DC Power Supply Kit

Technical Manual Rev rev2.0

A good Power Supply unit is as essential in an electronic workbench as a good DMM. This simple Power Supply Project, simple as it may be, has features and performance that of a laboratory power supply. It has has both constant voltage and constant current features, just to start with. The constant current feature is quite useful in both device (under test) troubleshooting and characterization, yet is conspicuously absent in most low cost power supply sold for hobby use. It has good voltage and current regulation, and reasonably low output noise in either mode.

And it is also fun and easy enough to build one yourself.

And, by all means, not the least, it uses a well built transformer that is adequately rated. The transformer is probably the most important component in a power supply circuit, and the most expensive.

It is a very unfortunate fact that most cheap powersupply sold for hobby cut their cost by using under rated and poorly manufactured transformer.

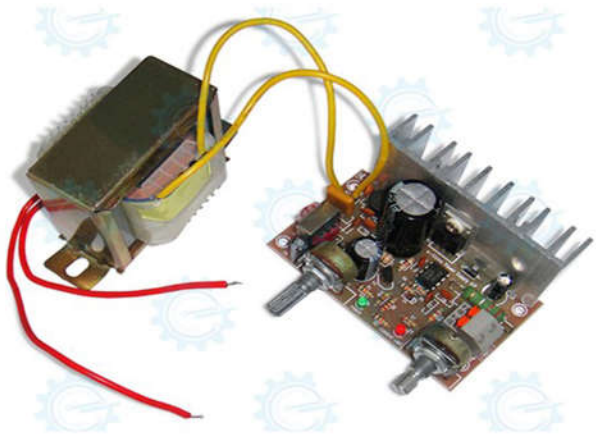
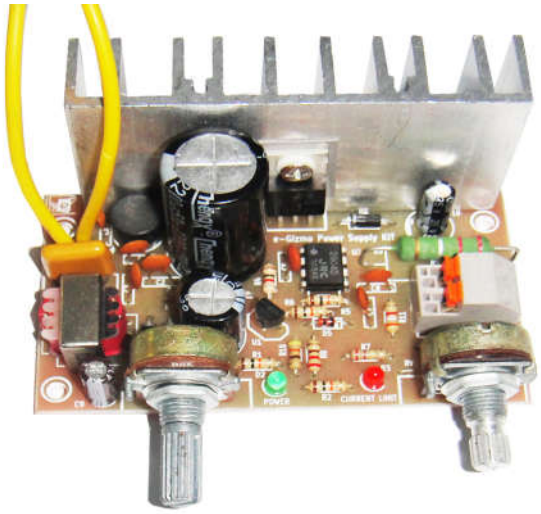


Figure 1. A completely assembled e-Gizmo DC Power Supply Kit



Measure Performance:

Output voltage: *1.28~17.58VDC (Note 1)*
Output Current: *0.1 to 1.1A (Note 2)*
Voltage regulation: *0.02% No load to Full Load*
Current Regulation @ 0.5A: *0.258%, 2.0V to 10.0*
Output Hum and Noise @ 10V (Unweighted):
170uV No load, CV Mode
300uV @ 1A CV Mode
230uV @ 0.5A CV Mode
22mV @ 0.5A, 10V CC Mode

Note 1: *Nominal voltage output specifi cations is 1.3 to 15VDC*
Note 2: *Maximum output current specifi cations is 1.0A*

Component values were intentionaly set for a wider range, encompassing portions outside of the nominal specifi cations. Performance outside of the nominal spec is not guaranteed.

