Adjustable active load maintains constant dc power dissipation

by Norm Bernstein
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An active load that dissipates constant power despite variations in supply voltages is useful for calibrating a dc power meter and for several thermal-control applications. Such a load may consist of one or more transistors, like the Darlington pair shown in the circuit diagram. The value of reference voltage V_{ref} and the accompanying control components determine how much power the load can dissipate. For the circuit arrangement shown, the transistors dissipate 1 watt when V_{ref} is 1 volt and proportionally less for lower reference voltages at any value of input voltage from 1 V to 10 V. The dissipation is constant to within 1% over this whole range of V_{in}.

The operation of the circuit is simple. Amplifier A_2 references the dissipating element to ground and produces a signal proportional to the load current. This signal is inverted by amplifier A_3 and then is multiplied by V_{in} in the AD435 multiplier. The output from the multiplier is therefore a voltage that is proportional to power dissipation. This voltage is compared to V_{ref} and integrated to produce a bias voltage for the Darlington pair.

If the load voltage changes, the integrator adjusts the Darlington bias until the multiplier output equals V_{ref}, thereby maintaining constant power. The power dissipation can be adjusted by simply changing V_{ref}.

This circuit arrangement can be used for almost any power range by applying appropriate biasing current to the transistors and scaling the multiplier inputs. To minimize errors from multiplier offset and drift, and thus optimize accuracy over dynamic range, the multiplier should be operated with an output of at least 100 millivolts. Therefore, the input voltage range for each multiplier input should be between 1 and 10 V. The color-tinted components in the diagram represent all of the power-dissipation elements and may be easily isolated from the rest of the circuit.

The constant-power property of this circuit has several interesting applications. For example, placing the power-dissipating elements within an environment of constant thermal transfer results in constant temperature. Measurement of temperature rise will give the thermal resistance of that environment. Or, if the power-dissipating elements are used as a heater for an environmental chamber, constant temperature can be achieved without the limit-cycling usually associated with thermostat-type controllers. □

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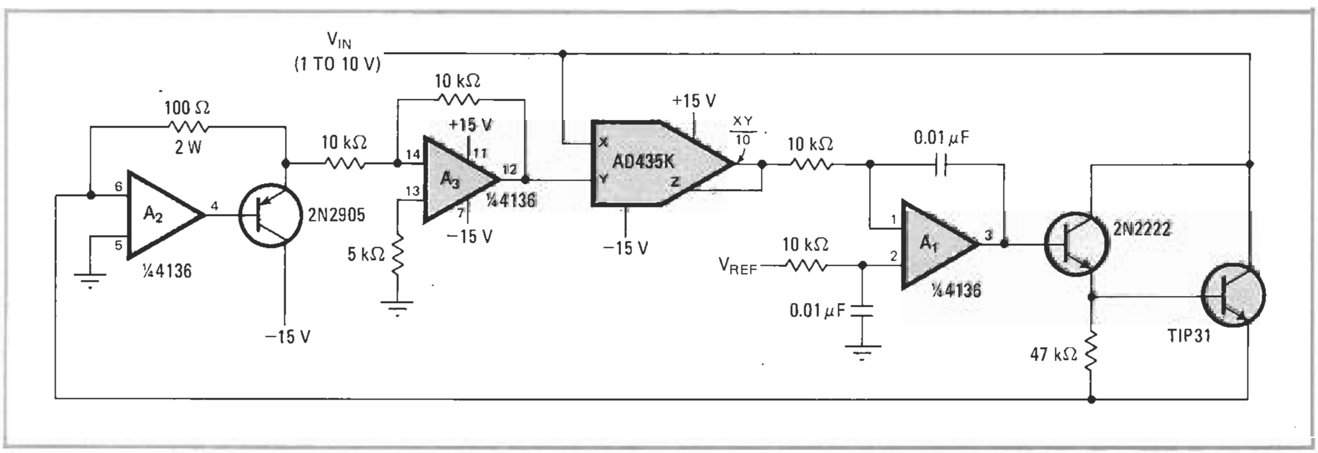

Constant dissipation. Darlington pair dissipates constant power for fixed V_{ref}, even though V_{in} varies. Maximum dissipation in load for circuit shown is 1 watt when V_{ref} is 1 V. Different load transistors and different biasing arrangements permit higher power dissipation.

