K&K Audio

RAKK dac
Mark III

Raleigh Audio

Low Voltage Power System

Assembly and Installation Manual

Version 2.8

Kit version

Use this manual with RAKK dac Mark III Low Voltage Power System

Module	Board version	Parts level
Input	2.1	C
Output	2.2	E
Power Boost	2.1	C

Required Tools and Supplies

35 to 50 Watt soldering iron
Diagonal cutting pliers
Long-nose pliers
Wire stripper
Solder

Warnings and Cautions

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

Power Requirements

The Input Module requires 120VAC at 100mA or 230VAC at 50mA.

The Output Module requires an input voltage of between 5VAC and 7VAC at 6VA.

Table of Contents

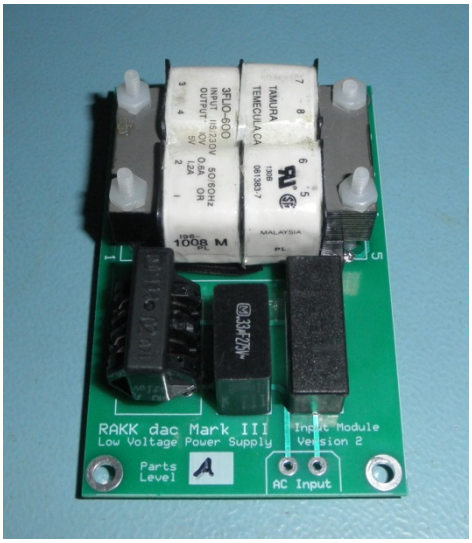
Assembly Instructions

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.

In the following steps you will populate the PC boards. All of the components are mounted on the top of the boards, which has the components labeled with white silkscreen.

Steps preceded by a "note" (♪) deal with components which must be oriented properly.

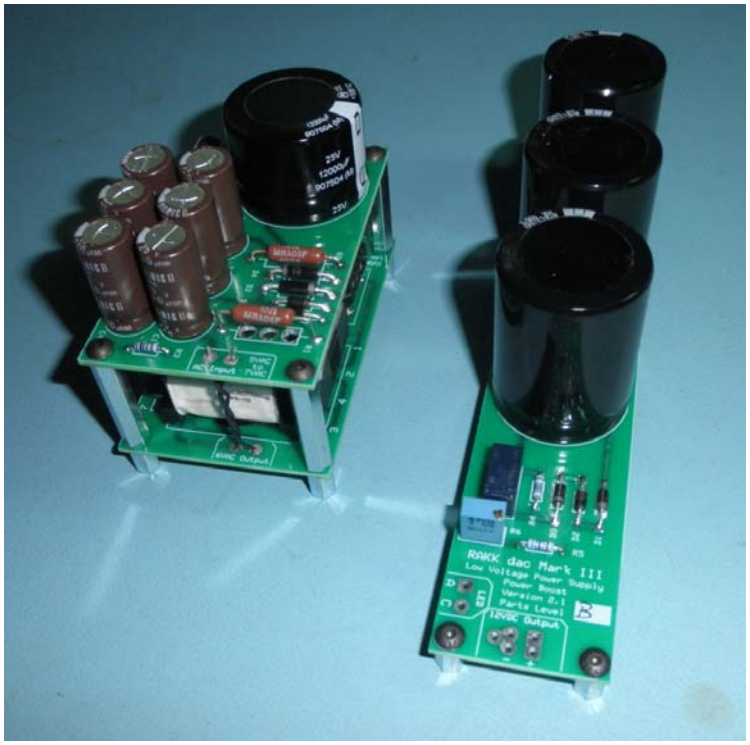
The Power System consists of one or more power supplies. There are three parts to a power supply—an Input Module, an Output Module and a Power Boost Module.



The Input Module takes the mains line voltage (120VAC or 230VAC) and produces an output of 6VAC. This module is capable of providing power for a single Output Module. While the output voltage is nominally 6VAC, the actual voltage will vary depending on the amount of current drawn by the load.

The Output Module takes 5VAC to 7VAC and produces either 5VDC or 12VDC. This module is capable of providing power for a single circuit board, which may be a RAKK dac or I2S adapter. The Output Module can be powered from either the Input Module or a Lundahl LL1683 transformer. An LL1683 can support up to three Output Modules. Thus, if you have an LL1683, you will not have any Input Modules. While the output voltage is nominally 5VDC or 12VDC, the actual voltage will vary slightly depending on the amount of current drawn by the load.

