UM10796

SSL5031CDB1210 18 W universal non-isolated buck LED driver demo board

Rev. 1.1 — 17 December 2014 **User manual**

Document information

Info	Content
Keywords	SSL5031CDB1210, buck, universal input, fixture application
Abstract	This user manual describes the performance, technical data, and the connection of the SSL5031CDB1210 demo board, using non-isolated buck topology. The SSL5031CTS is an NXP Semiconductors driver IC in TSOP6 package. It is intended to provide a low-cost, small form factor LED driver design. This SSL5031CDB1210 demo board is designed for fixture applications. It operates at a universal input range (90 V (AC)to 265 V (AC). The output voltage is approximately 53 V.

Revision history

Rev	Date	Description
v.1.1	20141217	updated issue
v.1	20141027	first issue

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1. Introduction

WARNING

Lethal voltage and fire ignition hazard

The non-insulated high voltages that are present when operating this product, constitute a risk of electric shock, personal injury, death and/or ignition of fire.

This product is intended for evaluation purposes only. It shall be operated in a designated test area by personnel qualified according to local requirements and labor laws to work with non-insulated mains voltages and high-voltage circuits. This product shall never be operated unattended.

This user manual describes the operation of the SSL5031CDB1210 demo board featuring the Solid-State-Lighting (SSL) LED driver SSL5031CTS in a universal input/18 W non-isolated application.

The SSL5031CDB1210 demo board is designed for driving LED loads from 35 V to 60 V. The nominal load is 53 V.

The PCB dimensions are compatible with fixture application.

The SSL5031CDB1210 demo board provides a simple and effective solution with a high Power Factor (PF), low Total Harmonic Distortion (THD), and high efficiency for Solid-State Lighting (SSL) applications.

1.1 Features

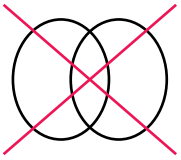
- Compact design with a low component count
- High efficiency: 90.3 % at 120 V (AC) and 88.7 % at 230 V (AC)
- Excellent line and load regulation
- Power factor > 0.9; A-THD: < 17.2 % at 120 V (AC) and < 20.8 % at 230 V (AC)
- Fixture applications
- Open LED string protection/short LED string protection
- Compliant with EN55015 conducted EMI
- Compliant with 2.5 kV ring wave and 2 kV combination wave line surge

Figure 3 shows the assembled top and bottom views.

2. Safety warning

The demo board input is connected to the 90 V to 265 V (AC) mains. Avoid touching the board while it is connected to the mains voltage and when it is in operation. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Galvanic isolation from the mains phase using a fixed or variable transformer is always recommended. Figure 1 shows the symbols on how to recognize these devices.

a. Isolated



b. Not isolated

Fig 1. Isolation symbols

3. Specifications

Table 1 lists the specification of the SSL5031CDB1210 demo board.

Table 1. SSL5031CDB1210 specifications

Symbol	Parameter	Value
V_{mains}	AC mains supply voltage	90 V to 265 V (AC)
P_{out}	output power	15.9 W
V_{LED}	output voltage	35 V to 60 V (53 V nominal)
I_{LED}	output current	300 mA
I_{ripple}	output current ripple	42 % (peak-to-peak)
$\Delta I_{LED}/\Delta V_{mains}$	line regulation	0.057 mA/V; ±1.7 %
$\Delta I_{LED}/\Delta V_{LED}$	load regulation	0.16 mA/V; ±0.3 % at ±10 % V_{LED}
η	efficiency	90.3 % at 120 V (AC)/60 Hz
		88.7 % at 230 V (AC)/50 Hz
PF	power factor	0.98 at 120 V (AC)/60 Hz
		0.95 at 230 V (AC)/50 Hz
THD	total harmonic distortion	17.2 % at 120 V (AC)/60 Hz
		20.8 % at 230 V (AC)/50 Hz
T_{oper}	operating temperature	−40 °C to +50 °C
-	board dimensions	49 mm × 28 mm
-	conducted electrostatic Interference (EMI)	EN55015

Figure 2 shows the dimensions of the demo board.

