User's Guide
SLUUBZ9–May 2020

TPS92200D1/D2EVM 30-V, 1.5-A Buck LED Driver Evaluation Module

This user's guide describes the characteristics and use of the high-current buck light-emitting diode (LED) driver evaluation module.

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1 Introduction

The TPS92200D1/D2EVM evaluation module (EVM) helps designers evaluate the operation and performance of the TPS92200D1/D2 synchronous buck switching regulator designed for high-current LED driver applications. The TPS92200D1/D2 is a 1.5-A synchronous buck LED driver and features a wide input voltage range (4.0 V to 30 V), deep analog mode dimming (1% to 100%) implemented by Analog or PWM input, and PWM mode dimming capability. It also has full protection, including LED open protection and short protection, sense resistor open protection and short protection, and thermal protection.

2 Warnings and Cautions

Observe the following precautions when using the TPS92200D1/D2EVM.

WARNING

When choosing an LED component (not included with this EVM) the end-user must consult the LED data sheet supplied by the LED manufacturer to identify the EN62471 Risk Group Rating and review any potential eye hazards associated with the LED chosen. Always consider and implement the use of effective light filtering and darkening protective eyewear and be fully aware of surrounding laboratory-type set-ups when viewing intense light sources that may be required to minimize or eliminate such risks in order to avoid accidents related to temporary blindness.

3 Description

The TPS92200D1/D2EVM provides an LED driver based on the TPS92200D1/D2 buck regulator. It is designed to operate with an input voltage in the range of 4.0 V to 30 V. The EVM is set up for a default output current of 0.5 A. For TPS92200D1EVM, it can work either in analog dimming mode with analog input(0.65V to 1.2V) or PWM dimming with 100Hz to 2kHz, 0-100% duty cycle PWM input. For TPS92200D2EVM, it works in analog dimming mode with 20kHz to 200kHz, 0-100% duty cycle PWM input. See the TPS92200D1/D2 data sheet (SLUSER4) for more information about choosing dimming mode and components selection. The forward voltage of the LED load is between approximately between 1.0 V and 30 V (depending on the input voltage). The TPS92200D1/D2 helps provide high efficiency, wide dimming range, good line regulation, and low output ripple LED driver.

3.1 Typical Applications

This converter design describes an application of the TPS92200D1/D2 as an LED driver using the following specifications. For applications with a different input voltage range or different output voltage and current, see the TPS92200D1/D2 data sheet (SLUSER4).

Table 1 lists the electrical performance specifications.

Table 1. TPS92200D1/D2EVM Electrical Performance Specifications

Parameter	Test Conditions	MIN	TYP	MAX	Units
Input voltage range, V_{IN}		4.0		30	V
Output voltage range, V_{OUT}	LED+ to LED–, depends on V_{IN}	1		<30	V
Output current	3.3V, 100% duty PWM input		0.5		A
Output current ripple	V_{IN} = 24 V, 6 White LEDs, 1-A output current		10		mApp
Analog dimming range	1.2V Analog input(TPS92200D1EVM)		1.2		V
Analog dimming range	3.3-V PWM amplitude, 50 kHz(TPS92200D2EVM)	1		100	%
PWM dimming range	1.2-V PWM amplitude, 100 Hz, V_{IN} = 24 V, 6 White LEDs, 1-A output current(TPS92200D1EVM)	1		100	%
Efficiency	V_{IN} = 12 V, 5 IR LEDs, 1.5 A output current, Analog dimming mode		96		%
Switching frequency			1000		kHz

3.2 Test Setup

This section describes the connectors and test points on the EVM and how to properly connect, setup, and use the TPS92200D1/D2EVM.

3.2.1 Connector Description

Table 2. EVM Connectors and Test Points

Reference Designator	Function
J1	V_{IN} (see Table 1 for V_{IN} range)
J2	LED load, make sure the LED has a maximum 1.5-A current rating
J3	2-pin header to disable driver when no dimming required
TP1	V_{IN}test point
TP2	BOOT test point
TP3	VOUT test point, also the anode of the LED load
TP4	SW test point
TP5	AC Loop test point 1. Used for loop response measurements.
TP6	AC Loop test point 2. Used for loop response measurements.
TP7	PWM or Analog input here
TP8	GND test point for VIN
TP9	GND test point for VOUT
TP10	GND test point for PWM input
TP11	FB test point

3.2.2 Input/Output Connection

A power supply capable of supplying 2 A must be connected to J1 through a pair of 20-AWG wires. The LED load must be connected to J2 through a pair of 20-AWG wires. The positive terminal of the LED load should be connected to the J2 terminal beside TP3 (VOUT), and the negative terminal of the LED load should be connected to the J2 terminal beside TP5. Wires should be twisted and kept as short as possible to minimize voltage drop, inductance, and EMI transmission.

