SB00004 *Solution brief*

Single panel driver and LED solution for non-dimmable T5 applications based on SSL5031BTS

Date: 2 December 2014

Status:	Design Idea	Design Concept	**Design Prototype**	Demo Board	Reference Design

See appendix for explanation

Keywords
SSL5031BTS, Buck converter, Low THD, high PF, high efficiency, universal mains, panel T5 LED SSL applications

NXP device(s)
SSL5031BTS.

Description of Application

This document describes the operation of a 15 W non-dimmable LED panel driver solution featuring the SSL5031BTS and using a non-isolated buck topology. The SSL5031BDB1269 board is intended for T5 panel LED Solid State Lighting (SSL) applications. The solution is implemented on a single PCB containing both the driver and the LEDs.

The SSL5031BDB1269 board features the SSL LED driver SSL5031BTS in a 15 W non-isolated and non-dimmable application for universal mains designed for 60 V @ 225 mA LED string load. The LED configuration is with four parallel LED strings (see circuit diagram).

Each LED string has nineteen LEDs in series giving a total of 60 V.

The single PCB dimensions are L x W is 502 mm x 14mm intended for T5 panels used in SSL applications

The board provides a simple and effective solution having high efficiency, high power factor and low THD over the complete universal mains range.

Features

- SSL5031BTS LED driver and LED strings integrated on one double layer PCB
- Non-isolated buck converter
- Power factor greater than 0.9 and THD < 25% over the complete universal mains
- Efficiency ranging from 88% to 90% across the universal mains 90 V to 305 V (AC)
- Open LED and short circuit LED string protection
- Over current protection (OCP) and Over temperature protection (OTP)

