39, R44, R49, R54	Resistor, 10 Ω , ½W tantalum	Brown, black, black, gold, brown bands	4
R29, R33	Resistor, 56 Ω , ½W tantalum	Green, blue, black, gold, brown bands	2
R9, R10	Resistor, 75 Ω , ½W tantalum	violet, green, black, gold, brown bands	2
R1 – R4	Resistor, 91 Ω , ½W tantalum	White, brown, black, gold, brown bands	4
R19, R20	Resistor, 100 Ω , 1W metal film	Brown, black, brown, gold bands	2
R37, R42, R47, R52	Resistor, 150 Ω , ½W tantalum	Brown, green, black, black, brown bands	4
R28, R31, R32, R35, R36, R40, R41, R45, R46, R50, R51, R55	Resistor, 1K, ¼W carbon composition	Brown, black, red, gold bands	12
R15, R16	Resistor, 2K, ½W tantalum	Red, black, black, brown, brown bands	2
R5 – R8	Resistor, 4.7K, ½W tantalum	Yellow, violet, black, brown, brown bands	4
R24 – R27	Resistor, 20K, 12W Mills wire-wound	Value marked on body	4
R17	Resistor, 100K, ¼W metal film	Brown, black, black, orange, brown bands	1
R18	Resistor, 150K, ¼W metal film	Brown, green, black, orange, brown bands	1
R22, R23	Resistor, 249K, ¼W metal film	Red, yellow, white, orange, brown bands	2
R21	Resistor, 499K, ¼W metal film	Yellow, white, white, orange, brown bands	1
R30, R34	Potentiometer, 100 Ω	Blue square, Y101 marked on body	2
R38, R43, R48, R53	Potentiometer, 500 Ω	Blue square, Y501 marked on body	4
T1, T2	Transformer	Lundahl LL1676 note: optional – used only for line-level input	(2) note
T3, T4	Transformer	Lundahl LL1674	2

Document Version History

Version	Description
A.1 (1.0)	Original document supporting parts level A
B.1 (1.1)	Original document supporting parts level B
B.2 (1.2)	Correct error in installation instructions.
1.3	Original document supporting parts level C
1.4	Included adjustment tool for potentiometers in parts list
1.5	Changed order of installation instructions.
1.6	Original document supporting parts level D
1.7	Original document supporting parts level E
1.8	Correct typo
1.9	(this document) Original document supporting parts level F

Parts Level History

Version	Description
A	Original level
B	Change ballast resistors R24 – R27 from 18K to 20K because of parts availability. This is not an audible change.
C	CCS update. MOSFETS are different and gate stoppers are different. This is an audible change.
D	Changed rectifier diodes for better temperature specification. Changed power board for better ventilation. This is not an audible change.
E	Added wire wraps to the parafeed capacitors. This is an audible change.
F	Changed the values of the gate stoppers to better inhibit oscillation (a rare occurrence) This is not an audible change unless the circuit is oscillating