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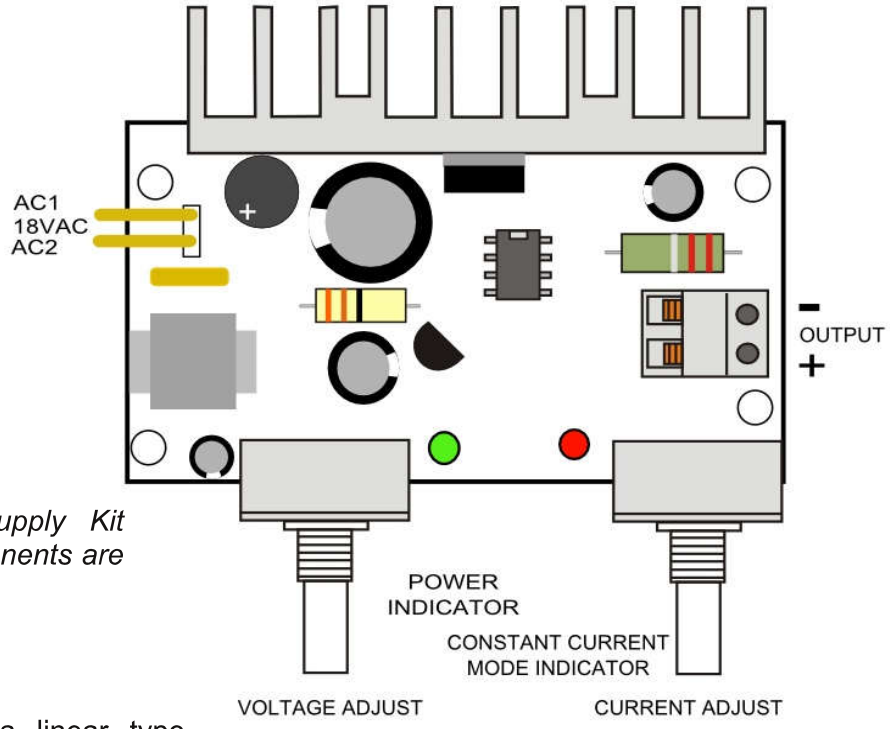

Figure 2. e-Gizmo DC Power Supply Kit component layout. Only major components are shown in the layout for clarity.

ABOUT THE CIRCUIT

The Simple Power Supply kit is a linear type regulated power supply circuit.

Voltage Regulator Function

The main voltage regulator is the hobby favorite LM317L adjustable voltage regulator U1. This regulator is made to operate at higher current outputwith the help of a series pass transistor Q1. Whenpower supply load current stays below 15 mA, theresulting voltage across R3 is not suffi cient to pushQ1 into conduction, hence, under this condition,Q1 is inactive and lets U1 to handle the load all by itself. But when the load current increases to more than 20mA, the voltage developing across R3 (0.02A * 33 = 0.66V) will activate Q1, causing most of the current load pass through it instead of U1.

Current Regulator Function

Current is continously monitored by comparator U2B by sensing the voltage across R2. If the current reached the preset level, U2B will activate by pulling its output towards the ground level. This action, as a consequence, will force the U1 output voltage to drop, The action stabilizes with just enough output voltage drop to keep the load current constant at the preset level determined by RV1.

U2A is used for constant current CC indication. When the power supply enters constant current mode, as just described in the preceding paragraph, the current passing through D5 will cause the voltage at the minus input pin 2 of U2A to become more positive that its plus input pin 3. This will force the output of U2A towards ground, hence, illuminating LED D3 for the CC mode indication.

Rectifier Circuits

Bridge rectifi er D1, together with C5, forms the main AC-DC full bridge rectifi er circuit. D6 and C12 is a half bridge rectifi er circuit that generates a negative bias for U2. A negative bias is necessary to ensure the constant current working at low output voltage conditions.
You probably notice the small capacitors wired across each diode element in the rectifi er circuit. These capacitors softens the starting and stopping of current conduction of the diodes during zero crossings to help minimize generation of electrical noise.