The Power Boost Module is inserted between an Output Module and a RAKK dac, providing additional capacitance needed by the RAKK dac for optimal performance. An I2S adapter does not use a Power Boost Module.



Output Module Assembly

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

_____

1. Mount four ⅜" standoffs on the bottom of the Output Module and secure with 6-32 screws.

_____

2. Insert a 1K (brown, black, black, brown, brown) resistor in location R3.

   Solder and trim the leads.

_____

♪

3. Insert an MBR150 diode in location D1. Orient the diode such that the end with the stripe is closest to the edge of the board.

   Solder and trim the leads.

_____

♪

4. Insert an MBR150 diode in location D2. Orient the diode such that the end with the stripe is closest to capacitor C2.

   Solder and trim the leads.

_____

♪

5. Insert a 1N5349B diode in location D3. Orient the diode such that the end with the stripe is closest to the edge of the board.

   Solder and trim the leads.

_____

♪

6. Insert a 1N5349B diode in location D4. Orient the diode such that the end with the stripe is closest to capacitor C2.

   Solder and trim the leads.

_____

7. Insert a 0.47Ω (or 0.5Ω) (marked on body) Mills resistor in location R2.

   Solder and trim the leads.

The output voltage of the Output Module may be either 5VDC or 12VDC depending upon what it is being used for. If the Output Module is being used to power an I2S adapter, the output voltage will be 5V. If the Output Module is being used to power a RAKK dac, the output voltage will be 12V.

There is a white square next to the output pads that may be used to indicate the output voltage. If your board has not been labeled, write the output value in the white square.

Skip the following step if the Output Module is being configured for 12V to power a RAKK dac.

♪

8. If the Output Module is being configured for 5V, insert a 1N5338B diode in location D5. Raise the diode about ¼" off the board and orient the diode such that the end with the stripe is closest to capacitor C3.

   Solder the leads.

In the following step you will customize the Output Module for your application.
If you have more than one Output Module, each will be separately customized.

The circuit boards being powered by the LVPS require either 5VDC or 12VDC. The output voltage of the Output Module is determined by two **v**ariable factors – the level of the input AC voltage and the output current draw. A ballast resistor (R1) is inserted in the circuit as compensation to set the level of the output voltage. Refer to the table below to determine what value resistor is required for location R1.

The table below assumes that you have either an LL1683 transformer or an Input Module. If you have a power source other than the LL1683 transformer or an Input Module, you will have to determine the value of R1 experimentally. The resistor values in the table will give you a starting point for your experiment. While the output voltage is nominally 5VDC or 12VDC, its allowable range is (+/-) 10%. While there is a wider range allowable, try to keep the voltage close to the nominal (or slightly below in the case of the 12V) if possible for cooling purposes. The voltage level is not critical because there are voltage regulators on the RAKK dac and adapters that control the level of the voltages that they need. Note that the output voltage will also be affected by the level of the mains power line voltage, which will vary over time.

		Nominal Output Voltage	Power Source		
			LL1683 (5.2V)	LL1683 (6.6V)	Input Module
Output Module Load	RAKK dac	12V	Not used	R1 = 2Ω	R1 = 1Ω
	I2S Adapter 1-input or 3-input	5V	R1 = 10Ω	Not used	R1 = 10Ω

Note: LL1683 windings – RAKK dac must use the 6.6VAC winding and adapters must use the 5.2VAC windings.

---

9. Install the required resistor in location R1. Install the resistor such that the body of the resistor is raised about ¼" above the surface of the board.

   Solder and trim the leads.

♪

10. Insert a 330µF capacitor in the following three locations: C4 – C6. Orient the capacitors such that their negative leads (marked on side) are closest to the edge of the board.

    Solder and trim the leads.

♪

11. Insert a 330µF capacitor in the following three locations: C1 – C3. Orient the capacitors such that their negative leads (marked on side) are closest to capacitors C4 – C6.

    Solder and trim the leads.

♪

12. Insert the 12,000µF capacitor in location C7. Orient the capacitor such that its negative lead (marked on side) is closest to the edge of the board.

    Solder and trim the leads.

All components should now be installed on the board. Check that all leads are soldered and that there are no “solder bridges” that connect things that should not be connected.