TP7 is the input terminals for the Analog/PWM dimming signal. For TPS92200D1EVM, If analog dimming mode is used, apply a DC voltage signal between 0.65V and 1.2V. If TPS92200D1EVM is used, apply a square wave with a low level of GND and a high level voltage higher than 2 V, typically 3.3 V. The PWM frequency range is 100 Hz to 2 kHz, typically 1 kHz. For TPS92200D2EVM, it only supports analog dimming mode, apply a square wave with a low level of GND and a high level voltage higher than 2 V, typically 3.3 V. The dimming frequency range is 20 kHz to 200 kHz.

Once the connection is ready, first apply the input voltage, then apply the Analog/PWM signal.

4 Performance Data and Typical Characteristics Curves

The figures in this section present the typical performance of the TPS92200D1/D2EVM. The ambient temperature is 25°C, unless otherwise noted.

4.1 Efficiency

Figure 1 shows the efficiency versus VDIM in analog dimming mode. The maximum LED current is 1.5 A when the VDIM is 1.2V. V_{IN} = 12 V, and an infrared (IR) LED load is used. The typical forward voltage of an IR LED is 1.7 V at 1.5 A. The LED number in series is 1, 3, and 5, respectively.

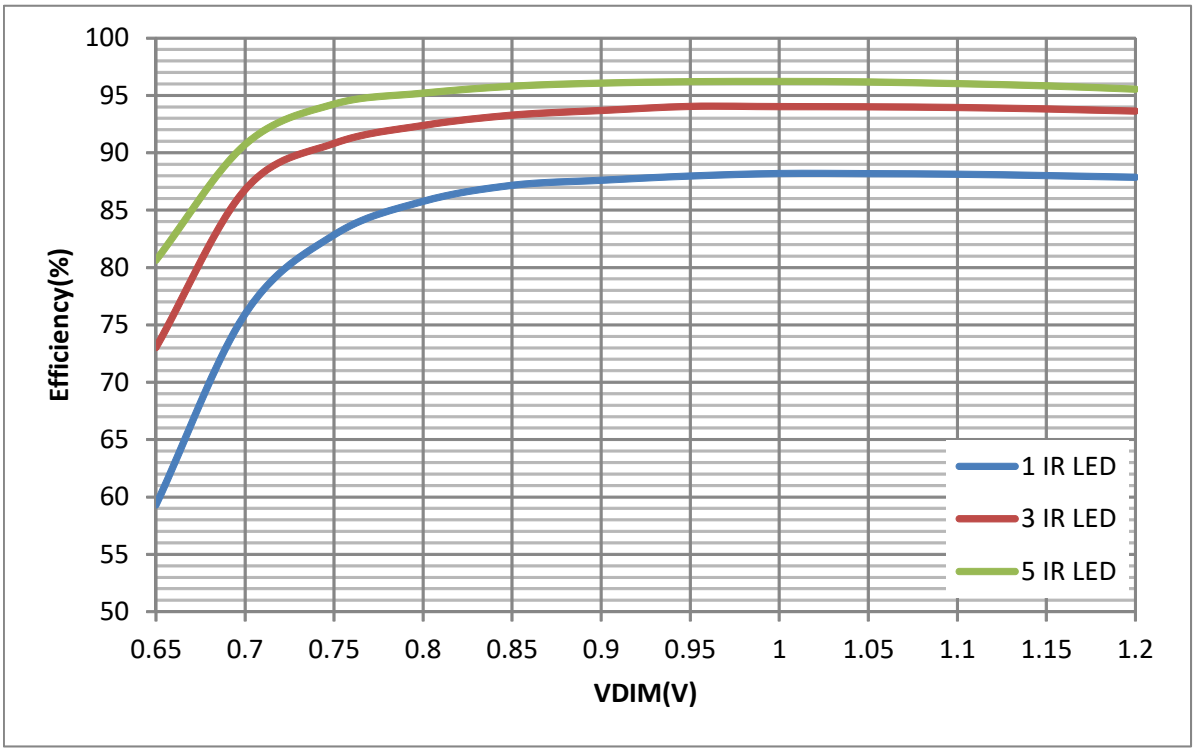

Figure 1. Efficiency vs. VDIM in Analog Dimming Mode(TPS92200D1), 1.5 A at VDIM>=1.2V, V_{IN} = 12 V

Figure 2 shows the efficiency versus PWM Duty Cycle in PWM dimming mode. PWM frequency is 500hz, LED current is set at 1.0 A. 6 White LEDs are used. The typical forward voltage of a White LED is 3 V at 1 A.

