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NASA TECH BRIEF

Improved Low Cost AC-to-DC Converter

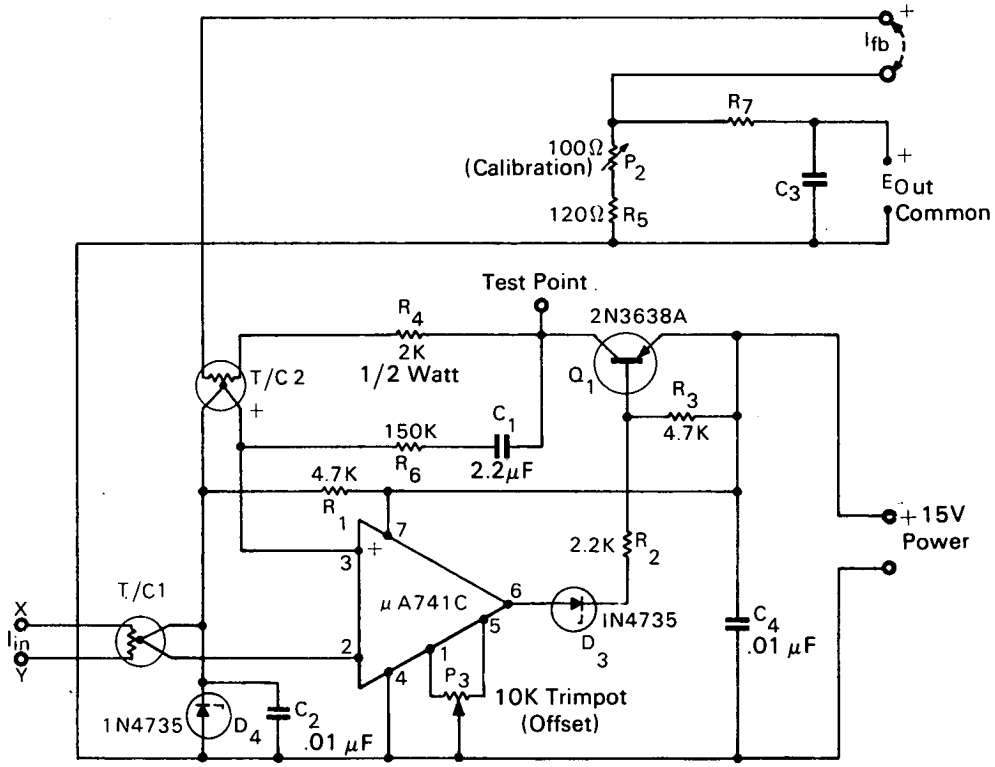

Figure 1

A low-cost circuit has been designed to convert an rms, ac voltage to a proportional dc voltage with good accuracy (±1 to ±1.5 percent) over a voltage range of approximately 6:1. The converter, which incorporates a pair of vacuum thermocouples (V-T/C's) in a dc feedback circuit, exhibits a temperature coefficient of approximately +0.01 to −0.04 percent over the temperature range from 20° to 165°F. This converter can be built at about one-quarter the cost of a similar commercially available circuit which operates at a ±1 percent accuracy over a 10:1 range and should be of interest to manufacturers and users of instruments, such as X-Y plotters and data recorders, that operate on dc voltages.

Figure 1 shows a circuit schematic with illustrative component values. The input T/C 1 is a 1 mA type used for current-to-voltage conversion in the input loop; T/C 2 is a 5 mA type used in the feedback loop. Each of these T/C's is contained in a glass bead and is electrically insulated from the heater to 100 volts

(continued overleaf)

peak. The T/C's are closely matched to avoid nonlinearity between input and output. A damping and filtering network in the negative feedback loop consists of a 150 kilohm resistor (R_6) in series with a 2.2 μF, 25V capacitor (C_1). Transistor Q_1 provides additional loop gain and also provides a voltage shift to allow the use of a grounded power supply. Resistor R_4 protects T/C 2 from burnout. A 10 kilohm potentiometer (P_3) serves as a dc offset adjustment. A 0 to 5 mA dc meter may be placed in series with T/C 2 as a permanent monitor. If a meter is not used, the terminals must be shorted. The output terminals of the circuit are connected in series with resistor R_5 and calibration potentiometer P_2. The latter is adjusted to provide a 1 V dc output when a normal maximum of 3 V rms is applied at the input, and P_1 (Figure 2a) is adjusted for a current of 1.2 mA through T/C 1. Zener diodes D1 and D2 (Figure 2a) protect the T/C 1 heater against burnout. Although T/C 1 has a nominal current rating of 1 mA, the slight overcurrent (1.2 mA) will ensure a higher T/C output voltage and greater overall accuracy.

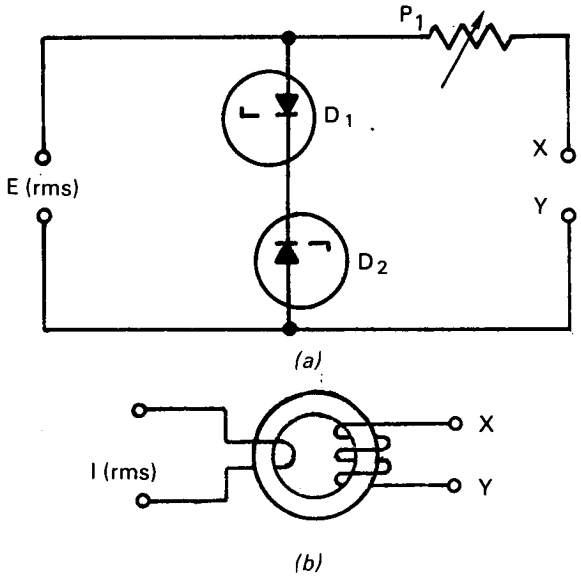

Figure 2.

Figure 2b shows an rms current-input circuit that can be used in place of the rms voltage input to the converter circuit. A current transformer with a ratio X_A / T/C1 (where X_A = the maximum current to be measured) is substituted for the input circuit of Figure 2a.

To remove noise from the output signal (E_{out}), a filter network may be added (R_7 C_3 in Figure 1). Such a network should maintain or reflect a low impedance ($\leq$ 2 kilohms) to the output terminals. The dc voltage output of this converter circuit is proportional to the rms current input. Because the thermocouples are insulated from the heaters to 100 V peak, there are no common-mode problems, and the output can be connected directly to the desired equipment (e.g., data system or recorder).

Note:

Requests for further information may be directed to:

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No patent action is contemplated by NASA.

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