

Dynamic Resistance

In a standard power supply that regulates output voltage the load resistance has a simple calculation:

$$R_O = V_O / I_O$$

LEDs are PN junction diodes with a dynamic resistance that shifts as their forward current changes. When the load is an LED or string of LEDs, the load resistance is replaced with the dynamic resistance, r_D . Simply dividing the LED forward voltage by forward current yields a value that is 5 to 10 times higher than the true dynamic resistance.

LED dynamic resistance is provided by some manufacturers, but in most cases must be calculated using I-V curves. (All LED manufacturers will provide at least one I-V curve.) To determine r_D at a certain forward current, draw a line tangent to the I-V slope as shown in *Figure 1*. Extend the line to the edges of the plot and record the change in forward voltage and forward current. Dividing ΔV_F by ΔI_F provides the r_D value at that point. *Figure 1* also shows a plot of several r_D values plotted against forward current to demonstrate how much r_D shifts as the forward current changes.

One amp is a typical driving current for 3W LEDs, and the calculation below shows how the dynamic resistance of a 3W white InGaN was determined at 1A:

$$\begin{aligned}\Delta V_F &= 4.0V - 3.45V \\ \Delta I_F &= 1.35A - 0A \\ r_D &= \Delta V_F / \Delta I_F = 0.55 / 1.35 = 0.4\Omega\end{aligned}$$

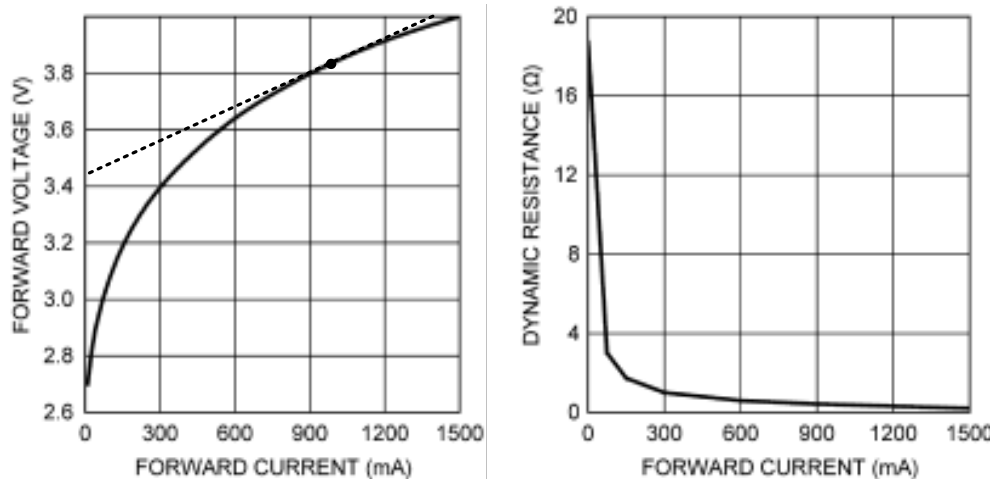


Figure 1: V_F Vs. I_F and r_D Vs. I_F Curves

Dynamic resistances combine in series and parallel like linear resistors, hence for a string of 'n' series-connected LEDs the total dynamic resistance would be:

$$r_{D-TOTAL} = n \times r_D + R_{SNS}$$

A curve-tracer capable of the 1A+ currents used by high power LEDs can be used to draw the I-V characteristic of an LED. If the curve tracer is capable of high current and high voltage, it can also be used to draw the complete I-V curve of the entire LED array. Total r_D can be determined using the tangent-line method from that plot. In the absence of a high power curve tracer, a laboratory bench-top power supply can be substituted by driving the LED or LED array at several forward currents and measuring the resulting forward voltages. A plot is created from the measured points, and again the tangent line method is used to find r_D .