



## elektor 40V Linear Voltage Regulator Kit Instruction Manual

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**±40 V Linear Voltage Regulator Kit  
Construction Manual**



## Contents

- 1 40V Linear Voltage Regulator Kit
- 2 Kit Contents
- 3 Tools Needed (not included)
- 4 Small Diodes and Resistors, 1 -watt and Horizontally Mounted 5-watt Resistors
- 5 Trimmers, Small Capacitors, Fuse Clips, Fuses, and Faston Connectors
- 6 Small Transistors, IC1, IC2, Small Electrolytic Capacitors, LEDs, D3, D6
- 7 Thermal Reliefs
- 8 Mounting the Large Heatsinks
- 9 Fitting the Large Power Transistors
- 10 The 1000- $\mu$ F Decoupling Capacitors
- 11 T4/T10 and the Small Heatsinks, Vertical 5-watt Resistors
- 12 The Assembled Product
- 13 Test Setup and Wiring Diagram
- 14 Bill of Materials
- 15 Specifications (both regulators)
- 16 Web Links
- 17 Schematic and PCB Layout
- 18 Documents / Resources
  - 18.1 References

## 40V Linear Voltage Regulator Kit

### Notice

This document is complementary to the information contained in:

1. the article “ $\pm 40$  V Linear Voltage Regulator for Fortissimo-100” published in Elektor Magazine edition September & October 2023;
2. the engineering background, reader queries and related discussions posted on the Elektor Labs website.

Web Links to these publications may be found in Section 15.

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[www.elektor.com](http://www.elektor.com);

[www.elektormagazine.com](http://www.elektormagazine.com).

### Kit Contents

- Printed circuit board (PCB).
- All parts listed in the Bill of Materials (BOM) given at the end of this manual (Section 12).
- Construction Manual (downloadable PDF file).

### Not included:

- Power transformer (2x 35 V/300 VA),
- (bridge) rectifier (25 A/200 V), and
- smoothing capacitors (4x 10,000  $\mu$ F/63 V).



Figure 1: Contents of the  $\pm 40$  V Linear Voltage Regulator kit as supplied by the Elektor Store.



Figure 2: All resistors and the two trimmer potentiometers in the kit.

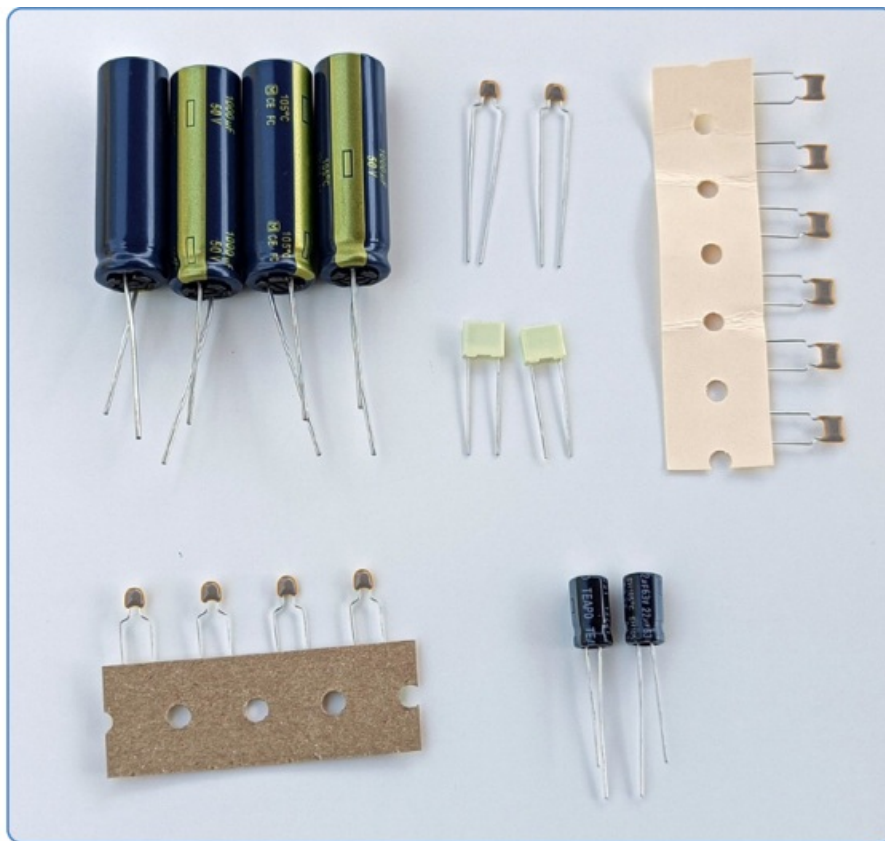


Figure 3: All capacitors in the kit.

