



EE&T Conference

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Agenda

- ▶ Energy Star Specifications For Intergral LED Lamps
 - Requirements For All Lamps
 - Directional Lamps Specific Requirements
- ▶ A PAR30/38 Application
 - Translating Lamp Requirements To Driver Requirements
 - Schematic
 - Results
- ▶ Other SSL2101 Form Factors & Topologies
- ▶ SSL Driver Product Offerings From NXP

Energy Star Specifications For Integral LED Lamps

- ▶ Integral LED Lamp is defined as a device which includes LEDs, and integrated LED driver, and an ANSI standardized base.
- ▶ Most recent amended version: 03/22/2010
 - http://www.energystar.gov/ia/partners/manuf_res/downloads/IntegralLamps_FINAL.pdf
- ▶ Deals with both “Standard” and “Non-Standard” Lamp types
- ▶ Sets minimum standards for Lamp performance
- ▶ Sets reference standards, performance characteristics, test procedures, and packaging requirements
- ▶ Criteria revisions expected over the next several years

Requirements For All Lamps

- ▶ Correlated Color Temperature (CCT)
 - Nominal CCT, Target CCT And Tolerance
 - 2700 K , 2725 +/- 145 K
 - 3000 K , 3045 +/- 175 K
 - 3500 K , 3465 +/- 245 K
 - 4000 K , 3985 +/- 275 K
- ▶ Color Maintenance:
 - Chromaticity change ≤ 0.007 on the CIE 1976 diagram within 6000 hour test period.
- ▶ Minimum CRI: 80
- ▶ Power Factor: ≥ 0.70 for lamp power $> 5W$
- ▶ EM &RFI: Must pass FCC 47 CFR Part 15
- ▶ Transient Protection: Seven strikes of a 100kHz ring wave, 2.5kV level, common mode and differential mode.

Directional Lamps Specific Requirements



- ▶ Applicable lamp types: BR, ER, K, MR, PAR, R
- ▶ Minimum luminous efficacy (based on Lamp diameter): > 40 Lm/W
- ▶ Minimum center beam intensity
 - PAR:
www.drintl.com/htmlmail/energystar/dec09/esintlampcenterbeamtool.zip
- ▶ Lumen Maintenance: > 70% lumen maintenance @ 25,000 hours of operation

