Project Ember

USER MANUAL – SEPTEMBER 25TH 2014

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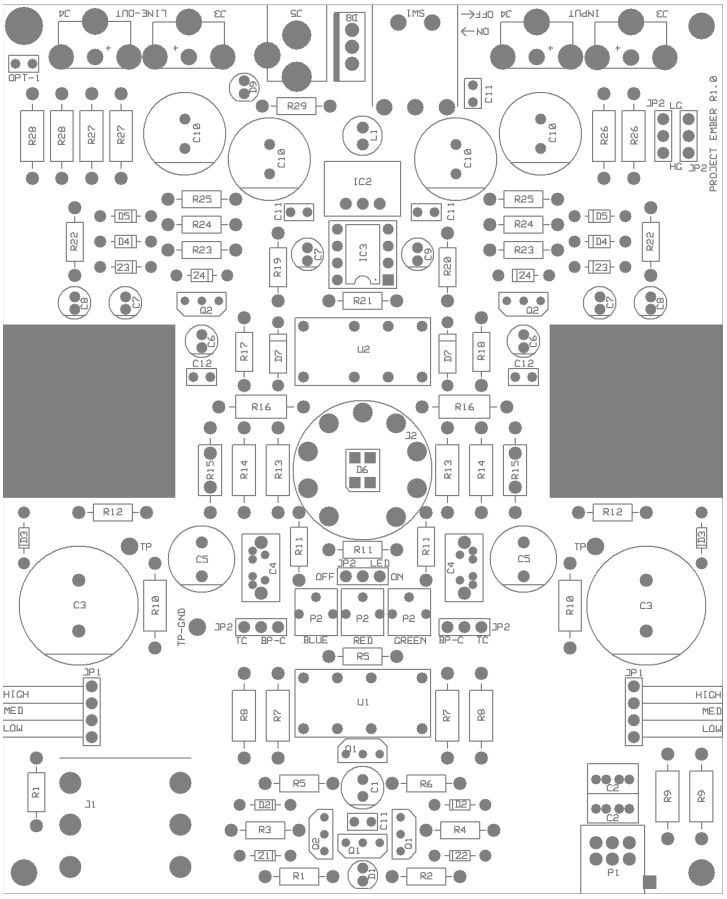


WARNING:

Although Project Ember runs at a generally safe 48VDC, Injury from improper assembly is quite possible. The main danger comes from installing the polarized capacitors backwards as they can only be installed in one direction much like a battery (more detail on capacitor installation comes later in this manual) If a capacitor is installed backwards, it may burst resulting in burns or eye injury. **If you are not experienced in electronics or electronic kit assembly, it would be wise to have an experienced electronics person review your work before powering the unit on.** Upon first power up, wear eye protection and be wary of any burning smells or electrical noises such as loud pops or buzzes

If using low impedance headphones with power ratings of 300mW or lower, there is a chance you could blow out the drivers if left playing at high levels – unattended. At high power levels an SPL of over 120dB may be reached in efficient headphones which is harmful to your hearing. Project Ember is a very high powered headphone amplifier – use caution and common sense. High output headphone amplifiers like Ember are designed to power very demanding headphones or provide all the headroom you could want with more efficient designs, not to see if you can get your jawbone to rattle.

Project Ember

Specifications

- Solid state output stage
- Non overall feedback - triode voltage gain stage
- Power consumption: 5W continuous, 15W peak
- Power supply: 48VDC (0.10A cont, 0.32A peak)
- Input Resistance: 20kΩ or 40kΩ depending on gain setting
- Input Sensitivity (6N23): 0.8V or 1.6V (dependent on gain setting and used tube)
- Gain: 14- 20dB (selectable and dependent on tube)
- Max Output voltage: 15.7Vrms at 300Ω
- Output Resistance: Selectable 0.1Ω, 35Ω or 120Ω
- Frequency Response: 3Hz – 65 KHz (-0.5dB) with 32Ω load
- Frequency Response: 1.5Hz – 190 KHz (-3dB) with 32Ω load
- Signal to Noise ratio: 92dBA (dependent on tube)
- Crosstalk: -89dB (dependent on tube)
- THD: > 0.010% (dependent on tube)
- Suitable for: 16-600Ω Headphones, 32-600Ω recommended

OUTPUT POWER INTO:	OUTPUT RESISTANCE		
	.1R	35R	120R
16Ω	600mW	590mW	180mW
32Ω	1.4W	1.2W	290mW
64Ω	2.4W	1.5W	450mW
120Ω	1.8W	1.1W	480mW
300Ω	765mW	600mW	390mW
600Ω	390mW	360mW	270mW

Tubes / Valves that can be used in Project Ember

6V TUBES:
6922
7308
8223
6AQ8
6DJ8
6N1P
6H23
6H23N
6L12
6N11
6N23
B719
Cca
CV2492
CV2493
CV5358
E88CC
E89CC,
E188CC
E189CC
E288CC
ECC85
ECC88
ECC89
ECC188
ECC189
ECC288
ECC289
JAN 7308

12V TUBES:
5751
5814
5814A
5963
6189
6201
6681
7025
7058
7729
6L13
12AD7
12AT7
12AV7
12AU7
12AX7
12DF7
12DM7
12DT7
A2900
B152
B309
B329
B339
B749
CV0455
CV0491
CV0492
CV4024

12V TUBES CONTINUED:
E181CC
E183CC
E283CC
E811CC
E812CC
E813CC
E2157
E2163
E2164
ECC81
ECC82
ECC83
ECC181
ECC182
ECC182
ECC801
ECC803
ECC803S
E81CC
E82CC
E83CC

Project Ember

Thank you for purchasing the Project Ember Headphone Amplifier Kit. This kit requires minimal electronics and soldering knowledge. The layout is easy to follow and setup is a snap! Please make sure to follow the instructions outlined in this guide and you will be enjoying your amp in no time. First, lets go over the tools and items required for your build which are as follows:

Required Assembly Tools:

- Soldering iron, 25W minimum – Variable temp soldering station preferred with 1.5 – 2mm wide chisel tip
- .032 diameter 60/40 or 63/37 Tin/Lead solder is recommended. Lead free is difficult to work with and not recommended
- We specifically recommend Kester 331 water soluble flux solder, available on our website for purchase under (Parts – Buy)
- Magnifying glass (recommended but not required)
- Rubber Gloves (recommended but not required)
- 3M Green or Red Scotch Brite (recommended but not required)
- 3/32th Allen Key
- Flush cuts
- 90% Isopropyl alcohol (recommended but not required)
- Paper Towels (recommended but not required)
- Digital Multi Meter (DMM or DVOM)
- Heatgun or Hairdryer (for securing heatsinks)

Before You Start Soldering:

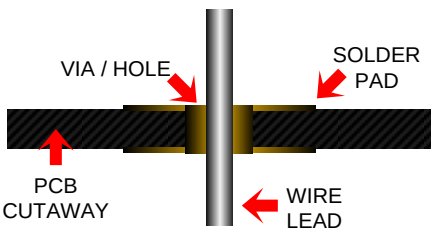
Prep work needs to be done. Wash your hands thoroughly and dry. Put on the recommended rubber gloves and scrub down the PCB (circuit board) on both the front and back side with 90% isopropyl alcohol to clean any residuals off of the board from manufacturing. Once the board has been cleaned, set it on a dry paper towel out of the way. Try to use the rubber gloves during the entire assembly process to keep oils off of the board and solder joints.

Proper soldering is key to a quality final product. If you are new to soldering, here are some basic guidelines to follow. It would be wise to buy a copper project board and a few cheap resistors or other components to practice with before starting this project.

Soldering and Solder Joints:

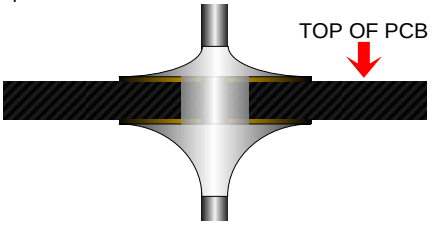
- For best results and maximum conductivity of any component, Wipe each wire lead down using Scotch Bright. Only one or two passes are required, making sure all of the surface has been cleaned. This removes oxidation or any other build up on the metal that has accumulated over time. Once cleaned, it is a good idea the further clean the wire leads with 90%+ isopropyl alcohol. Make sure all alcohol has evaporated prior to soldering as alcohol is VERY FLAMMABLE.
- Do not use to much or to little solder on each joint. See images below to get an idea of what you should be looking for
- The idea is to heat the pad and the component wire lead quickly and efficiently so that solder flows to each equally. Wetting the tip of your iron with a very small amount of solder will aid in quickly heating up the pad and wire lead.
- Having to heat a component for long periods of time, especially capacitors or LED's is NOT a good thing. When soldering capacitors or LED's, heat them only long enough to ensure a quality joint and let the unit cool down before soldering the second lead.
- The solder joint should look bright and metallic. A dull or dark gray looking joint is referred to as a "cold solder joint" Cold solder joints may not pose a problem initially, but can show up later in the amps life.
- After every solder joint, make sure to clean the flux off your soldering iron tip with a wet sponge that should be provided with your soldering iron kit.