Electronic load aids power-supply testing

by M.J. Salvati
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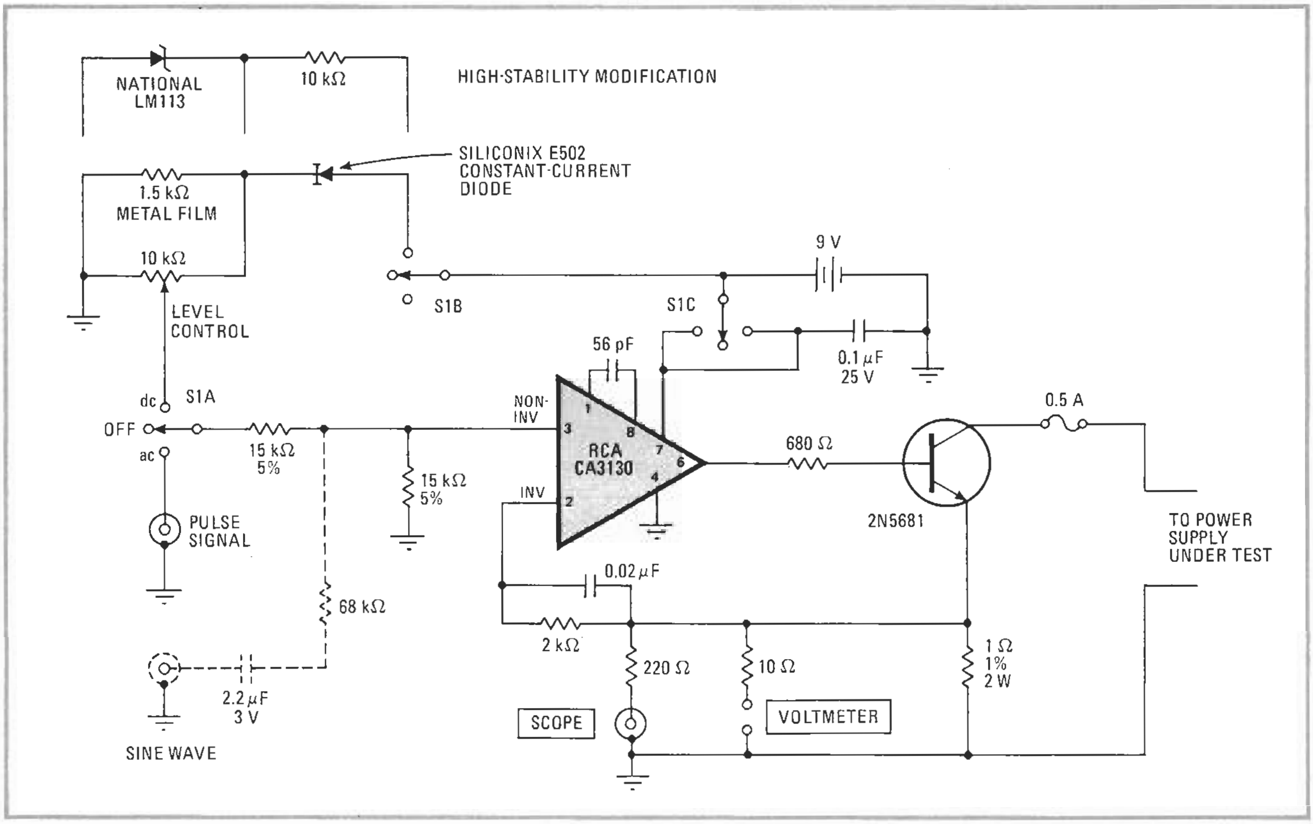
An electronic load for testing the static and dynamic characteristics of small- to medium-sized power supplies can be assembled for a parts cost of about $12. The tests include voltage regulation (by either static or dynamic techniques), ripple vs current drain, transient response, and temperature vs current drain.

The device can provide a static (dc) load of 1–250 milliamperes or a dynamic (ac) load of up to 1 ampere

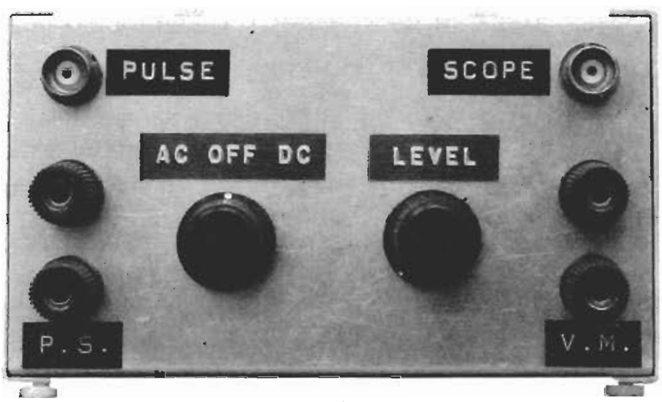


1. Electronic load. Characteristics of a power supply are tested with this circuit, which controls current delivered by the supply. Regulation, ripple, transient response, and temperature effects can be measured at currents up to 1 A peak or 0.25 A dc and voltages of 1.5 to 100 V.

