An Active VOLTAGE REFERENCE

Variable zener makes useful voltage calibrator

By Michael Andrews

WHEN a reasonably accurate dc source is required for calibration purposes, some of us reach for what we hope is a good alkaline or mercury cell. As many have discovered, this is usually not the best choice. One can also use a zener diode having the desired (or close to desired) voltage breakdown. However, if the zener current varies, so does the output voltage.

The Active Reference shown in Fig. 1 reduces this inconsistency by presenting a constant impedance to the zener source, coupled with the capability of providing four (or more if desired) output reference voltages from a single zener.

Zener diode *D1* uses *R1* and one of the 9-volt batteries to develop the 5.1-volt (in this case) source. Op amp *IC1*, in conjunction with *R2* (R_{in}) and a switch-selectable *R3* through *R6* (R_f) serves both as a buffer and active attenuator whose output is defined by the choice of the selected R_f value. In this arrangement, *IC1* is an inverting amplifier whose stage gain is equal to R_f/R_{in}. By proper choice of these elements, output of the op amp is predictable.

For example, if R_f is 100,000 ohms and R_{in} is 100,000 ohms, the stage gain is 1, making the output equal to the input (zener) voltage. If R_f is 10,000 ohms with R_{in} remaining at 100,000 ohms, the stage gain equals 0.1 which equates to a divide-by-10. Therefore, the output voltage becomes 0.51 volts. There are limits on how far this concept can be carried, and these are determined by the noise floor of the op amp and associated circuit components.

If you have a laboratory-calibrated voltmeter, a 100,000-ohm potentiometer can be substituted for the switched R_f, and the output monitored by the voltmeter. Accuracy of the Active Reference is dependent on the tolerance of the resistors and zener diode used.

The Active Reference can also be used to emulate odd values of zener diodes in regulated power supplies, such as that shown in Fig.2. This illustrates a conventional series-pass configuration with the output determined by the Active Reference level. The transformer, rectifier, and filters should be able to handle the desired output; the 2N3055 should be heat sinked. ◇

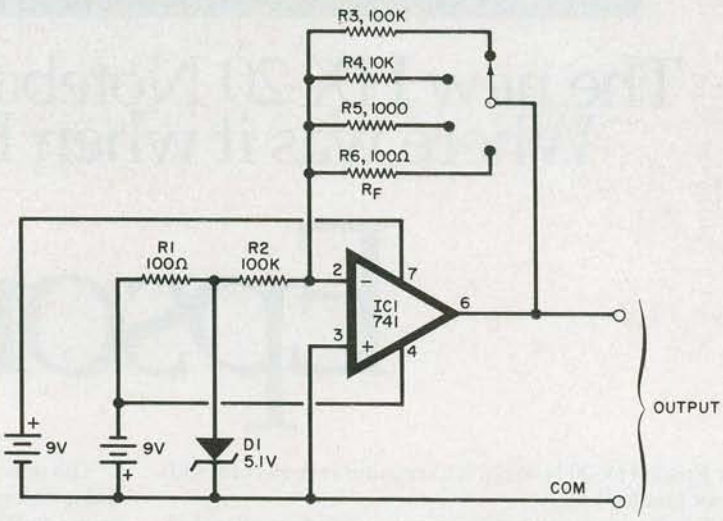

Fig. 1. Schematic of the active reference circuit.

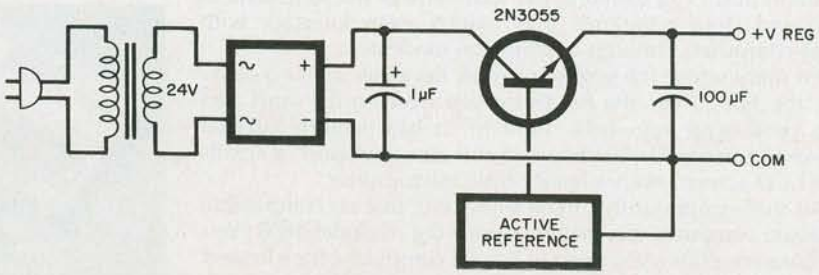

Fig. 2. The active reference can be used in regulated power supplies.