CUTAWAY OF A VIA AND SOLDER PAD PRIOR TO SOLDERING:



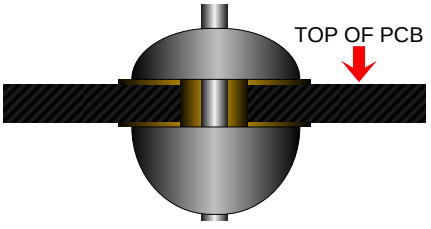
PROPER SOLDER JOINT:

- Solder is bright and shiny. It is curved smoothly starting at the edge of the solder pad until it reaches the lead from the component
- Solder should fill the via and flow through the board slightly. It is ok to add solder to the top side of the board, however it is not required



IMPROPER SOLDER JOINT:

- A large blob of solder, often dull in color is not desired. The solder may not flow into the via hole and cause a poor connection or failure later in the amplifiers life.



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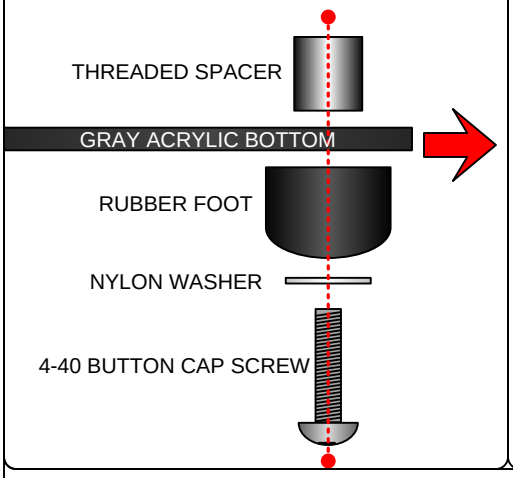
Bottom Chassis Prep / Final Chassis Assembly:

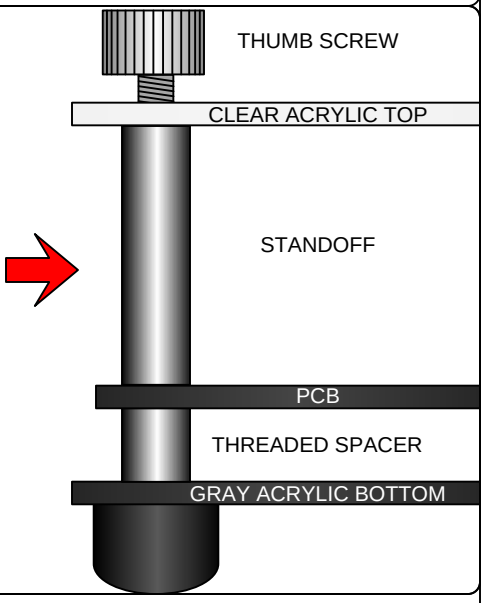
ASSEMBLE EACH OF THE 4 RUBBER FEET AS SHOWN, ATTACHING EACH FOOT TO THE GRAY SMOKED ACRYLIC BOTTOM CHASSIS



- ONCE THE PCB HAS BEEN ASSEMBLED, SET IT ONTO THE FOUR THREADS STICKING OUT OF THE BOTTOM GRAY ACRYLIC CHASSIS THAT YOU PREVIOUSLY ASSEMBLED.

- THREAD ON EACH OF THE FOUR HEX STANDOFFS ONTO THE THREADS THAT ARE NOW PROTRUDING THROUGH THE PCB, SECURING THE PCB TO THE GRAY ACRYLIC CHASSIS BOTTOM. PROCEED TO POWER ON THE UNIT (AS DESCRIBED ON PAGE 2, WEARING EYE PROTECTION AND AT A SAFE DISTANCE IN CASE OF A MISTAKE IN ASSEMBLY)

- ONCE THE AMPLIFIERS FUNCTIONALITY HAS BEEN TESTED AND THE UNIT HAS HAD A CHANCE TO FULLY WARM UP FOR 30 MINUTES, SET THE BIAS AS DESCRIBED LATER IN THIS MANUAL BEFORE PLACING THE TOP CLEAR ACRYLIC COVER IN PLACE



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Project Ember Operation Guide:

Normal Operation and Notes:

- Plug in the amplifier and then the power supply (in that order). Make sure the tube, headphone jack and input RCA's are secure. Once the amplifier is turned to the ON position, the front red LED (closest to the volume knob and headphone jack) will illuminate red for approximately 30 seconds. This indicates the protection circuit is active while the tube is warming up. It may take several minutes for the tube to fully warm up depending on the tube type used
- When the protection circuit activates and de-activates, a slight click may occur

- When the power switch is turned on and the amplifier is plugged in, the red LED at the back of the amplifier will illuminate

- Depending on the tube type chosen and the sensitivity of headphones used, background noise (hiss) may be present. Choosing a higher output impedance setting, or a lower gain tube can generally eliminate any background noise with sensitive headphones. This does not mean a high gain tube can not be used in our designs. Selecting a higher output resistance or lower input gain setting may reduce noise with higher gain tubes. We advise you experiment with several tubes to find out what you like best

- If load testing Project Ember, it is not recommended to attach a dummy load with a value below 15Ω when testing at full output power for a long periods. Heatsinks and the output devices at the bottom will become quite hot during testing. The amplifier will go into thermal protection when chip temperatures of 150oC are reached, indicated by the red protection LED at the front of the amplifier. Under normal conditions (playing music) even when driving low impedance loads, the output devices will get slightly warm at best.

- Some channel imbalance below 9 o'clock on the volume potentiometer is normal. We recommend you adjust your source output levels and use Project Ember with a volume setting of 9 o'clock or greater

- If input capacitors are bypassed, you will hear a scratching sound when adjusting the volume potentiometer

- Some faint scratch when turning the volpot is normal. This does not indicate a bad volpot – just a micro amount of DC that is present with certain tubes. This type of scratch is generally only heard with no music playing / rotating the volpot

- Cell phones or radio frequency devices in close proximity to Project Ember may create noise that is audible when listening to music (generally clicks or digital noises)

- Clean your Project Ember with a microfiber cloth and plastic cleaner (dusting with a microfiber cloth is generally all that is required). Compressed air is also great option for dust.

- Dual triode tubes with high heater current demands (above 500mA) are not recommended for this design (UNLESS EQUIPPED WITH A SUPERCHARGER MODULE). They may work without issues but the risk of the DC regulator IC2 failing after a certain period is possible.

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- When the RGB LED (LED under the tube) flickers upon startup, the (temporarily, current demand is higher than the regulator can handle. An example of tubes with very high startup current demands would be an E80CC or 12BH7's. If this flickering stops within a few seconds and the tube lights up normally, then you should be O.K. If this flickering takes longer than 10 seconds, this particular tube should not be used

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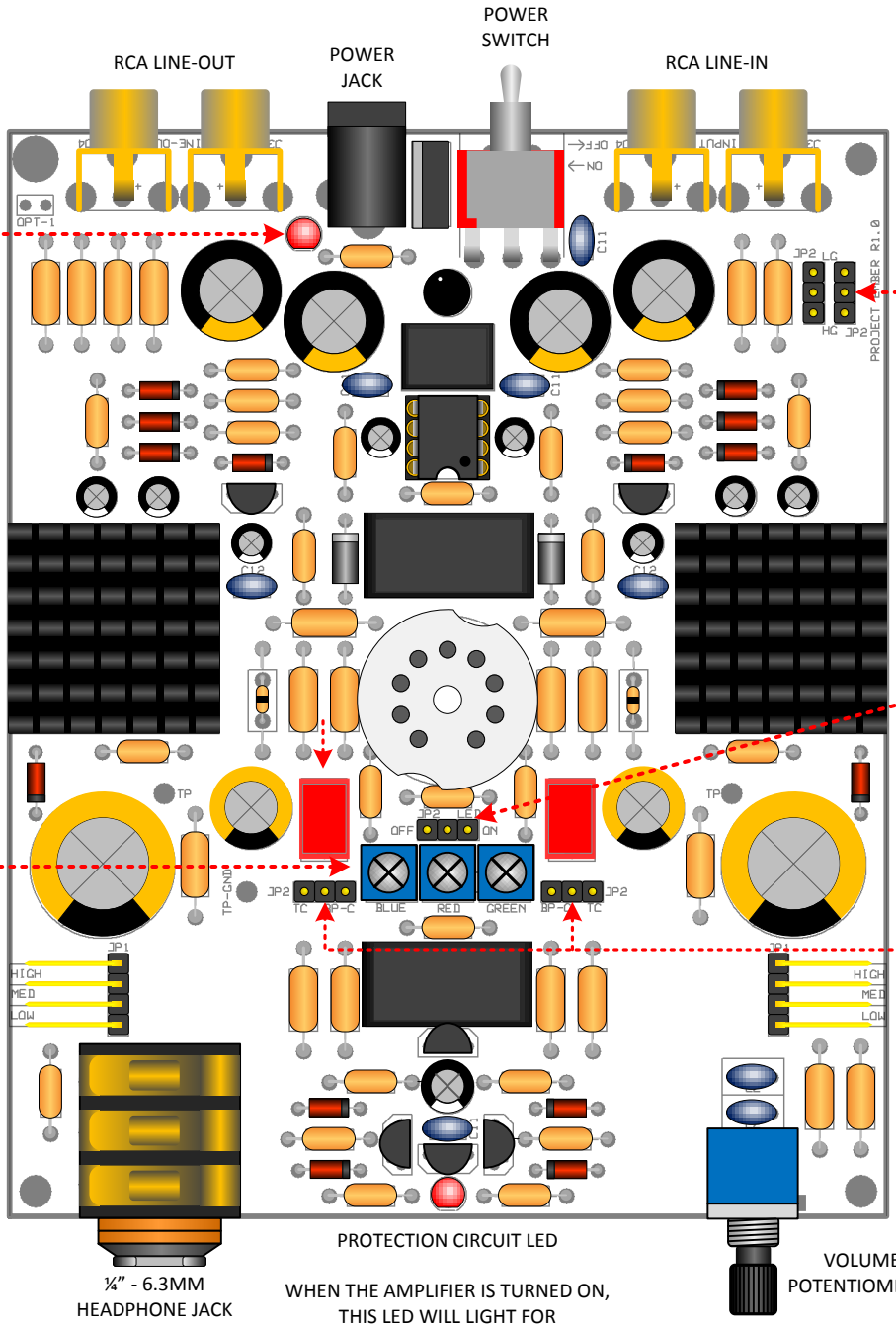
- Hot swapping tubes is not recommended (swapping tubes while the amplifier is on). Even though it does not cause technical errors or malfunctions it could damage headphones rated for 1W or less.

