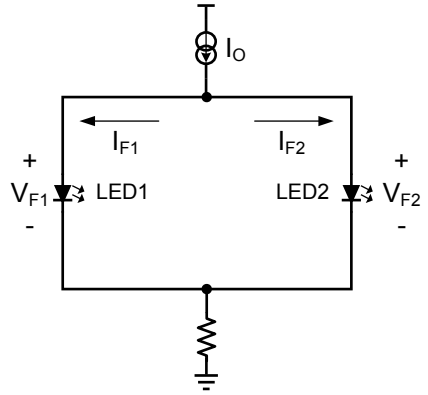
Pitfalls of Parallel LED Arrays

Whenever LEDs are placed in parallel the potential exists for a mismatch in the current that flows through the different branches. The forward voltage, V_F, of each LED varies with process, so unless each LED is binned or selected to match V_F, the LED or LED string with the lowest total forward voltage will draw the most current. (*Figure 1*)This problem is compounded by the negative temperature coefficient of LEDs (and all PN junction diodes). The LEDs that draw the most current suffer the greatest increase in die temperature, and as their die temperature increases their V_F decreases, creating a positive feedback loop. Elevated die temperature both reduces the light output and decreases the lifetime of the LEDs.



For $V_{F1} < V_{F2}$, $I_{F1} > I_{F2}$
For $V_{F2} < V_{F1}$, $I_{F1} < I_{F2}$

Figure 1: Mismatched LEDs in Parallel

The system of *Figure 1* also illustrates a potential over-current condition if one of the LEDs fails as an open circuit. Without some protection scheme, the entire drive current I_O will flow through the remaining LED(s), likely causing thermal overstress. Likewise, if one of the LEDs fails as a short circuit, the total forward voltage of that string will drop significantly, causing higher current to flow through the affected branch.

To maintain safety and reliability in a parallel LED system, forward voltage should be binned or matched. Fault monitoring should detect LEDs that fail as either short or open circuits. Finally, the entire array should have evenly distributed heat sinking, to ensure that V_F change with respect to die temperature occurs uniformly over all the LEDs.