A PAR38 Application

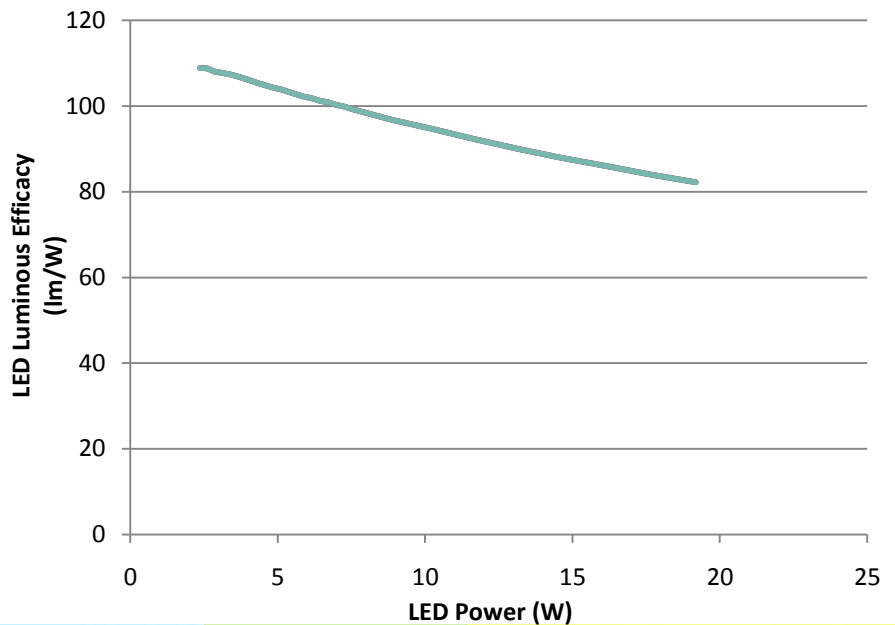
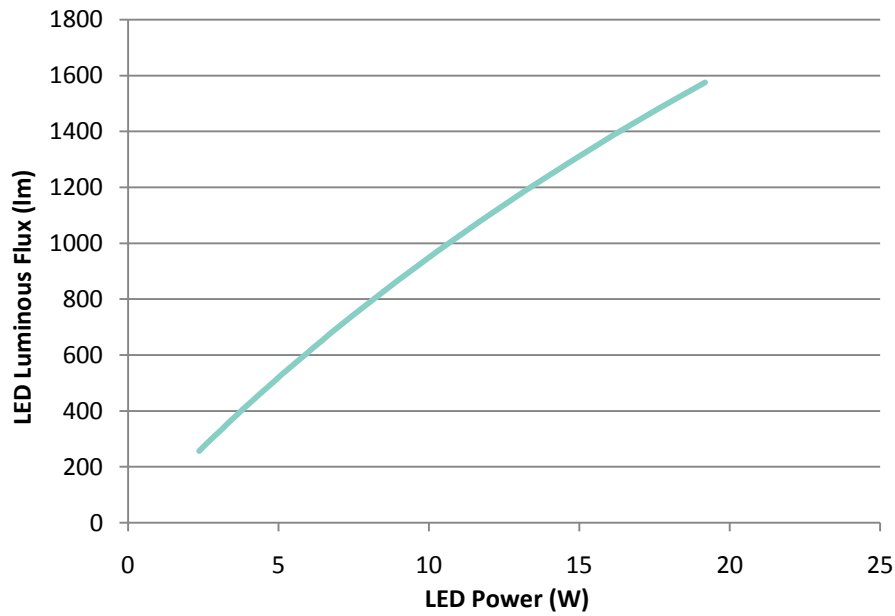
Replacing The PAR38 Incandescent Bulb

- ▶ 120V +/-10% Operation
- ▶ 980 Lumens Output
- ▶ 75W Power Dissipation
- ▶ 2500 Hour Operational Life
- ▶ 13 Lumens per Watt performance
- ▶ -20°C - +45°C Ambient Operation



Translating Incandescent Lamp Performance To SSL Lamp Requirements

- ▶ 80°C LED Temp (Solder Point)
- ▶ 90% Optical Efficiency
- ▶ 9 Cool White LEDs, 450mA Drive Current, 26.42V LED String Voltage

