DESIGN SHOWCASE

Power meter achieves ±1% accuracy

Power meters provide an early warning of thermal overload by monitoring the power consumption in high-reliability systems. Power monitoring is especially suitable for systems in which the load voltage and current are both variable such as industrial heating and motor controllers. Such a power meter/controller (Figure 1) is based on the principle that power equals the product of current and voltage. Its typical accuracy is better than 1%.

A current sensor (U2) measures output current, and a four-quadrant analog voltage multiplier (U1 and U3) generates the product of output voltage and current. An optional unity-gain inverter (U4) inverts the inverted multiplier output. This power meter is most accurate for multiplier inputs (J1 and J2) between 3V and 15V. Choose the current-sense resistor, R_{SENSE}, as follows:

$$R_{SENSE}(\Omega) = \frac{1}{P(W)}$$

where R_{SENSE} is in ohms and P is the output power in watts. If power delivery to the load is 10W, for instance, choose $R_{SENSE} = 0.1\Omega$.

The Figure 1 circuit, with a 0.1Ω sense resistor, has a unity-gain transfer function in which the output voltage is proportional to load power. For instance, the output voltage is 10V when the load power is 10W. To change the gain transfer function, change the sense resistor as follows:

$$Gain = 10R_{SENSE}$$

Figure 2 compares power-measurement error with load power for the Figure 1 circuit. Note that the accuracy is better than $\pm 1\%$ for load power in the 3W to 14W range.

For proper operation, the analog multiplier must first be calibrated according to the following procedure (which also appears in Motorola's MC1495 data sheet). To

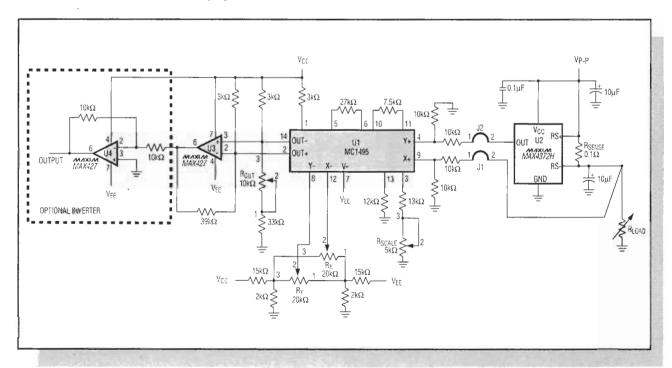


Figure 1. This power meter, whose output voltage is proportional to load power, achieves $\pm 1\%$ accuracy.

calibrate the multiplier, remove jumper J1 (X input) and J2 (Y input), and use the following procedures:

- X-input offset adjustment: Connect a 1.0kHz, 5V_{P-P} sinewave to the Y input, and connect the X input to ground. Using an oscilloscope to monitor the output, adjust R_X for an AC null (zero amplitude) in the sinewave.
- 2) **Y-input offset adjustment:** Connect a 1.0kHz, 5V_{P-P} sinewave to the X input, and connect the Y input to ground. Using an oscilloscope to monitor the output, adjust R_Y for AC null (zero amplitude) in the sinewave.
- 3) Output offset adjustment: Connect both X and Y inputs to ground. Adjust R_{OUT} until the output DC voltage is zero.
- Scale factor (Gain): Connect both X and Y inputs to 10VDC. Adjust R_{SCALE} until the output voltage is 10VDC.
- 5) Repeat steps 1 through 4 as necessary.

A similar idea appeared in EDN.

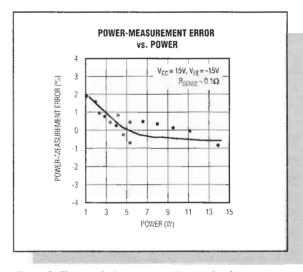


Figure 2. This graph shows measured power has better than ±1% accuracy for power levels between 3W and 14W.