Fig 2. SSL5031CDB1210 demo board dimensions

4. Board photographs

aaa-015476

a. Top view

aaa-015477

b. Bottom view

Fig 3. SSL5031CDB1210 demo board photographs

5. Board connections

The SSL5031CDB1210 demo board is optimized for a 90 V to 265 V (AC) mains supply. It is designed to work with multiple LEDs or an LED module.

Under the expected conditions, the output current is 300 mA when using an LED string with a forward voltage (V_F) from 35 V to 60 V. The current can be adjusted using resistors R1 and R2.

J1 and J2 are the connections for the mains voltage. J3 (LED+) and J4 (LED−) are the connections for the LED load. Figure 4 shows the connections.

Fig 4. SSL5031CDB1210 board connections

6. Functional description

6.1 Input filtering

Capacitors C1 and C2 and inductor L1 filter the switching current from the buck converter to the line. Capacitors C1 and C2 also provide a low-impedance path for the switching current. To retain a power factor > 0.9, the value of capacitors C1 and C2 must be kept low.

Varistor MOV1 across the AC line and the Transient Voltage Suppressor (TVS) diode on V_{bus} provide protection against transient surge voltages.

6.2 Setting the output current

The LED output current is the primary parameter to set in an LED driver. It is regulated and sensed using R_{sense} resistors R1 and R2.

The LED output current can be calculated with Equation 1:

$$I_{LED} = \frac{V_{reg(AV)ISNS}}{R_{sense}} \quad (1)$$

Where:

- $V_{reg(AV)ISNS}$ = 0.4 V

Remark: $I_{peak(max)} = \frac{V_{ISNS(max)}}{R_{sense}}$ determines the maximum peak.

6.3 Output OverVoltage Protection (OVP)

Output OVP is implemented by measuring the voltage at the DEMOVP pin during the secondary stroke.

The DEMOVP pin senses the output voltage through resistive divider (R5, R6, and R7) connected between the LEDP node and the DEMOVP pin. When it reaches $V_{(th)ovp}$ in an open-load condition, OVP is triggered and IC restarts when the VCC voltage is discharged internally.

To prevent false OVP detection, an internal counter ensures that the OVP level is reached in three continuous cycles, triggering the OVP protection. So, to dissipate the energy from those three cycles during every restart, an output resistor (R8) is required.

Remark: In SSL5031BTS version, DEMOVP pin is also used for thermal foldback protection. For more information, see the *SSL5031BTS data sheet*.

