

# Regulating voltage with just one quad IC and one supply

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Full-range, high-performance power supplies are often bulky and expensive because they require two independent voltage sources—one main and one reference—with associated rectifiers, filter capacitors, and reference regulator circuitry.

But only one unregulated source of about 26 volts dc and one ground-sensing quad operational amplifier are necessary in a regulated power supply that provides 1 ampere at 0 to 20 v with foldback current-limiting and overload indication. It achieves line and load regulation within  $\pm 0.02\%$  over the full range of load conditions, even when the input voltage varies between 24 and 28 v dc. When the regulator is quiescent, its current require-

ment amounts to less than 10 milliamperes.

Amplifier  $A_1$  is a self-biased, constant-current amplifier that provides a stable reference voltage [Electronics, March 13, 1972, p. 74]. Its output,  $V_1$ , depends on the breakdown voltage  $V_z$  of the zener diode,  $D_1$ :

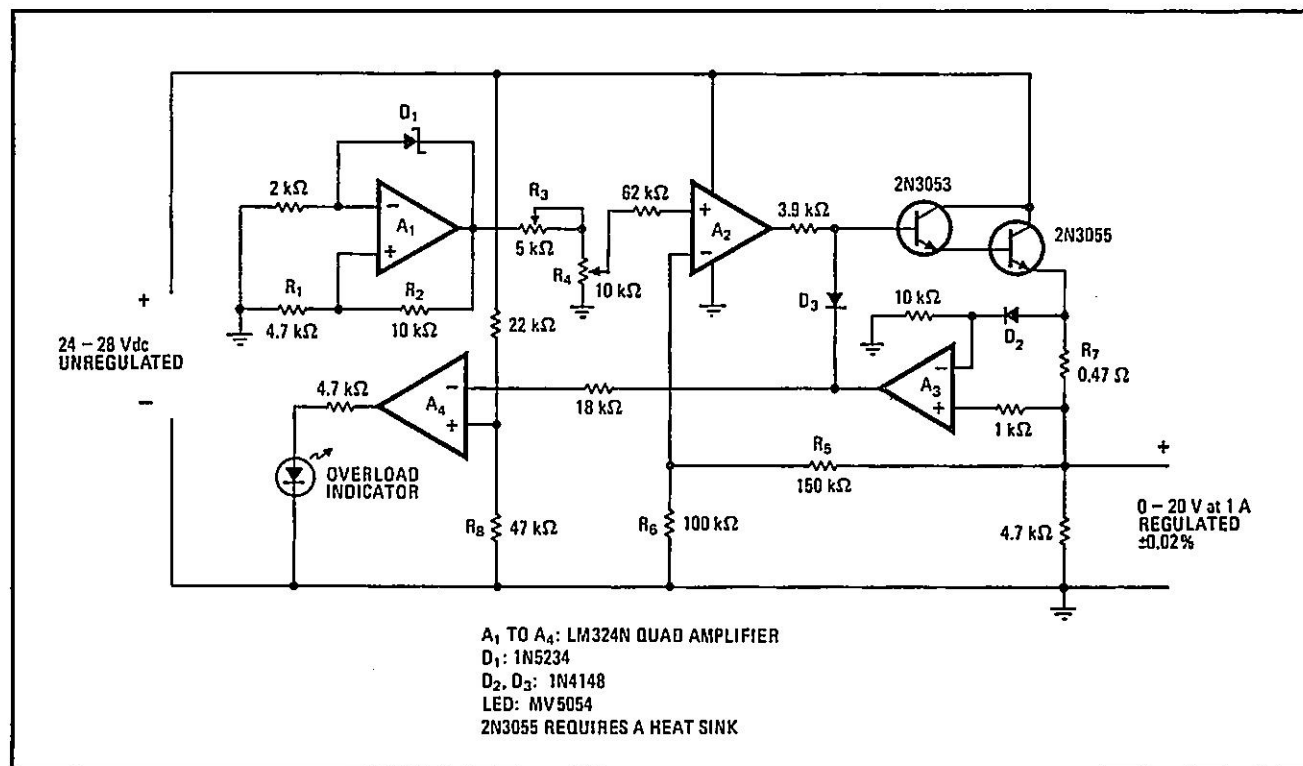
$$V_1 = V_z [1 + (R_1/R_2)]$$

It is approximately 9.1 v for the values shown in the diagram. The potentiometers  $R_3$  and  $R_4$  bring  $V_1$  down to a desired value  $V_2$ , which is amplified by  $A_2$  and the Darlington output stage to the output level:

$$V_{out} = V_2(R_5 + R_6)/R_6$$

With  $R_4$  at its maximum-voltage position, variable resistor  $R_3$  sets the voltage at exactly 20 v; thereafter,  $R_4$  varies the output voltage over its full range. The output stage gain is 2.5 for the values shown.

Amplifier  $A_3$  monitors the regulator's output current under varying loads. It compares the voltage across  $R_7$  (a very small resistance) with the drop across diode  $D_2$ . Whenever the former is greater than the latter, the output of  $A_3$  drops, biasing diode  $D_3$  for-



**Op amp regulator.** An unregulated 26-volt source becomes a 1-ampere 0-to-20-V supply regulated to within  $\pm 0.02\%$  by a simple quad operational amplifier. Input can vary between 24 V and 28 V, and quiescent current is less than 10 mA. A light-emitting diode gives an overload indication, the level of which depends on the value of resistor  $R_6$ . Single power Darlington can replace the two transistors.