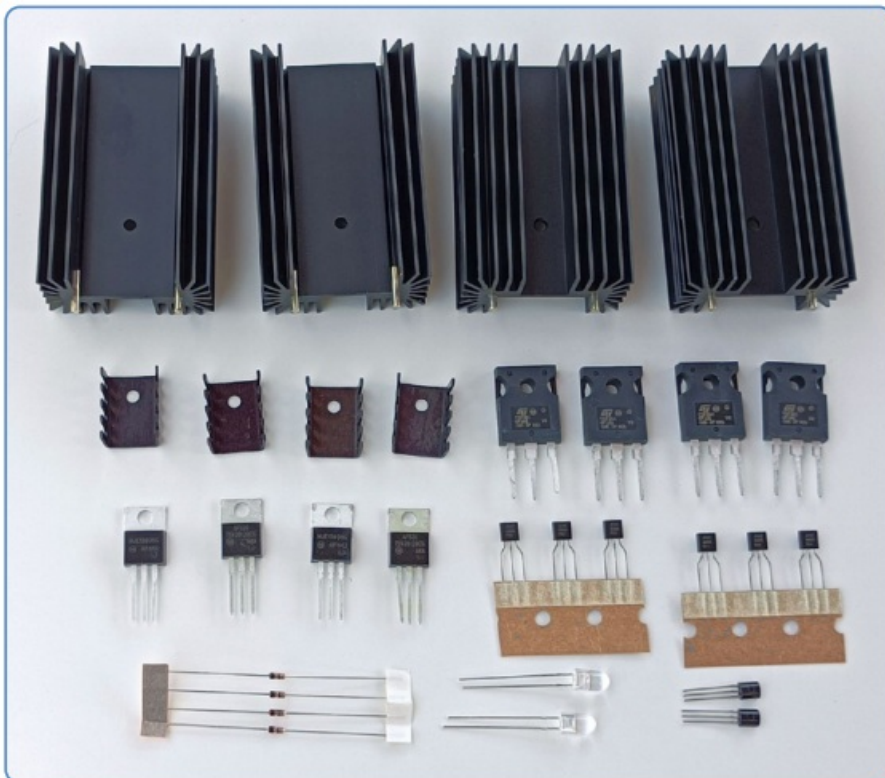


Figure 4: All semiconductors and heatsinks in the kit.

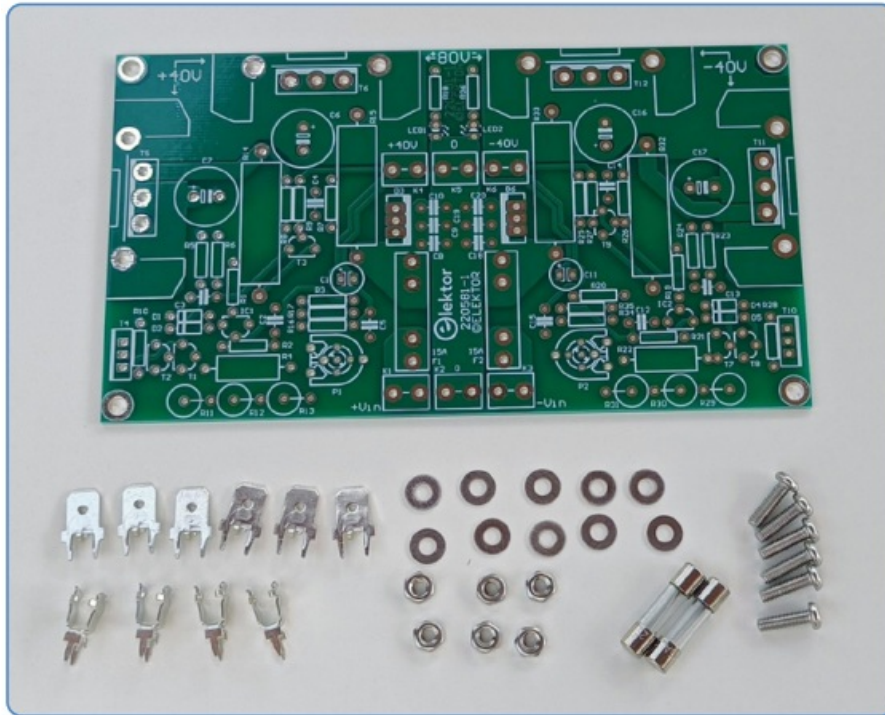


Figure 5: Fuses, fuse clips, screws, nuts, washers, Faston connectors, and PCB in the kit.

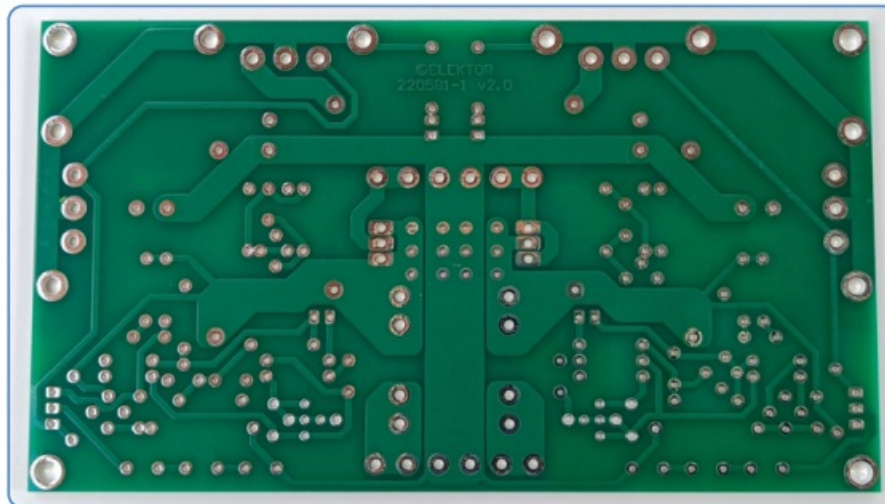


Figure 6: Bottom side of the PCB no. 220581-1 v2.0.

### Tools Needed (not included)

- Soldering equipment for through-hole components. Soldering iron rated at 100 watts minimum.
- Small pliers with flat jaws.
- Pliers with special jaws for pressing a thermal relief (bend) in the leads of the power transistors. Alternatively: pliers with round jaws.
- Lead forming tool for small axial resistors and diodes
- Pozidriv screwdriver (note: depends on the exact type of screws in kit).