7. Performance

7.1 Efficiency

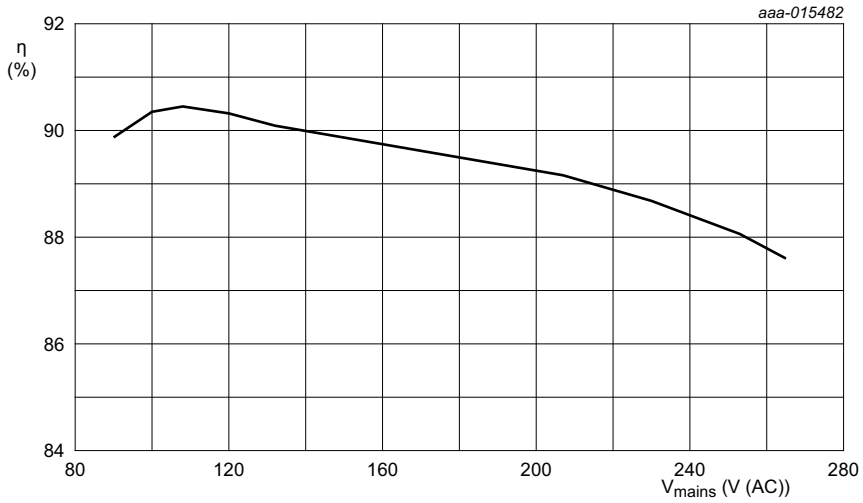


Fig 5. Efficiency as a function of mains voltage

7.2 Power factor

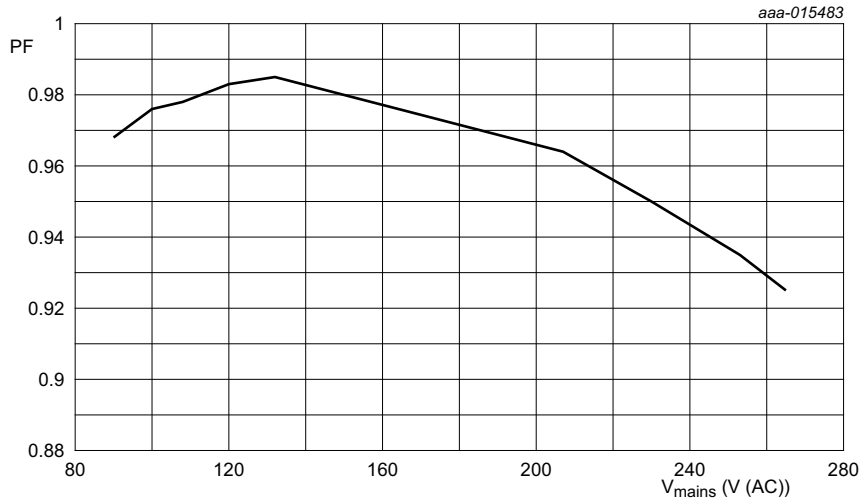


Fig 6. Power factor as a function of mains voltage

7.3 Total harmonic distortion

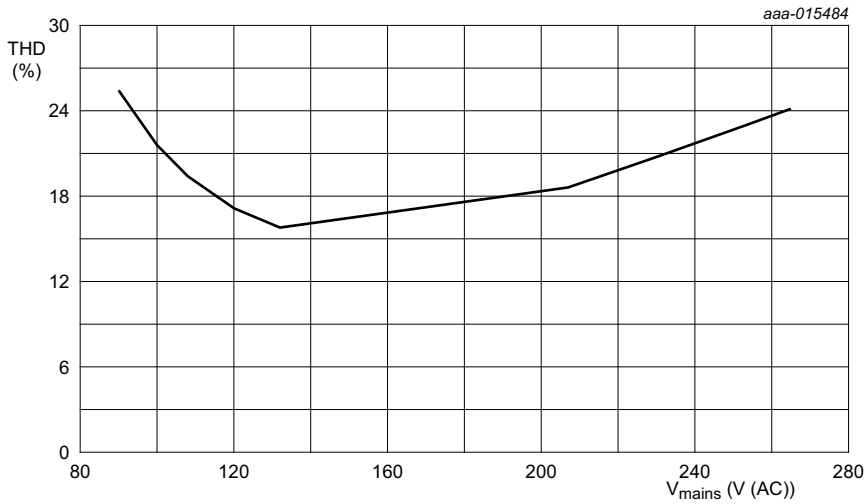