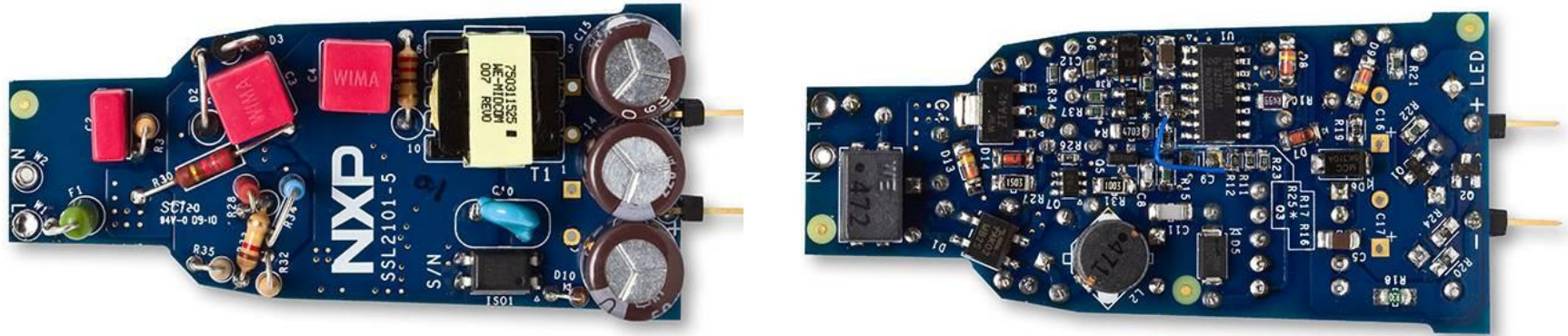


Driver Design Criteria

For This Example

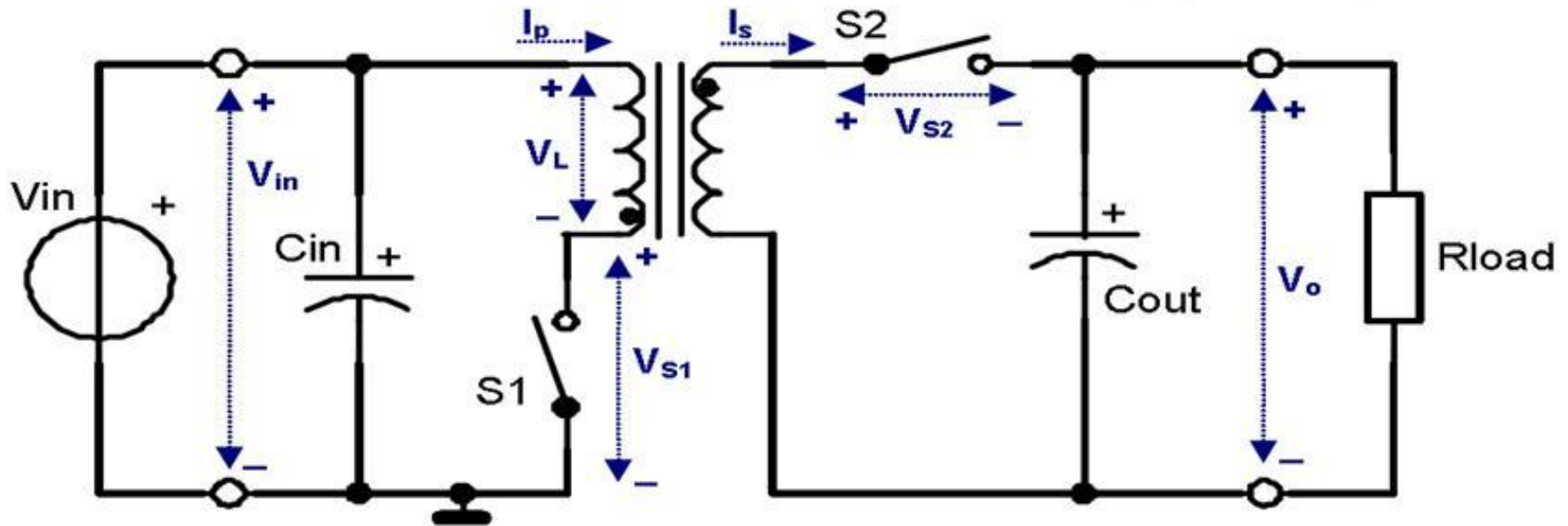
- ▶ Big 3:
 1. Small Form Factor (must fit in neck of PAR38 Bulb outline)
 2. Cost
 3. Efficiency
- ▶ Isolated – Flyback
- ▶ TRIAC Dimmer Compatible
- ▶ Application Characteristics
 - 30V Output
 - 450mA LED Current @ Full-ON
- ▶ Must target Energy Star Directional Bulb targets