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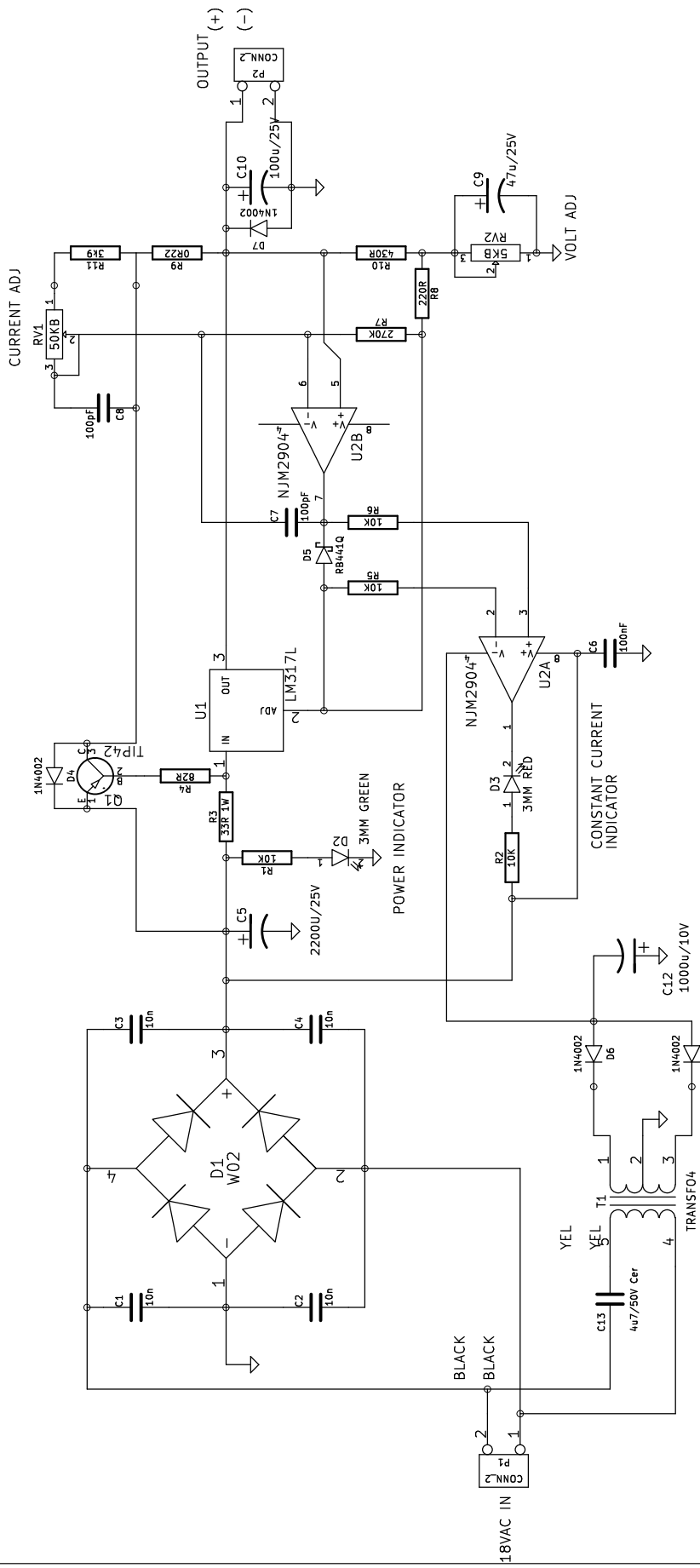

Figure 3. e-Gizmo DC Power Supply Kit complete schematic diagram. Note the transformer is not shown in this schematic.

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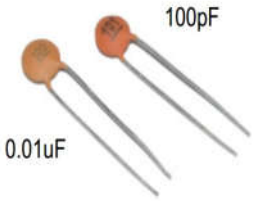
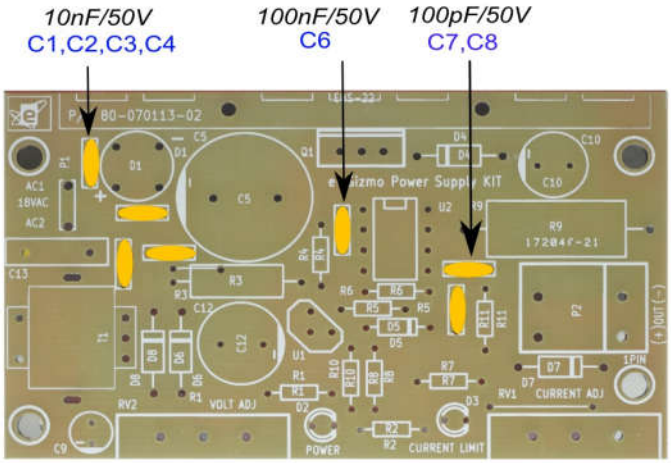
ILLUSTRATED ASSEMBLY GUIDE