Fig 7. Total harmonic distortion as a function of mains voltage

7.4 Line regulation

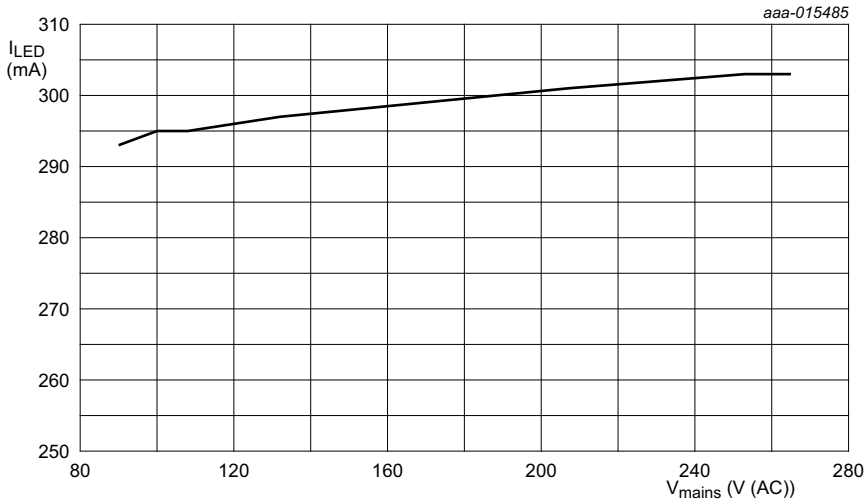
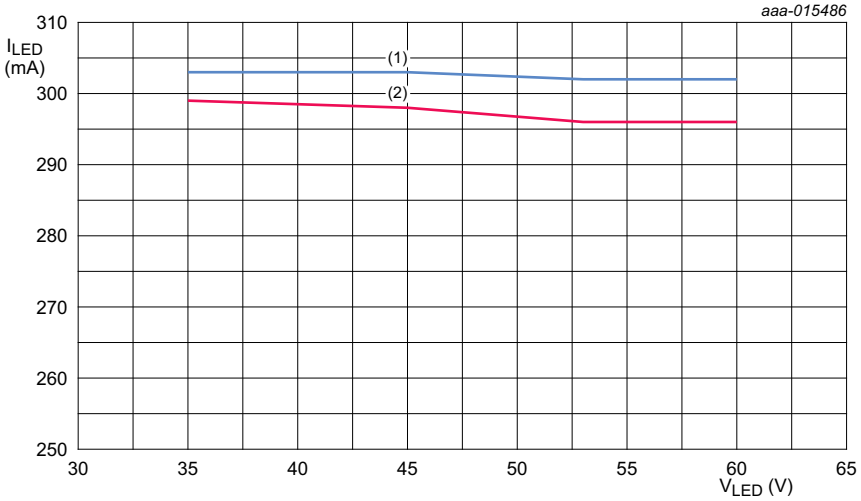


Fig 8. Output LED current as a function of mains voltage

7.5 Load regulation



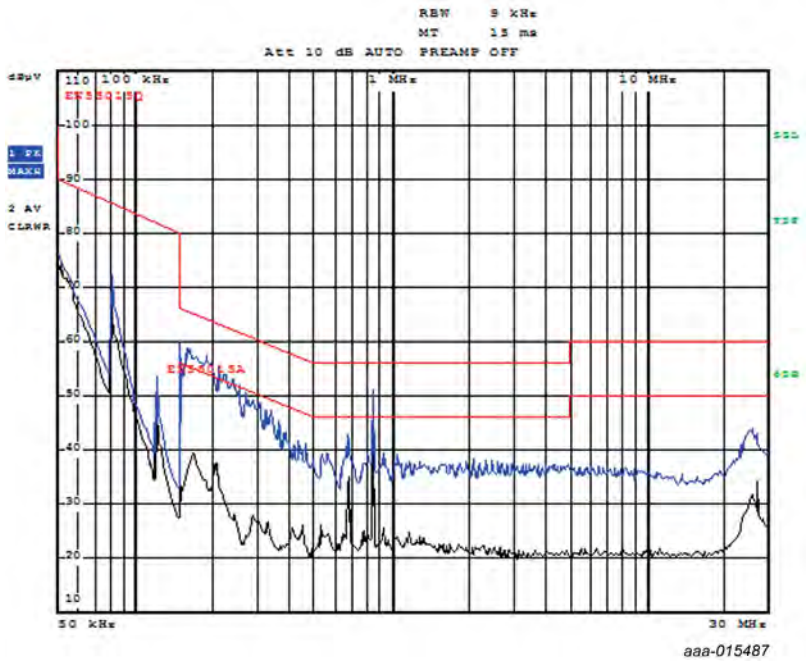
(1) V_{mains} = 230 V (AC)

(2) V_{mains} = 120 V (AC)