Project Ember

Assembly Guide



WHEN THE AMPLIFIER IS TURNED ON, THIS LED WILL LIGHT FOR APPROXIMATLEY 30 SECONDS INDICATING THE PROTECTION CIRCUIT IS ACTIVE WHILE THE TUBE WARMS UP

IF THERMAL LIMIT IS EVER REACHED, THE PROTECTION CIRCUIT WILL ACTIVATE AND THE LED WILL LIGHT

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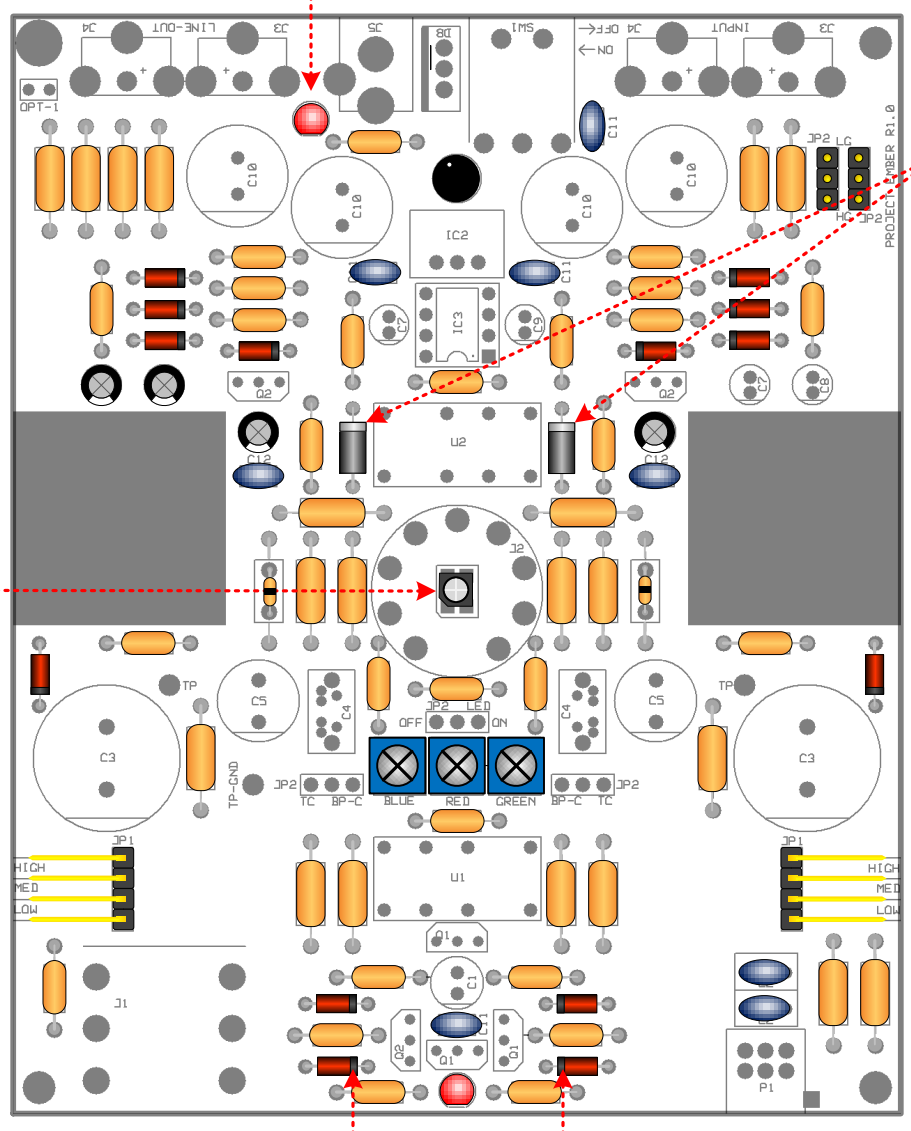
STEP 1: POPULATE ALL SMALL COMPONENTS ON THE BOARD SUCH AS RESISTORS, RIGHT ANGLE JUMPERS, DIODES AND SMALL CAPACITORS. THROUGHOUT YOUR BUILD, ALWAYS INSTALL THE SMALLER PARTS FIRST, WORKING YOUR WAY UP TO THE LARGER COMPONENTS

FLAT SPOT OR THE SHORT LEAD ON RED LED (INDICATES NEGATIVE SIDE OF LED) MUST FACE EXACTLY AS SHOWN

PAY CLOSE ATTENTION TO THE GRAY BAND ON EACH DIODE AS THEY ARE DIRECTIONAL

NOTCH ON THE RGB LED (ORIENTATION MARKING) MUST FACE THE WHITE MARKING ON THE PCB AS SHOWN

LED MUST BE INSTALLED BEFORE SOLDERING THE TUBE SOCKET IN PLACE



PAY CLOSE ATTENTION TO THE BLACK BAND ON ALL DIODES OR ZENERS AS THEY ARE DIRECTIONAL

- RESISTORS AND INDUCTORS ARE NONPOLAR AND CAN BE FITTED IN EITHER DIRECTION. WHEN INSTALLING COMPONENTS, MAKE SURE THE COMPONENT VALUES ALWAYS FACE UP SO THEY ARE VISIBLE (CAN AID IN TROUBLESHOOTING IF A COMPONENT IS PLACED IMPROPERLY)