A PAR Driver Solution From NXP

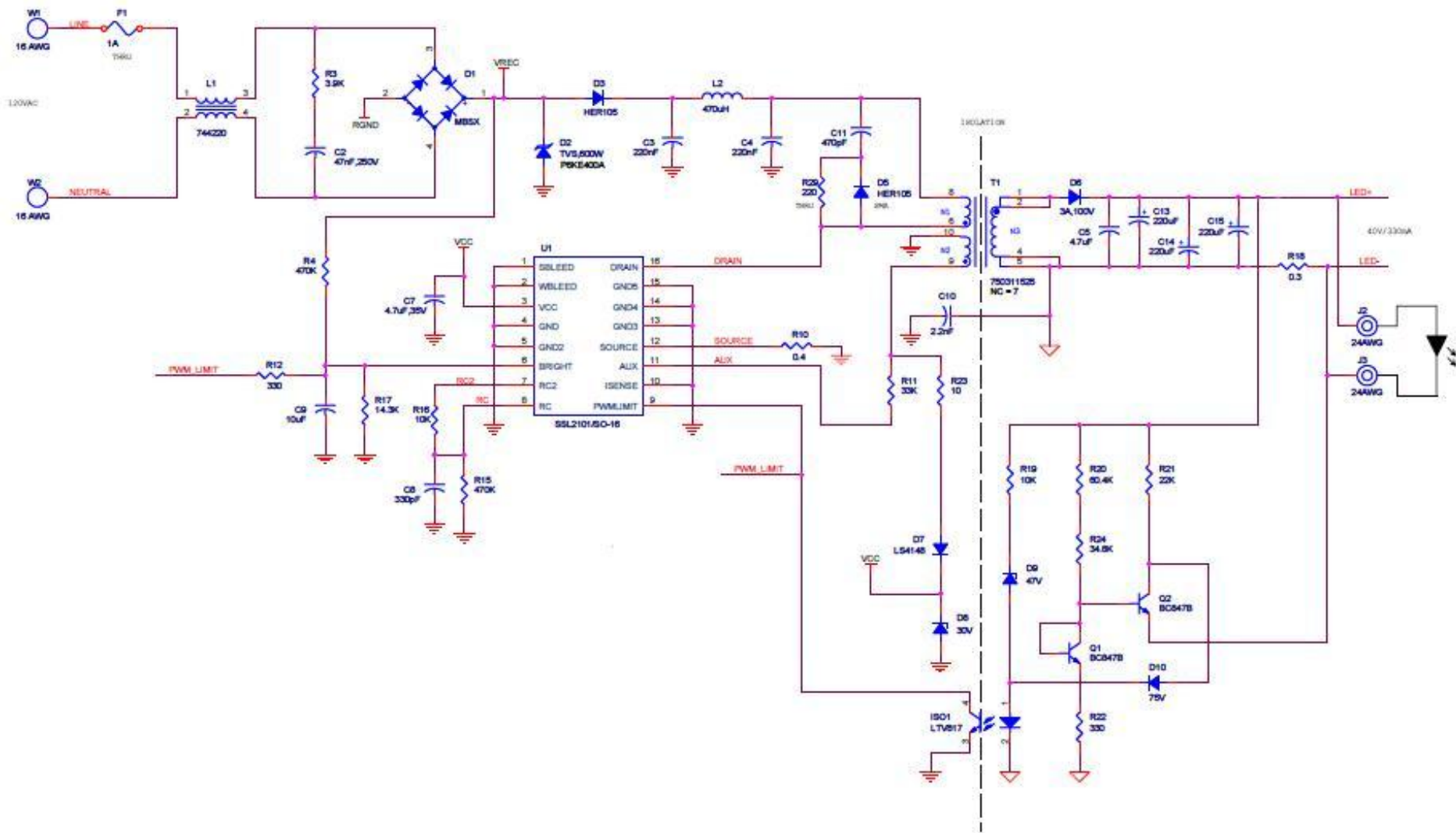


- ▶ Uses SSL2101 SSL SMPS Controller with Integrated MOSFET Switch
- ▶ Isolated Flyback driver for Integrated LED Lamp applications
- ▶ 450mA output current
- ▶ Designed for Long Life, High Thermal Stress, and EMC Compliance