Power Boost Module Assembly

---

1. Mount five ⅜” standoffs on the bottom of the Power Boost Module and secure with 6-32 screws.

---

2. Insert a 10K (brown, black, black, red, brown) resistor in location R5.

   Solder and trim the leads.

---

3. Insert a 1K (brown, black, black, brown, brown) resistor in location R4.

   Solder and trim the leads.

♪

4. Insert a 1N4007 (marked on body) diode in location D1.
   Orient the diode such that the end of the diode with the band is closest to resistor R5.

   Solder and trim the leads.

♪

5. Insert a 1N4007 (marked on body) diode in location D2.
   Orient the diode such that the end of the diode with the band is closest to capacitor C3.

   Solder and trim the leads.

♪

6. Insert a 1N4007 (marked on body) diode in location D3.
   Orient the diode such that the end of the diode with the band is closest to resistor R5.

   Solder and trim the leads.

---

7. Insert a 0.47Ω (or 0.5Ω) (marked on body) Mills resistor in the following three locations: R1 – R3.

   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.

8. Insert the relay in location K1.

   Solder the leads.

9. Insert a 50KΩ potentiometer in location R6.

   Solder and trim the leads.

♪

10. Insert a 27,000 µF capacitor in location C1.
    Orient the capacitor such that its negative lead (marked on side) is closest to resistor R1.

    Solder the leads.

♪

11. Insert a 27,000 µF capacitor in location C2.
    Orient the capacitor such that its negative lead (marked on side) is closest to resistor R2.

    Solder the leads.

♪

12. Insert a 27,000 µF capacitor in location C3.
    Orient the capacitor such that its negative lead (marked on side) is closest to resistor R3.

    Solder the leads.

All components should now be installed on the board. Check that all leads are soldered and that there are no “solder bridges” that connect things that should not be connected.

Input Module Assembly

Skip this section if you do not have an Input Module.

---

1. Remove the transformer from the board and set it aside.

---

2. Insert the fuse holder in location F1.

   Solder the pins.

---

3. Insert the proper fuse in the fuse holder cover and install the cover and fuse in the fuse holder.

   The fuse should be:
   100mA “slow-blow” (time delay) for 120VAC
   50mA “slow-blow” (time delay) for 230VAC

---

4. Insert the 0.27µF (or 0.33µF), 275V (marked on body) capacitor in location C1.

   Solder and trim the leads.
   Save the ends of the leads that you cut to be used as jumpers later.

---

5. Insert the common-mode choke in location L1.

   Solder the leads.

WARNING:

Non-conductive Nylon screws are provided to secure the transformer in the next step. Do not substitute metal screws, which will cause a short circuit that will damage the circuit and may cause bodily injury or even death.

♪

6. Insert the transformer, T1, in its location. Align the transformer such that the pin numbers on the transformer match the pin numbers on the board. Secure the transformer with three 4-40 x 1" Nylon screws and Nylon nuts. Insert the screws from the bottom of the board with the nuts on the transformer frame. Tighten the screws snugly but do not over-tighten.

   Note that a forth Nylon screw has already been mounted on the transformer in the hole closest to pin 7. This will ensure proper orientation of the transformer because there is no hole in the board for this location.

_____

7. Solder and trim all eight pins on the transformer.

_____

8. Wire the transformer with jumpers on the bottom of the board for your mains line voltage.

   For 120VAC:
   Connect pad A to pad B
   Connect pad C to pad D.

   For 230VAC:
   Connect pad E to pad F.

_____
_____

All components should now be installed on the board. Check that all leads are soldered and that there are no "solder bridges" that connect things that should not be connected.

Final Assembly

Skip this section if you do not have an Input Module.

An Output Module is designed to mount on top of an Input Module and these instructions assume that if you have an Input Module, it will have an Output Module mounted on it.

---

1. Remove the four ⅜" standoffs from the Output Module.

---

2. Mount four 1.25" standoffs on the bottom of the Output Module and secure with 6-32 screws.

---

3. Insert a ½" 6-32 setscrew about half-way into each 1.25" standoff.

♪

4. Set the Output Module on top of the Input Module such that the 5VAC to 7VAC AC Input pads on the Output Module align with the pair of 6VAC Output pads on the Input Module.