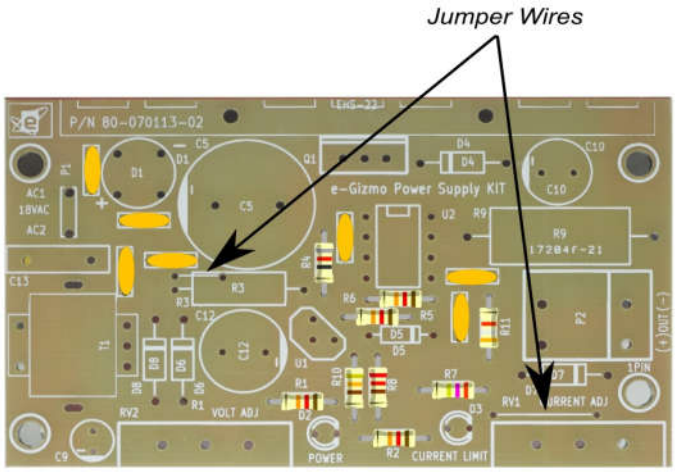
1. Insert and solder all ceramic capacitors. Only two values of ceramic capacitors are used in this kit. The 0.01uF are marked with “103”, while the 100pF are marked with “101”.



2. Mount and solder C6. C6 is a box type 100nF Polyester Film capacitor. It is green colored in the picture, but may sometimes comes in Blue or even yellow color.



3. Mount and solder all 1/4W resistors.
4. At this point, you will notice that you already have plenty of cut-off component leads. The two jumper wires can now be soldered using a pair of these cut-off component leads.

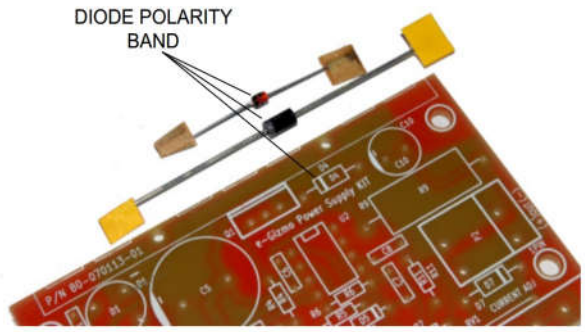


5. Mount and solder the two big resistors R3 and R9.

Mounting and soldering of polarized components.

The capacitors and resistors that you have mounted so far do not care about their pin orientation, you can mount swap their pins without any effect in their function. The following components you will be mounting next are polarized, now, you have to pay a closer attention to when mounting them. Mounting them in the wrong orientation will result in circuit failure, possibly, a permanent damage.

1. Diodes. Note the printing of the diode components in the PCB. Each one is marked with a band indicating its correct polarity. So are the diode that are to be mounted in this locations. Make sure the band of the diode correspond to the band printed in the PCB.



