Idea Exchange

Technical Tidbits for the QRPer

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The following item is an excerpt from the "Idea Exchange" column in the Spring 2014 issue of QRP Quarterly. *The column is edited by WA8MCQ.*

Simple Adjustable Tracking Power Supply

From Bryant Julstrom, KCØZNG—

The usual experimenter's bench power supply provides an adjustable positive voltage of up to 25V at up to 1A of current. This suffices for many circuits and projects, but others require positive and negative voltages of equal magnitude. Op-amps, for example, often require ±15V.

Fixed matched voltages are easy to provide with a pair of three-terminal regulators, one positive and one negative. A more flexible solution imitates the adjustable positive supply: a tracking power supply provides an adjustable positive voltage and an equal but negative voltage; the negative voltage tracks the positive one.

A simple way to obtain adjustable symmetric voltages extends the two-regulator fixed-voltage solution with adjustable regulators and a two-section pot, which adjusts the positive and negative voltages simultaneously. This is simple, but tracking accuracy depends on matching the resistances associated with the two regulators, including the pot's two sections. A related circuit uses an op-amp to invert the control voltage of a positive regulator to control a negative one or a pass transistor. This is elegant, but it limits the supply's voltage to slightly less than the op-amp's maximum input voltage, usually 18V. Manufacturers have produced a number of integrated circuits designed to control tracking power supplies. W1KLK described a supply that used the SG1301 back in 1973 (see Reference). A similar chip is the RC4194. These and others like them have become unobtainium in recent years.

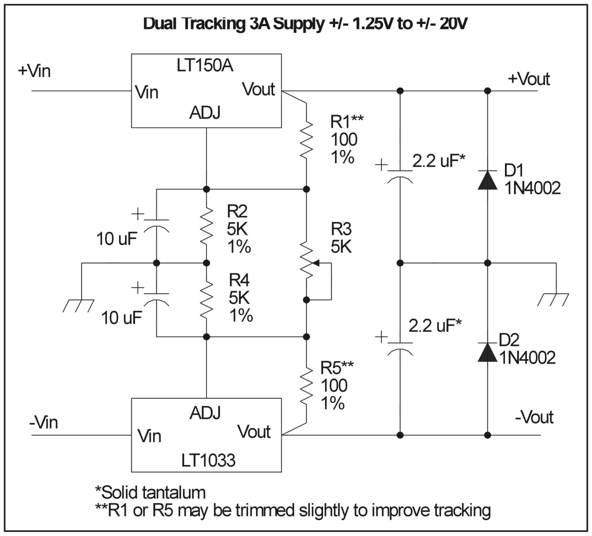

Figure 13—From the datasheet of the LT1033, a tracking regulator circuit that uses positive and negative regulators.

The Circuit

The datasheet for the LT1033, a negative three-terminal regulator from Linear Technology, presents another option: a tracking regulator circuit in which a single pot sets the output voltages of a positive and a negative regulator. Figure 13, reproduced from the datasheet, shows the circuit. It isn't necessary to use the regulators shown; I implemented the circuit using two old standbys, an LM317 positive regulator and an LM337 negative regulator, both in TO-220 packages. Note that the input voltages of the circuit are limited only by the maximum inputs of the two regulators, now ±40V.

Input to the tracking regulator is a pair of voltages and a common line between them. This requires a power transformer with a center-tapped secondary. The beefiest transformer in my junk box provided only 26 VCT, and input to the regulator of ±13V was too low. One solution uses two identical transformers with their primary windings in parallel and their secondaries in series.

I chose to use the one transformer and back-to-back half-wave voltage doublers, one on either side of the secondary winding's center tap, to provide about ±26V to the tracking regulator. This halves the current that can be drawn from the transformer, but it is rated at 2A, and 1A in each leg of the supply is sufficient for a wide range of projects. A voltmeter can be switched across either of the supply's outputs.