Basic Principles Of A Flyback Converter



SSL2101 Flyback Design

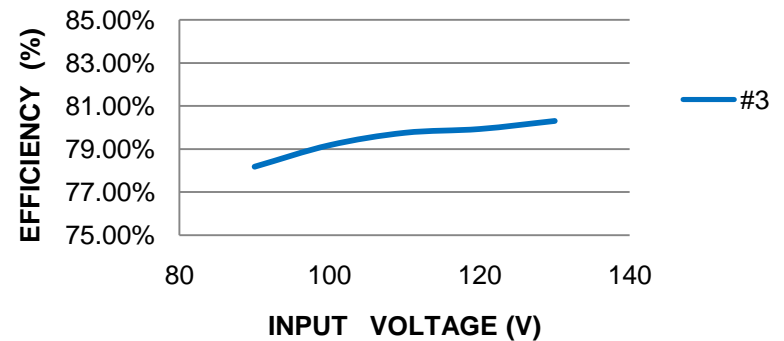


SSL2101 Flyback Design

Input Voltage Variation Performance

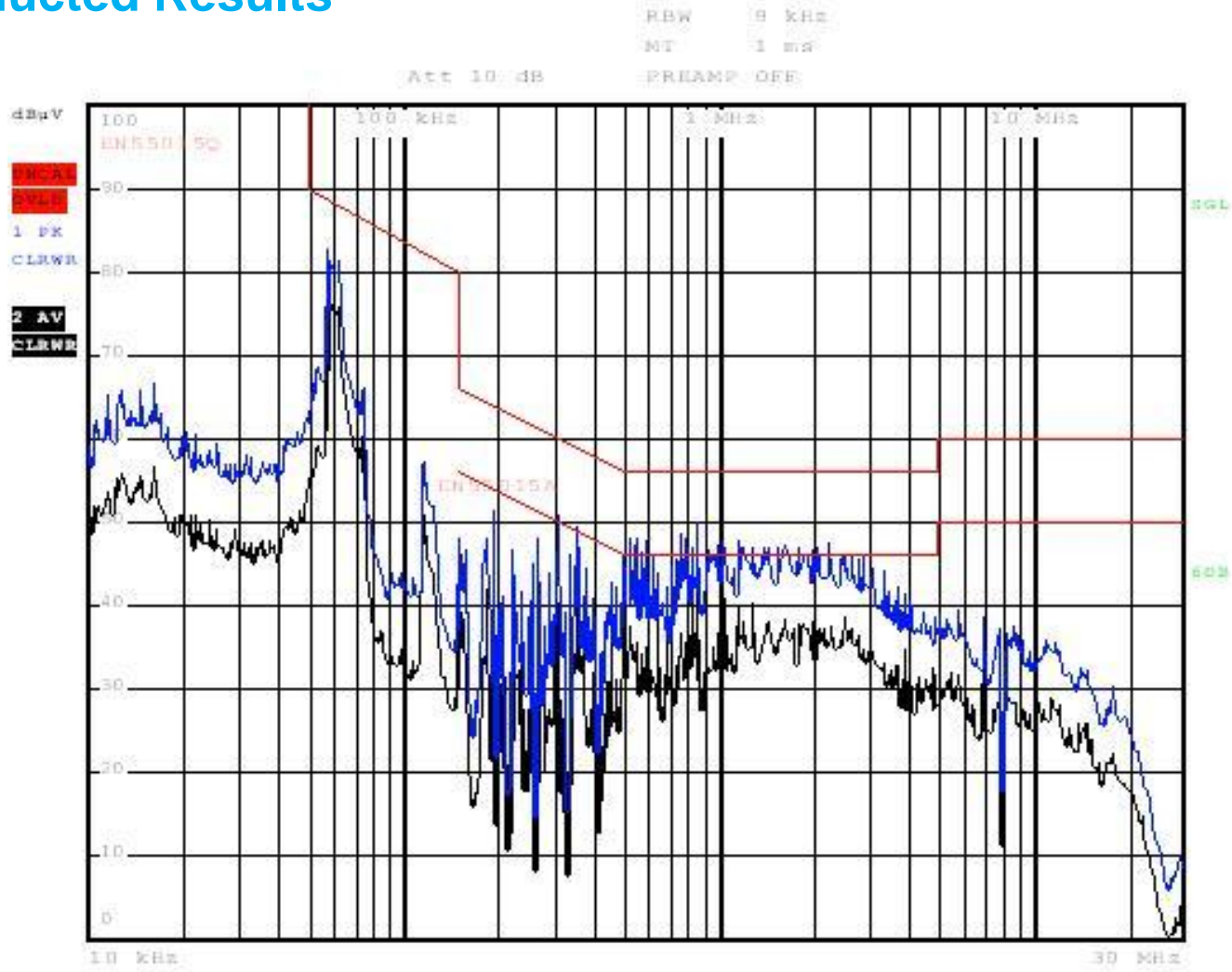
A: Input voltage variation dependency					
Pout=power delivered into LED's					
Vin	Pin	Pout	eff	Pf	
90	14.89	11.90	79.9%	0.99	
100	15.60	12.50	80.1%	0.97	
110	16.10	13.00	80.7%	0.96	
120	17.00	13.70	80.6%	0.95	
130	16.90	13.60	80.5%	0.96	
140	17.10	13.82	80.8%	0.96	