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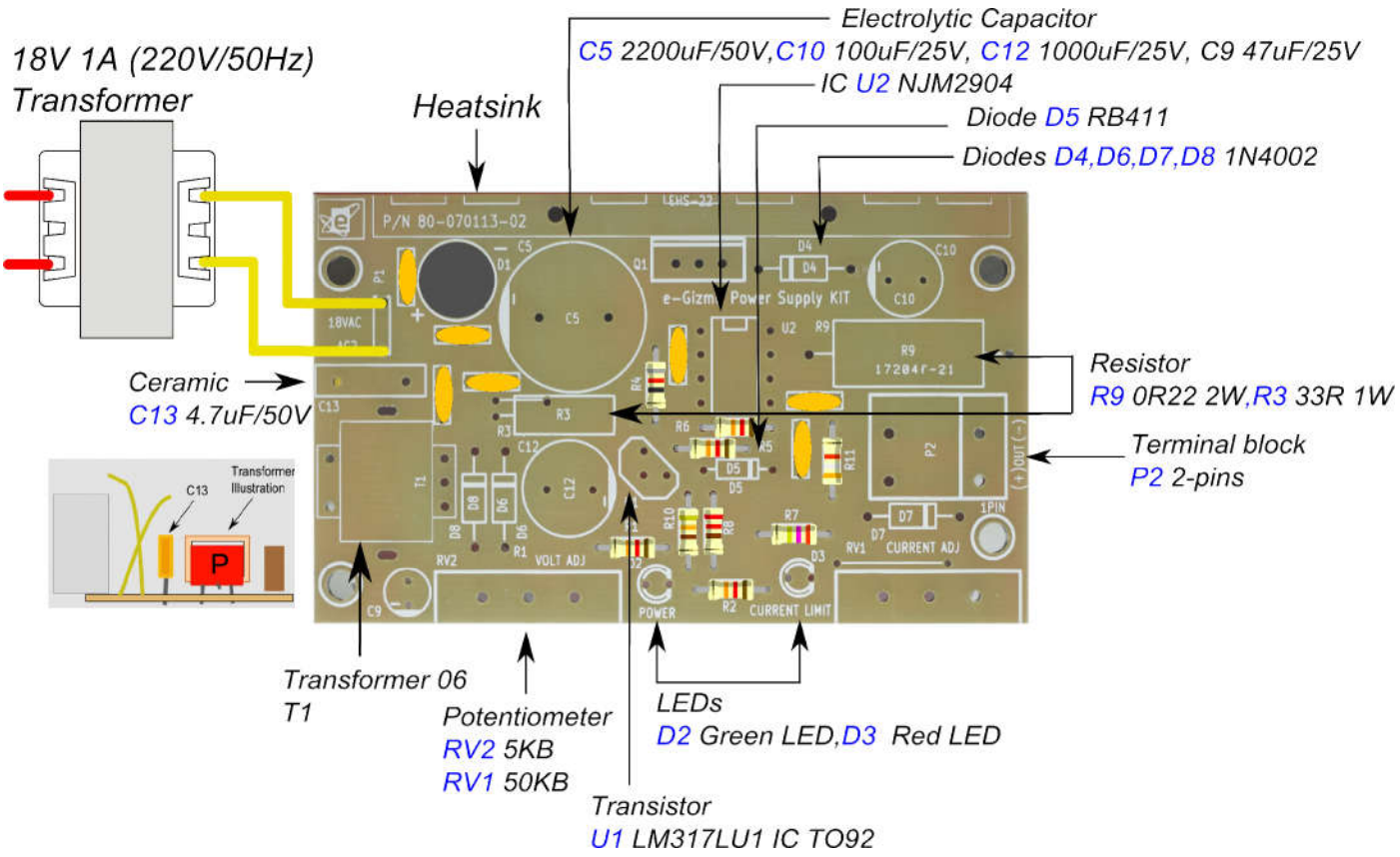
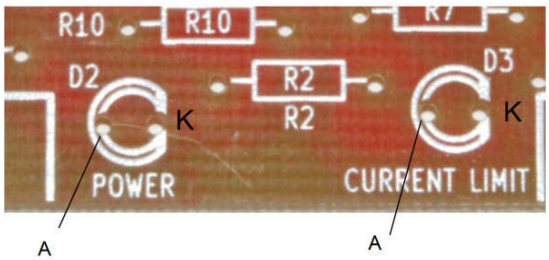


2.LEDs. The green LED is used as a power indicator hence should be mounted on D2 position. The red LED is for D3 current limit indicator. See photos below for more details and precautions when mounting the LEDs.

NOTE: A (ANODE) LEAD IS LONGER



NOTE: DO NOT INSERT THE LEDs ALL THE WAY IN. LEAVE AT LEAST 3MM SPACE BETWEEN ITS BASE THE THE PCB SURFACE.

3. U1 and U2. U1 should have its flat side facing U2. U2, on the other hand, must have its pin 1 oriented closest to Q1.

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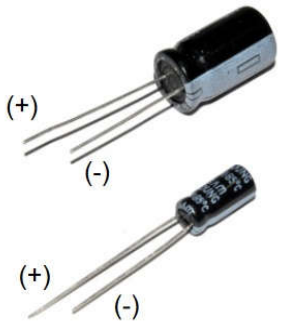
4. Electrolytic Capacitors.



POLARIZED ELECTROLYTIC CAPS HAVE THIER NEGATIVE PINS MARKED PROMINENTLY WITH A HEAVY STRIPE ON ITS BODY. THE (-) PIN IS ALSO CUT SHORTER FOR EASY IDENTIFICATION.