- DIODES, TRANSISTORS, IC'S AND ELECTROLYTIC CAPACITORS ARE POLAR AND PROPER ORIENTATION IS REQUIRED

Project Ember

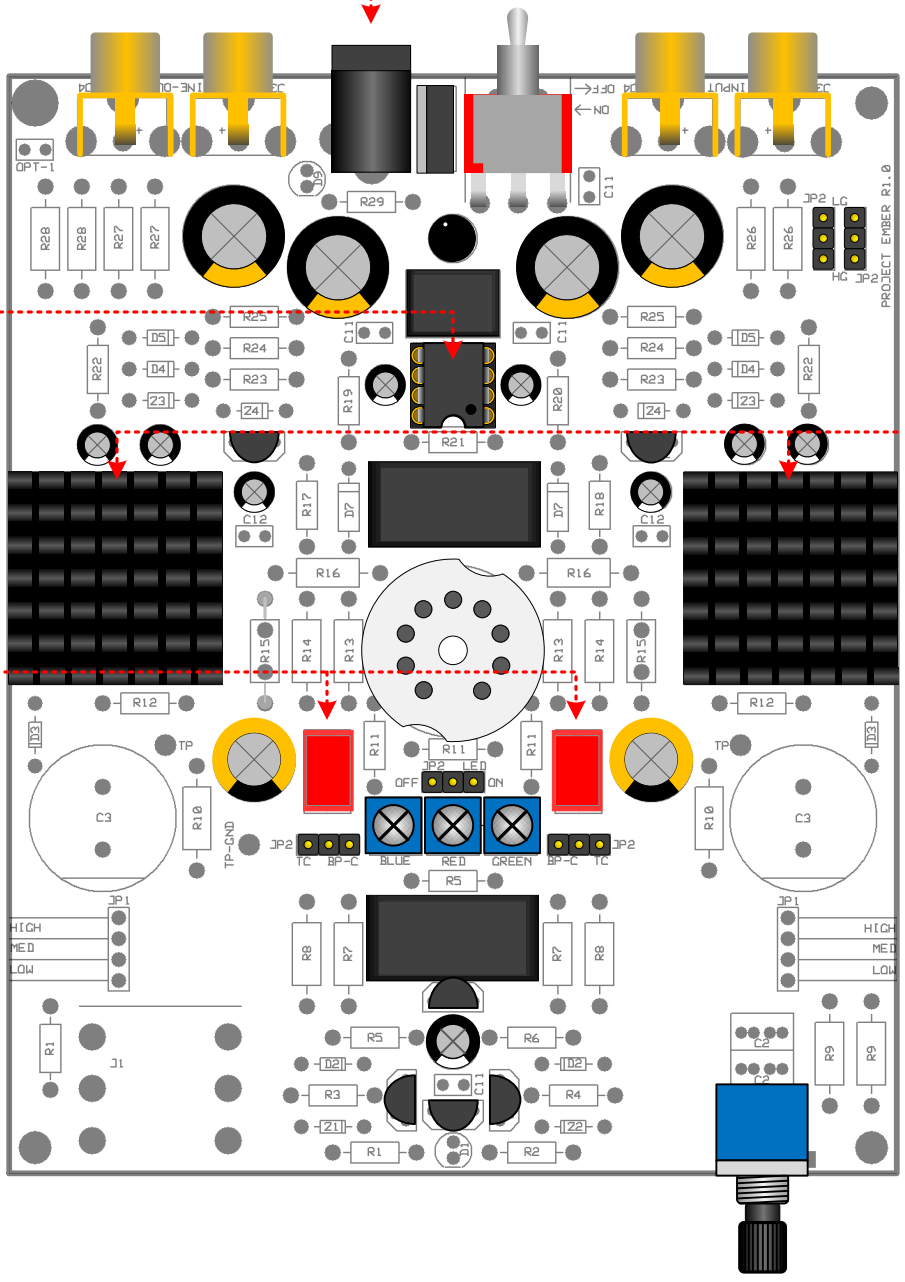
STEP 2: POPULATE ALL MID SIZE COMPONENTS SUCH AS RCA'S, POWER COMPONENTS, SMALL CAPACITORS, TUBE SOCKET, RELAYS, TRIMMERS AND SO FORTH

POLARIZED CAPACITORS MUST BE INSTALLED IN THE CORRECT DIRECTION (WILL HAVE A STRIPE DOWN THE SIDE DESIGNATING POLARITY) INSTALL THIS STRIPE FACING THE FLAT SPOT ON THE CAPACITOR OUTLINE ON THE BOARD

PLEASE NOTE: CENTER PIN OF DC SOCKET IS POSITIVE / 48VDC+

OPAMP IS DIRECTIONAL MAKE SURE THE BLACK DOT (PIN 1) IS CLOSEST TO THE TUBE SOCKET WHEN INSTALLED

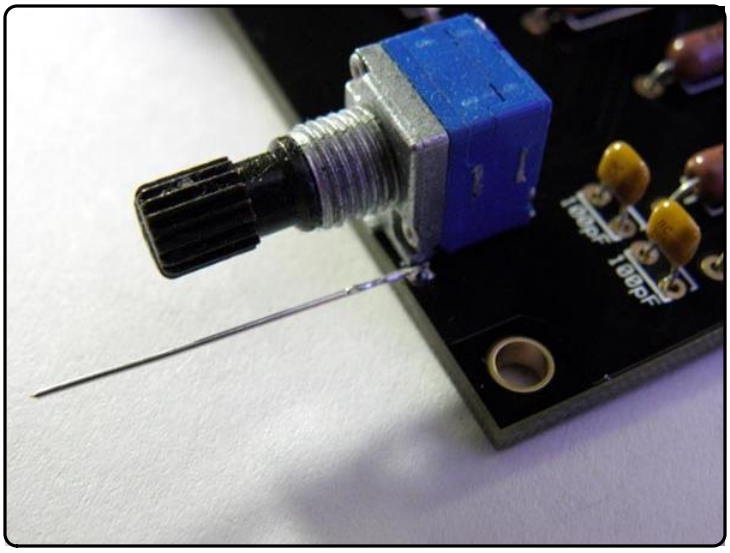
INPUT CAPACITORS ARE NONPOLAR MEANING THEY HAVE NO STRIPE AND CAN BE INSTALLED IN EITHER DIRECTION



PEEL OFF THE PROTECTIVE ADHESIVE LAYER ON THE BOTTOM SIDE OF THE HEATSINK(S). PLACE THE HEATSINKS DIRECTLY OVER THE THERMAL PADS ON THE PCB. ONCE INSTALLED, USE A HAIR DRYER OR HEATGUN TO BREIFLY HEAT UP EACH HEATSINK WHICH WILL ACTIVATE THE ADHESIVE.

CAUTION: IF USING A HEATGUN, ONLY APPLY HEAT FOR A FEW SECONDS DIRECTLY ONTO EACH HEATSINK

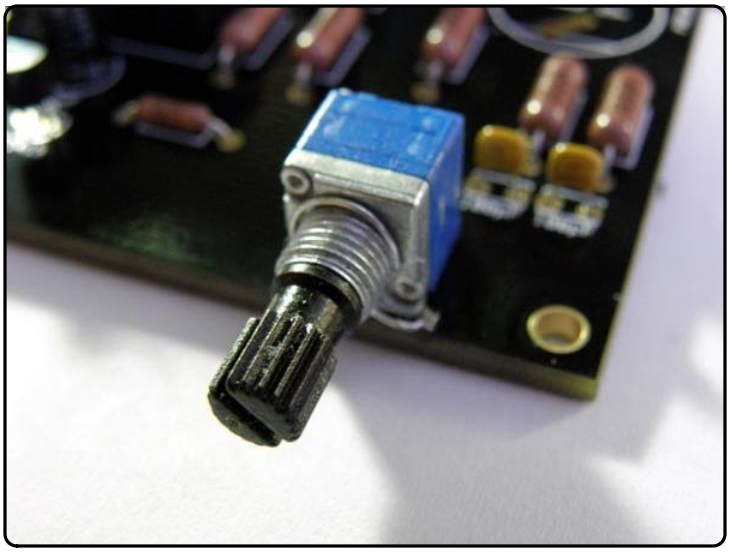
VOLPOT GROUNDING



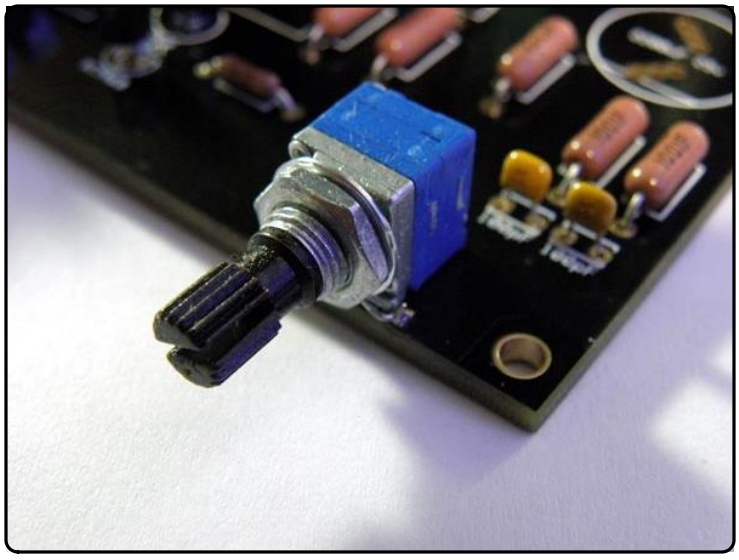
GROUNDING THE VOLUME POTENTIOMETER IS REQUIRED AS WITHOUT IT, THE AMPLIFIER MAY BE SUBJECTED TO NOISE / INTERFERENCE.

THE IMAGES ARE OF THE PREVIOUS GENERATION SUNRISE, HOWEVER THE GROUNDING PRINCIPAL IS EXACTLY THE SAME.

FIRST, INSERT A WIRE LEAD INTO THE RIGHT SIDE VIA NEXT TO THE VOLPOT AND SOLDER IN PLACE.