Efficiency with Dimmer (MAX)



SSL2101 Flyback Design

EMI Conducted Results

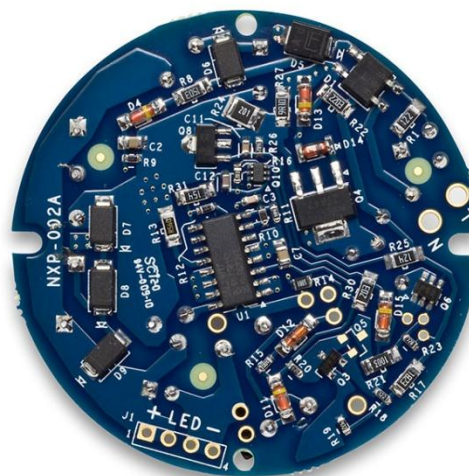
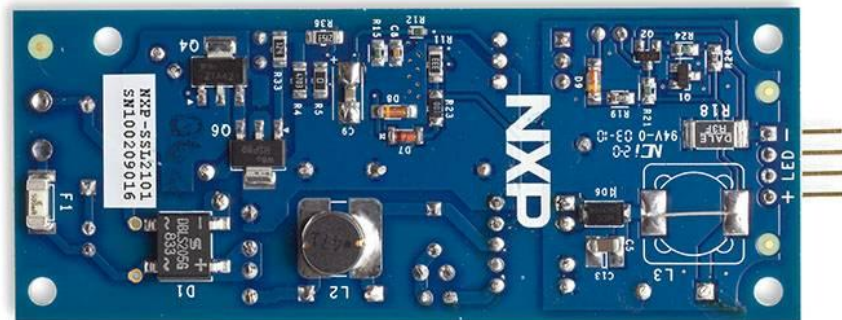


SSL2101 Flyback Design

Key Design Features

- ▶ Long-Life rated electrolytic capacitors are part of the design
- ▶ Design For Manufacturing
 - SMT devices loaded on bottom side and PTH devices on top side for easy PCB assembly
- ▶ Design For Reliability
 - Thermal analysis conducted on design and devices rated to exceed thermal requirements.
 - Critical components strategically placed based on thermal analysis.

SSL2101 Form Factor Designs



LED PAR Bulb Design Results

- ▶ 62 Lumens / Watt - Lamp efficiency
- ▶ >84% efficiency of LED Driver in Buck topology
- ▶ >80% efficiency of LED Driver in Flyback topology
- ▶ >0.84 Power Factor of LED Driver in Buck topology
- ▶ >0.95 Power Factor of LED Driver in Flyback topology
- ▶ LED Driver designs (Buck & Flyback) pass EMC requirements
- ▶ LED Driver designed to meet high temperature requirements and achieve long (>35K Hours) life.

A bright idea for LED luminaries ...