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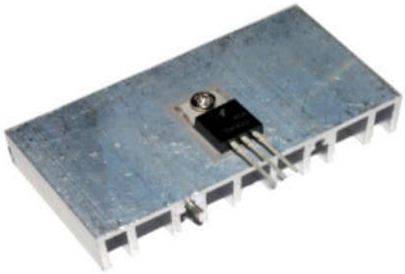
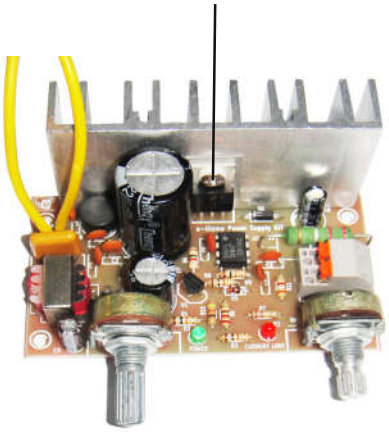
5. Potentiometers and Terminals. Be careful not to mix up the the potentiometer. RV1 is a 50KB pot, while RV2 is 5KB. The “B” prefix for both potentiometer means “Linear” type. Make sure you are using the B type. Using nonlinear potentiometers (i.e. Type A, C, or D) will make the power supply difficult to set in some settings.

6. Transistor Q1. Transistor Q1 must be mounted on its heat sink and then are together mounted in the PCB. A silicone transistor insulator (gray) must be used, not so much for the insulation, but to ensure good thermal bonding between the transistor and the heat sink. Do not tighten the screw yet. Let the transistor move freely. The mounting screw shall be tightened after the transistor-heat-sink assembly is mounted and soldered.



7. Mount and solder the transistor-heatsink assembly. Tighten the transistor mounting screw.

TIGHTEN Q1 MOUNTING SCREW AFTER THE HEATSINK AND Q1 ARE SOLDERED IN PLACE.



Transformer Wiring

The transformer used in this project has two secondary windings. The Yellow pair carry the main 18VAC power source, while the Red pair connects to the 220V AC outlet.

The wire connects to the circuit board by soldeing it directly to the board.

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TESTING PROCEDURE:

The following are quick test you should perform to verify the operation of your newly assembled power supply.

Constant Voltage Mode Verification

1. Connect a DMM set at 20VDC range at the Power Supply Output.

2. Rotate both Power Supply the Voltage and Current fully clockwise.

3. Eyes on the DMM readout, switch ON the power supply and note the DMM readings. It should read somewhere within 15.0-19.0VDC. If the readings falls outside this range, quickly turn OFF the power supply
. This indicates a serious problem with the power supply circuit. Inspect your power supply for assembly errors, wrong components, and soldering faults

