LED Lighting

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The LED lighting applications are growing rapidly. LED light strings typically use converter and driver modules that have unique resistor requirements. It is important to understand the basic circuit components and topologies used to learn why certain resistor types are better choices for each circuit element

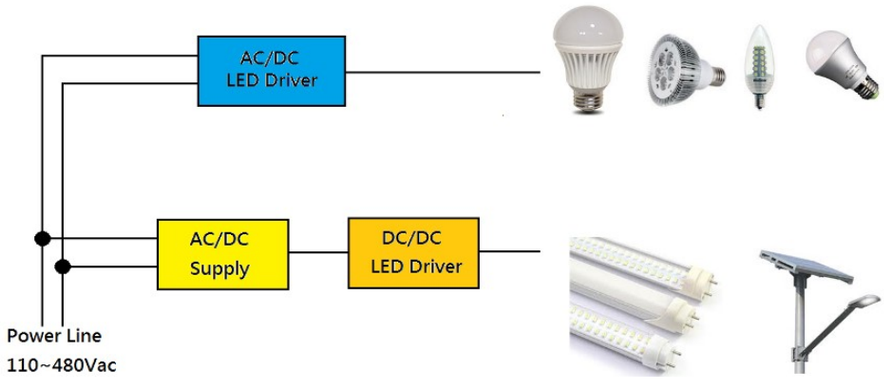

Fig. 1 LED Lighting Drivers

LED Lighting Basics

LEDs require some basic circuit components to function properly and reliably. The first component is typically an AC to DC converter. Many times, this is accomplished by using a diode bridge rectifier but there are also many AC to DC converter IC's that will work as well. A power factor correction block is sometimes used for higher efficiency and for electromagnetic interference compliance. Buck converters / controllers are commonly used as the basic power block because they provide the constant current needed to maintain LED brightness. Finally, a DC to DC converter and transformer driver may be utilized to provide the proper power levels and isolation for the LED light string.

Many semiconductor suppliers have LED Driver IC's that integrate two or more of the blocks noted above and will simplify the circuitry. Those driver ICs however are typically more complex and expensive so there is a tradeoff between simplicity or smaller size and cost.