SSL2101
SSL2102
SSL2103



For high efficient isolated and non-isolated mains dimmable LED drivers

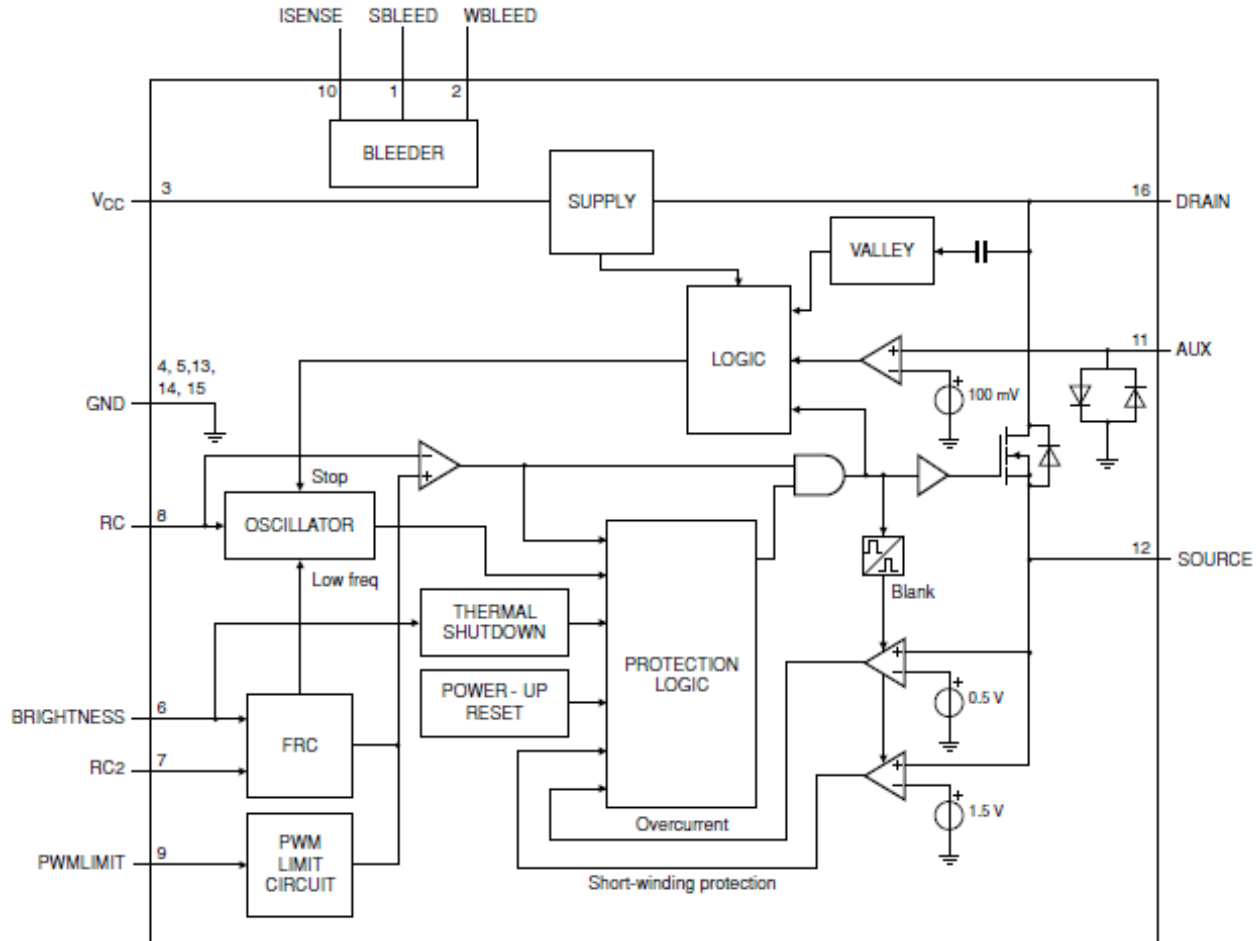
One platform, three devices, addressing all applications

Key Features

- ▶ Deep Dimming with build in logarithmic dimming curve.
- ▶ SSL2101/2102:
 - Integrated 650V power switch (6.5Ohm)
 - 2 Integrated HV bleeder switches & control for triac/transistor dimmer compatibility
 - self supplying (operates from 80 – 276VAC)
- ▶ SSL2103:
 - External power switch
 - External bleeder bipolar transistors
- ▶ Valley switching and demagnetization protection
- ▶ Constant T_{on} time control
- ▶ Temperature protection, Under voltage lock-out, Short winding protection, adjustable over-current protection

SS2101 SSL Driver IC

Block Diagram



A bright idea for LED luminaries ...

SSL2103



Based on same platform as SSL2101 and SSL2102.

