Temperature Compensation Circuit for Constant LED Intensity

Application Brief I-012

Introduction

The luminous intensity of an LED has a temperature dependence of exp [k (T - T_A)], where k is on the order of -0.01 / °C. This means that as temperature linearly increases or decreases, the light intensity of an LED exponentially decreases or increases respectively. This characteristic is a liability in outdoor applications where the LED becomes dimmer during the warmer daytime when sunlight viewability is of concern. The circuit configuration shown in Figure 1 is an example of how to minimize the intensity dependency on temperature problems in a voltage sourced application where the LED current is set with the LED in series with a current limiting resistor (Rlim). This configuration can also be used as a discrete circuit whose output is referred to other LED biasing networks (that have the same type of LED as the discrete) under the same ambient temperature condition.

Description

If large enough quiescent voltage levels (i.e. Vb < -5 V) are used to bias the LED under nominal temperature conditions, then any pn junction potential variations (i.e. silicon = -2 mV/ °C is a small linear value) can be treated as negligible in a circuit trying to compensate for the exponential dependence of light intensity on temperature.

The circuit in Figure 1 utilizes a temperature compensated current source feeding a PIN photodiode and a transresistance amplifier. The transresistance amplifier's output drives the base of a PNP transistor used to supply voltage and current to the LED and current limiting resistor. The details of designing each part of the circuit are not the scope of this application brief as much as is the concept of the overall circuit's functionality.

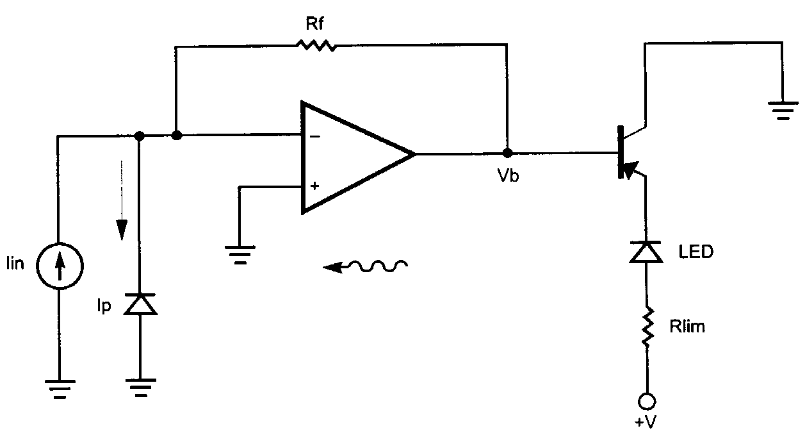

Figure 1. Temperature Compensation Circuit for Constant LED Intensity.

As a cause and effect example, compensation for an increase in temperature will be described here. As the temperature increases, the nominal light intensity of the LED will decrease. This decreases the amount of light falling on the photodiode and thus decreases the photodiode current. However, this effect increases the percentage of current Iin being fed through the feedback resistor Rf. This causes the base of the PNP to drop its voltage value and thus increase the LED current. Increasing the LED current increases the LED luminous intensity to near the nominal value. How stable the LED light intensity can be made with this circuit configuration will depend upon the nominal light output desired (the optical "Q" point) and the component values selected. It is important that the responsivity of the photodetector is high enough at the LED's dominant wavelength to allow for at least a few tens of microamps. If the responsivity is too low, then the current source value Iin will have to be low for the variations in the photodiode current to cause a significant change in the current flowing through the feedback resistor Rf. Working in the nanoamp region will be troublesome due to the combined inherent noise characteristics of all the components. Use as large a feedback resistor as possible with a low noise operational amplifier. Too large of an Rf value will not cause the feedback circuit to oscillate since the thermal transients are in the seconds range at best.

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