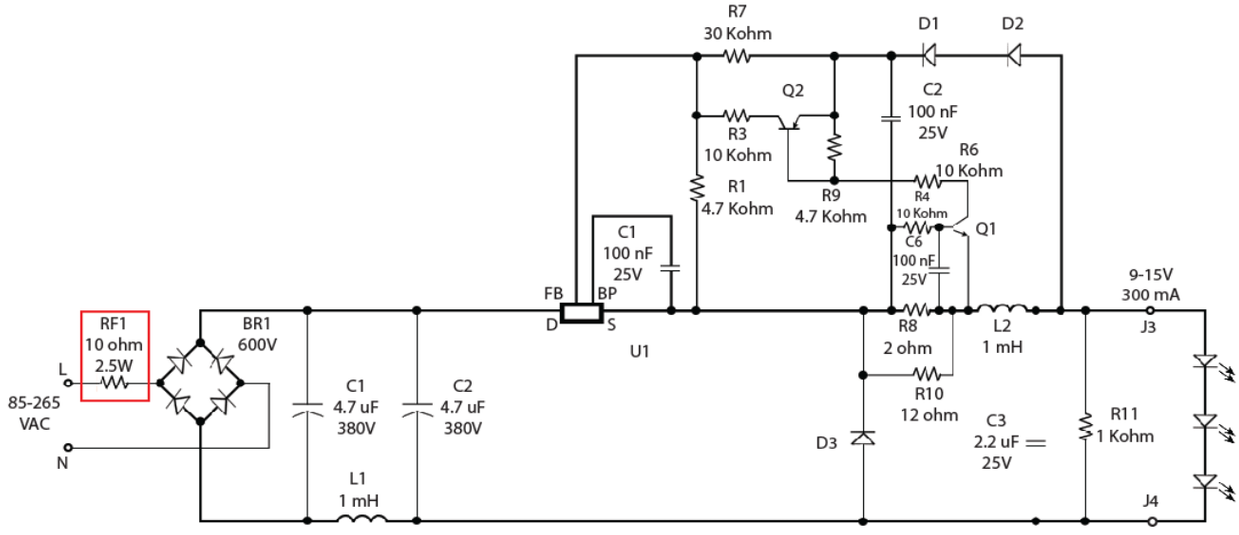

Fig.2 Diode Bridge Rectifier

AC to DC Conversion

When a diode bridge rectifier is used for the AC to DC conversion, there may be a need for a fuse or fusible wirewound resistor for overcurrent protection. The fuses are typically rated for somewhere between 2.5 and 5 amps. The fusible wirewounds will typically be in the 2 to 5 watt range and have resistance values around 10 ohms as seen in the schematic shown in Fig. 2. A fusible wirewound is typically designed such that the element wire will fuse from the excessive heat created from a continuous overload and will open safely and without allowing significant heat to be generated from the part. A standard wirewound by comparison is typically designed to be robust and will experience extreme heat before fusing, potentially melting nearby components or connectors and potentially starting a fire. Unlike fusible film resistors, fusible wirewounds can handle higher surge currents with very little permanent resistance shift, yet will fuse under continuous overload conditions to protect the more expensive circuitry. Thermal fusing wirewounds are another excellent option as they provide high current handling and a guaranteed fusing response above a given fusing temperature. Thermal fusing wirewounds incorporate a separate thermal fuse inside the device which allows the fusing temperature to be adjusted to suit the design guidelines for the surrounding components or safety regulations for the light itself.

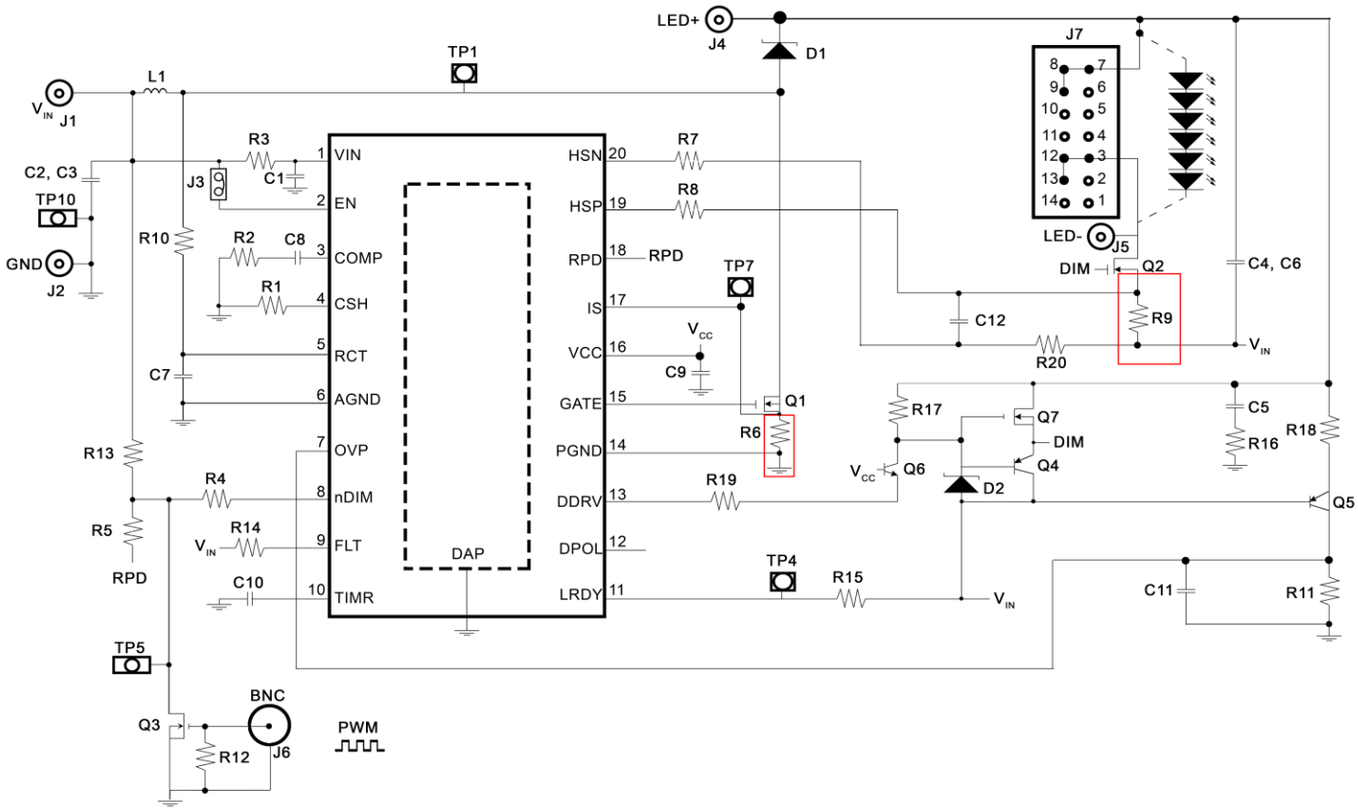

Fig. 3 Common Buck Controller Design

Buck Converter / Controller

Many common reference designs for buck converters will utilize a current sense resistor. A current sense resistor is typically used for power control and monitoring. Using a chip resistor for current sensing provides an inexpensive and reliable method of power monitoring and has a very straightforward implementation. For many common commercial and residential LED bulbs, the chip resistors may utilize larger case sizes, such as those from 1206 to 2512. However, due to the relatively low current levels required for driving the LEDs, the resistance values are usually relatively high (1Ω to 5Ω) for these current sense resistors and thus can usually be realized with commodity thick film chips. Some applications with larger or multiple LED strings or in industrial applications where high efficiency is critical to reducing energy costs, require a low resistance value, or a high power rating for a given package size or both. For these instances, higher performance current sense resistors such as those with foil elements or all metal construction are required. All metal resistors provide the best surge current handling and remain highly stable after thousands of life hours.

