Fixed-voltage regulator pair forms bipolar power supply

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Two fixed-voltage regulators and suitable feedback circuitry can form a bipolar power supply that combines the excellent voltage regulation, trackability, and high current capacity of the three-terminal integrated-circuit voltage regulator with the voltage adjustability of more expensive supplies. This unit provides bipolar voltage from 8 to 20 volts at 1 ampere. The trackability, defined for an adjustable power supply as the voltage difference remaining between the bipolar ports at the desired output voltage, is 1%. Regulation for both line and load is about 100 millivolts.

Many IC bipolar regulators are available, but they provide only 100 milliamperes or so and their output voltages are essentially nonadjustable. Other popular regulators provide high current (up to 3 A) but are fixed-voltage devices. Although IC bipolar regulators can be modified with high-power transistors to boost the output current capability, and separate positive and negative voltage regulators can be connected directly to meet special voltage and power requirements, both designs still lack both adjustability and trackability. These features are often needed in many applications.

Figure 1 shows the regulated supply that employs two popular three-terminal regulators and a three-transistor feedback circuit. A 115-v, 60-hertz alternating current input is transformed to approximately 40 v across its center-tapped winding, and is rectified and filtered to generate ±27 v to the input of the respective regulators. The positive voltage output is:

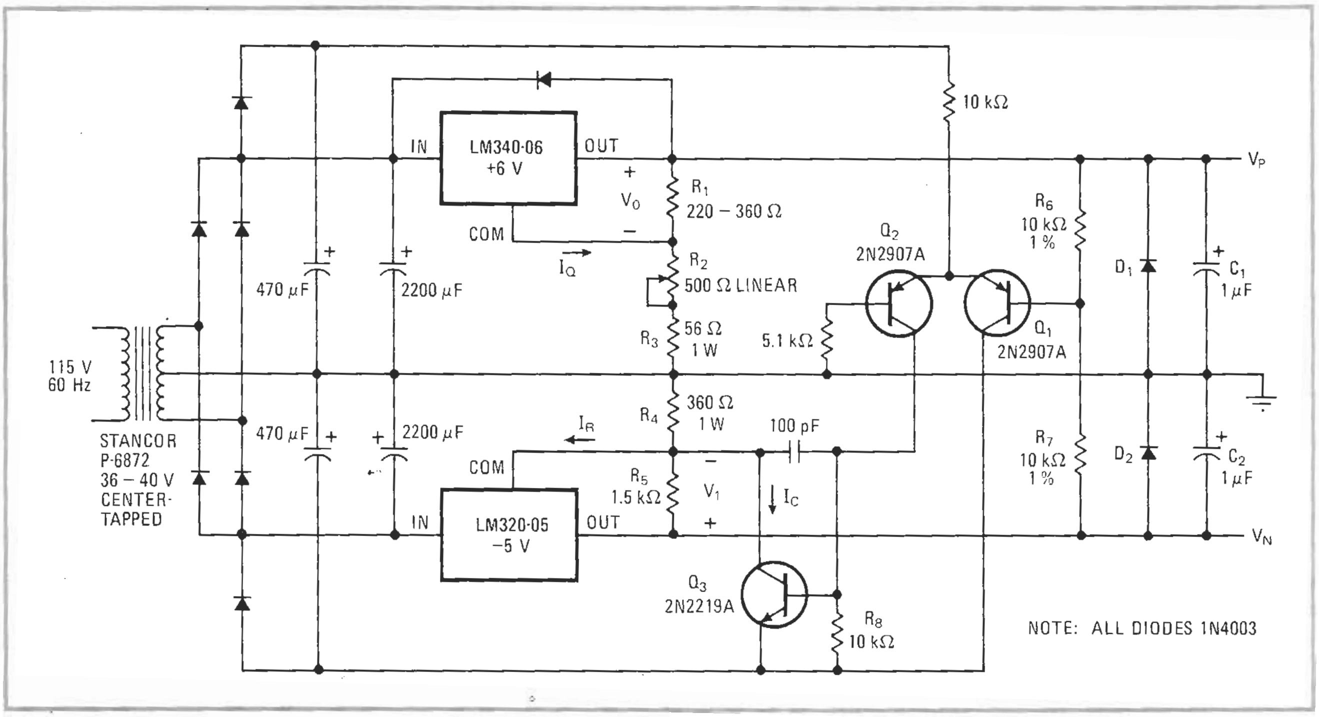
$$V_P = [1+(R_2+R_3)/R_1]\,V_o+(R_2+R_3)I_Q$$

where V_o may nominally range from 5.75 to 6.25 v for the fixed-voltage LM340-06 device and I_Q is the quiescent regulator current, which is 10 milliamperes maximum and is fairly independent of input voltage and load current. Adjustment of R_2 will change the output voltage, and accordingly, the negative voltage output V_N. The negative output is:

$$V_N = (1+R_4/R_5)V_1+R_4(I_C+I_R)$$

where I_R is the quiescent regulator current, I_C is the collector current of transistor Q_3, and V_1 is the output voltage of the negative regulator.

The LM320-05, which is a −5-v regulator, and transistors Q_1 through Q_3 form a slaved configuration. A differential amplifier composed of transistors Q_1 and Q_2 monitors the difference in magnitude between V_P and V_N through a precision voltage divider R_6 and R_7 and compares it to a zero reference. Normally, the voltage at this junction is zero, because $V_P = -V_N$. Any error voltage is amplified to cause a change in the collector



Bipolar-tracking power supply. Adjustable voltage output is obtained with fixed-voltage regulators if each regulator is connected back to back through current-varied networks. Circuit retains regulation properties, has high current capability, excellent trackability.

current of Q_3, which in turn changes the voltage across R_4 and consequently V_N.

The high output current that can be produced by the supply generates several points where power dissipation is great. Components must be selected to ensure that those levels can be adequately handled. The maximum current through Q_3 is 78 mA. The maximum power consumption is about 500 mw. The 2N2219A transistor is used for this application. Both regulators should be mounted on suitable heat sinks. Resistor R_3 prevents excessive current through R_2 when its value is low.

Heavy common-mode loads may cause difficulty in the operation of the feedback network during start-up unless diodes D_1 and D_2 are used to clamp the circuit outputs. C_1 and C_2 are tantalum capacitors for improved transient response. □