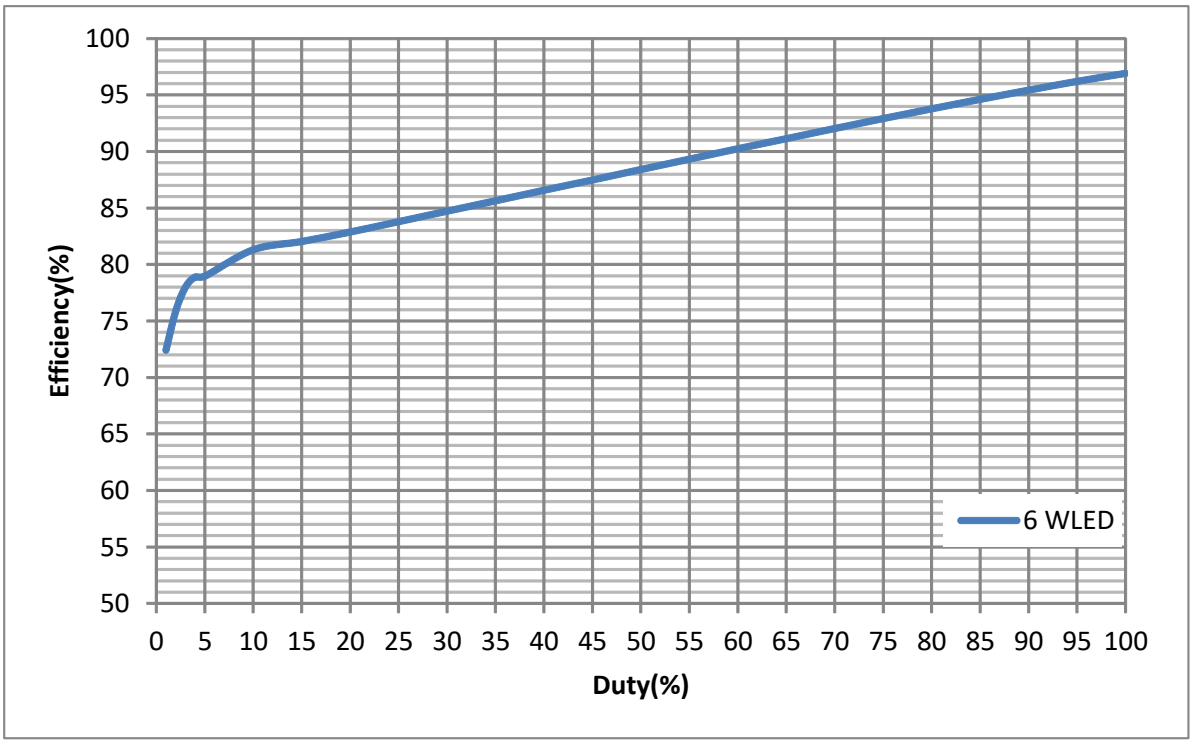

Figure 2. Efficiency vs. PWM Duty Cycle in PWM Dimming Mode(TPS92200D1), 1.0 A at 100% Duty

Figure 3 shows the efficiency versus PWM Duty Cycle in Analog dimming mode. PWM frequency is 50khz, LED current is set at 1.0 A. two IR LEDs are used. The typical forward voltage of a White LED is 1.65 V at 1 A.

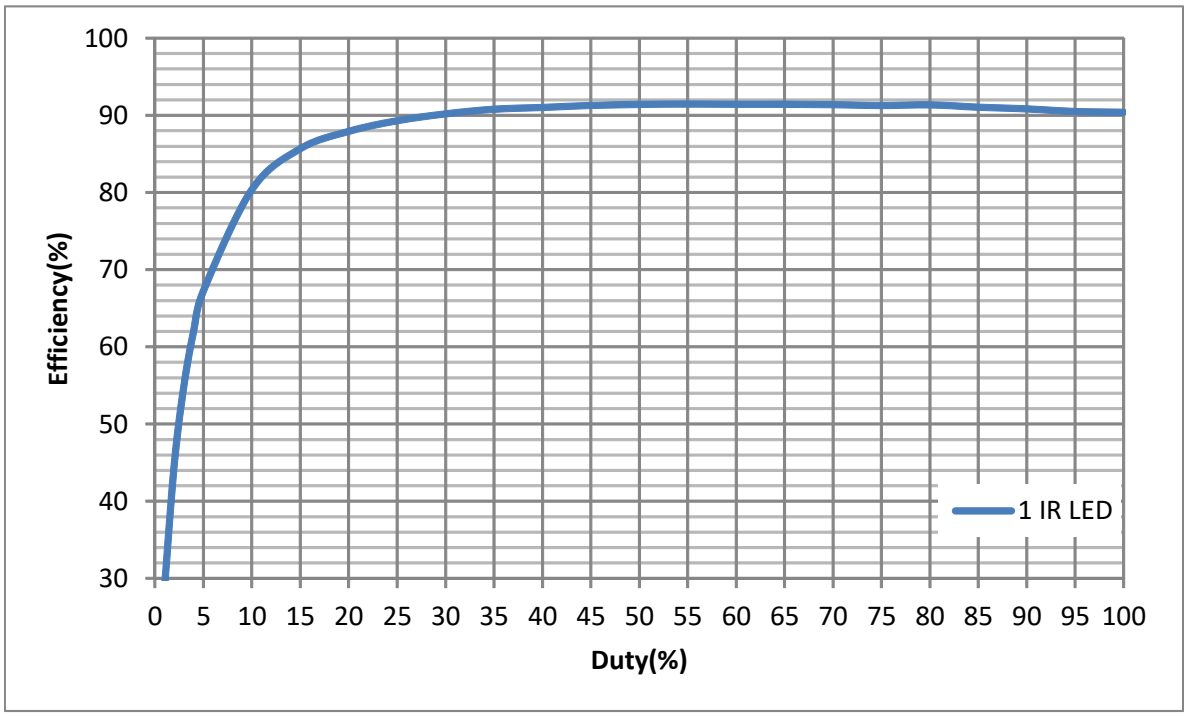

Figure 3. Efficiency vs. PWM Duty Cycle in Analog Dimming Mode(TPS92200D2)