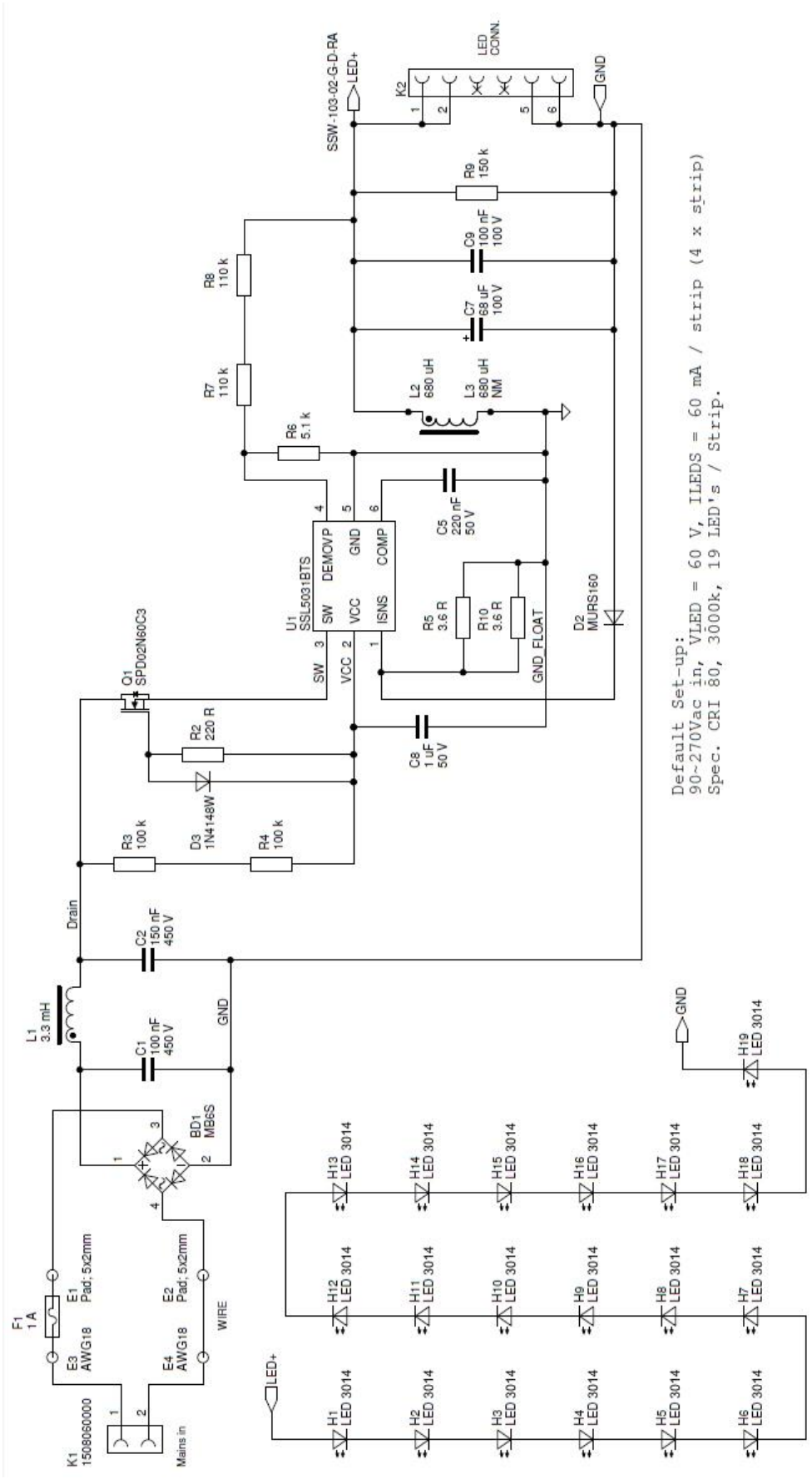
Performance

Symbol	Parameter	Value
V_{MAINS}	AC mains supply voltage	90 V – 305 V (AC)
P_{IN}	Input power	15 W
P_{OUT}	Output power	13.4 W
V_{LED}	Output voltage (LED voltage)	58 V
I_{LED}	Output current (LED current)	230 mA
I_{RIPPLE}	Output ripple current	±25 %
$\Delta I_{LED}/ \Delta V_{MAINS}$	Line regulation	±1.75 % for ΔV_{MAINS} = 100 V to 277 V
$\Delta I_{LED}/ \Delta V_{LED}$	Load regulation	0.5 mA/V
η	Efficiency 100% load	88 % to 90 %
PF	Power Factor	> 0.91
THD	Total harmonic distortion	< 25 % for ΔV_{MAINS} = 100 V to 277 V
f_{SW}	Switching frequency	45 kHz to 80 kHz for ΔV_{MAINS} = 100 V to 277 V
PCB dimensions	L x W	502 mm x 14mm
PCB thickness	CEM-3	1.2 mm (Cu = 35 µm) *

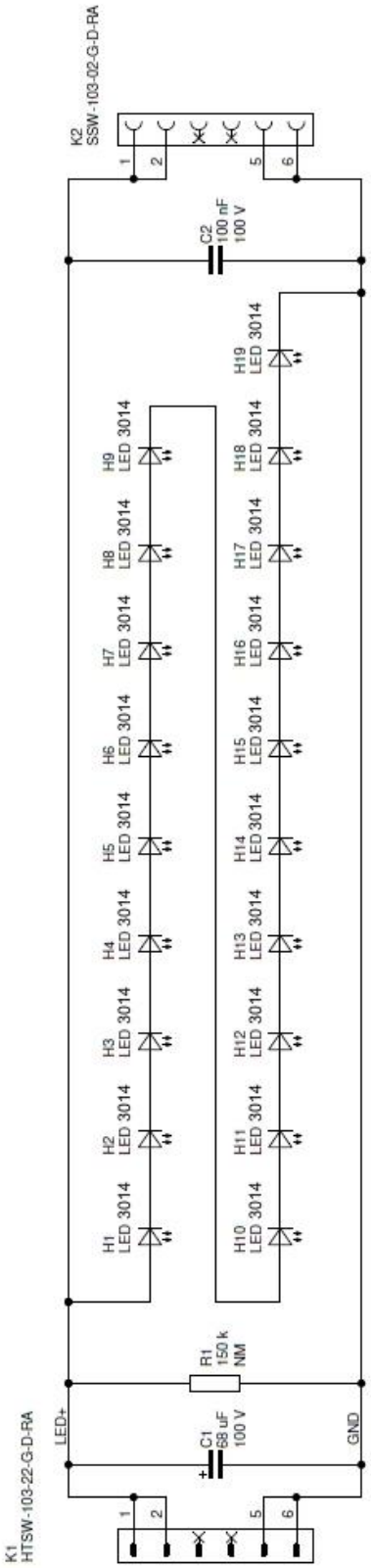
*Cu thickness of 70 µm or 105 µm should be used with CEM-3 for better thermal performance