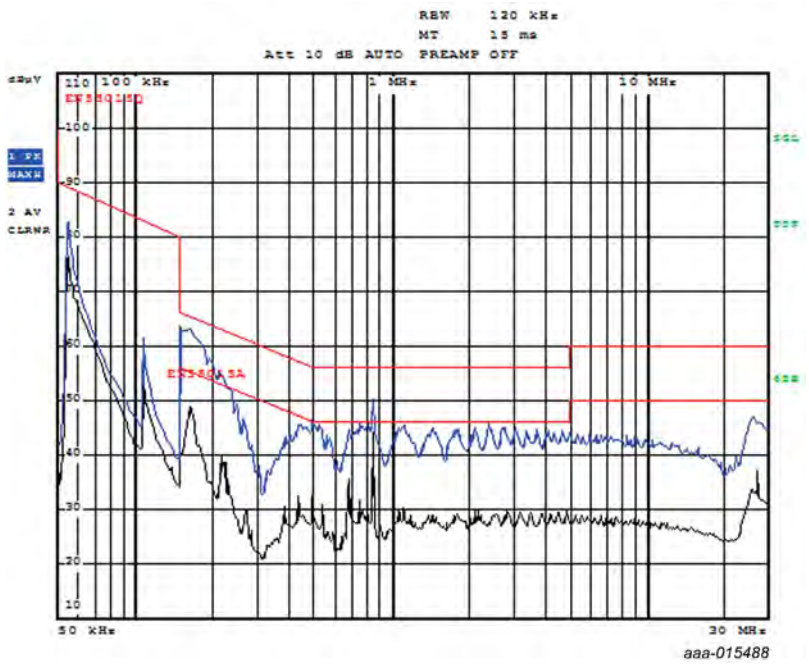
Fig 9. LED current as a function of LED voltage

7.6 ElectroMagnetic Interference (EMI)

Figure 11 shows the conducted EMI result of the SSL5031CDB1210 demo board.