4.2 Line Regulation

Figure 4 shows the output current deviation ratio vs. input voltage in analog dimming mode. VDIM is 1.2V. 1 White LED is used as load. The LED current is set at 250mA, 500mA, 1.0A and 1.5A, respectively. The typical forward voltage of the White LED is 3.1 V at 1.5 A, and 2.8 V at 0.35 A.

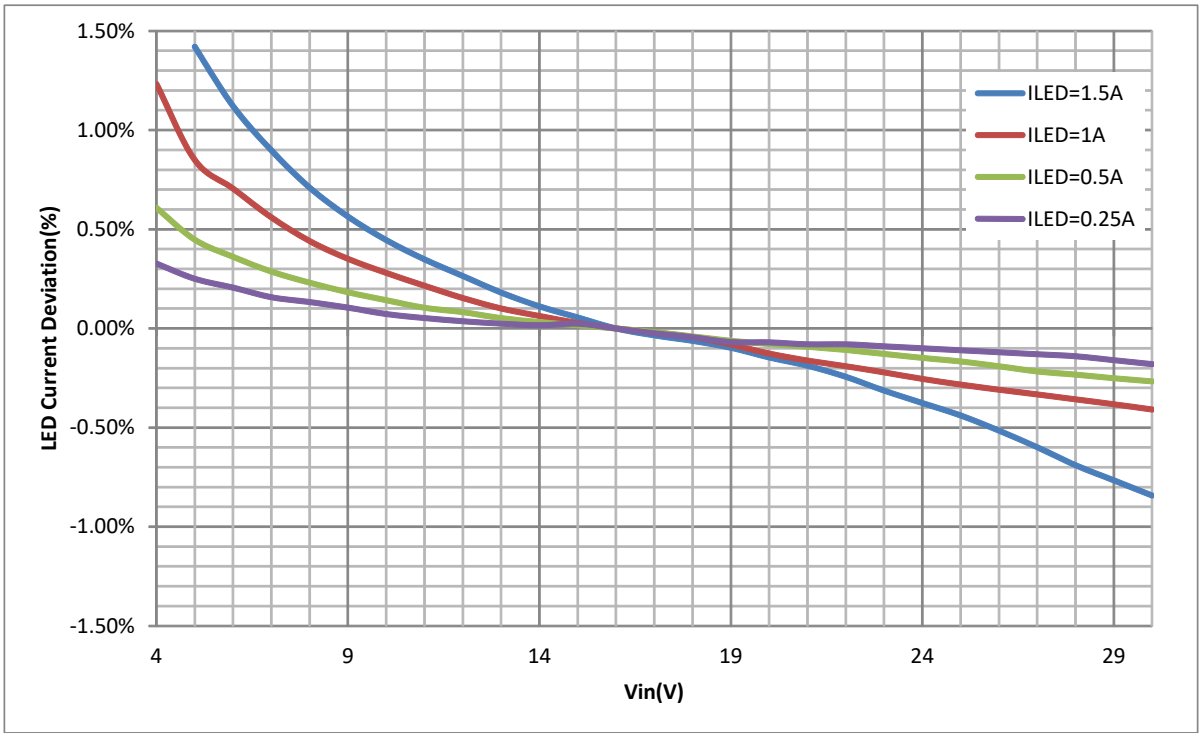

Figure 4. LED Current Deviation vs. Input Voltage in Analog Dimming Mode, 1 WLED

4.3 Load Regulation

Figure 5 shows the output current deviation ratio vs. output voltage in analog dimming mode. VDIM is 1.2V. White LEDs are used as load, LED number in series is 1, 2, 3, 4, 5, and 6, respectively. LED current is set at 250mA, 500mA, 1.0A and 1.5A, respectively. The typical forward voltage of the White LED is 3.1 V at 1.5 A, and 2.8 V at 0.35 A. Changing the LED number in series from 1 piece to 6 pieces will change the output voltage from approximately 3 V to approximately 18 V. Input voltage is fixed at 24 V.