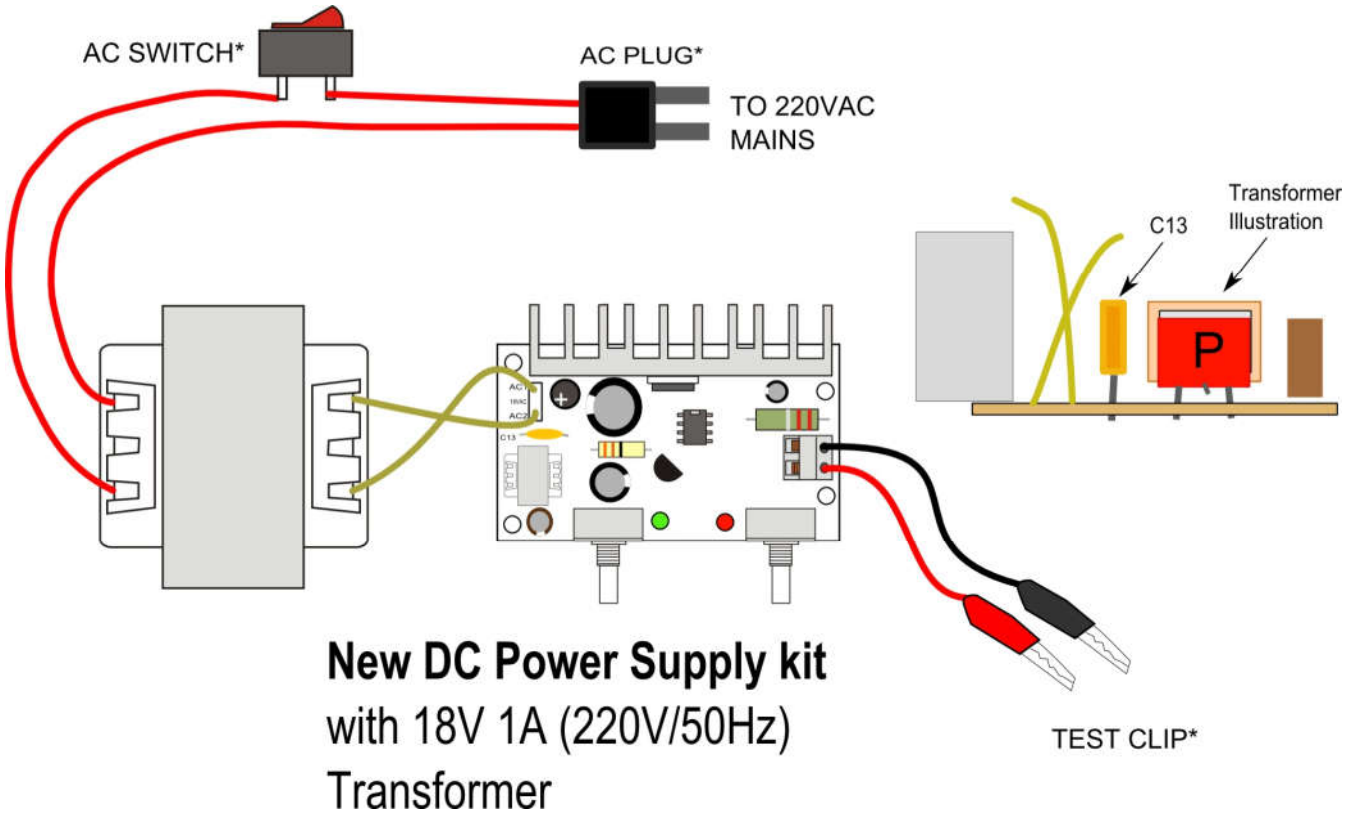

Figure 5. Wiring guide to connect off-PCB components. Note, wire colors of the transformer may change, hence, should always be checked with the actual transformer supplied with the kit. Any change in wiring color will be promptly indicated in the transformer label.

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4.If the voltage is within the expected range, proceed with the test by gently rotating the Voltage control counter clockwise while observing the DMM readout.

You should see the output voltage dropping as you rotate the control. At full counterclockwise position, voltage will be somewhere between 1.2 to 1.4VDC.

Constant Current Mode Verification

To verify the constant current mode, you need a high power resistor to use as a test load. It is best if you can grab a 10R 10W, although any 5W resistor with resistance between 4.7 ohm and 10 ohm will do.

1. Rotate the voltage control in full clockwise rotation and the current control in full counter clockwise position.

2. Connect you test load. You should see the output voltage drop to 3V or less, depending on your test resistor. Check the constant current indicated led should also be lit.

3.With eyes on the DMM, slowly rotate the current control clockwise. You should see the voltage rising as the current control is rotated. With a 10R test load, the voltage should stop rising once it reaches 10V to 12V. With lower resistance test load, voltage rise will stop at a correspondingly lower voltage.If your power supply passes these quick test, it is probably built good and ready for use. Otherwise, you have prepare yourself for the rework and troubleshooting at hand.

BILL OF MATERIALS

Ceramic Capacitors, 50VDC
2 100pF C7 C8
4 10n C1 C2 C3 C4
1 100nF/50V C6

Electrolytic Capacitors
1 47u/25V C9
1 100u/25V C10
1 1000u/10V C12
1 2200U/25V C5

Light Emitting Diode
1 3MM GREEN D2
1 3MM RED D3

Diode & Rectifiers
1 W02 D1
3 1N4002 D4 D6 D7 D8
1 RB441Q D5
Connectors
1 CONN_2 P2

Transistors
1 TIP42 Q1

Resistors, 1/4W unless indicated
1 0R22 R9
1 33R 1W R3
1 82R R4
1 220R R8
1 430R R10
1 3k9 R11
4 10K R1 R2 R5 R6
1 270K R7
1 5KB RV2
1 50KB RV1

Integrated Circuits
1 NJM2904 U2
1 LM317L TO92 U1

Miscellaneous
1 PCB
1 TO-220 Silicone Insulator
1 3x10mm Machine Screw
1 EHS-22 Heat Sink
1 Transformer, 220VAC Pri, 18V@1A

NOTE: AC cord, test clips, AC switch, and other hardwares are not included with the kit and are sold separately.

