Lutron Electronics Co., Inc. ex-parte meeting at the U.S. Department of Energy

Subject: LED drivers are not external power supplies

Meeting date: 11 February 2015

Attendees:
John Cymbalsky, Equipment and Appliance Standards Program Manager, Building Technologies Office, DOE
Jeremy Dommu, Project Manager, Equipment and Appliance Standards Program, Building Technologies Office, DOE
Laura Barhydt, Assistant General Counsel for Enforcement, DOE
Steve Goering, EPS Attorney in Enforcement, DOE
Alison MacDonald, Navigant Consulting
Bob Newman, PE, Lutron Fellow, Lutron
Pekka Hakkarainen, PhD, VP Government and Industry Relations, Lutron (recorder of these notes)

Cc: Ashley Armstrong, Supervisory Project Manager, Equipment and Appliance Standards Program, Building Technologies Office, DOE

This meeting was requested to give additional clarification to comments submitted by Lutron in December 2014 to the External Power Supply Test Procedure NOPR, docket number EERE–2014–BT–TP–0043. Lutron felt that more technical communication was needed to support the position that LED drivers that *have control inputs* (including dimming) or that *are configurable* (output power and voltage/current) are not external power supplies. We believe that what is described below is applicable to the solid state lighting industry as a whole, and not just to Lutron.

As indicated in the attached diagrams, an external power supply is a device that converts household AC current to DC or lower voltage AC current to operate a consumer product *using a single stage power conversion circuit*. All external power supplies that were analyzed for the February 2014 final rule have this characteristic, and a standard with minimum electrical efficiencies in the 85-88% range, depending on power rating, makes sense for these products. There may be a limited class of LED drivers that employ a single stage power conversion circuit, and that can be detached from the LED light engine by the consumer, such as in the case of a simple table lamp. Such drivers may possibly be external power supplies and thus subject to the February 2014 rule. Lutron does not manufacture these types of LED drivers. This meeting covered LED drivers that are typically permanently installed in hard wired luminaires, or permanently installed but remote from the luminaire such as in the case of cove lights.

Contrasted to an external power supply, an LED driver provides carefully controlled power to an LED light engine *using a two stage power conversion circuit*. The two stages are necessary because the first stage converts AC current to a DC current while also ensuring that the input power quality of the LED Driver satisfied strict power factor and total harmonic distortion requirements. The second stage provides power to the LED light engine in a controlled manner using feedback and measurement circuits in order to keep the light output as constant as possible, and at the desired level. State of the art power conversion efficiencies of 94% for both of these stages result in a combined efficiency of 88%, *without* taking into account the power allowances that are required for the feedback and measurement circuit, for the control input receiver circuit, or for the microprocessor or other application specific integrated circuit that is required to operate the LED driver while also giving it an identity programming feature. The last feature is required because the market requirements for LED drivers have resulted in the need to have configurable LED drivers. The LED driver manufacturer produces an LED driver that has a wide potential operating range, such as from 30W to 70W operation with output voltage from 12V to 60V. The luminaire manufacturer (OEM) configures the driver to match the LED light engine that has been ordered with the luminaire. This greatly reduces the amount of inventory that is required and thus reduces the lead time and the price of the end product to the purchaser of the luminaire, compared to a situation where each design of an LED light engine requires a custom designed driver. However, this flexibility comes with the result that only one of the operating points has the highest efficiency, and this typically occurs at the highest voltage and power ratings.

Finally, market conditions have also dictated that LED driver manufacturers must provide drivers that can operate at both 120V and 277V input voltages. It is recognized that this universal input voltage feature alone does not differentiate LED drivers from external power supplies, many of which also support universal input voltages (120-240V). However, when drivers are designed for this range, the highest efficiency is obtained at the highest operating voltage (277V) when the currents are the lowest. All of these multiple factors yield the result that while it may be possible to design an LED driver that operates at 88% efficiency at 277V, at its highest output power and output voltage configurations and (for dimming drivers) at full light output, when operated at any other point, the efficiency is going be reduced.

Lutron takes the position that the intent of the statutory definition of an external power supply was that it would apply to devices that do very little if anything other than convert household AC current to DC current or lower voltage AC current for the purpose of operating a consumer product. If the removal of any additional feature significantly changed the operation or the functioning of the device, it would not be an external power supply. Thus, the removal of a “power on” indicator light on the device does not change the functioning of the device and therefore an external power supply with an indicator light is still an external power supply and subject to the standard. A desktop computer with a USB port converts 120V AC current to DC current supplied through the USB port to operate computer peripherals such as a flash drive, but the desktop computer is not an external power supply. The removal of the motherboard significantly changes the operation of the device, in fact probably makes it virtually inoperable. In the same manner, the removal of the feedback and measurement circuit, to pick a specific example, from an LED driver significantly changes the operation of the driver: the light output of the LED light engine would be unstable and thus unacceptable to the building occupants.