### Small Diodes and Resistors, 1 -watt and Horizontally Mounted 5-watt Resistors

Start with soldering the lowest parts: small diodes, small resistors, 1-watt resistors, and the horizontally mounted 5-watt resistors. Because of component sourcing issues, the resistors and capacitors in the kit may come from different series and manufacturers than specified in the BOM and/or shown in the photos of the board

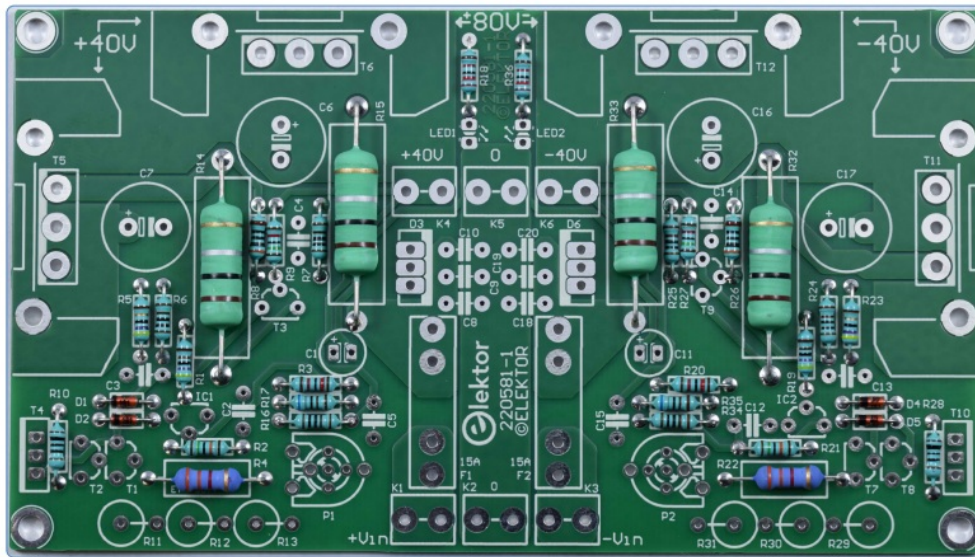


Figure 7: Low-profile components soldered.

### Trimmers, Small Capacitors, Fuse Clips, Fuses, and Faston Connectors

Proceed with soldering the trimmer potentiometers, small capacitors, PCB-mount fuse clips, and Faston (spade) connectors. The trimpot footprints also permit vertical multiturn trimmers to be used.

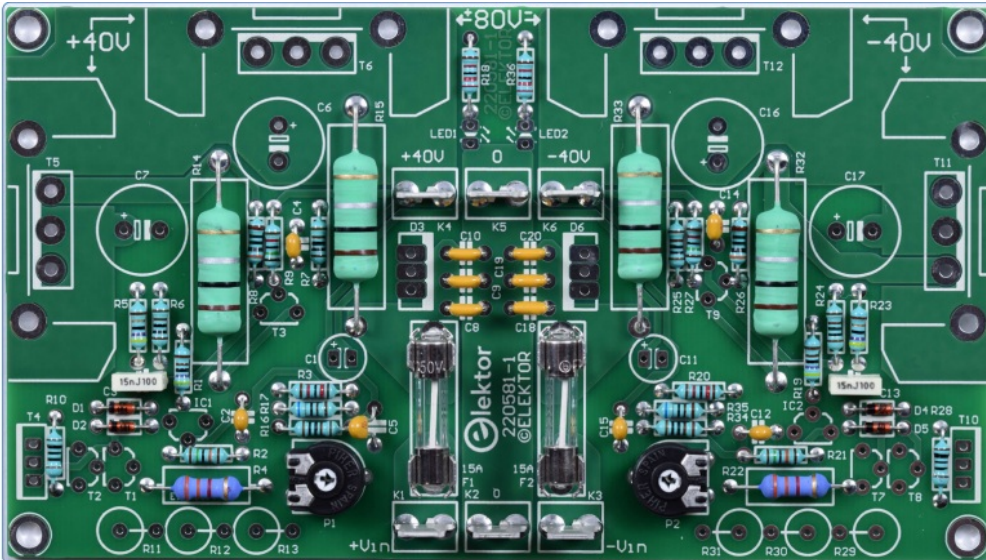


Figure 8: Trimmers, small capacitors, fuse clips, and Faston connectors soldered; fuses installed.

### Small Transistors, IC1, IC2, Small Electrolytic Capacitors, LEDs, D3, D6

Proceed with soldering the small transistors, IC1 and IC2, small electrolytic capacitors, LEDs, D3, and D6. LED1 is mounted the other way round with respect to LED2. Look at the Top overlay at the end if in doubt.

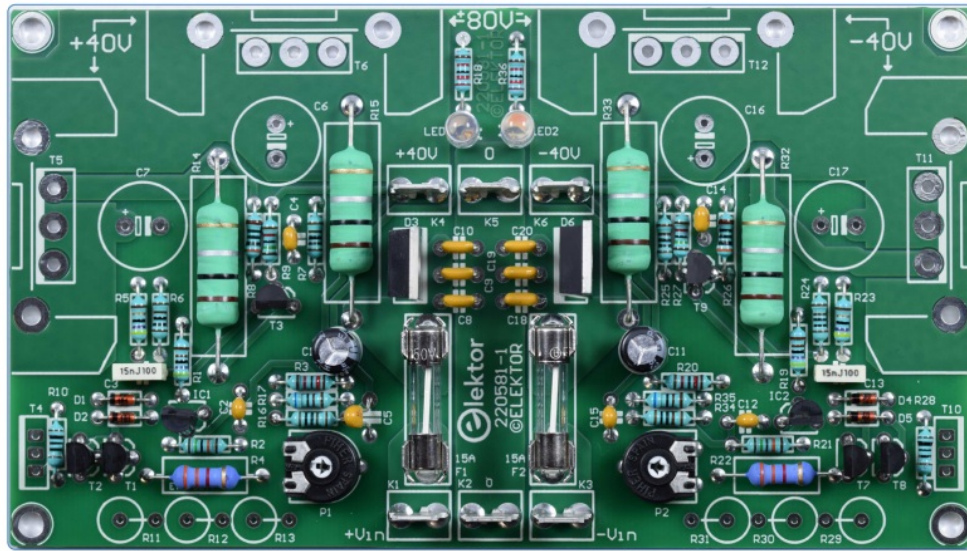


Figure 9: Small transistors, IC1, IC2, C1, C11, LEDs, D3 and D6 soldered.