V_{mains} (V)	I_{mains} (mA)	P_{IN} (W)	V_{LED} (V)	I_{LED} (mA)	P_{LED} (W)	PF	THD (%)	η
100	145	14	57.5	220	12.7	0.96	25	90
120	121	14.2	57.8	222	12.8	0.97	19	91
230	67	14.6	57.5	226	13	0.95	18	89
277	59	15	57.4	228	13.2	0.91	22	88

Circuit Diagram (SSL5031BTS driver and LED board)



Circuit diagram (LED board 3x)



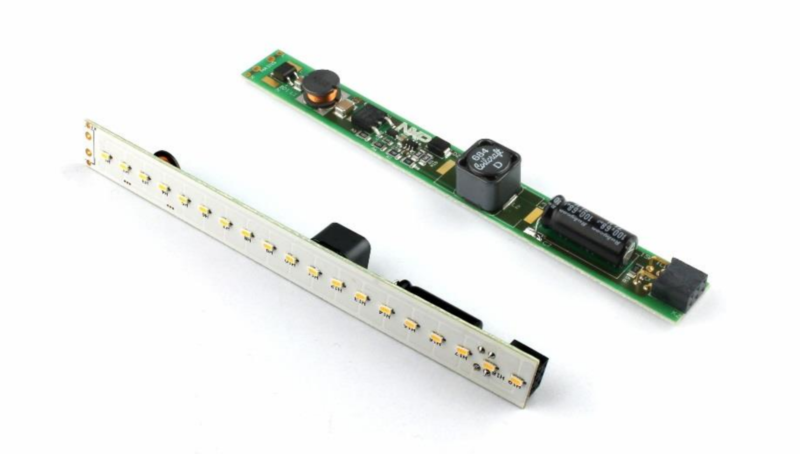
Component List (SSL5031BTS driver and LED board)

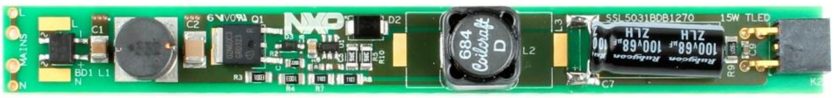
Part ref.	Description	Manufacturer	Part number
BD1	Bridge Rect.; 420 V; 500 mA	Vishay	MB6S-E3-45
C1	Capacitor; 100 nF; 10 %; 450 V; X7T; 1210	Murata	GR332DD72W104KW01L
C2	Capacitor; 150 nF; 10 %; 450 V; X7T; 1812	Murata	GR343DD72W154KW01L
C5	Capacitor; 220 nF; 10 %; 50 V; X7R; 0603	Any Manufacturer	n.a.
C7	Capacitor; 68 µF; 20 %; 100 V; ALU; THT	Rubycon	100ZLH68MEFC8X20
C8	Capacitor; 1 µF; 10 %; 50 V; X7R; 0805	AVX	08055C105KAT2A
C9	Capacitor; 100 nF; 10 %; 100 V; X7R; 0603	Murata	GRM188R72A104KA35D
D2	Diode; 600 V; 1 A	Vishay	MURS160-E3-52T
D3	Diode; 100 V; 300 mA	Diode Inc.	1N4148W-7-F
F1	Fuse; 1 A; 250 V; Slow Blow	Multicomp	MCPMP 1A 250V
H1 to H19	SMD 3014 White LED; 4000 K; CRI = 80	APT Electronics Ltd.	LL-KGLCKU-U44E4-T
K1	Terminal Block; 2p.; 5.08mm	Weidmuller	1508060000
K2	Receptacle; 6 Way; R/A; Dual; 2.54mm	Samtec	SSW-103-02-G-D-RA
L1	Inductor; 3.3 mH; 10 %; 120 mA; SMD	Bourns	SDR1006-332KL
L2	Inductor; 680 uH; 10 %; 1.3 A; SMD	Coilcraft	MSS1210-684KEB
L3	Inductor; 680 uH; 10 %; 1 A	Bourns	5900-681-RC
Q1	MOSFET-N; 650 V; 1.8 A	Infineon	SPD02N60C3
R2	Resistor; 220 Ω; 1 %; 125 mW; 150 V; 0805	Yageo	RC0805FR-07220RL
R3	Resistor; 100 kΩ; 1 %; 250 mW; 1206	Vishay	CRCW1206100KFKEA
R4	Resistor; 100 kΩ; 1 %; 250 mW; 1206	Vishay	CRCW1206100KFKEA
R5	Resistor; 3.6 Ω; 1 %; 250 mW; 1206	Panasonic	ERJ8RQF3R6V
R6	Resistor; 5.1 kΩ; 1 %; 63 mW; 0603	Multicomp	MC0063W060315K1
R7	Resistor; 110 kΩ; 1 %; 250 mW; 1206	Vishay	CRCW1206110KFKEA
R8	Resistor; 110 kΩ; 1 %; 250 mW; 1206	Vishay	CRCW1206110KFKEA
R9	Resistor; 150 kΩ; 1 %; 250 mW; 1206	Vishay	CRCW1206150KFKEA
R10	Resistor; 3.6 Ω; 1 %; 250 mW; 1206	Panasonic	ERJ8RQF3R6V
U1	LED Driver; SSL5031BTS	NXP	SSL5031BTS