---

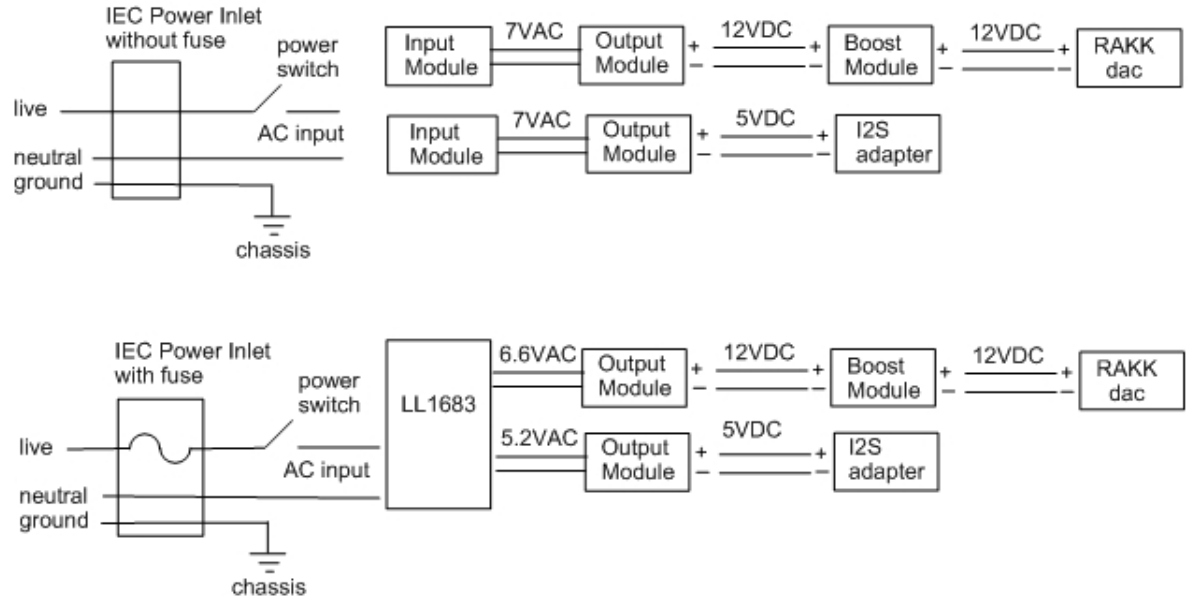
5. Install a ⅜" standoff as a nut on each of the four 1.25" standoffs.

---

6. Cut the 3.5" piece of wire in half, strip ¼" from all ends, tin the ends and twist the two wires together. Install the pair of wires between the 6VAC pads on the Input Module to the 5VAC to 7VAC **"AC Input"** pads on the Output Module.

   Solder and trim the leads.

Power System Installation



The above figure shows two different low voltage power systems.

On the top is a system supporting a RAKK dac with a Passive Output, requiring only low voltage power supplies. It has two Input Modules powering a RAKK dac and an I2S adapter.

On the bottom is a system supporting a RAKK dac with an Active Output, requiring a high voltage power supply in addition to the low voltage power supplies. It has an LL1683 transformer powering a RAKK dac and an I2S adapter.

In order to preclude ground loops, each power supply is galvanically isolated from the other power supplies. Three important rules are followed: First, two Output Modules cannot share an input AC – rather, each is fed by its own transformer winding. Second, two loads (RAKK dac or adapter) cannot share an Output Module – rather, each load has a separate Output Module. Third, there are no ground connections anywhere in the power system – rather, each separate power supply will pick up a ground from its load. These are very different grounds and must not be mixed.

The following sections will provide instructions for wiring the low voltage power system.

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.

In the following steps all wires should be soldered.

Wiring the Low Voltage Power System with an LL1683 Transformer

Skip this section if you do not have an LL1683 transformer.

An LL1683 can support one, two, or three Output Modules.

Refer to the LL1683 data sheet for these instructions.

These instructions assume that one winding, pins B1 and B6, is used for filament power. The other three low-voltage windings are available to support Output Modules.

If you are using the LL1683 with a RAKK Active Output:
You should use a 500mA fuse on your power input for 120VAC.
You should use a 315mA fuse on your power input for 230VAC.

---

1. Remove any and all wires from pins B2, B3, B4, B5, B7 and B8 of the LL1683.

   If any of these pins were used for a LED power-on indicator, the LED will be moved to the 12V power supply.

   Note: If you have a RAKK Active Output, pins B1 and B6 are used for filament power.