Figure 14 shows the circuit of the entire tracking power supply. I used 1N5402s in the voltage doublers because I had a bunch of them. As in Figure 13, the two 2.2 µF capacitors should be solid tantalum. The regulator departs from the circuit in the datasheet in two places. First, to adjust tracking, one of the two 100 ohm resistors is replaced with a 200 ohm trimpot, following a suggestion in the datasheet. Second, a 330 ohm resistor sets the regulator's minimum outputs at about ±3.6V, for reasons that will be clear in a

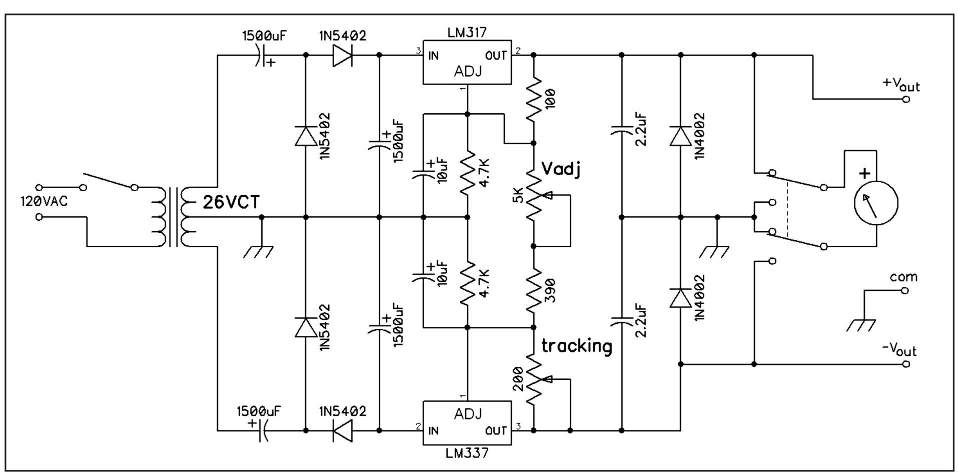

Figure 14—A tracking power supply using familiar parts, based on the regulator circuit in Figure 13.

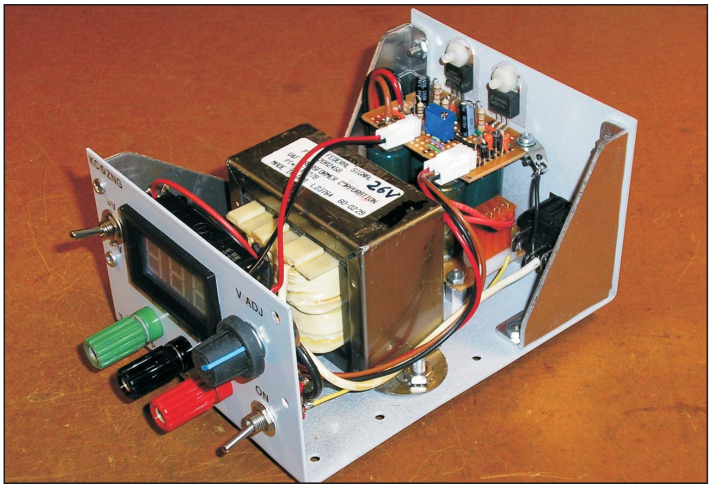

Figure 15—Interior view of the tracking power supply.

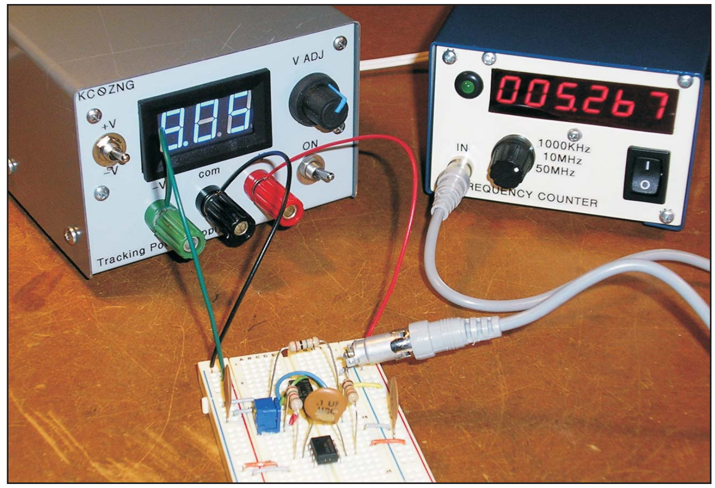

Figure 16—The tracking power supply in use.