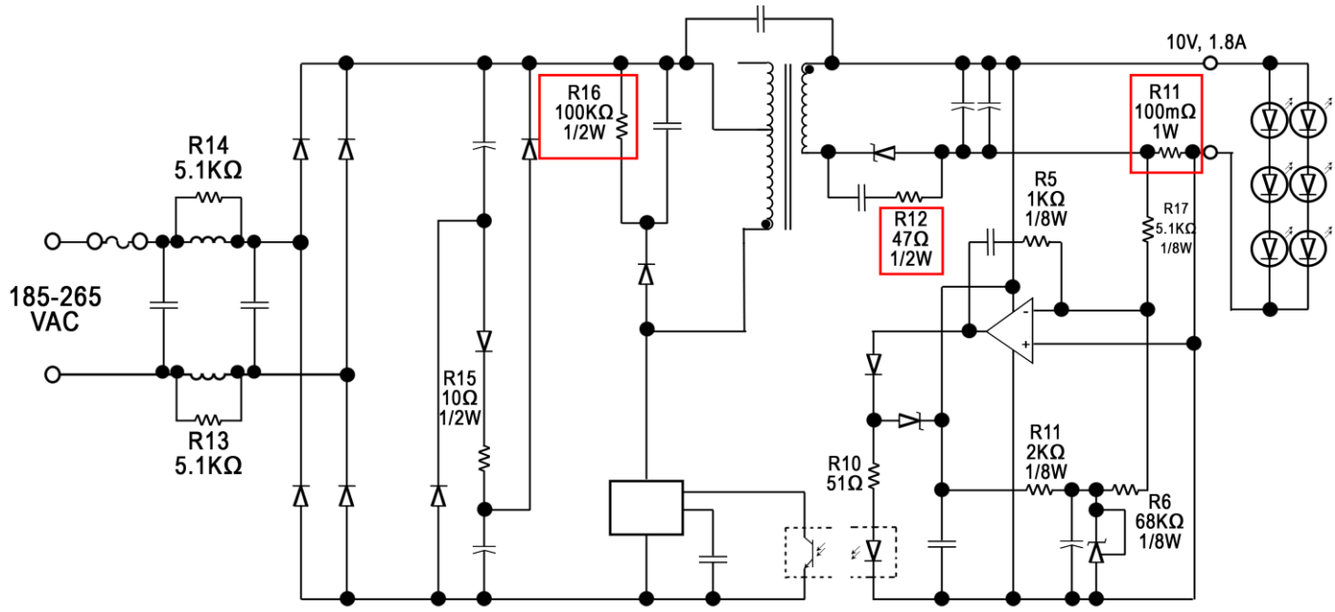

Fig. 4 LED Driver Using a Transformer

DC to DC Converter / Transformer Driver

For DC driven LED strings, this is the final stage before power is delivered to the LED or LED string. Transformers are a popular choice when isolation is desired. In many cases, a resistor is used to limit current through the transformer, noted as R12 and R16 in the schematic shown in Fig. 4. Because of the surges seen during power up and down, these resistors must be able to withstand surges. Anti-surge thick film chip resistors are an ideal choice for this stage. These types of resistors provide a higher level of surge handling and the pulse performance is very repeatable and reliable. Yet, under continuous overload conditions, the film elements will eventually open, preventing runaway fault conditions and protecting the surrounding circuitry. It should be noted that current sense resistors are still commonly used in these converters to monitor the LED driving current.

Summary

LED lighting is an important part of lowering the overall power consumption for lighting in general as LED lights consume far less power than traditional incandescent and CFL lights. However, unlike traditional light bulbs and ballasts, LED lights require circuitry for operation. AC to DC converter implementation commonly uses a diode bridge rectifier at the input where fusible wirewounds, or thermally protected wirewounds are a great choice. When Buck converters or controllers are used, current sensing will typically be required. Depending on the number of LEDs or LED strings and the efficiency requirements, commodity thick film chip resistors may be used, or all metal sense resistors can provide higher efficiency and are able to support larger LED strings. For DC to DC converters utilizing a transformer are used, anti-surge thick film chip resistors provide a great low cost current limiter for the transformer and will fuse under continuous overloads.