peak current on power supplies with output voltages anywhere from 1.5 to 100 volts. The current drain in either mode is independent of output voltage of the power supply under test. The pulse-repetition rate in the ac mode can reach 30 kilohertz for a fast-rise pulse and 200 kHz for a sine wave. The average power dissipation is limited to 3 watts continuous and 5 W intermittent because of the small size of the switched transistor shown in the circuit diagram of Fig. 1. A higher-power transistor can be used if necessary, but switching speed may suffer.

As the diagram shows, the tester is essentially a variation of the classic current sink, one that can be modulated and in which the load current through the transistor is controlled by the CA3130 operational amplifier. The ability of the CA3130 to work from a single supply with ground-referenced input and its very low current drain allow the tester to be powered by a single 9-V transistor-radio battery. Because the device is self-powered, it can be used for testing very-low-voltage power supplies.

A switch at the input of the op amp selects either dc or pulsed operation of the supply. The dc mode uses an E502 constant-current diode in the reference-voltage source. It draws only 0.43 mA from the battery, and has a temperature coefficient close to zero. The voltage thus dropped across the level-adjustment potentiometer is very stable. If even greater stability is desired, the E502 and 1,500-ohm resistor can be replaced by the more expensive but superior LM113 voltage-reference diode and 10-kilohm resistor as shown in the diagram. The modification shown in dashed lines allows superposition of sine-wave modulation on the dc bias for tests of output impedance vs frequency.



2. All packed up and ready to go. Complete electronic load circuit, including the 9-volt battery that powers it, is housed in a standard 3-by-2-by-5¼-inch aluminum box. Connectors can be seen.

The current level is set by means of the level control in the dc mode and monitored by a dc voltmeter or a dc scope. The peak current level in the pulsed (ac) mode depends on the input-signal amplitude, and is monitored on a scope. The ratio of output current to input signal in this mode is 1 A/2 V peak. The conversion ratio at the scope and voltmeter terminals is 1 mV/mA in either mode. □

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Switched load checks power supply response

by William M. Polivka
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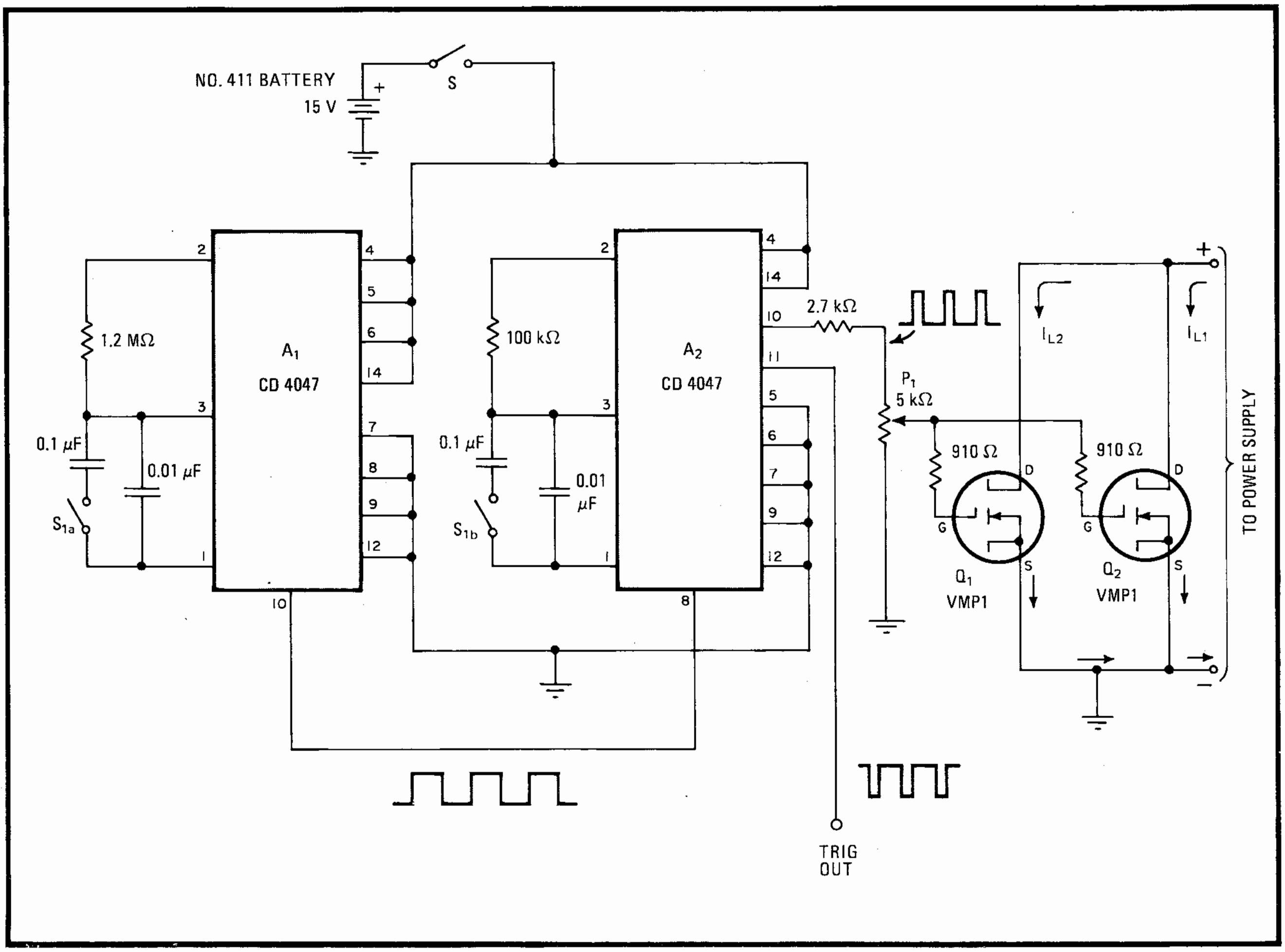
The transient response of a power supply is easily checked with the aid of this pulse loader, which periodically places a short circuit across the supply's output in order to simulate sudden load changes. Using complementary-MOS integrated circuits and V-groove MOS power transistors, the compact, self-contained unit runs on a battery, so that it presents no ground-loop problems to the supply under test.