Offers full flexibility to extend the range of applications

- ▶ External Power MOS
 - Flexibility on application power range
- ▶ External bleeder transistors
 - Current drive allows bipolar transistors
 - Flexibility on dimmer compatibility range
- ▶ SO14 package
- ▶ Same behaviour and operating modes as SSL2101
 - One learning for the engineer
 - Platform approach

A bright idea for LED luminaries ...

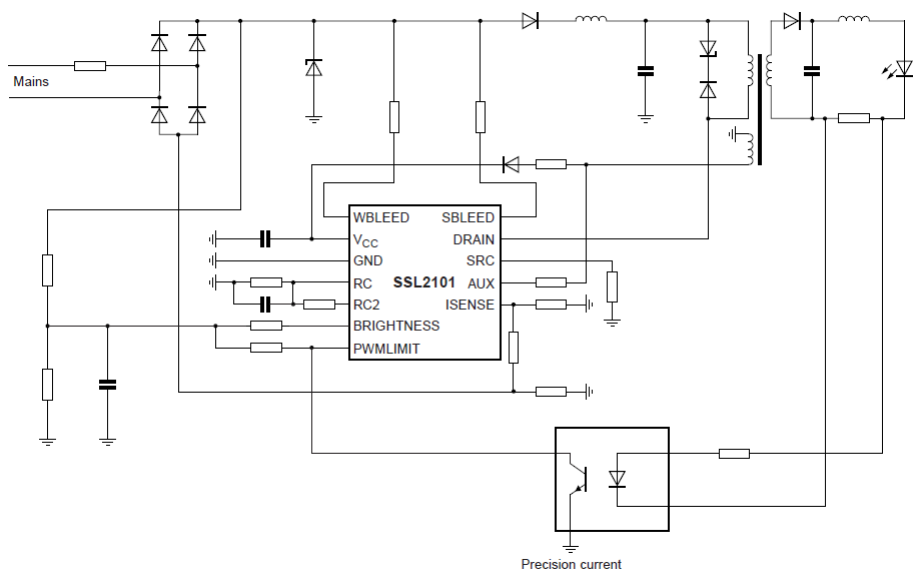
SSL2103



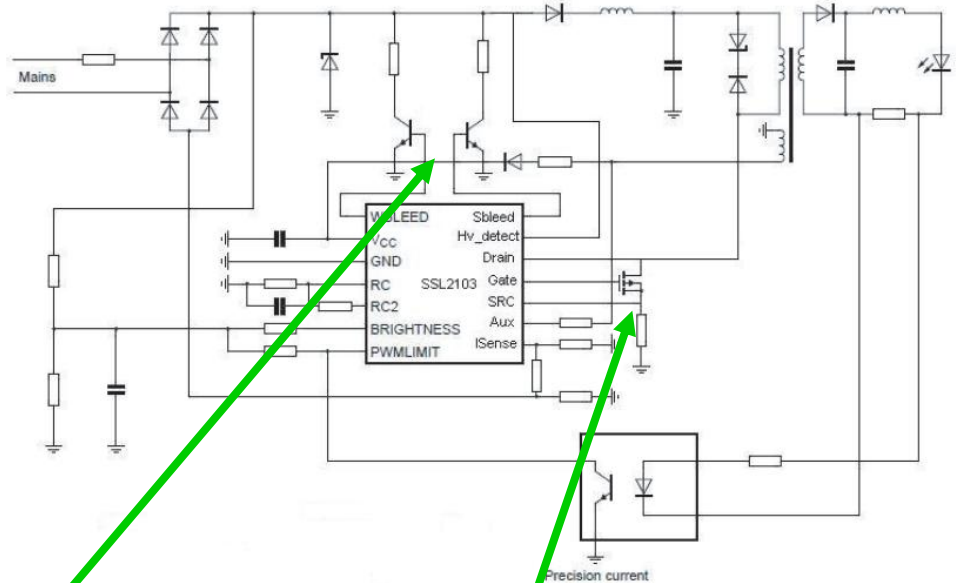
Based on same platform as SSL2101 and SSL2102.

Offers full flexibility to extend the range of applications

Typical SSL2101 Flyback Application



Typical SSL2103 Flyback Application



External bleeder transistors

External Power Mos