a. 120 V/60 Hz and EN55015B limits



b. 230 V/50 Hz and EN55015B limits

Fig 10. Conducted EMI

8. Schematic

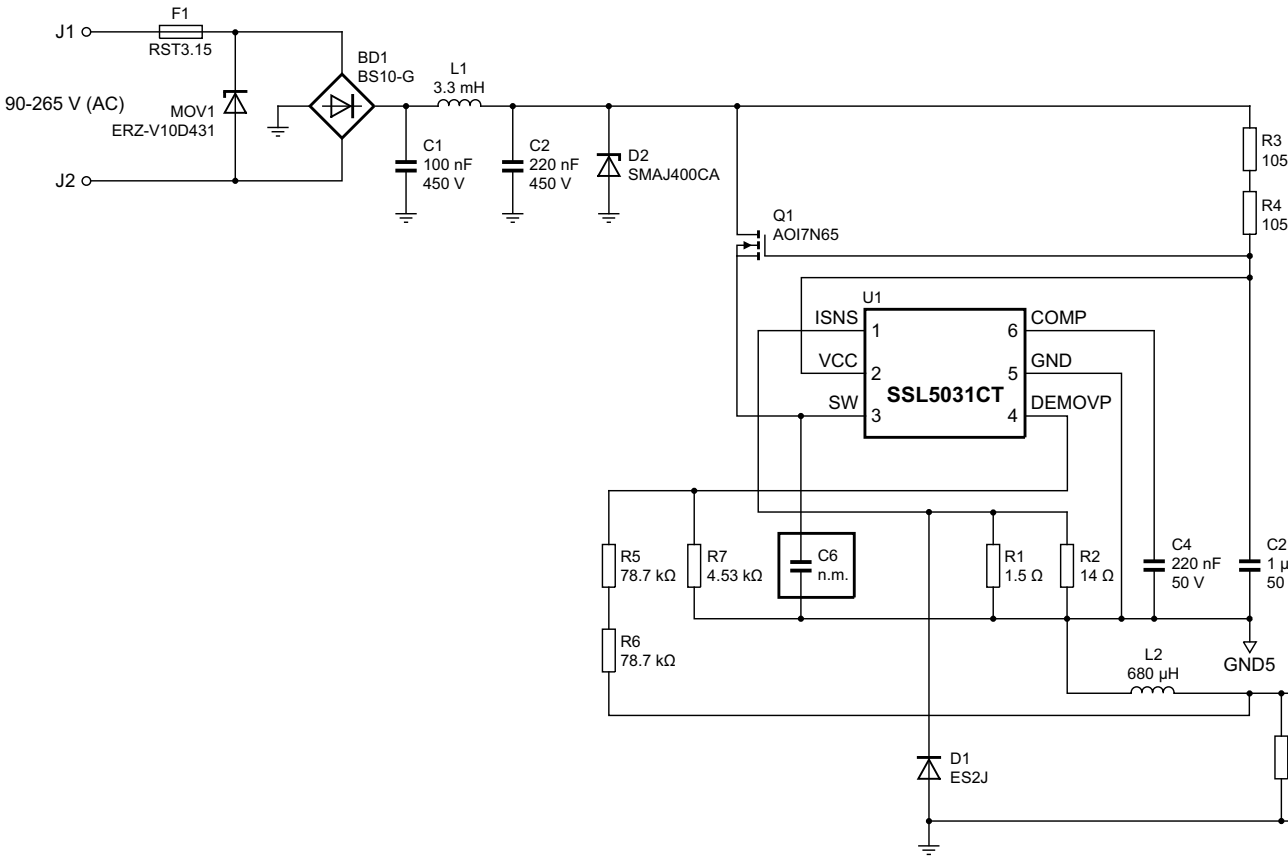


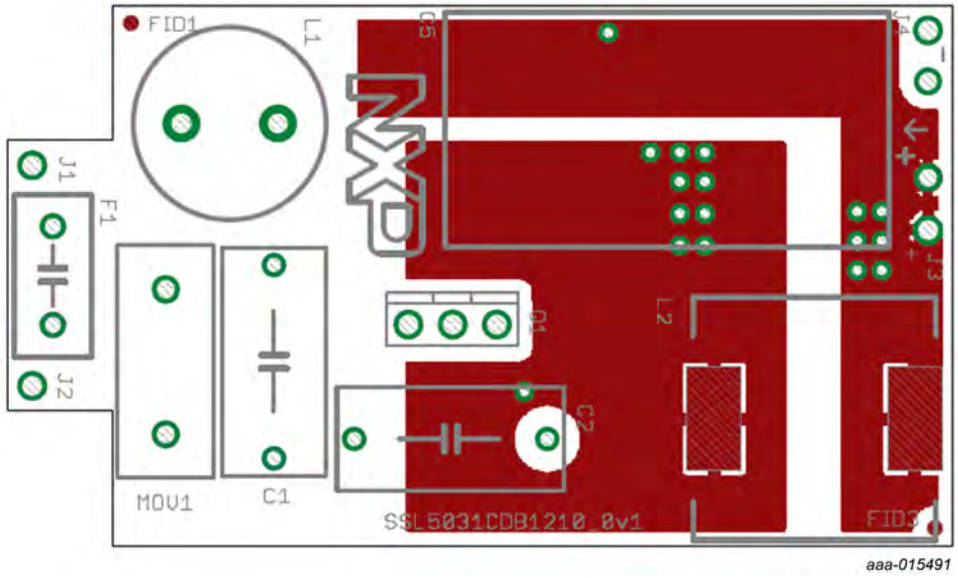
Fig 11. SSL5031CDB1210 demo board schematic

9. Bill Of Materials (BOM)

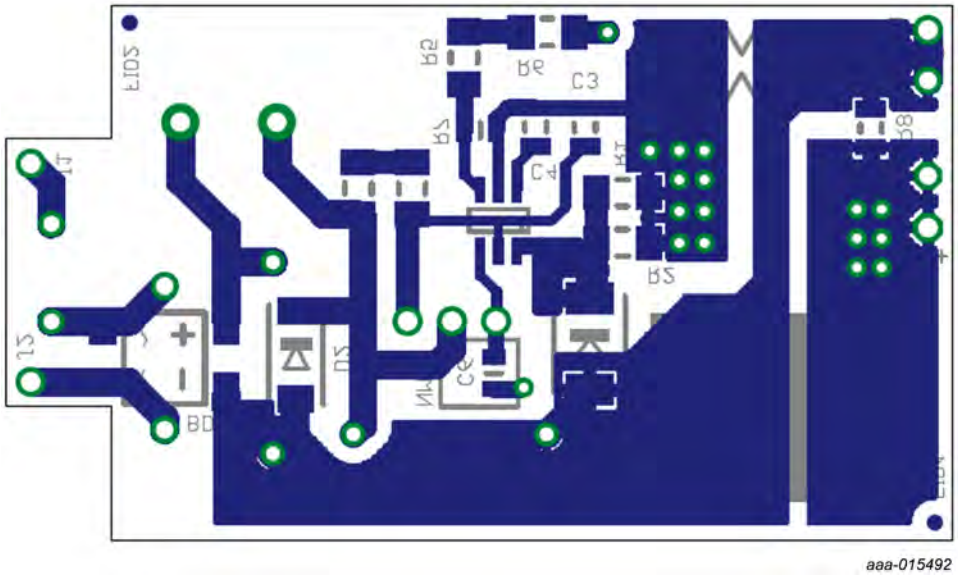
Table 2. SSL5031CDB1210 bill of materials