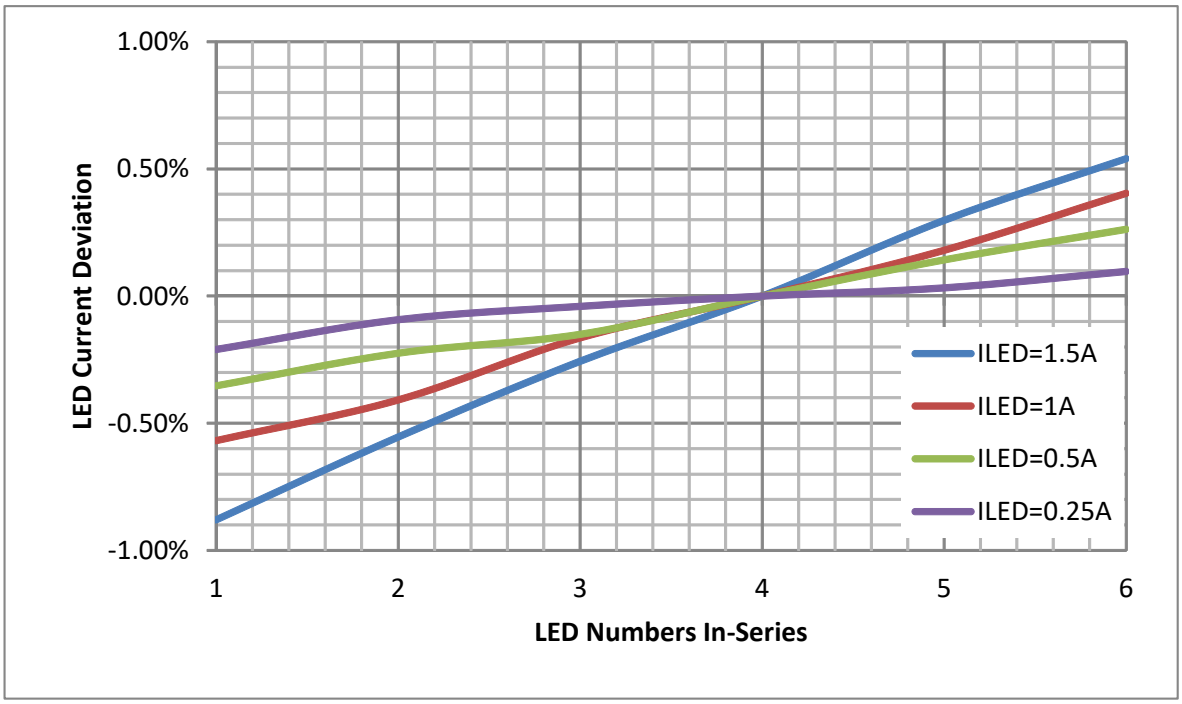

Figure 5. LED Current Deviation vs. LED Numbers in Series in Analog Dimming Mode, V_{IN} = 24 V

4.4 Analog Dimming

Figure 6 shows the output current ratio to the full-scale output current versus VDIM voltage level in analog dimming mode. V_{IN} = 12 V, 1 White LED is used as load. The LED current is set at 1.0 A with VDIM=1.2V.