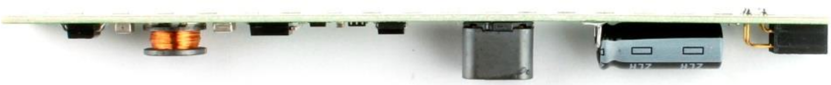
Component List (LED board 3x)

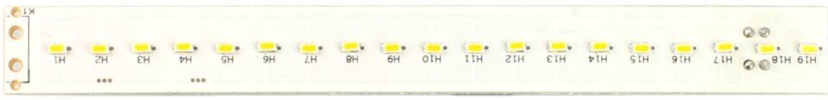
Part ref.	Description	Manufacturer	Part number
C1	Capacitor; 68 µF; 20 %; 100 V; ALU; THT	Rubycon	100ZLH68MEFC8X20
C2	Capacitor; 100 nF; 10 %; 100 V; X7R; 0603	Murata	GRM188R72A104KA35D
H1 to H19	SMD 3014 White LED; 4000 K; CRI = 80	APT Electronics Ltd.	LL-KGLCKU-U44E4-T
K1	Header; 6 Way; R/A; Dual; 2.54mm	Samtec	HTSW-103-22-G-D-RA
K2	Receptacle; 6 Way; R/A; Dual; 2.54mm	Samtec	SSW-103-02-G-D-RA
R1 (n.m.)	Resistor; 150 kΩ; 1 %; 250 mW; 1206	Vishay	CRCW1206150KFKEA