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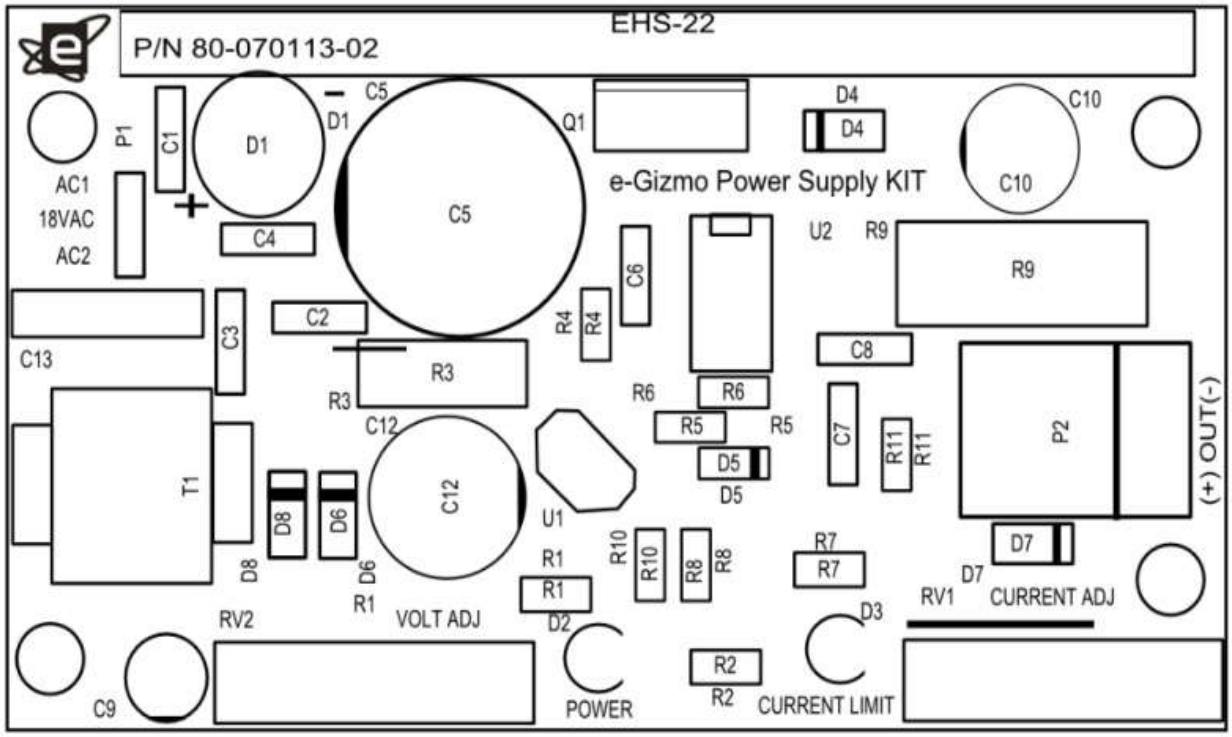
PCB ARTWORK

CAUTION:NOT DRAWN TO 1:1 SCALE



Power Supply kit component layout

APPLICATION PRECAUTIONS

Make sure there is plenty of air circulation around the heat sink, especially if you mounted the kit inside an enclosure. The heat sink can run pretty hot, and Q1 may overheat if there is no suffi cient air to cool it. Q1 will run hottest when operated at low voltage (1.3V) with maximum current (1.0A). A small box fan to force air circulation will be a good idea.
The kit constant current feature also protects the output against momentary short circuit conditions. But highly inductive load, such as solenoid, may force current go the wrong way in the output circuit, and may damage the power supply.

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