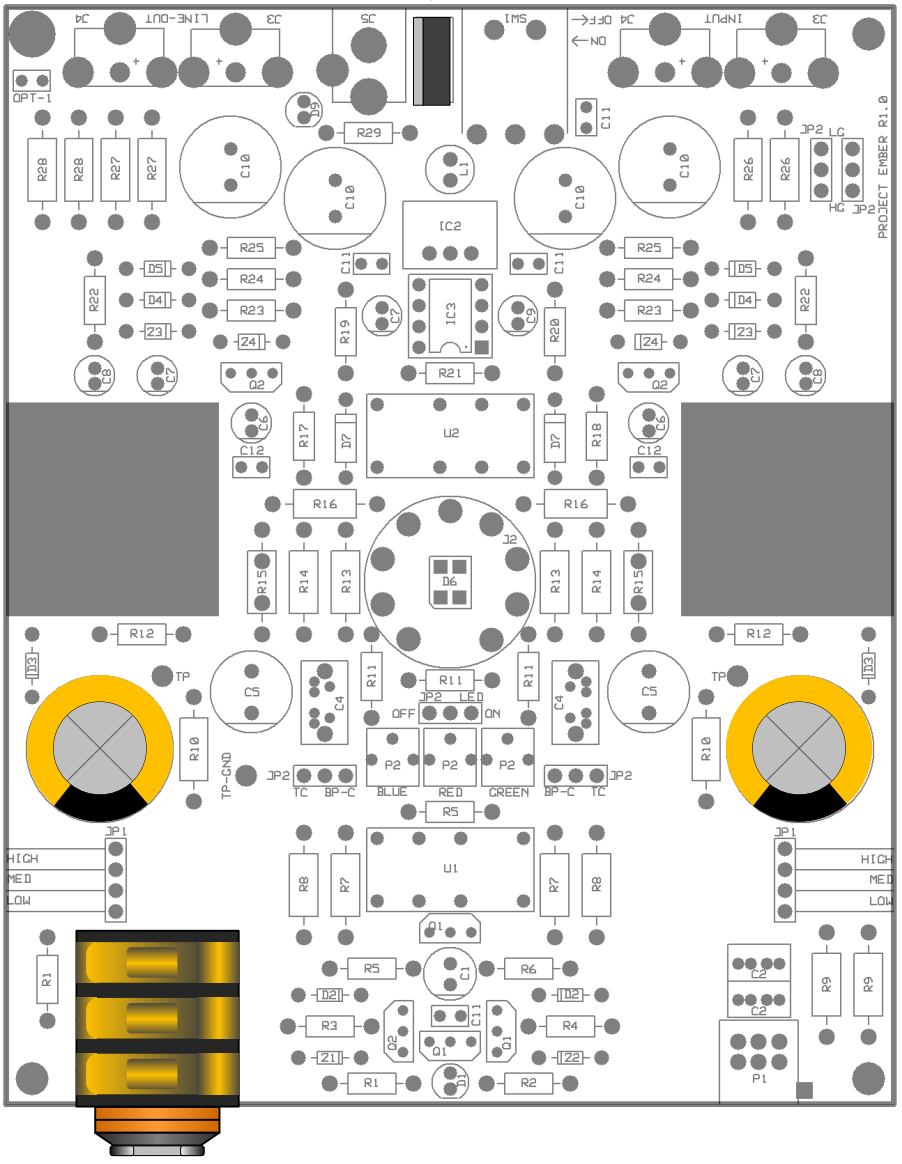
WRAP THE WIRE LEAD AROUND THE THREADED PORTION OF THE VOLPOT AS SHOWN.



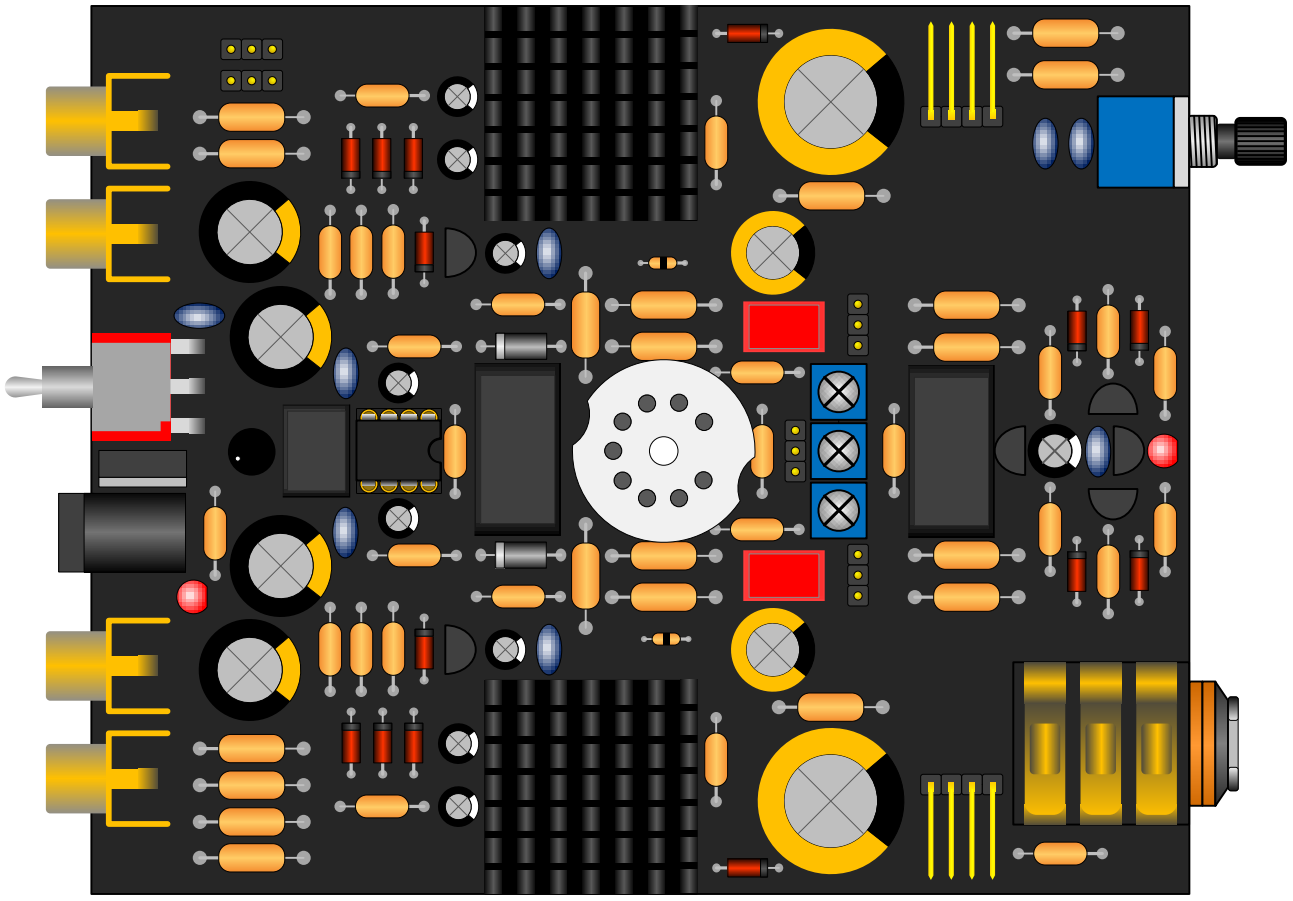
PUT ON WASHER AND NUT INCLUDED IN THE KIT. ONCE TIGHT, THE VOLUME KNOB MAY BE INSTALLED.

STEP 3: POPULATE ALL LARGE SIZE COMPONENTS SUCH AS LARGE CAPACITORS, TO220 DIODE AND HEADPHONE JACK

POSITION THE TO220 DIODE EXACTLY AS SHOWN

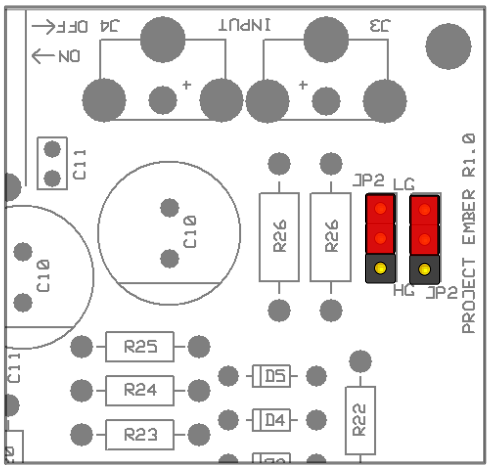


COMPLETED EMBER LAYOUT AND PHOTO:

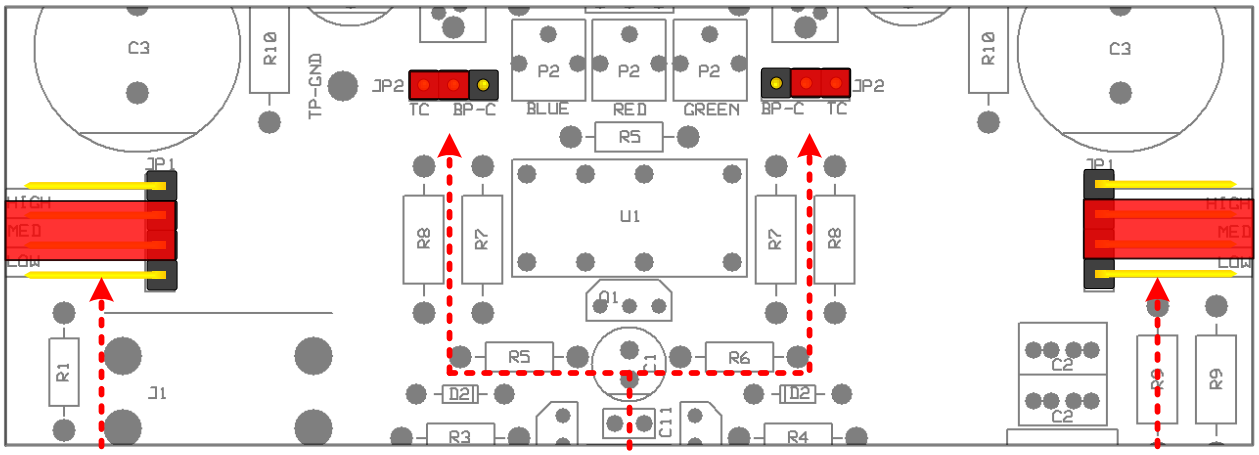


Project Ember

Project Ember has several jumpers settings to customize the amp the way you would like it. Below gives you the details on what these jumper settings do!