---

2. Set all of the power supply Modules in their places but do not secure them yet.

---

3. Install a twisted pair of wires from transformer pins B4 and B7 to the 5VAC to 7VAC **"AC Input"** pads on the Output Module which is to be used to power the RAKK dac.

   Remember that each Output Module has been personalized for its intended function.

---

4. Install a twisted pair of wires from the **"12VDC Output"** pads on this Output Module which is to be used to power the RAKK dac, and the **"12VDC Input"** pads on the Power Boost Module. Observe polarity – that is, connect the **"-"** pad to the **"-"** pad and **"+"** pad to the **"+"** pad.

---

5. Install a twisted pair of wires from the **"12VDC Output"** pads on the Power Boost Module and the **"12V"** pads on the RAKK dac. Observe polarity.

---

6. If you have a RAKK TOSLINK to SPDIF adapter, install a twisted pair of wires from the **"12VDC Output"** pads on the Power Boost Module and the **"12V"** pads on the TOSLINK adapter. Observe polarity.

---

7. If you have a power indicator LED, install a twisted pair of wires from the LED **"A"** and **"C"** pads on the Power Boost Module to the LED. Connect the **"A"** pad to the LED anode and the **"C"** pad to the LED cathode. The longer lead on the LED is the anode.

   Note that the LED intensity is controlled by the adjustable resistor R6.

Skip the rest of this section if you do not have an I2S Adapter.

---

8. If you have an I2S Adapter, install a twisted pair of wires from transformer pins B3 and B8 to the 5VAC to 7VAC **"AC Input"** pads on the Output Module which is to be used to power that adapter.

---

9. Install a twisted pair of wires from the **"5VDC Output"** pads on this Output Module to the **"5V"** pads on the I2S Adapter. Observe polarity.

---

10. Secure all of the Modules to the chassis.

Wiring the Low Voltage Power System with Input Modules

Skip this section if you do not have Input Modules.

This section assumes that each Input Module has an Output Module mounted on it and connected electrically. If not, you will need to interconnect those modules.

---

1. Set all of the power supply Modules in their places but do not secure them yet.

---

2. Run a twisted-pair of wires from the power switch and IEC Power Inlet to the "**AC Input**" pads on the first Input Module.

---

3. If you have a second Input Module, install a twisted pair of wires from the "**AC Input**" pads on the first Input Module to the "**AC Input**" pads on the second Input Module.

---

4. If you have a third Input Module, install a twisted pair of wires from the "**AC Input**" pads on the second Input Module to the "**AC Input**" pads on the third Input Module.

---

5. Install a twisted pair of wires from the **"12VDC Output"** pads on the Output Module which is to be used to power the RAKK dac, and the **"12VDC Input"** pads on the Power Boost Module. Observe polarity – that is, connect the **"-"** pad to the **"-"** pad and **"+"** pad to the **"+"** pad.

   Remember that each Output Module has been personalized for its intended function.

---

6. Install a twisted pair of wires from the **"12VDC Output"** pads on the Power Boost Module and the **"12V"** pads on the RAKK dac. Observe polarity.

---

7. If you have a RAKK TOSLINK to SPDIF adapter, install a twisted pair of wires from the **"12VDC Output"** pads on the Power Boost Module and the **"12V"** pads on the TOSLINK adapter. Observe polarity.

Skip this next step if your RAKK dac does not have a Passive Output Stage.

8. If you have a RAKK dac Passive Output stage, install a wire from the **"12VDC Output" "-"** pad on the Power Boost Module to the chassis where the Mains power safety ground connects to the chassis.

---

9. If you have a power indicator LED, install a twisted pair of wires from the LED **"A"** and **"C"** pads on the Power Boost Module to the LED. Connect the **"A"** pad to the LED anode and the **"C"** pad to the LED cathode. The longer lead on the LED is the anode.

   Note that the LED intensity is controlled by the adjustable resistor R6.

Skip the rest of this section if you do not have an I2S Adapter.

---

10. If this Output Module is to power an I2S adapter, follow the instructions for wiring the power in that manual.

---

11. Secure all of the Modules to the chassis.

Non-standard Power Input Installation Instructions

If you do not have Input Modules, and are using transformers other than the LL1683, adapt the Input Module instructions above for your transformers.

Note that the Output Module powering the RAKK dac requires a transformer that provides a minimum of 6.3VAC and a maximum of 7VAC at a minimum of 6 Volt-Amperes. An Output Module powering an I2S adapter or USB adapter requires a transformer that provides a minimum of 5VAC and a maximum of 7VAC at a minimum of 6 Volt-Amperes.

