An LED's intrinsic capacitance works in a 650-mV LRC circuit

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You can use the inherent capacitance of an LED to make a series resonant boost circuit that can create a voltage large enough to light the LED. Depending on the color of the LED, you need a voltage higher than 1.6V to turn it on. The threshold, or knee, voltage rises higher as the LED wavelength becomes shorter. All PN-junction diodes, including LEDs, have capacitance due to depletion and diffusion profiles.

You can light an LED using its capacitance in a series LRC (inductance/resistance/capacitance) resonant circuit. In such a circuit, the Q factor determines the multiple of the generator voltage that appears across LC. If you fashion a circuit with a high enough Q factor, you boost the generator voltage enough to light the LED. The Q factor of the resonant circuit is a function of the resistance, inductance, and capacitance, as the following **equation** shows: $Q=(1/R)\sqrt{(L/C)}$.

You can verify this calculation with a simple circuit using a blue LED in series with an inductor (**Figure 1**). The knee voltage of the LED is 2.45V, and the signal generator has an internal resistance of 50Ω. An inductance of 100 μH and the 50-pF capacitance of a typical LED yield a Q of 28. The amplitude of the sinusoidal signal generator is set at 650 mV p-p. You can then vary the generator's output frequency until you see the circuit's resonant point. As the circuit approaches the

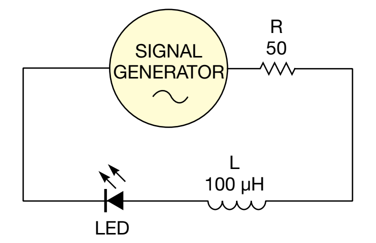

Figure 1 In this LRC circuit, the resistance is the source resistance of the sine-wave generator. The LED provides the capacitance.

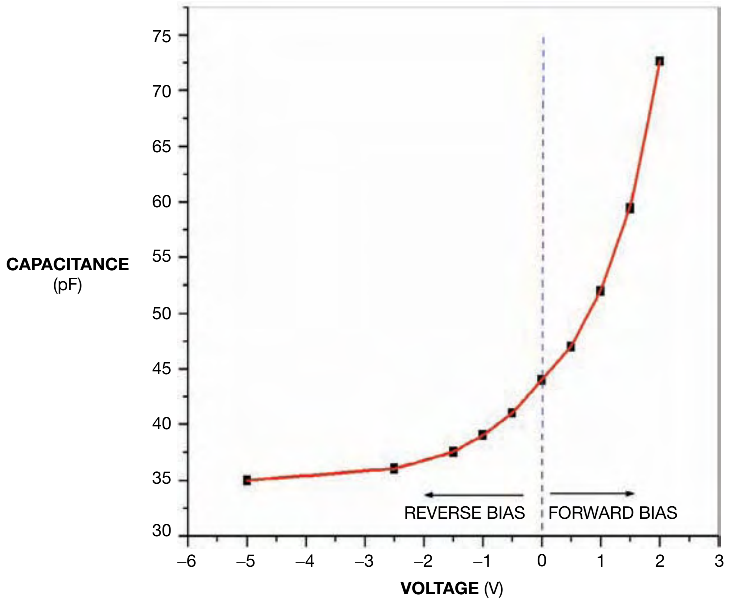

Figure 2 The junction capacitance of an LED increases as you go from a reverse bias of –5V to a forward bias of 2V.

resonant frequency, the voltage across the LED starts to increase. The resonant point manifests itself as a small jump in voltage, rather than a smooth progression, due to a positive feedback at resonance. The positive feedback happens because the capacitance of any PN-junction device is not linear (**Figure 2**). As the circuit approaches the resonant frequency, the LED voltage increases, which also increases the LED capacitance, resulting in lower resonant frequency.

For a blue LED, the voltage waveform as the circuit approaches resonance is 1.55 MHz. The circuit settles at 1.69 MHz (**Figure 3**). The forward-biased LED is thus emitting light, clipping the positive parts of the boosted waveform. Using the same 650-mV-p-p generator amplitude on other colors of LEDs produces different resonant frequencies. You can see a similar effect with a square-wave generator because it also contains the fundamental components of the resonant frequency. **EDN**

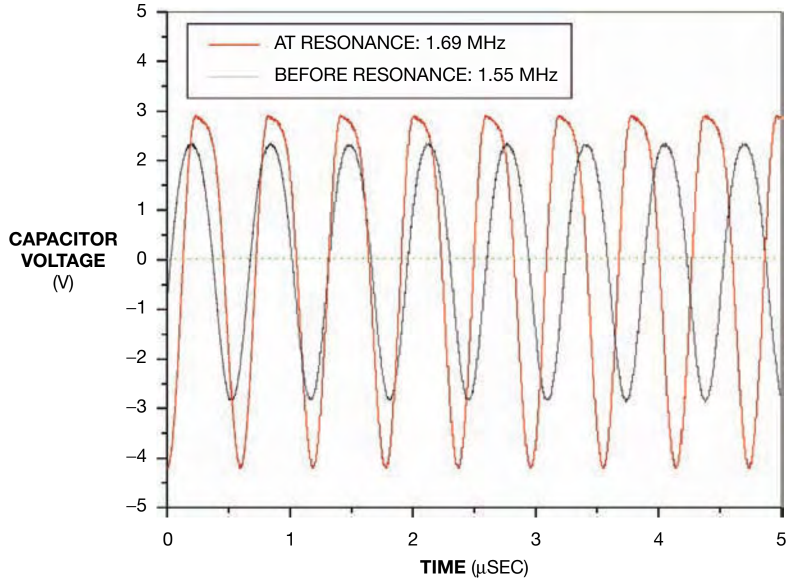

Figure 3 The effect of the LED capacitance increasing with applied voltage means the circuit will jump to a frequency as you approach the resonant point.