INPUT GAIN CAN BE CHANGED VIA THE LG (LOW GAIN) AND HG (HIGH GAIN) JUMPER TABS AT THE BACK, RIGHT HAND CORNER OF THE AMPLIFIER. DEFAULT SETTING IS LOW GAIN. HIGH GAIN WILL INCREASE LEVELS BY APPROXIMATLEY +6dB



INPUT CAPACITORS CAN BE BYPASSED PER YOUR PREFERENCE. MANY VIEW THIS AS A PURIST FUNCTION AS IT IS ONE LESS COMPONENT IN THE SIGNAL PATH. WITH INPUT CAPS BYPASSED, YOU MAY HEAR A SCRATCHY SOUND WHEN ADJUSTING VOLUME. THIS WILL NOT DAMAGE YOUR HEADPHONES OR YOUR AMPLIFIER

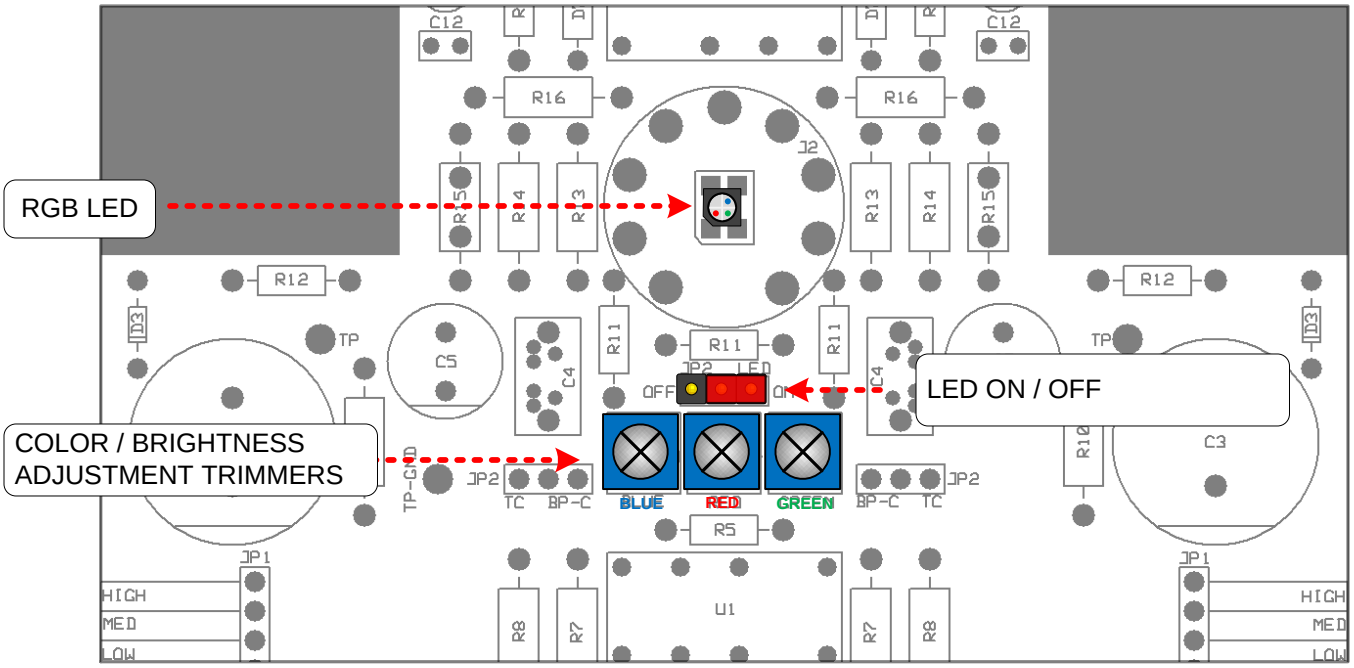
TC = SIGNAL GOES THROUGH CAP (EXAMPLE SETTING IN RED)

BP-C = SIGNAL DOES NOT GO THROUGH INPUT CAP (BYPASSED)

OUTPUT RESISTANCE IS CONFIGURABLE BETWEEN 0.1Ω (LOW) 35Ω (MID) AND 120Ω (HIGH). HIGHER OUTPUT RESISTANCE CAN HAVE AN EFFECT ON BASS AND/OR TREBLE FREQUENCIES. THIS EFFECT IS DEPENDANT ON THE HEADPHONE IMPEDANCE. (EXAMPLE OF 35Ω SETTING IN RED) EXPERIMENT BY CHANGING THE SETTINGS TO FIND WHAT YOUR PREFERENCE IS

Project Ember

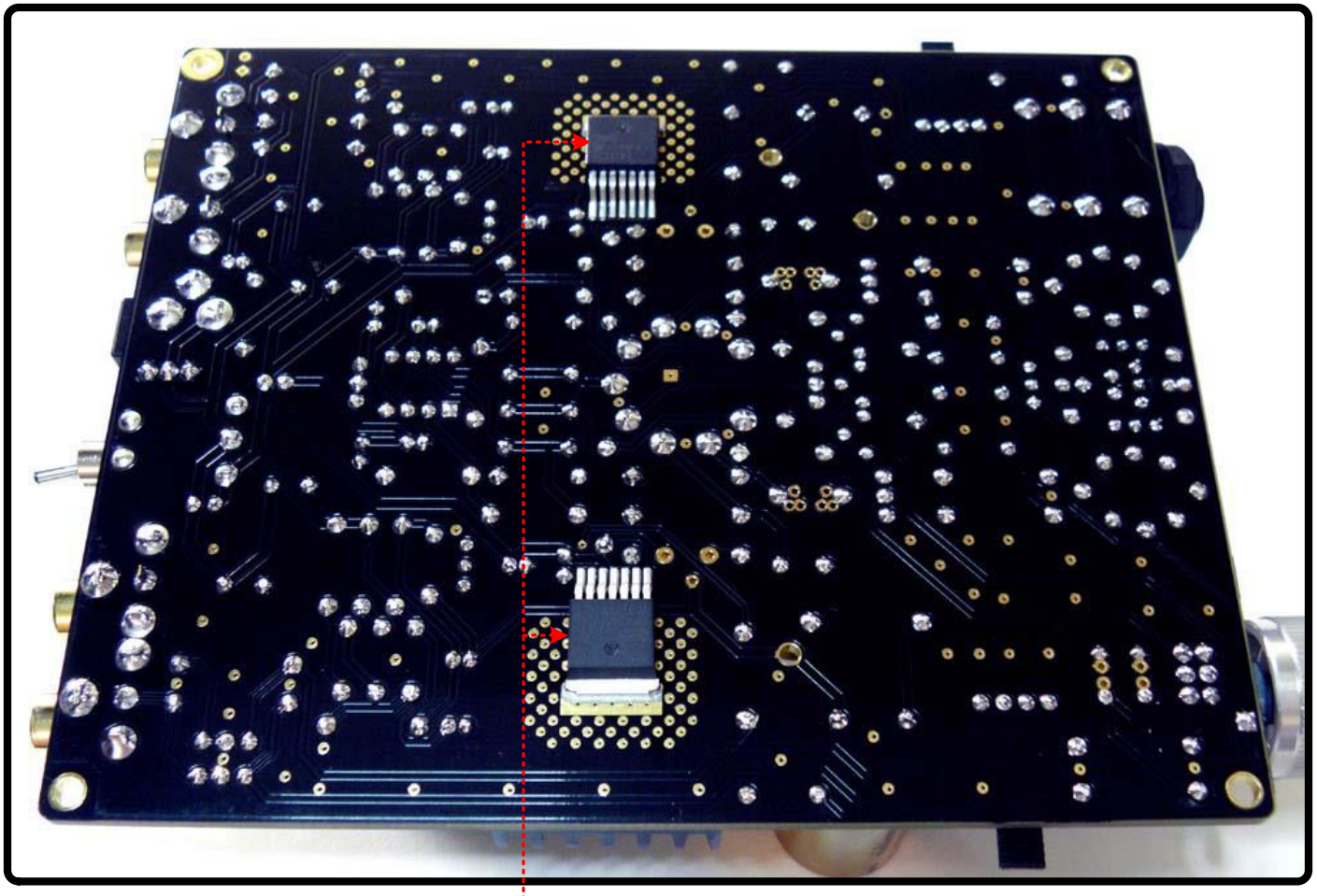
LED Light Color



Another feature of Project Ember is an adjustable RGB (RED GREEN BLUE) LED under the tube. RGB LED's can produce almost any color desirable. We understand this is not an audiophile feature or a feature that has anything to do with the sound of the amplifier. Each of us has a favorite color that is enjoyable to look at. Using the three trimmers located above, you can dial in any color you desire and also the brightness of that color. Often manufacturers tie you into their specific color scheme on their products. We feel it is important for you to choose the color you desire which can set an enjoyable mood when listening to your music. Adjust the brightness and color by turning each of the trimmers with a small jewelers screwdriver. Or simply disable the RGB LED (jumper) enjoy the glow of the tube.