## Thermal Reliefs

Create thermal reliefs in the leads of the four power transistors. For example, by using special pliers as shown in Figure 10, although pliers with round jaws can also be used. Create the bends as close as possible to the transistor packages. The heatsinks have a predrilled hole and there's not much room for error. Of course, you could drill a 3-mm hole a little above the existing one.

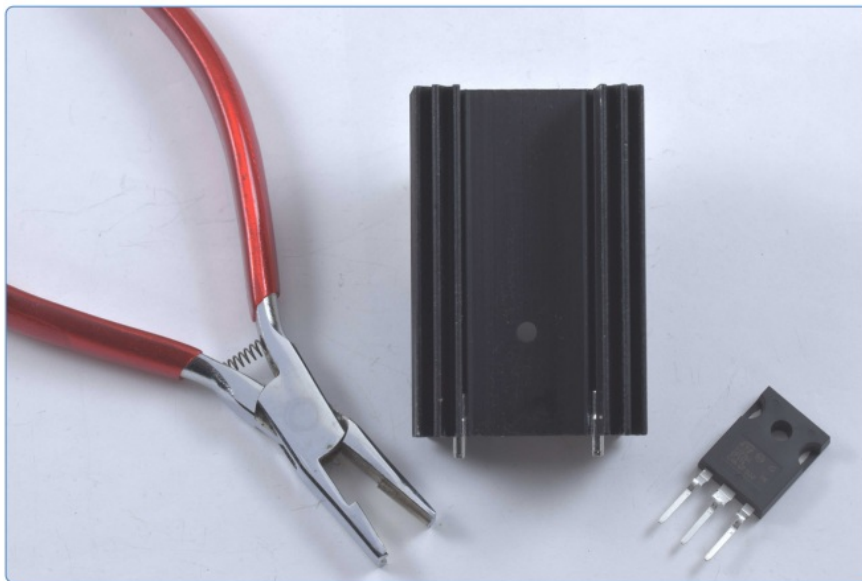


Figure 10: Heatsink, power transistor, and special pliers to create the thermal reliefs in the power transistor leads.

## Mounting the Large Heatsinks

Now place the heatsinks on the PCB. The easiest way is to install the four heatsinks onto the PCB and then turn the assembly upside down. Solder the two pins per heatsink while pushing them toward the edge of the PCB (the holes for the pins are slightly oversized), and make sure the heatsink remains perpendicular to the PCB. Check this for each heatsink after soldering.



Figure 11: The four large heatsinks soldered onto the board.

### Fitting the Large Power Transistors

For each power transistor, refer to the BoM and the PCB overlay to make absolutely sure the device goes into the correct PCB position. The type code print is not easily visible after soldering.

Put a very thin layer of thermal grease (a.k.a. heat transfer compound) on the back of the power transistors. The thermal reliefs in the leads of the four larger power transistors should have been made already (see Section 6). Place the transistors against the heatsink, one at a time. Use a 10-mm M3 screw to secure the transistor, keeping the screw head at the outside and the nut at the side of the transistor. Place two M3 washers under the screw head. This way, the screw is just long enough to fully engage with the nut but not protrude from it. The nearby 1000- $\mu$ F decoupling capacitor is close to the transistor, so make sure the screw does not touch it. Firmly secure the screw and do the same for the other three power transistors. Only then solder the leads of the power transistors.



Figure 12: Power transistors fitted to the heatsinks and soldered onto the board.

### The 1000- $\mu$ F Decoupling Capacitors

The large 1000- $\mu$ F decoupling capacitors can now be inserted into the PCB and soldered. Be sure they are placed exactly perpendicular and do not touch any of the screw/nut sets securing the power transistors.



Figure 13: The four large 1000- $\mu$ F decoupling capacitors added.

### T4/T10 and the Small Heatsinks, Vertical 5-watt Resistors

At this point, transistors T4 and T10 can be fitted to their small heatsinks. Two back-to-back mounted heatsinks are used per transistor to reduce thermal resistance.

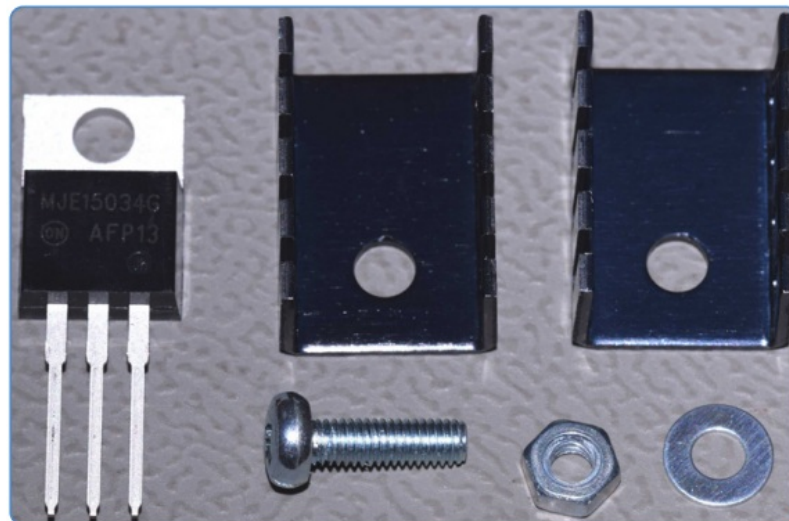


Figure 14: The TO220 transistors, two FK231SA220 heatsinks, M3 screw, washer, and nut. Put some thermal grease on the back of T4 and T10 and on one of the heatsinks per transistor.