Additional Grounding Instructions

If you have a RAKK dac Passive Output stage, connect any other ground or common point that you may have in the system, for example output jacks, to the chassis at the point where the Mains safety ground is connected to the chassis.

When your system is completely wired, it should exhibit the following grounding characteristics:

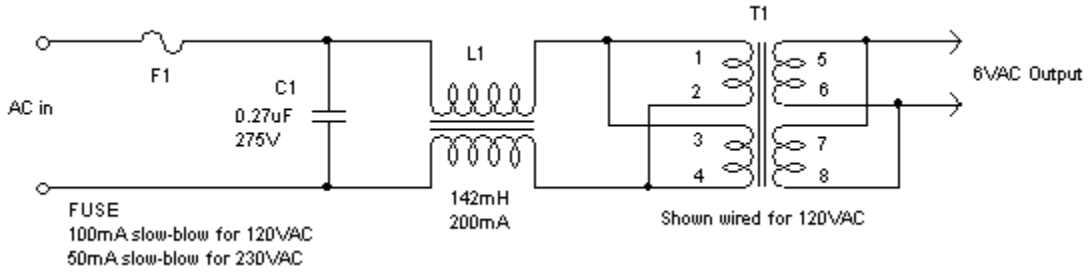
- If you have a RAKK dac Passive Output stage, the only path between the system ground and the chassis should be the wire connected from the **"12VDC Output" "-"** pad on the Power Boost Module to the chassis.

- If you have a RAKK dac Active Output stage, the only path between the system ground and the chassis should be from the **"12VDC Output" "-"** pad on the Power Boost Module, to the **"12V -"** pad on the RAKK dac, (internally connected to the **"REF"** pad on the RAKK dac), to the **"REF"** pad on the Active Output board, through the ground buss on the Active Output board, to a wire connected to the chassis.

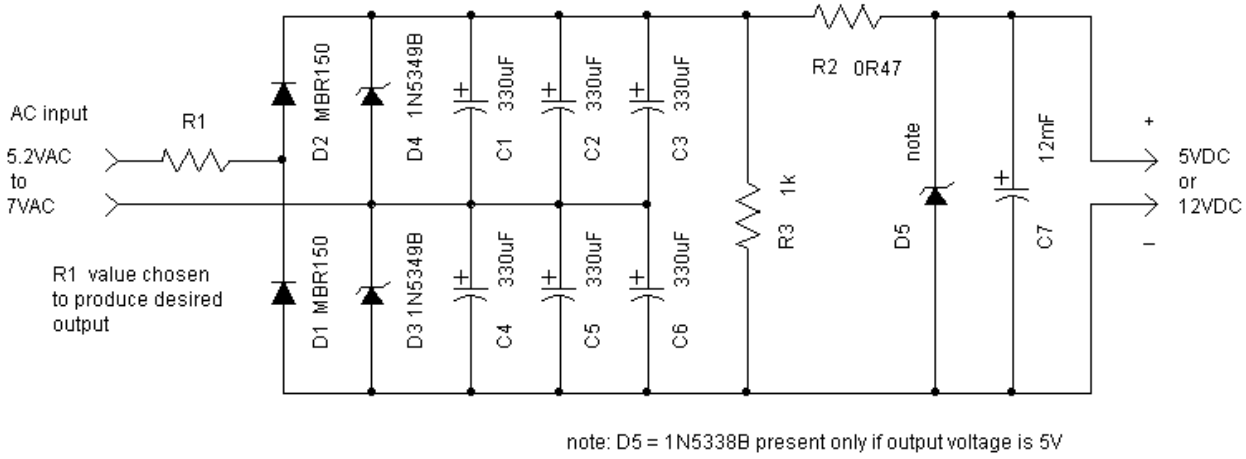
- When the power cable is installed, and the power cables of all attaching devices are installed, with all the adapter cables being installed to the attaching devices, there should be a connection or path between the "-" pad on any Output Module to the "-" pad on any other Output Module.