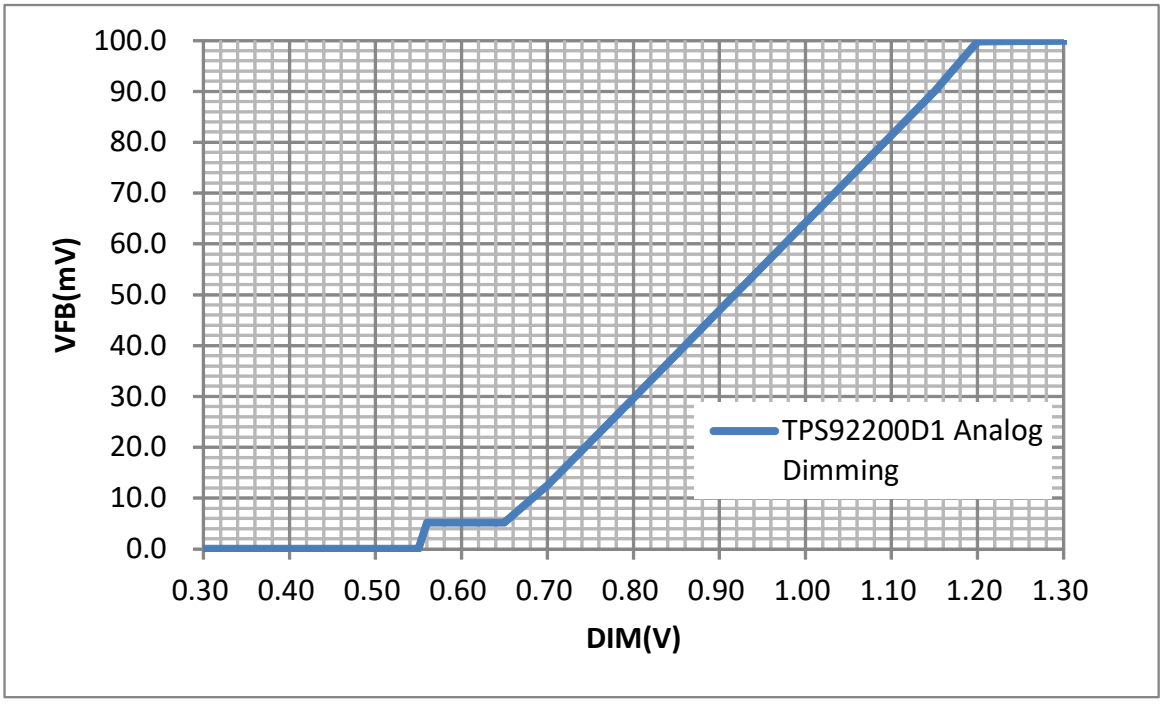

Figure 6. Output Current Ratio vs. VDIM in Analog Dimming Mode(TPS92200D1)

Figure 7 shows the output current ratio to the full-scale output current versus PWM duty cycle in analog dimming mode. V_{IN} = 12 V, 2 White LEDs in series used as load. The LED current is set at 1.0 A with 100% PWM duty. PWM frequency is 50 kHz.

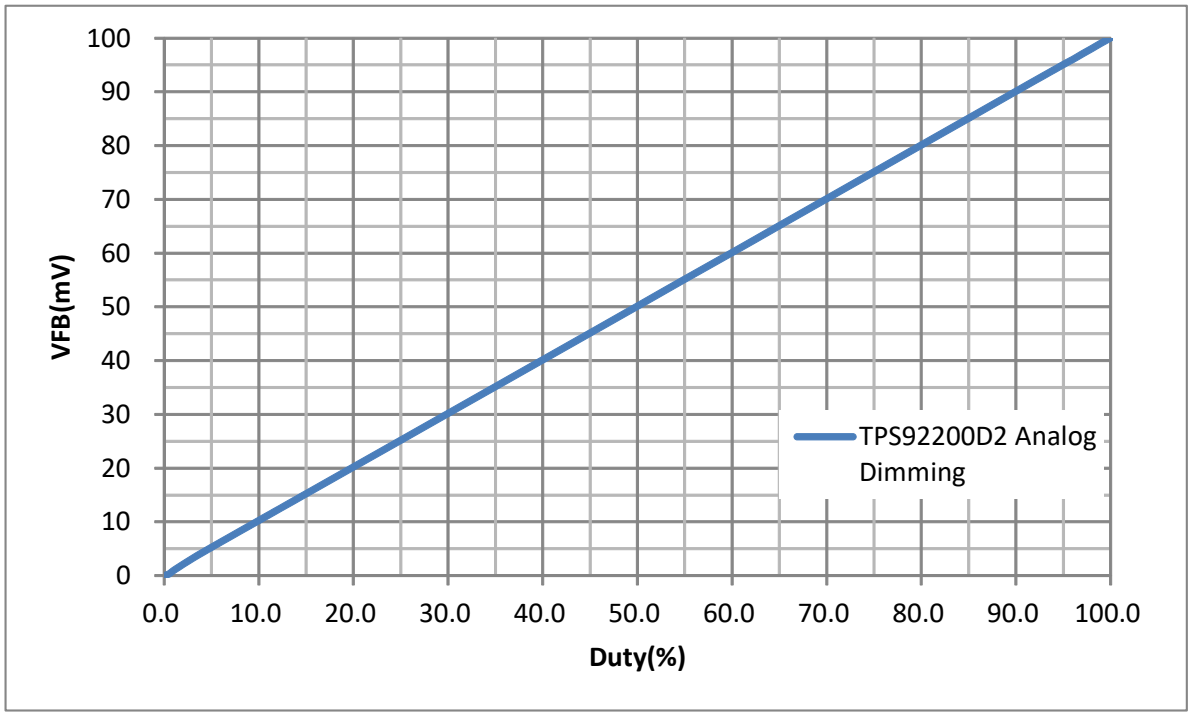

Figure 7. Output Current ratio vs PWM Duty Cycle in Analog Dimming Mode(TPS92200D2)

4.5 PWM Dimming Waveforms

Figure 8, Figure 9, and Figure 10 illustrate the PWM dimming waveforms at 1%, 50%, and 99% duty cycles, respectively, in PWM dimming mode. Input voltage is 24 V, with 6 White LEDs in series used as load. The LED current is set at 1.0 A, PWM frequency is 100 Hz.