Figure 15: Thermal grease applied to the back of the TO220 transistor and to one of the heatsinks. Now press the backs of the two heatsinks against each other and fasten the transistor firmly to the assembly using the M3 screw, washer, and nut.

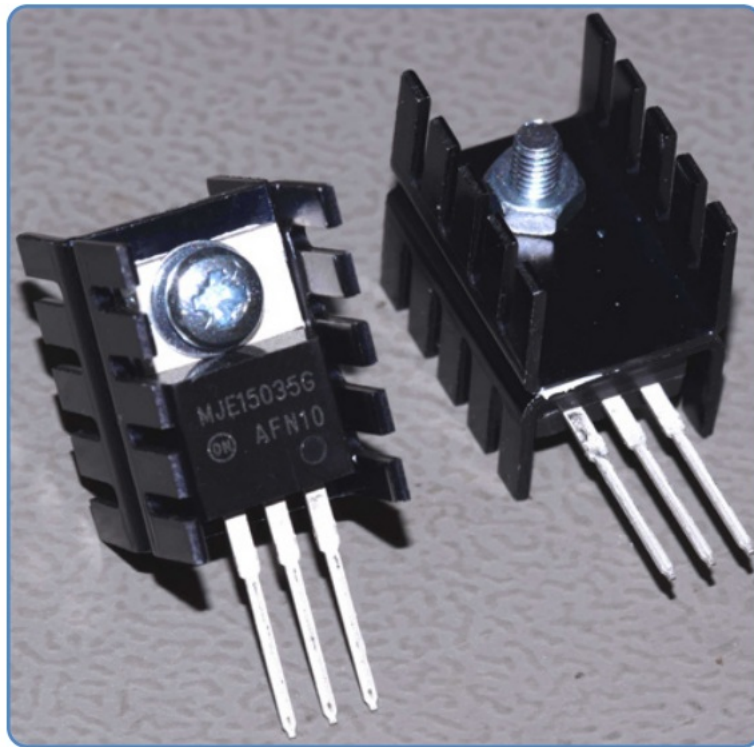


Figure 16: TO220 transistors T4 and T10 attached to a pair of mini heatsinks. For each power transistor, refer to the BoM and the PCB overlay to make absolutely sure the device goes into the correct PCB position. Now solder the last two transistors T4 and T10, and the vertically mounted 5-watt resistors R11, R12, R13, R29, R30, and R31.

## The Assembled Product



Figure 17: The prototype, ready for testing.

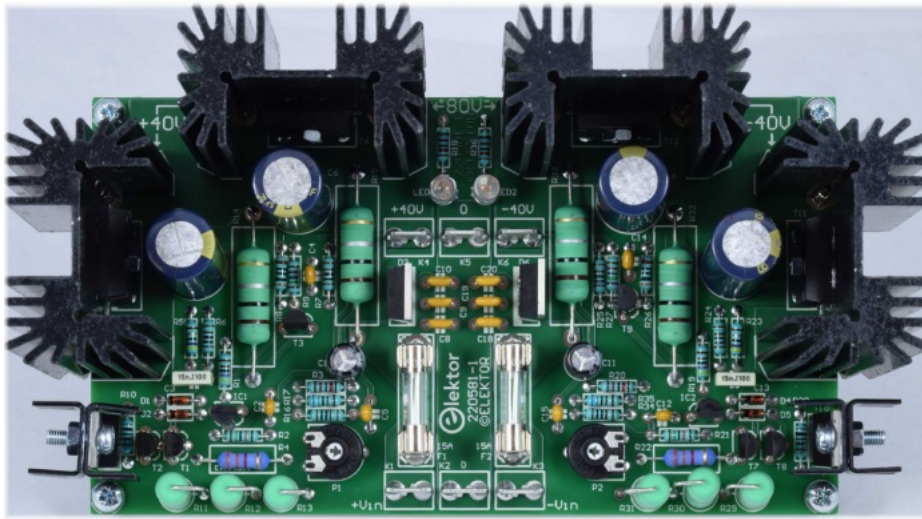


Figure 18: Top view of prototype assembled at Elektor Labs.

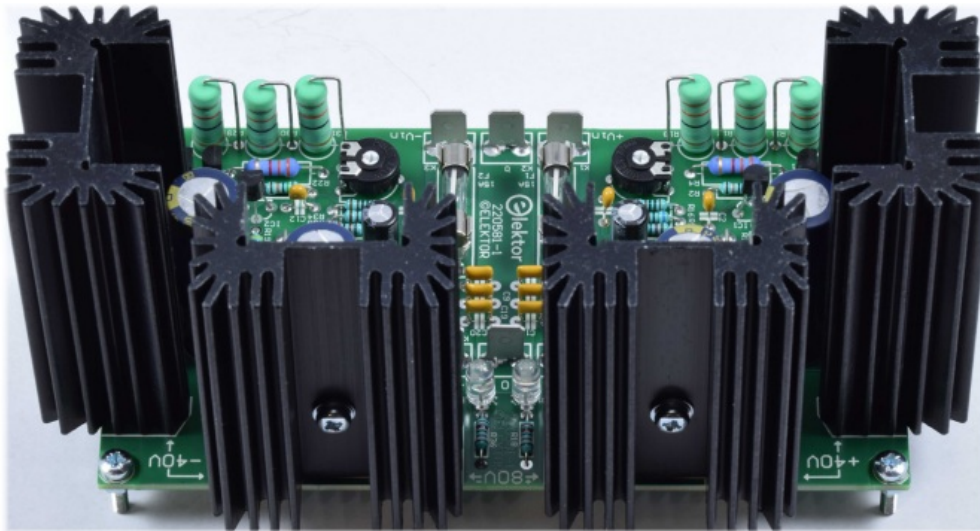


Figure 19: Side view of the large heatsinks. Notice the screws are on the outside.

