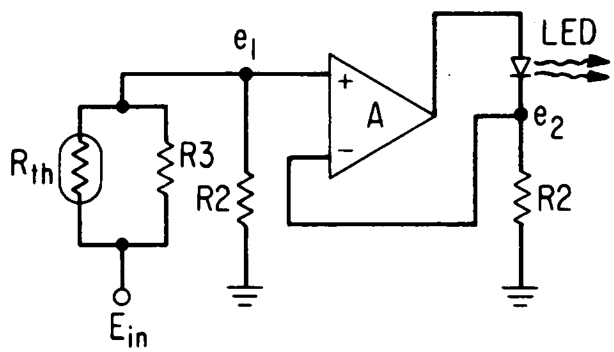
NASA TECH BRIEF
Ames Research Center

Temperature Compensation of Light-Emitting Diodes

The problem:

To devise a circuit which will maintain the light output of a light-emitting diode constant as the ambient temperature changes.



The solution:

Supply the input voltage to the light-emitting diode by a circuit which includes a thermistor–resistor combination to compensate for temperature fluctuations.

How it's done:

The thermistor, R_{th}, shown in the diagram is a resistive element with a negative temperature coefficient. The other resistors in the circuit are conventional, high quality components with nearly zero temperature coefficients.

The operational amplifier used in the circuit is conventional; however, it must have high gain, low input current, and essentially zero offset. The light-emitting diode, whose radiated output is to be maintained constant as the temperature varies, is identified as LED in the diagram.

When a potential is applied to the input terminal E_{in}, the amplifier supplies power to the light-emitting diode; the output of light can be controlled by the input voltage. For example, suppose that E_{in} is a constant, positive voltage, and that the temperature remains consant; because of current flow in the circuit comprised of R_{th}, R3 and R1, a portion, e_1, of the voltage applied at the input will appear at the positive terminal of the amplifier. The output voltage that is supplied by the amplifier to the series combination of LED and R2 will be of such magnitude that the feedback voltage (e_2) will reduce the net voltage across the input terminals of the amplifier to essentially zero, that is, $e_1 = e_2$. The current flowing through LED must be the same as the current through R2 because the amplifier effectively draws no current and, therefore, the current through R2 must be directly proportional to e_1 as well as e_2.

However, if the temperature varies, the resistance of the parallel combination R_{th} and R3 will vary, and this will result in a change in the magnitude of e_1. By appropriate selection of components, the change in e_1 resulting from a change in temperature as sensed by the thermistor can be made to compensate for changes in the light output of an LED. For example, an experimental circuit held the radiated power output of an LED constant to better than 1% over the range of 10° to 50°C; without compensation, the change in light output would be more than 100%.

Notes:

1. Techniques are available for designing thermistor–resistor networks which will produce the variation of e_1 with temperature necessary to maintain LED radiated power output essentially constant over a wide temperature range.

(continued overleaf)

2. Similar circuits can be used for compensation of temperature-induced variations in photodiode applications.
3. A combination of a temperature-compensated LED and a temperature-compensated photodiode provides a very stable photon-coupled isolator.
4. Requests for additional information may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP72-10218

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code 200-11A
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