The external power supply test procedure indicates that external power supplies are tested at 120V input voltage. Furthermore, the average efficiency is the average of the efficiencies at 25%, 50%, 75% and 100% loading relative to rated power. It is very unclear how to apply this test procedure to LED drivers, especially those that are configurable, because it is not clear what the 25%, 50%, 75% and 100% loading points are. The driver is customized to operate a particular LED light engine, and using it for any other light engine is a misapplication. Furthermore, using the test procedure as proposed has no relevance for the case of constant current LED drivers, because the driver would never see those artificial operating points in the real world. And for universal voltage drivers described above, the 120V operating input voltage is immediately a disadvantage relative to the fact that the driver design also has to support 277V operation.

In conclusion, Lutron does not believe that it is technologically feasible to design LED drivers that meet, at the same time, practical market requirements *and* the efficiency standards for external power supplies from the February 2014 final rule. In addition, the no load power consumption limit that is sensible for external power supplies makes no sense for LED drivers, since they are never in a no load condition in practice.

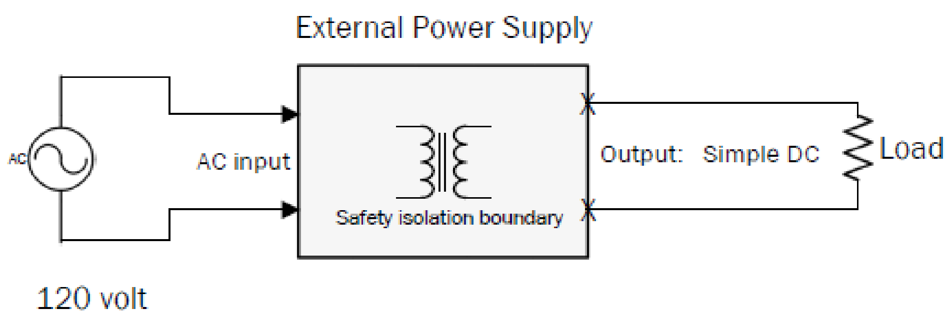
We therefore strongly urge DOE to conduct a separate rulemaking for LED drivers. We are in favor of minimum energy standards for these devices, but we feel that the external power supply standard is inappropriate if applied to all LED drivers.

It would be a significant loss to the nation to require all LED drivers to comply with the external power supply standard. This would require the LED driver designs to migrate to single stage power conversion, with the result that control (dimming, daylight harvesting, occupancy sensing, demand response etc.) and configuration features would be lost. As indicated in an LBNL metastudy[1] from 2012, all lighting control strategies mentioned above (except demand response) result in about 30% energy savings at the building level. These savings would be lost in LED lighting applications, and furthermore LED lighting would no longer comply with many building energy code requirements.

[1] Williams, A., B. Atkinson, K. Garbesi, E. Page and F. Rubinstein, "Lighting Controls in Commercial Buildings", Leukos Vol 8, No 3, January 2012

Generic External Power Supply

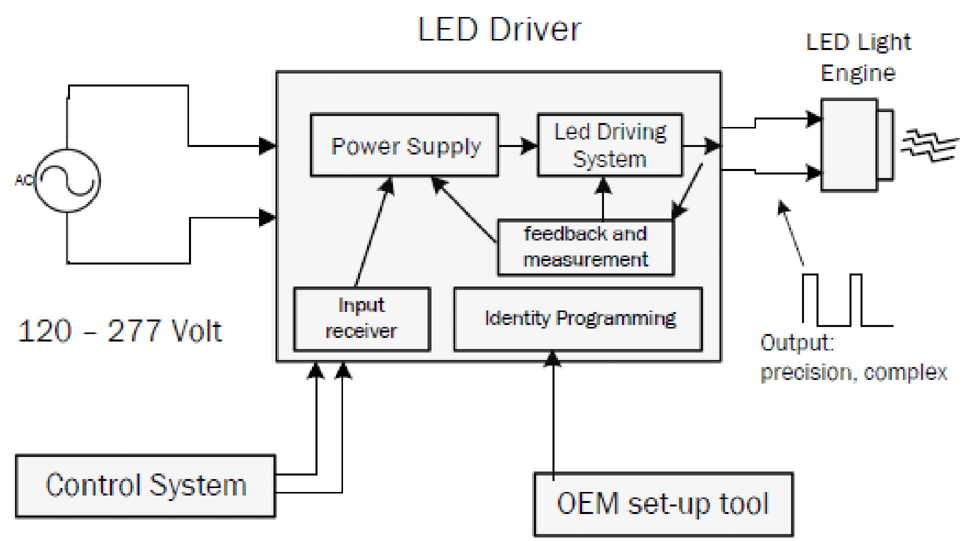
Standard Utility Power converted for an unspecified load



- DOE rules only apply to 120 volt application
- External Power Supply may be connected with NO load, this is a real condition
- External Power Supply does NOT actually provide controllability to the load, just power

LED Driver

Standard and Industrial Power converted to drive LED loads



- Driver operation from a wide input 120-277 volts
- Driver must listen to a control system all the time.
- Driver must consume power to listen even when off.
- Industry has adopted a procedure to "customize" each unit at the OEM to give the Driver its electrical characteristics
- Driver provides operational control of the LED