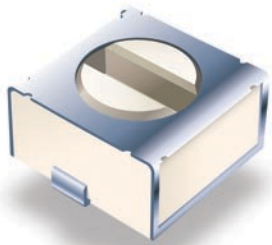


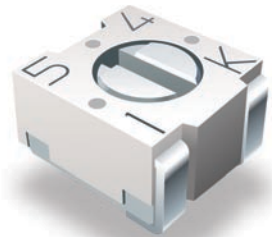


# Application Note

## Integrating Bourns® Trimpot® Trimming Potentiometers for Dimmer Control in LED Light Bulbs



3312



3313

Light Emitting Diodes (LEDs) have been gaining popularity in consumer electronics and automotive lighting, and now LED lighting is emerging as a potential replacement for the standard incandescent bulb. The LED lighting market is expected to boom in the next decade as design challenges are overcome. An example of added steps and design challenges for LED bulbs is the requirement to adjust the brightness and unification of the LEDs. A trimming potentiometer, also called a trimmer, is an effective way to satisfy these dimming control needs and provides the ability to also adjust brightness parameters on the manufacturing line.

### A Trimmer and LED Lighting Primer

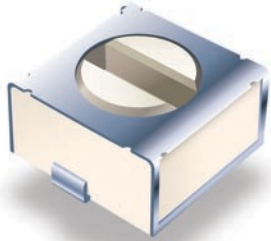
Trimmer technology is designed for use in applications where the unit must be calibrated before shipment from the factory. In the design of LED light bulbs, the trimmer is incorporated to adjust brightness and unification of the LEDs. One attractive feature of an LED lighting system is its long life compared to other lighting solutions. Pre-calibrated LED light bulb electronics may also use a trimmer for required adjustments to account for variations in other circuit components over time. It is expected that their longer life and energy savings will exceed the capabilities of any competing lighting technology.

As with most new technologies, the LED light bulb faces design challenges before it can effectively become the de facto standard. LED light bulbs are used in numerous environments, as are the incandescent bulbs they aim to replace. One fundamental difference is that LED light bulbs require electronics on printed circuit boards to drive the LEDs rather than simply installing a standalone bulb in a fixture. Cost and size are two obstacles that must be overcome in the design of electronics for LED light bulbs. Available space is the same as for an incandescent bulb so size constraints for the electronics become critical. While a single LED is smaller than an incandescent light bulb, an array of LEDs is typically used. This array must be controlled so that a uniform amount of light shines from each point on the LED light bulb. Since the voltage to the LED determines the brightness, it needs to be designed to a broad voltage range so that each LED can accommodate the desired illumination. When a dimmer is used, the LEDs will turn on at the desired brightness or switch on and off at a reduced duty cycle to give the impression of decreased brightness.

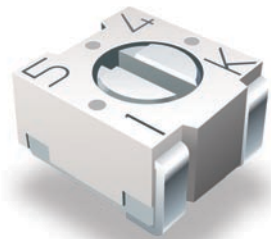
## Trimmers in Action

Within the electronics of an LED light bulb, a trimmer is incorporated in the interface to the LEDs and typically includes additional resistors. As a passive component, the trimmer does not consume power, though it is important to limit the voltage at the trimmer to its rated voltage to avoid damaging the part. Current through the trimmer also must be limited to keep the power within the rated power range for the operating voltage and temperature. Due to the variety of installation points for LED light bulbs, they may be susceptible to environmental factors such as dust and moisture. Thus, fully sealed trimmers are a more robust option for LED lighting applications since oxidation or contamination may result if a sealed trimmer is not used.

Brightness and unification are adjusted according to the voltage at the dimmer or driver circuit. The trimmer is inserted as shown in the schematic below such that total resistance can be adjusted by rotating the trimmer. Resistors R1 and R2 are chosen so that the sum of their values provides the minimal resistance and voltage drop for the circuit, accounting for margin. Trimmer VR1 is inserted with a maximum resistance value that, when added to R1 and R2, provides the maximum resistance and maximum voltage drop to the circuit. In addition to selecting the resistance value, it is important to consider the required resistance tolerance. Tighter tolerance may require a more expensive trimmer, and some applications will specify the importance of accuracy over cost.