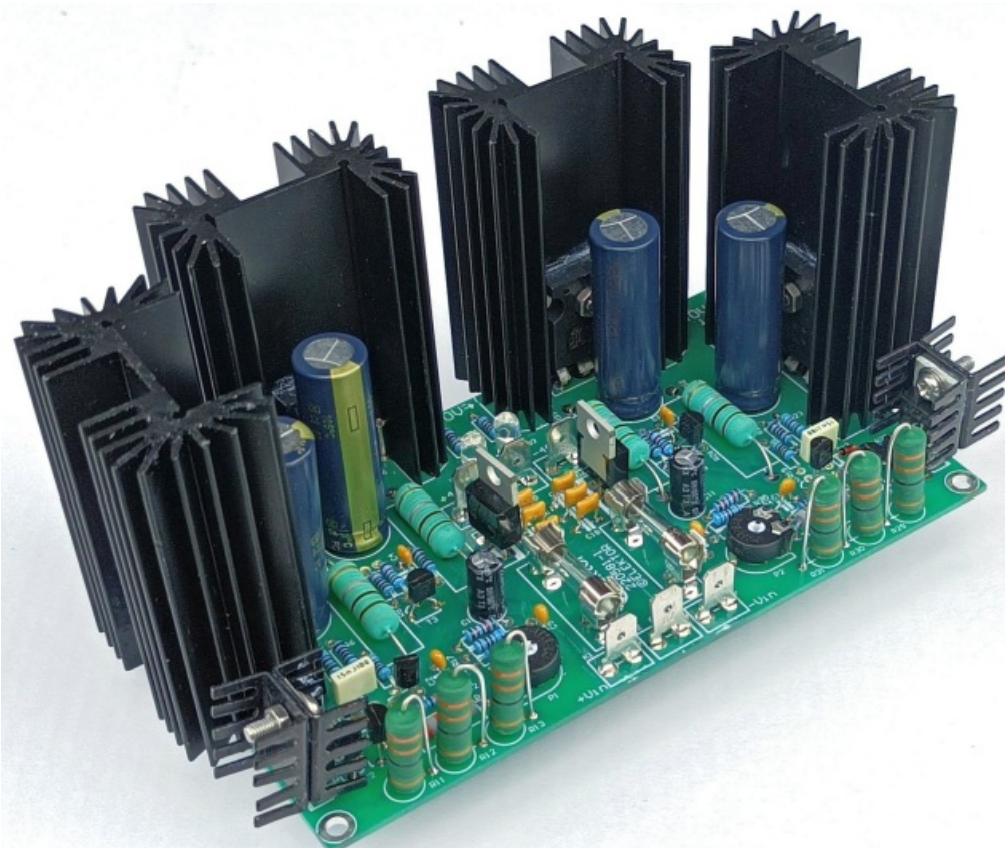


Figure 20: This regulator was built from components in the kit.

## Test Setup and Wiring Diagram

1. 1 pc. TX-146-300-235 power transformer (300 VA, 2x 35 VAC secondary)
2. 2 pcs. 10,000  $\mu$ F electrolytic capacitor per supply voltage rail (i.e., 20 mF on each rail)
3. 1 pc. SB352SBPC style bridge rectifier, 35 A/200 V (25 A/100V satisfactory)

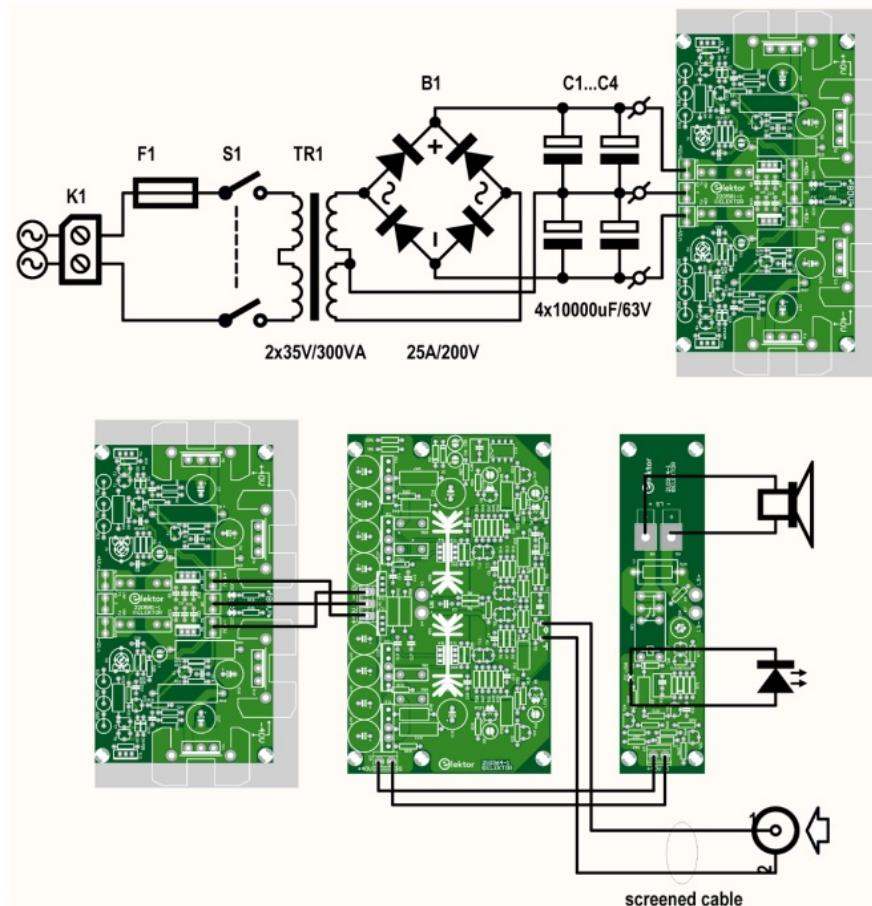


Figure 21: Wiring diagram and suggested unregulated power supply.