Project Ember

OPA551 OUTPUTS



THE OUTPUT STAGES OF THE AMPLIFIER (OPA551 - DDPAK7 IC'S) ARE LOCATED ON THE BOTTOM SIDE OF THE AMPLIFIER. THEY COME PRE-INSTALLED – REFLOW SOLDERED TO THE PCB. PRIOR TO SHIPPING, ALL FLUX FROM THE REFLOW PROCESS WILL BE CLEANED AND REMOVED FROM THE PCB

IT IS NORMAL FOR A SMALL AMOUNT OF SOLDER TO BLEED THROUGH THE THERMAL VIAS AND BE VISIBLE ON THE HEATSINK THERMAL PAD (LARGE GOLD SQUARES ON THE TOP SIDE OF THE PCB). WHEN INSTALLING THE HEATSINK(S), THE SOLDER WILL NOT BE VISIBLE

DO NOT ATTEMPT TO REMOVE OR REPLACE THE OPA551's WITH ANY OTHER TYPE

Project Ember

Resistors
R1 = SM 100K X2
R2 = SM 470K X 1
R3 = SM 10K X 1
R4 = SM 220K X 1
R5 = SM 330R X 2
R6 = SM 4K7 X 1
R7 = LG 47R X 2
R8 = LG 120R X 2
R9 = LG 10K X 2
R10 = LG 2.2K X 2
R11 = SM 220R X 3
R12 = SM 22K X 2
R13 = LG 100K X 2
R14 = LG 1K X 2
R15 = LG 0R X 2
R16 = LG 1K X 2
R17 = SM 1K X 1
R18 = SM 39K X 1
R19 = SM 10K X 1
R20 = SM 1K X 1
R21 = SM 18R X 1
R22 = SM 39K X 2
R23 = SM 39K X 2
R24 = SM 18K X 2
R25 = SM 1K8 X 2
R26 = LG 20K X 2
R27 = LG 220R X 2
R28 = LG 1K X 2
R29 = SM 100K X 1

Diodes
Z1 = BZX79-C43 X 1
Z2 = BZX79-C39 X 1
Z3 = BZX79-C10 X 2
Z4 = BZX79-C22 X 2
D1 = RED LED X 1
D2 = 1N4148 X 2
D3 = 1N4148 X 2
D4 = 1N4148 X 2
D5 = 1N4148 X 2
D6 = RGB LED X 1
D7 = SB140 X 2
D8 = TO-220 DIODE
D9 = RED LED X 1

Regulators
IC1 = OPA551 X 2
IC2 = DC-DC X1
IC3 = TS921 X 1

Jacks
J1 = HEADPHONE JACK X 1
J2 = TUBE SOCKET X 1
J3 = BLACK RCA JACK X 2
J4 = RED RCA JACK X 2
J5 = POWER INPUT JACK X 1

Capacitors
C1 = 47uF 63V X 1
C2 = 47pF X 2
C3 = 2200uF 63V X 2
C4 = 1uF X 2
C5 = 470uF 10V X 2
C6 = 10uF 63V X 2
C7 = 10uF 63V X 3
C8 = 100uF 16V X 2
C9 = 4.7uF 63V X 1
C10 = 47uF 100V x 4
C11 = 100nF X 4
C12 = 100nF X 2

Transistors
Q1 = BC546 X 3
Q2 = BC556 X 3

Inductor
L1 = 100uH X 1

Jumpers
JP1 = 4 PIN RA X 2
JP2 = 3 PIN STRAIGHT X 5

Switches
SW1 = POWER SWITCH X 1

Potentiometers / Trimmers
P1 = 10K VOLUME POTENTIOMETER X 1
P2 = 50K SINGLE TURN TRIMMER X 3

Relay
U1 = 48V RELAY X 1
U2 = 5V HIGH SENSITIVITY RELAY X 1

Other
HEATSINK X 2
JUMPER TABS X 7

G1217

Supercharger

USER MANUAL – JULY 3RD 2014

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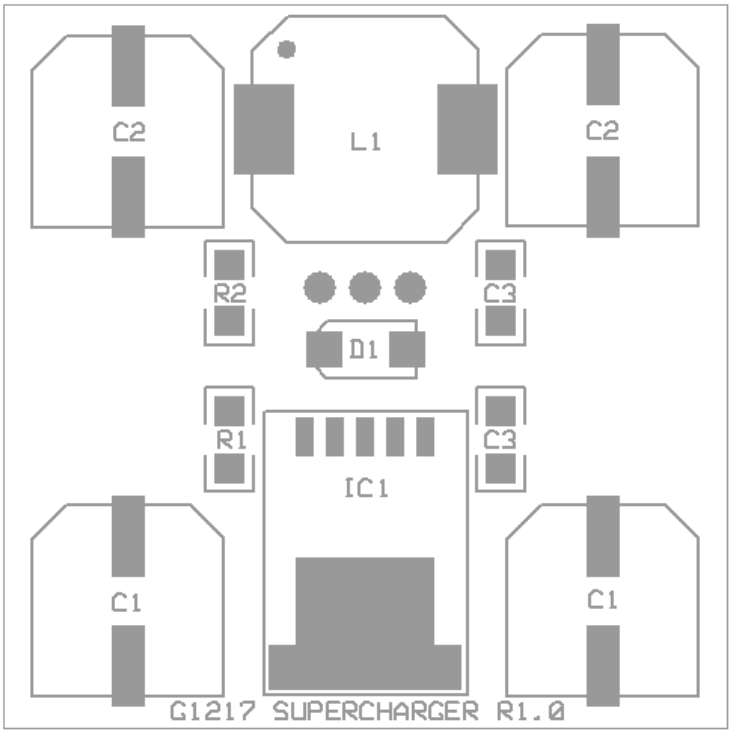
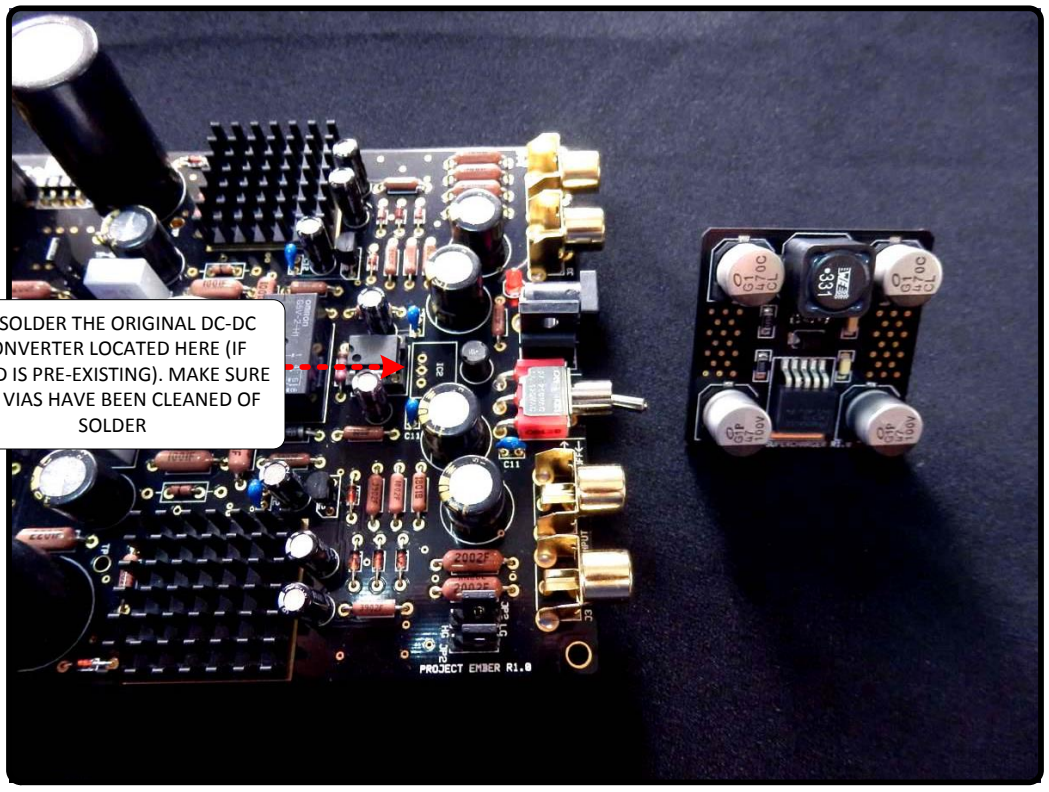
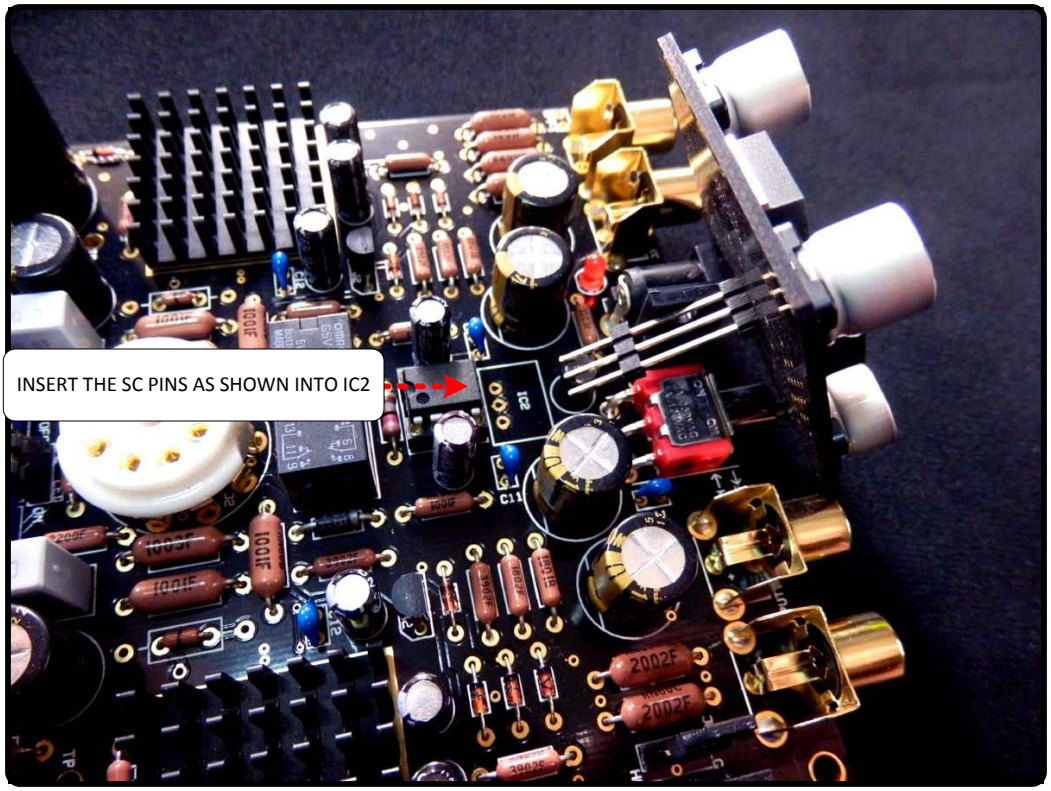