As shown in the circuit for the pulsed load, astable multivibrator A_1 and one-shot A_2 set respectively the frequency and the width of the pulses that switch on load transistors Q_1 and Q_2. S_1 selects either of two combinations of frequency and width—in this case, 2 hertz at 25 milliseconds or 20 Hz at 2.5 ms. Note that a low duty cycle is required to reduce heat dissipation in Q_1 and Q_2. A trigger signal for driving an oscilloscope or other instrument to observe the supply's response appears at pin 11 of A_2.

Potentiometer P_1 sets the point at which Q_1 and Q_2 fire, so that the magnitude of the pulsed supply current passing through the load transistors can be selected from zero to the maximum capability of the V-MOS devices. Each field-effect transistor handles 2 amperes at 12 volts, values that derate to 400 milliamperes at 60 V. Moreover, an increase in supply loading may be attained simply by adding transistors in shunt at the output of the unit, as required. □



Load dynamics. Low-cost tester, with aid of scope, finds transient response of power supply by ordering periodic increase in supply current to simulate load changes. A_1 and A_2 set frequency and width of switching waveform. $Q_1 - Q_2$ sink current proportional to setting of P_1.

Electronic sink simulates load for testing power supplies

by Henry Santana
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The bank of bulky, high-power load resistors normally required to check the current-delivery capability of various power supplies can be eliminated by this programmable load. Able to simulate an equivalent resistance as low as a few milliohms and handle input powers up to 50 watts, this compact unit, which uses operational amplifiers and transistors to limit the amount of current it will sink, serves as a good general-purpose device for production-line testing. It can be built for $40.

The idea behind the circuit is explained with the aid of (a). Neglecting the on-resistance of transistor Q_1, and considering that a virtual ground exists between the inverting and noninverting inputs of operational amplifier A_1:

$$V_1 = V_{in} = K\alpha V_2 \qquad 0<\alpha<1 \qquad (1)$$

where K represents the gain of A_2, α is selected by a potentiometer, and V_2 is a floating supply required to maintain the necessary bias on the control transistor. Also note that $V_2 = I_{in}R_a$. When this expression is substituted in Eq. 1, it is seen that:

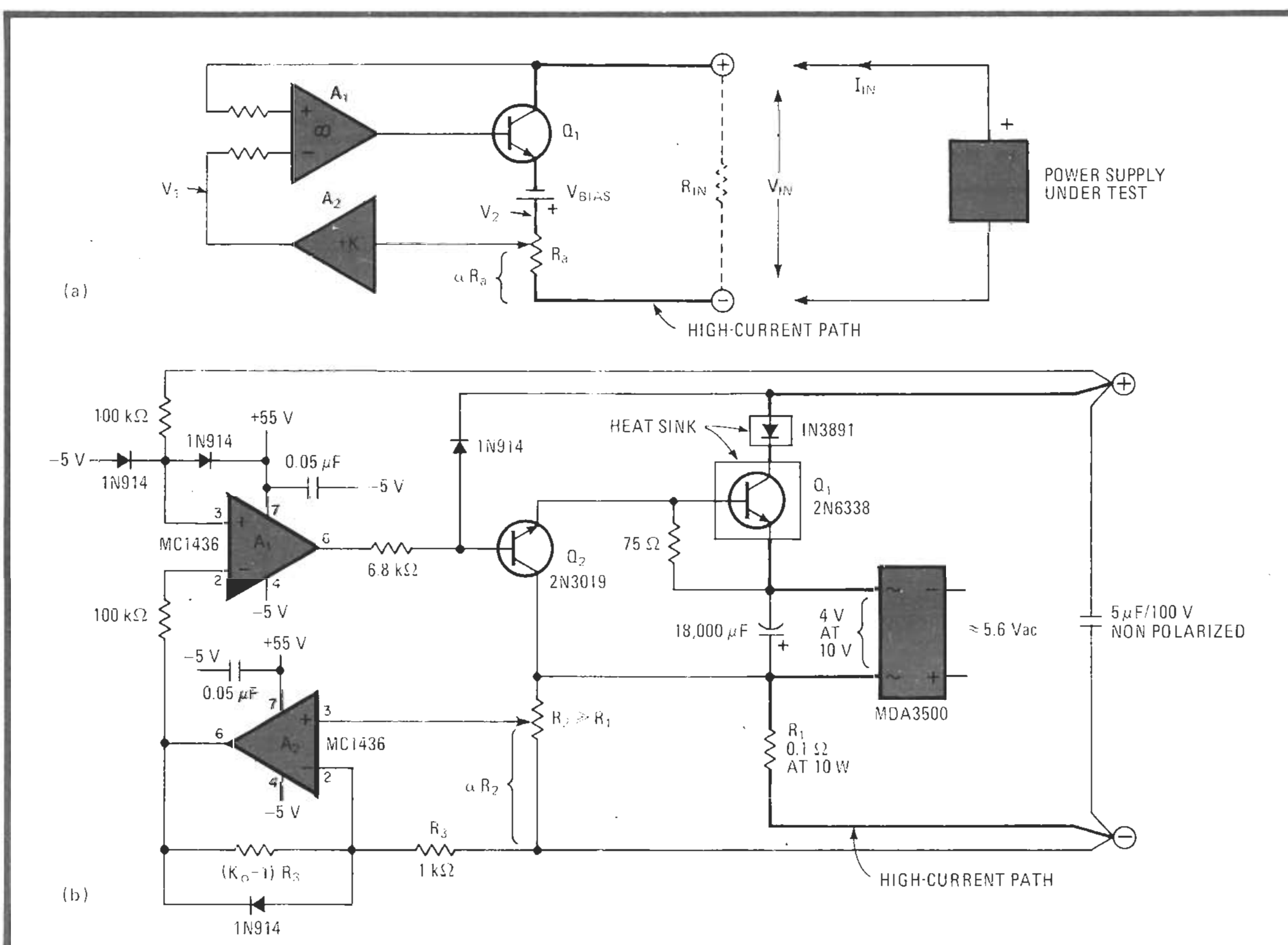
$$R_{in} = V_{in}/I_{in} = K\alpha R_a \qquad (2)$$

and therefore the resistance seen by the power supply under test can be set by R_a.

The circuit required to implement the idealized configuration is shown in (b). High-voltage op amps are used for A_1 and A_2 to handle the large input potentials expected. Q_2 has been added in order to supply adequate drive current to the output (control) transistor. R_a in (a) is represented by R_1 and R_2 in (b), where the value of R_1 is made small in order to minimize the voltage (V_2) needed to bias the control transistor.

If the gain of A_2 is selected for $K = 500$, R_{in} can be made to vary from approximately 0 to 50 ohms. If R_2 can be selected digitally, any resistor value in this range can be automatically ordered up. The unit can withstand a maximum input voltage of 50 volts and input currents up to 10 amperes, though the maximum input power cannot exceed 50 watts, as mentioned previously.

The components in the path of high current should be mounted on suitable heat sinks, for the power dissipated is approximately $P_d = (5+V_{in})I_{in}$. □



Equivalent resistor. Suitably configured op amp and power transistor combination (a) will function as a programmable electronic load. Practical implementation of idealized circuit is shown in (b). Unit handles a maximum power input of 50 watts.