Reference	Description and values	Part number	Manufacturer
BD1	bridge rectifier; 1000 V; 0.8 A	B10S-G	Comchip Tech
C1	capacitor; 0.1 μF; 450 V	ECW-F2W104JAQ	Panasonic
C2	capacitor; 0.22 μF; 450 V	ECW-F2W224JAQ	Panasonic
C3	capacitor; 1 μF; 50 V; X7R; 0805	CL21B105KBFNNNE	Samsung
C4	capacitor; 220 nF; 50 V; X7R; 0603	UMK212B7224KG-T	Taiyo Yuden
C5	capacitor; 390 μF; 63 V	EKZE630ELL391MK25S	Chemi-Con
D1	diode; fast; 600 V; 2 A	ES2J-LTP	Micro Commercial
D2	diode; TVS; 400 V	SMAJ400CA	Littelfuse
F1	fuse; 250 V (AC)	RST 3.15	Bel Fuse
L1	inductor; 3300 μH	RL-5480HC-3-3300	Renco
L2	inductor, 680 μH	MSS1210-684KEB	Coilcraft
MOV1	varistor; 387 V	ERZ-V10D431	Panasonic
Q1	N-MOSFET; 650 V; 7 A	AOI7N65	Alpha & Omega Semiconductor
R1	resistor; 1.5 Ω; 1206; 1 %	CRCW12061R50FKEA	Vishay
R2	resistor; 14 W; 1206, 1 %	ERJ-8ENF14R0V	Panasonic
R3; R4	resistor; 105 kΩ, 1206; 1 %	ERJ-8ENF1053V	Panasonic
R5; R6	resistor; 78.7 kΩ; 1206; 1 %	ERJ-8ENF7872V	Panasonic
R7	resistor, 4.53 kΩ; 0603; 1 %	ERJ-3EKF4531V	Panasonic
R8	resistor; 40.2 kΩ; 0805	RMCF0805FT40K2	Stackpole Electronics
U1	IC; SSL5031CTS; TSOP6	SSL5031CTS	NXP Semiconductors

10. Board layout



a. Top view



b. Bottom view

Fig 12. SSL5031CDB1210 demo board layout

11. Abbreviations

Table 3. Abbreviations

Acronym	Description
EMI	ElectroMagnetic Interference
LED	Light-Emitting Diode
OCP	OverCurrent Protection
OTP	OverTemperature Protection
PF	Power Factor
SSL	Solid-State Lighting

12. References

[1] **SSL5031CTS data sheet —** Compact high power factor/low-THD buck LED driver IC

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14. Contents

1 Introduction 3
1.1 Features 3
2 Safety warning 4
3 Specifications. 5
4 Board photographs 6
5 Board connections 7
6 Functional description 8
6.1 Input filtering 8
6.2 Setting the output current 8
6.3 Output OverVoltage Protection (OVP) 8
7 Performance. 9
7.1 Efficiency 9
7.2 Power factor 9
7.3 Total harmonic distortion. 10
7.4 Line regulation 10
7.5 Load regulation. 11
7.6 ElectroMagnetic Interference (EMI) 12
8 Schematic. 13
9 Bill Of Materials (BOM) 14
10 Board layout. 15
11 Abbreviations. 16
12 References 16
13 Legal information. 17
13.1 Definitions. 17
13.2 Disclaimers 17
13.3 Trademarks. 17
14 Contents 18

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