PCB

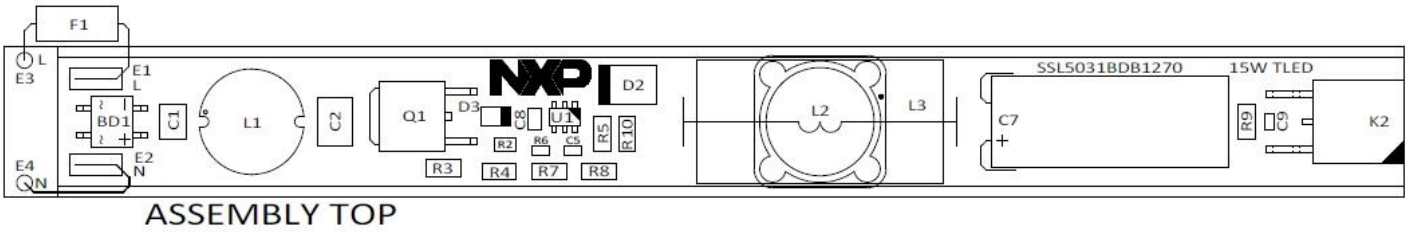


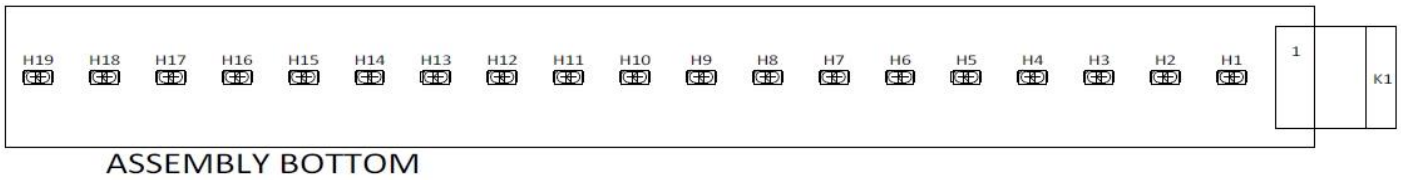




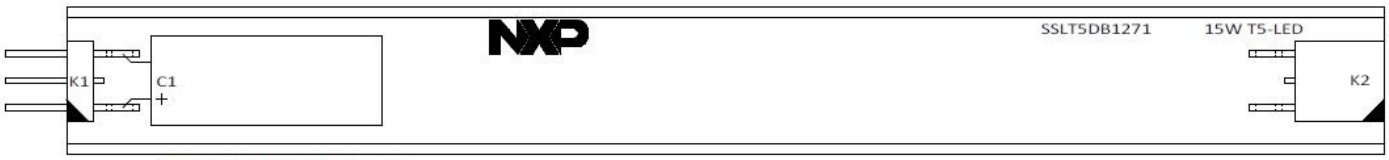


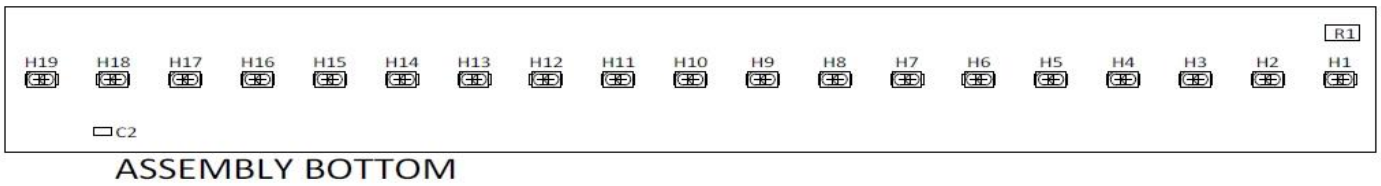
Assembly (SSL5031BTS driver and LED board)





Assembly (LED board 3x)





Literature

- SSL5031BTS Datasheet Compact high power factor/low-THD buck LED driver IC

Appendix

	Status	Description
	Design Idea	• Principle application design • Based upon native behavior of the constituting components and the elementary interactions • No or only coarse dimensioning of components • Not implemented and tested
	Design Concept	• Principle application design • Based upon building blocks that are known to operate correctly and that are known to interact without conflicts • At least coarse dimensioning of components • All individual building blocks were individually implemented and tested but not in the presented configuration
☑	Design Prototype	• Full implementation of an application principle • Implemented on a breadboard or prototype PCB • (Basic) operation verified and evaluated • Proper dimensioning of components, but not optimized • (Limited) operational performance data available
	Demo Board Design	• Full implementation of an application • Implemented on a PCB • Operation and performance under typical conditions verified • Optimal component dimensioning for typical operation • The demo board is intended for evaluation and offers the possibility to experiment with various implementation options; the demo board can be a versatile starting point for developing an end-application • The design and the PCB are not meant as a blueprint for an end-application or mass production
	Reference Design	• Full implementation of an application • Implemented on a PCB that conforms to the requirements in the specific application segment (form factor, UL requirements, manufacturability, etc.) • Operation and performance under all required conditions verified Optimal component dimensioning for operation under all required conditions • Full documentation (User Manual) available • The design and the PCB can be used as a blueprint for an end-application or mass production

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