Designed to increase available heater current from 500mA (600mA peak) to well past 1A. This allows a much broader qty of tubes to be rolled into your Project Ember. Tubes such as the 6n6p, 6n30p, 12bh7 and so forth can now be used and powered properly! Also initial tube warm up time is drastically decreased (with tubes drawing 500mA or more)

INSTALLING THE SUPERCHARGER INTO PROJECT EMBER:





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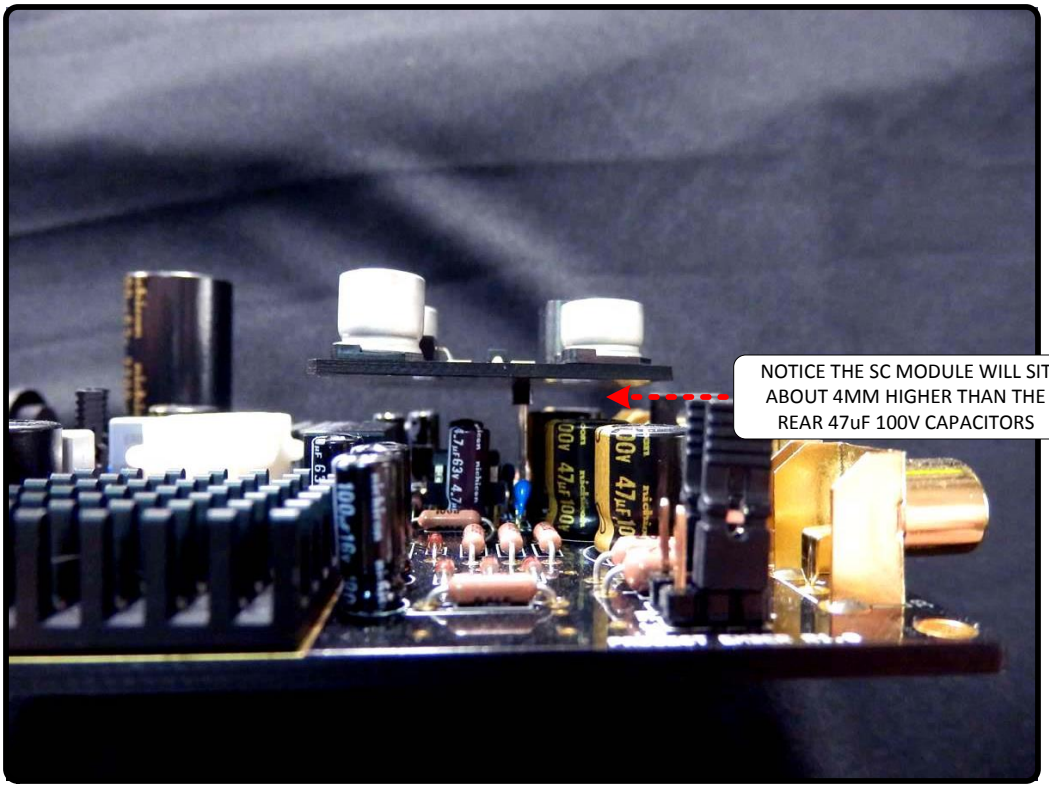

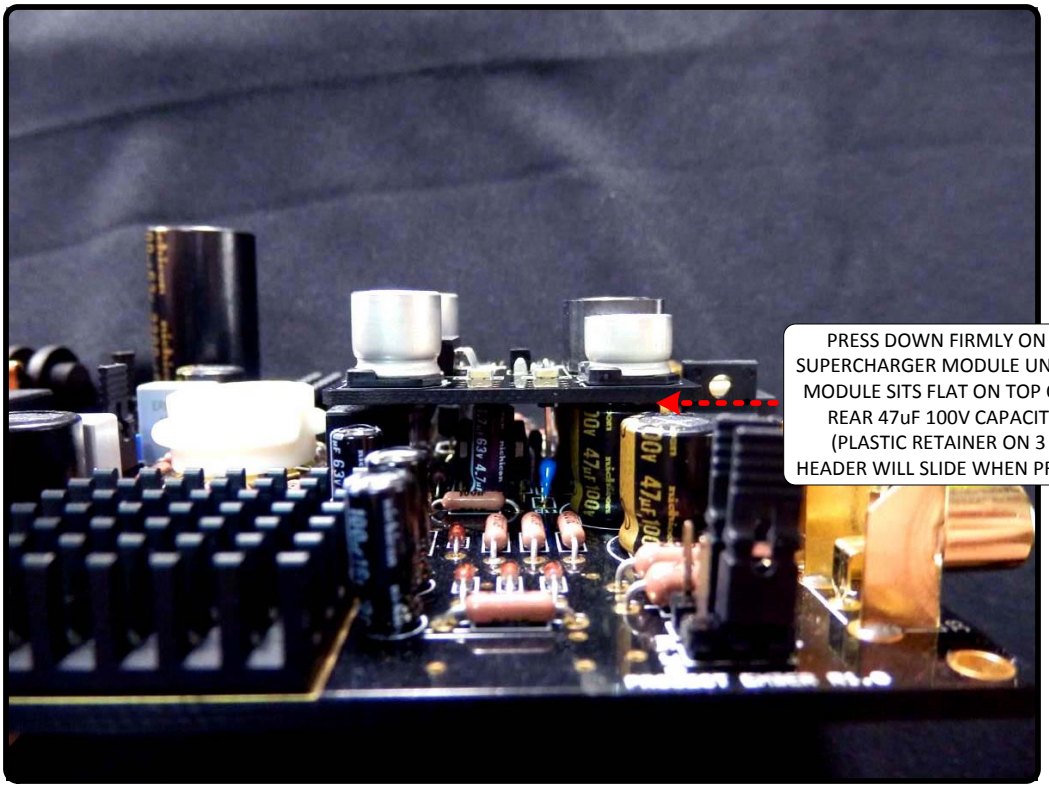

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Supercharger

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