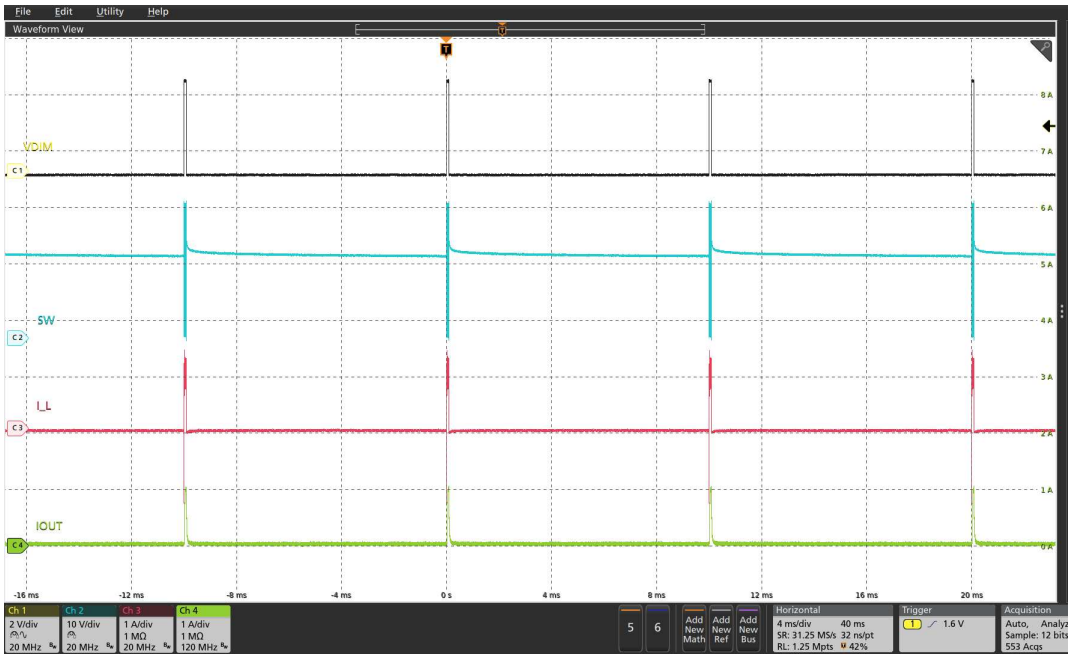

Figure 8. 1% Duty Cycle 100-Hz PWM Dimming(TPS92200D1)

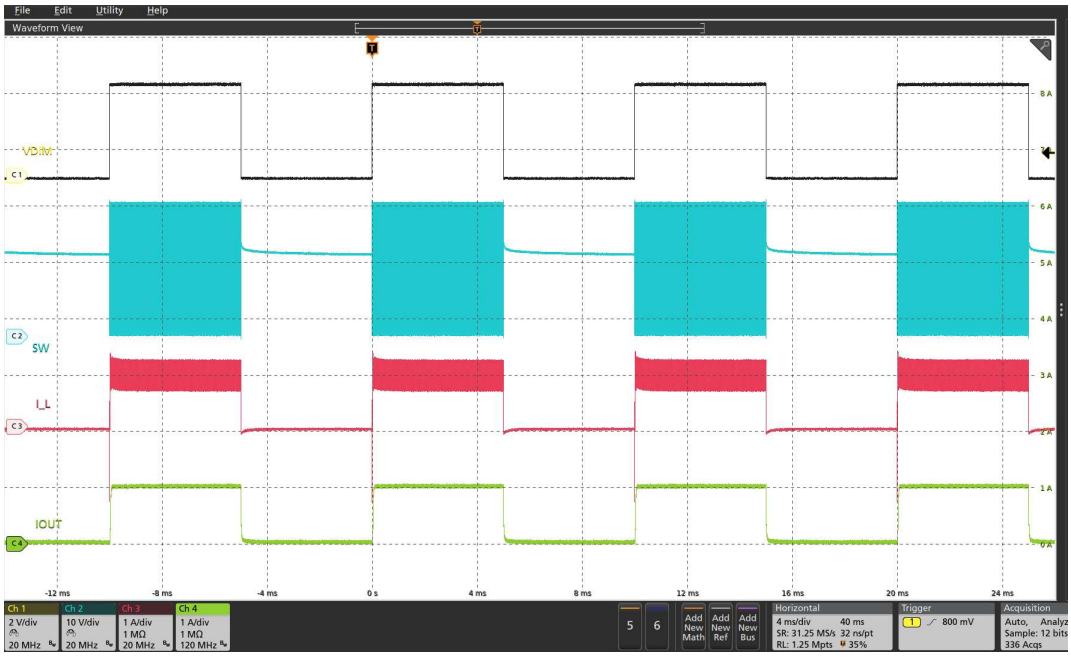

Figure 9. 50% Duty Cycle 100-Hz PWM Dimming(TPS92200D1)