### Warning:

The large heatsinks are connected to the  $\pm 40$  V output voltage and not to GND.  
Always remove the input voltage before touching or working on the regulator!

## Bill of Materials

Resistors	Semicondu
R1, R19 = 4.7 k $\Omega$ , 1%, 0.6 W R2, R21 = 150 k $\Omega$ , 1%, 0.6 W R3, R20 = 12 k $\Omega$ , 1%, 0.6 W R4, R22 = 3.3 k $\Omega$ , 5%, 1 W, body size 5 x 12 mm max. R5, R23 = 47 $\Omega$ , 1%, 0.6 W R6, R7, R16, R24, R25, R34 = 1 k $\Omega$ , 1%, 0.6 W R8, R26 = 300 $\Omega$ , 1%, 0.6 W R9, R27 = 15 k $\Omega$ , 1%, 0.6 W R10, R28 = 100 $\Omega$ , 1%, 0.6 W R11, R12, R13, R29, R30, R31 = 33 $\Omega$ , 5%, 5 W, body diam. 6.4 mm max. (axial, mounted upright) R14, R15, R32, R33 = 0.1 $\Omega$ , 10%, 5 W (body 7.8 x 25 mm max.) R17, R35 = 6.8 k $\Omega$ , 1%, 0.6 W R18, R36 = 22 k $\Omega$ , 1%, 0.6 W P1, P2 = 500 $\Omega$ , 0.15 W, trimmer, top adjust (Piher PT10LV10-501A2 020-S)	D1, D2, D4, D5 = SD101A SB00018/D8, DO D3, D6 = HTR20L120CT, TO-220 LED1, LED2 = LED, green, 5 mm (T-1 $\frac{3}{4}$ ) T1, T2, T9 = BC546B, TO-92 T3, T7, T8 = BC556B, TO-92 T4 = MJE15035, TO-220 T5, T6 = TIP36C, TO-247 T10 = MJE15034, TO-220 T11, T12 = TIP35C, TO-247 IC1, IC2 = TL431BCLPG, TO-92
Capacitors	Miscellane
C1, C11 = 22 $\mu$ F, 20%, 63 V, pitch 2.5 mm, diam. 6.3 mm max. C2, C5, C12, C15 = 10 nF, 10%, 100 V, ceramic X7R , pitch 5 mm C3, C13 = 15 nF, 5%, 100 V, PET, pitch 5 mm C4, C14 = 47 nF, 10%, 50 V, ceramic X7R, pitch 5 mm C6, C7, C16, C17 = 1000 $\mu$ F, 20%, 50 V, pitch 5 mm, D 12.5 mm, 5000h@105°C (EEUFC1H102L , Panasonic ) C8, C9, C10, C18, C19, C20 = 100 nF, 10%, 100 V, pitch 5 mm, ceramic X7R	K1, K2, K3, K4, K5, K6 = Faston PCB tab, tw mm F1, F2 = Fuse clips, 20 A, Littelfuse 01000020Z, for 5x20mm fuse F1, F 5x20 mm HS1, HS2, HS2, HS4 = heatsink MC33271 (for T5/T6/T11/T12), 2.7 °C/W 4x heatsink type FK231SA220, 24 K/W (for T 10x M3 washer, plain, steel 6x M3 screw, 10 mm, pan head 6x M3 nut

## Specifications (both regulators)

Input voltage range	52 V (low power usage)...43 V
Output voltage range	approx. 38,9...41.4 V (theoretically) 38.6...41.1 V measured
Dropout voltage at 6 A	42 V
Dropout voltage at 9.5 A	43 V
Dropout voltage at 13.5 A	44 V
Max. current	15 A peak (half sine wave) 4.8 A average
SOAR protection	15 A at 45 V in
Ripple rejection	>60 dB (5 ADC)
No-load input current	27 mA (52 V in)

## Web Links

Voltage Regulator kit: [www.elektor.com/elektor-40-v-linear-voltage-regulator-kit](http://www.elektor.com/elektor-40-v-linear-voltage-regulator-kit)

Voltage Regulator project on Elektor Labs website: [www.elektormagazine.com/labs/linear-voltage-regulator-for-fortissimo-100](http://www.elektormagazine.com/labs/linear-voltage-regulator-for-fortissimo-100)

Fortissimo-100 project on Elektor Labs website: [www.elektormagazine.com/labs/fortissimo-100](http://www.elektormagazine.com/labs/fortissimo-100)

Figure 23: Top overlay of the PCB of the +40 V Linear Voltage Regulator (220581-1 v2.0).