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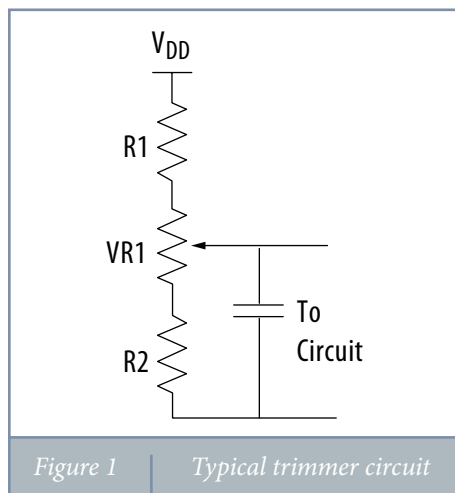
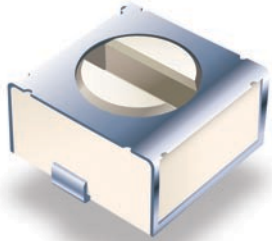
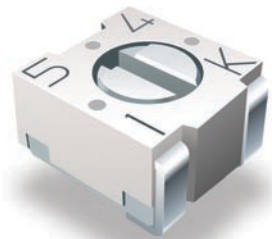


Figure 1 | Typical trimmer circuit

Placement of the trimmer will help determine the appropriate package for the application. Since adjustment may be necessary, the trimmer must be accessible and unobstructed from other components. Some packages allow only bottom adjust, and mounting options include board edge and surface mount styles. Available board real estate is a large factor in determining the part to choose for LED light bulb electronics. Once the LED light bulb electronics have been assembled and the trimmer is mounted on the board, the resistance value of the trimmer can be conveniently modified by turning the rotor, thus controlling the voltage to the LEDs and finally the brightness of the array of LEDs.



3312

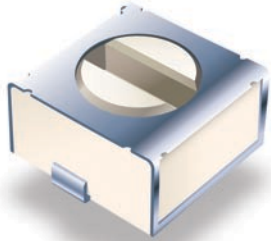


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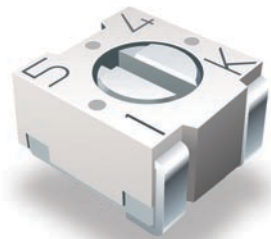
## Integrating Bourns® Trimmers

When implemented properly, a trimmer will provide continuous reliable operation of the LED light bulb, beginning from the instant it is installed in a light socket. Expertise and design advice are available from Bourns, a leader in resistive products and creator of the original trimming potentiometer over half a century ago. Bourns offers a wide range of sealed, unsealed, single-turn, and multiturn trimmers to suit numerous designs. Two models of sealed Bourns® trimmers are especially well-suited for LED light bulb electronics, namely Bourns® Models 3312 and 3313.

The resistance range to deliver the desired voltage to LED light bulbs is large. Each model provides benefits to a design, including the 100-turn life cycle of model 3313. This trimmer can be adjusted within the circuit since a rotor stop is designed into the part. Its plastic housing ensures a long life, and makes it compatible with designs using radio frequency (RF) components in close proximity, which is especially important when wireless interfaces are featured in light bulb controls. Models 3312 and 3313 are single-turn trimmers with cermet construction, and are available in numerous package types. They are compatible with surface mount designs, and are compatible with pick and place equipment and automatic adjustment equipment.



3312



3313

## Conclusion

The key features that make trimmers ideal for use in LED light bulb electronic designs include accuracy, reliability, and sensitivity. With a sealed package, models 3312 and 3313 provide reliability even in prolonged exposure to damp conditions. Bourns offers these three miniature packages with a range of prices to fit the specifications of a variety of designs. The convenience and reliability of adjusting the trimmer prior to shipping the LED light bulb offers tremendous savings potential for cost and time, making it possible to ship each unit pre-calibrated and ready for installation. The resultant precise control helps ensure consistent brightness and uniformity of the LED light bulb over its entire extended lifetime.

## References

Datasheets for the 3312 and 3313 models can be found online at:

- <http://www.bourns.com/data/global/pdfs/3312.pdf>
- <http://www.bourns.com/data/global/pdfs/3313.pdf>

Additional information regarding trimmers, including a primer on trimmer operation, is accessible in Bourns online technical library.

- <http://www.bourns.com/data/global/pdfs/trmrpmr.pdf>

For further technical support and for complete trimmer and LED solutions, please visit

[www.bourns.com](http://www.bourns.com)

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