Schematic Diagrams

Input Module Schematic

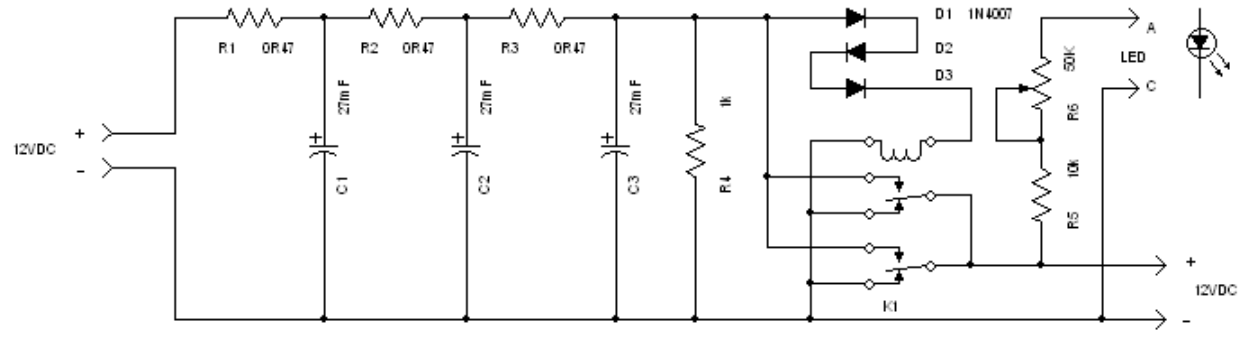


Output Module Schematic



note: D5 = 1N5338B present only if output voltage is 5V

Power Boost Module Schematic



Parts List (Level E)

Output Module Parts

Designator	Part	Description	Qty
	PC board	version 2.2	1
D1, D2	Diode, MBR150	cylinder, value marked on body	2
D3, D4	Diode, 1N5349B	cylinder, value marked on body	2
D5	Diode, 1N5338B	cylinder, value marked on body note- only if output voltage = 5V	1 (note)
C1 – C6	Capacitor, 330µF, 25V	brown cylinder	6
C7	Capacitor, 12,000µF, 25V	black cylinder	1
R1	Resistor, Mills, (various)	black or brown radial cylinder, value marked on body	1
R2	Resistor, Mills 0.47Ω or 0.5Ω	brown radial cylinder, value marked on body	1
R3	Resistor, 1KΩ	brown, black, black, brown, brown bands	1
	Standoff, 6-32 x ⅜”		4
	Screw, 6-32 x ¼”		8

Input Module Parts

Designator	Part	Description	Qty
	PC board	Version 2.1	1
T1	Transformer, 5VAC		1
C1	Capacitor 0.27µF, 275V or 0.33µF, 275V	black, rectangle	1
L1	Common mode choke, 144-02	looks like a small transformer With four pins	1
F1	Fuse holder	black rectangle	1
	Fuse holder cover		1
	Fuse, 50mA or 100mA “slow-blow” (time delay)	cylinder	1
	Standoff, 6-32 x 1.25”		4
	Setscrew, 6-32 x ½”		4
	Screw, Nylon 4-40 x 1”		3
	Nut, Nylon 4-40		3
	Wire, #22		3.5”

Power Boost Module Parts

Designator	Part	Description	Qty
	PC board	Version 2.1	1
C1 – C3	Capacitor, 27,000µF, 25V	black cylinder	3
R1 – R3	Resistor, Mills, 0.47Ω or 0.5Ω	brown cylinder	3
R4	Resistor, 1KΩ	brown, black, black, brown, brown bands	1
R5	Resistor, 10KΩ	brown, black, black, red, brown bands	1
R6	Potentiometer, 50KΩ	blue rectangle	1
D1 – D3	Diode, 1N4007	black cylinder	3
K1	Relay, 12V	black rectangle	1
	Standoff, 6-32 x ⅜”		5
	Screw, 6-32 x ¼”		10
	wrench, hex, 5/64”	for socket screws	1

Document Version History

Version	Description
2.1	Original document to support parts level B
2.2	changed value of ballast resistor.
2.3	changed to support parts level C
2.4	changed to support parts level D
2.5	updated fuse information
2.6	changed value of ballast resistors
2.7	support parts level E
2.8	(this document) updated adapter voltage

Parts Level History

Version	Description
A	Beta level
B	Original production level
C	Changed C1 on the Input Module from 0.33µF to 0.27µF because of parts availability. Changed 0.5Ω resistors to 0.47Ω because of parts availability. This is not an audible change.
D	Provide for 5VDC output
E	Change Zener diode type for 5V This is not an audible change