AMPLIFIER AND COMPARATOR CIRCUITS   Application Note 1128: Jun 26, 2002

CIRCUIT PROTECTION MEASUREMENT CIRCUITS

Regulated Power Source is Insensitive to Load-Resistance Changes

This circuit combines a current-sense amplifier, some op amps and a four-quadrant analog voltage multiplier to create a circuit capable of delivering an adjustable, fixed power level to a variable load. This is useful in industrial heating and cooling applications to deliver constant power to a varying load.

For the heating/cooling elements common in industrial applications (such as positive-temperature-coefficient heaters and thermal-electric coolers), resistance is not a fixed quantity. Instead, R values for these elements can change more than 100% during operation, and the result is a change in power dissipation for elements driven by a fixed voltage or current source. Worse, the heating or cooling element can be damaged by excessive power. Driving the element with a fixed and regulated power driver overcomes these problems (Figure 1).

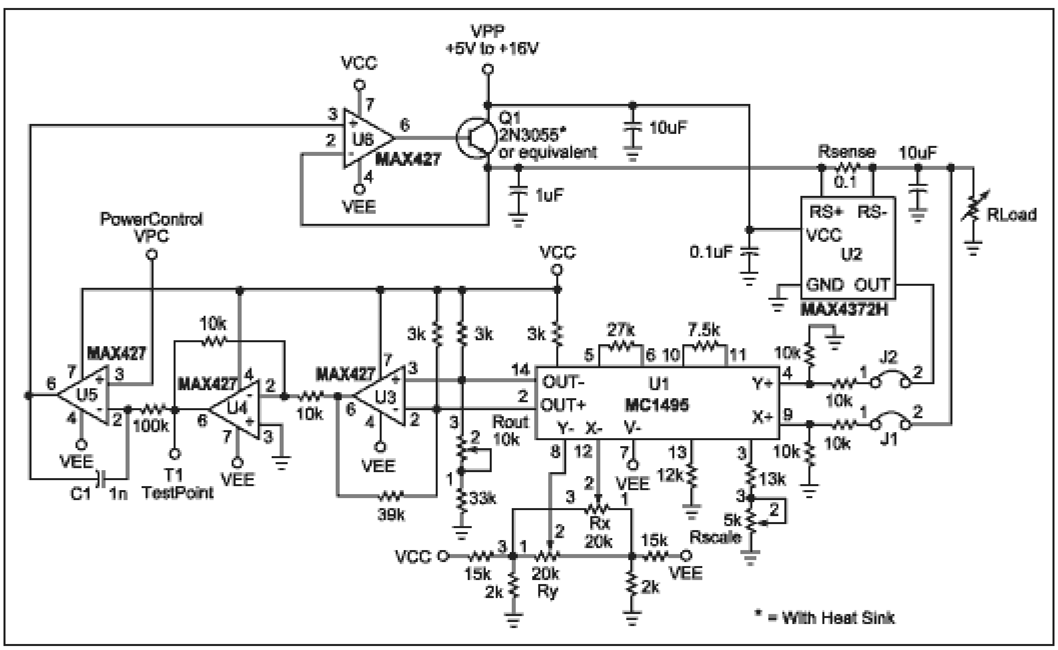

Figure 1. This regulated power source delivers fixed power to a varying load.

The circuit shown is analogous to a voltage or current source, delivering fixed power levels that are independent of the load resistance. A feedback loop senses load power and automatically adjusts the output voltage to maintain the desired power level. That is accomplished by measuring the output current with a current sensor (U2), and then obtaining the output power by multiplying the output current and voltage together with a four-quadrant analog voltage multiplier (U1 and U3).

Because the multiplier output is inverted, a unity-gain inverting stage (U4) is added to re-invert the output-power signal. The op amp (U5) then compares output power to the reference power (VPC input), and integrates any difference between them. The integrator provides an automatic power adjustment by increasing or decreasing the output voltage until output power equals reference power. U6 and Q1 form a voltage follower that drives the load.

Use the following formula to set the output power:

VPC = 10(P)(Rsense),

where P is the desired output power in watts, Rsense is the sensing resistor in ohms, and VPC (power control) is the reference power input in volts. If, for example, the desired power at the load is 1W and Rsense = 0.1Ω, then set VPC = +1V.

Curves for load power vs. load resistance (0.5W and 1W loads, Figure 2), show that power delivered to the load changes less than ±7% for a change of 10,000% (two decades) in load resistance. If you define load regulation as the change in output power divided by the output power, then for a load change of 6Ω to 40Ω at 1W, the load regulation is ±2%.

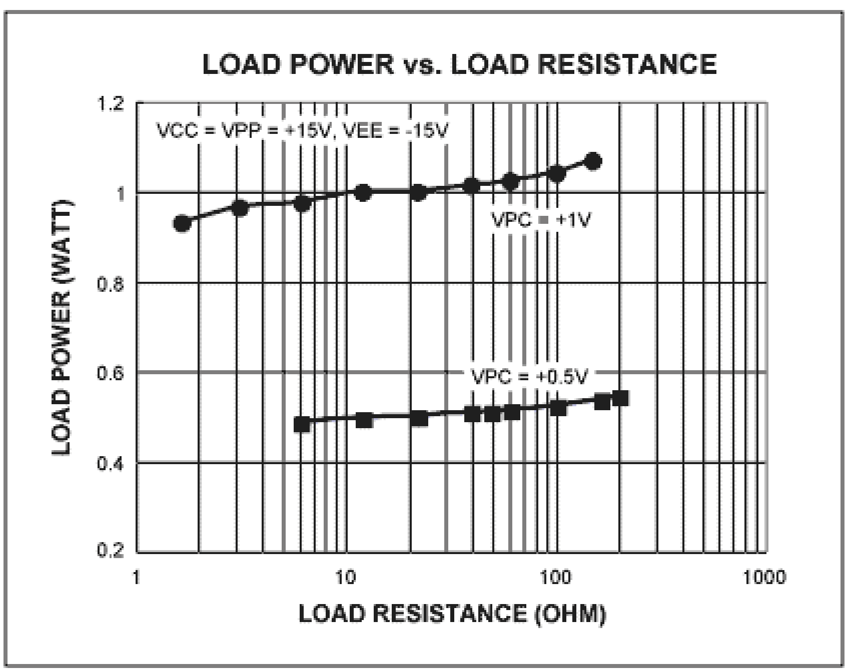

Figure 2. Power delivery to the load is nearly independent of load resistance.

To work properly, the analog multiplier must be calibrated as explained in the Motorola's MC1495 data sheet. That calibration procedure is repeated below for convenience. Jumpers J1 (X-input) and J2 (Y-input) are removed for the calibration.

1. X-input offset adjustment:

- Connect a 1.0kHz, 5Vpp sinewave to the Y-input.
- Connect the X-input to ground.
- Using an oscilloscope to monitor test point T1, adjust Rx for an AC null (zero amplitude) in the sinewave.

2. Y-input offset adjustment:

- Connect a 1.0kHz, 5Vpp sinewave to the X-input.
- Connect Y-input to ground.
- Using an oscilloscope to monitor test point T1, adjust Ry for an AC null (zero amplitude) in the sinewave.

3. Output-offset adjustment:

- Connect the X-input and Y-input to ground.
- Adjust Rout until the DC voltage at T1 is zero.

4. Scale factor (gain):

- Connect the X-input and Y-input to +10VDC.
- Adjust Rscale until the DC voltage at T1 is +10VDC.
- Repeat steps 1 through 4 as necessary.

A similar version of this article appeared in the April 4, 2002 issue of *EDN* magazine.

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