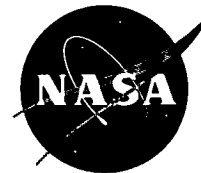


# NASA TECH BRIEF

Ames Research Center

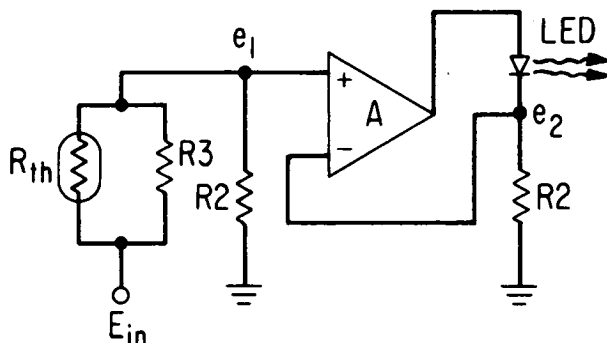


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## Temperature Compensation of Light-Emitting Diodes

### 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 constant; because of current flow in the circuit comprised of  $R_{th}$ ,  $R_3$  and  $R_1$ , 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  $R_2$  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  $R_2$  because the amplifier effectively draws no current and, therefore, the current through  $R_2$  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  $R_3$  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  $10^\circ$  to  $50^\circ\text{C}$ ; 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: TSP-72-10218

**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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