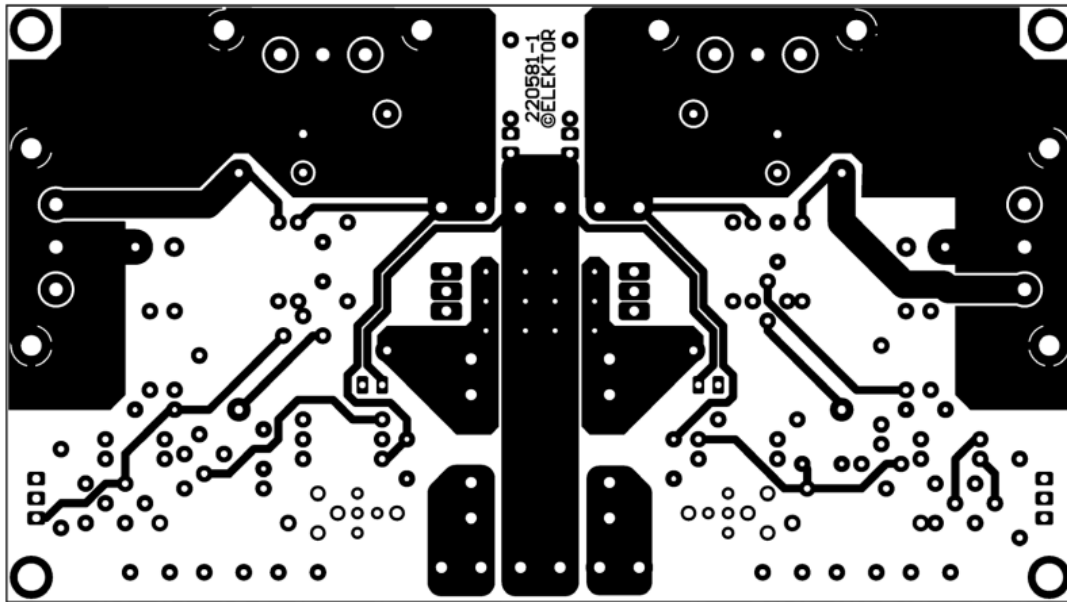


Figure 24: Copper on top of the PCB of the +40 V Linear Voltage Regulator.

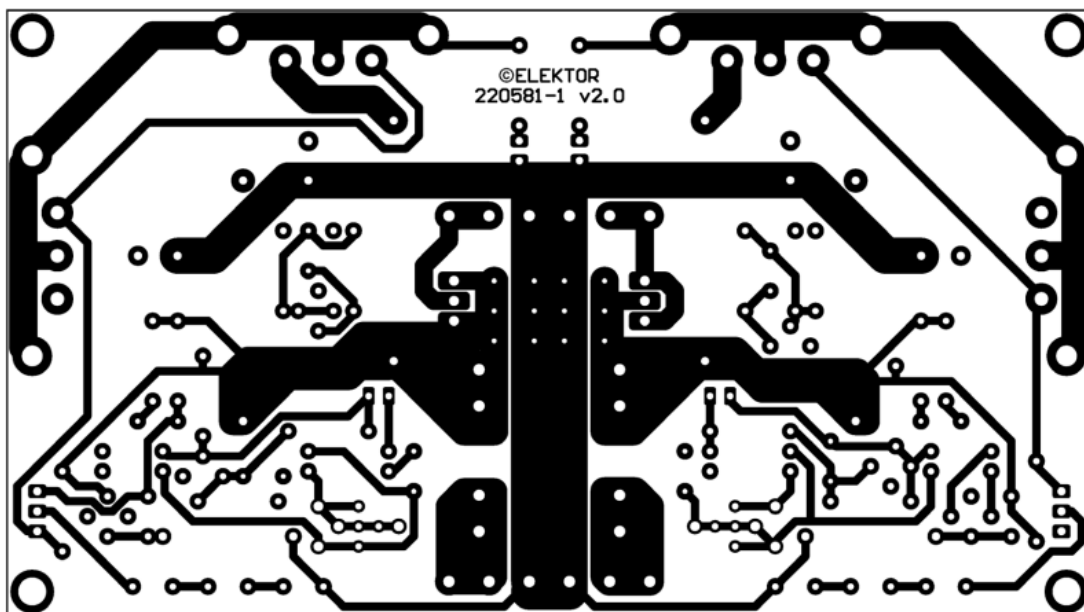


Figure 25: Copper on bottom of the PCB of the +40 V Linear Voltage Regulator.



## Documents / Resources



[elektor 40V Linear Voltage Regulator Kit](#) [pdf] Instruction Manual  
 40V Linear Voltage Regulator Kit, Linear Voltage Regulator Kit, Voltage Regulator Kit, Regulator Kit, Kit

## References

- [!\[\]\(1fa45a4e3a4dbe569cae65410a9008db\_img.jpg\) Your Store for Raspberry Pi, Arduino & ESP32 | Elektor](#)
- [!\[\]\(4704a622c626cb51a56b7a01526ff7ca\_img.jpg\) Elektor Â±40 V Linear Voltage Regulator Kit](#)
- [!\[\]\(68da944a7678e7c5a5243f13b2b65d79\_img.jpg\) Elektor Fortissimo-100 Power Amplifier Kit](#)
- [!\[\]\(11f856d6a3424f919544744b795bdd93\_img.jpg\) Elektor Magazine: Your Electronics Community > Design Share Earn | Elektor Magazine](#)
- [!\[\]\(25606c4d3b7362da8d60d9164fa38a4b\_img.jpg\) ±40-V Linear Voltage Regulator | Elektor Magazine](#)
- [!\[\]\(a5165e77ac9dabad8d880d8f56de9d6c\_img.jpg\) Elektor "Fortissimo-100" Power Amplifier Kit | Elektor Magazine](#)
- [!\[\]\(defec12c92941050da330b57c68f0aff\_img.jpg\) Linear Voltage Regulator for Fortissimo-100 \[220581\] | Elektor Magazine](#)
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