moment. The schematic was developed using the freeware version of DipTrace™ and edited with Microsoft Paint.

Space on my bench is limited, so I wanted the supply to be no larger than necessary. Its front panel holds three binding posts, two miniature toggle switches, the voltage-adjustment pot and its knob, and a voltmeter. The meter is a three-digit LED unit from Marlin P. Jones (www.mpja.com; 30217 ME with blue digits, also available in green and red). It is powered by the voltage it measures, as long as that voltage is at least 3.6V (thus the 330 ohm resistor mentioned above).

Inside the enclosure are the transformer and two circuit boards: the two voltage doublers occupy one and the tracking regulator the other. The LM317 and LM337 are mounted at the edge of the regulator board and attached to the back panel, which then serves as a heat sink, with mica insulators, nylon bolts, and a smear of heat sink compound,. The panel also holds a snap-in IEC three-wire line connector. All the parts came from my junk box except the digital meter and the four 1500µF electrolytic capacitors in the voltage doublers.

The enclosure was bent up from two pieces of sheet aluminum, with brackets at each corner of the bottom half to stiffen the front and back panels and provide attachments for the top, which is held on with sheet metal screws. The enclosure is painted in two shades of gray, and labeled with black-on-clear tape from a Brother™ label-maker. The unit rests on four press-on rubber feet.

Figure 15 shows the unit with the top off and before the last bracket was installed. The regulator board is visible on the back panel. The doubler board is below it, mostly hidden behind the transformer. It's tight in there; cutouts on the brackets' tabs accommodate the line connector, the transformer's mounting tabs, and the switches and pot on the front panel.

Adjustment and Performance

The only adjustment in the supply is the tracking trimpot, which must be set so that the two voltages track each other accurately. This is touchy, but the two voltages can be made to match within 0.1V throughout the supply's range. The completed supply provides closely matched positive and negative voltages from ±3.6V to about ±23V, and a maximum current of 1A in each leg. Figure 16 shows the unit in use.

The tracking adjustment and the front-panel voltage adjustment are delicate. In both cases, multi-turn pots would be much easier to set. The tracking trimpot could be replaced with a series resistor and a smaller-value pot. An analog meter or a digital meter with a separate power supply would allow smaller output voltages. One could augment the supply's measurements with current metering or with simultaneous measurements in both legs, though more meters will require a larger enclosure. A higher-voltage transformer or, as mentioned, two transformers would allow output voltages of greater magnitude. However, as constructed, I've found this supply a handy addition to my bench.

[WA8MCQ Note—I added Figure 17 which shows the connections of some commonly used 3 terminal regulators. I got myself in trouble a time or two over the years when I forgot that the connections of positive and negative regulators are different.]

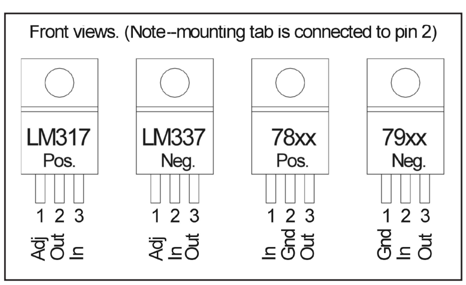

Figure 17—Pin connections of various regulators.

Reference:

W1KLK: "A Dual-Polarity IC Regulator," Technical Topics, *QST*, February, 1973, p.49.

—de KCØZNG

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