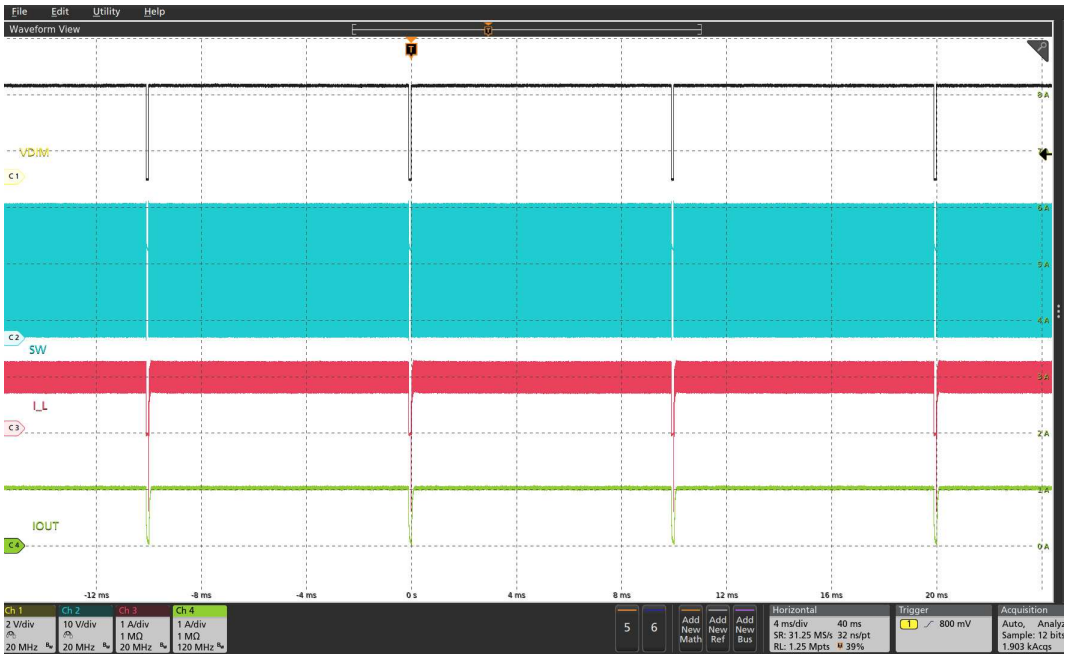

Figure 10. 99% Duty Cycle 100-Hz PWM Dimming(TPS92200D1)

5 Schematic

Figure 11 displays the TPS92200D1EVM schematic.

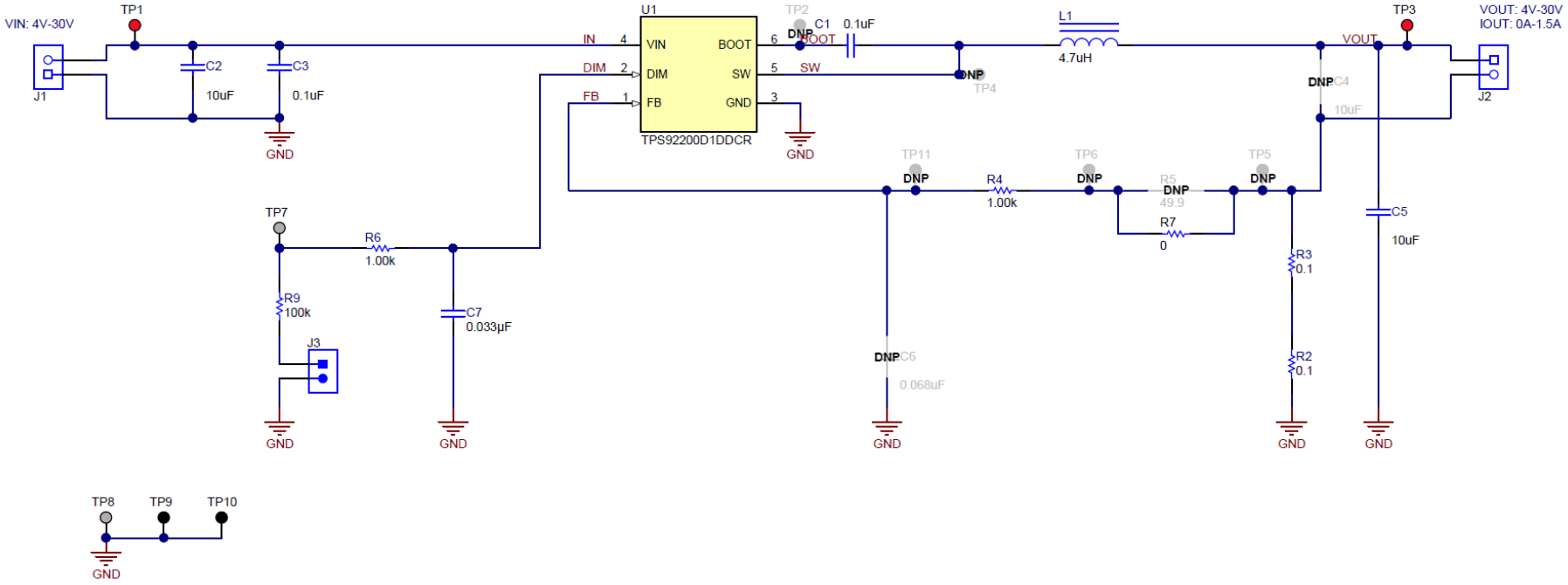

Figure 11. TPS92200D1EVM Schematic

Figure 12 displays the TPS92200D2EVM schematic.

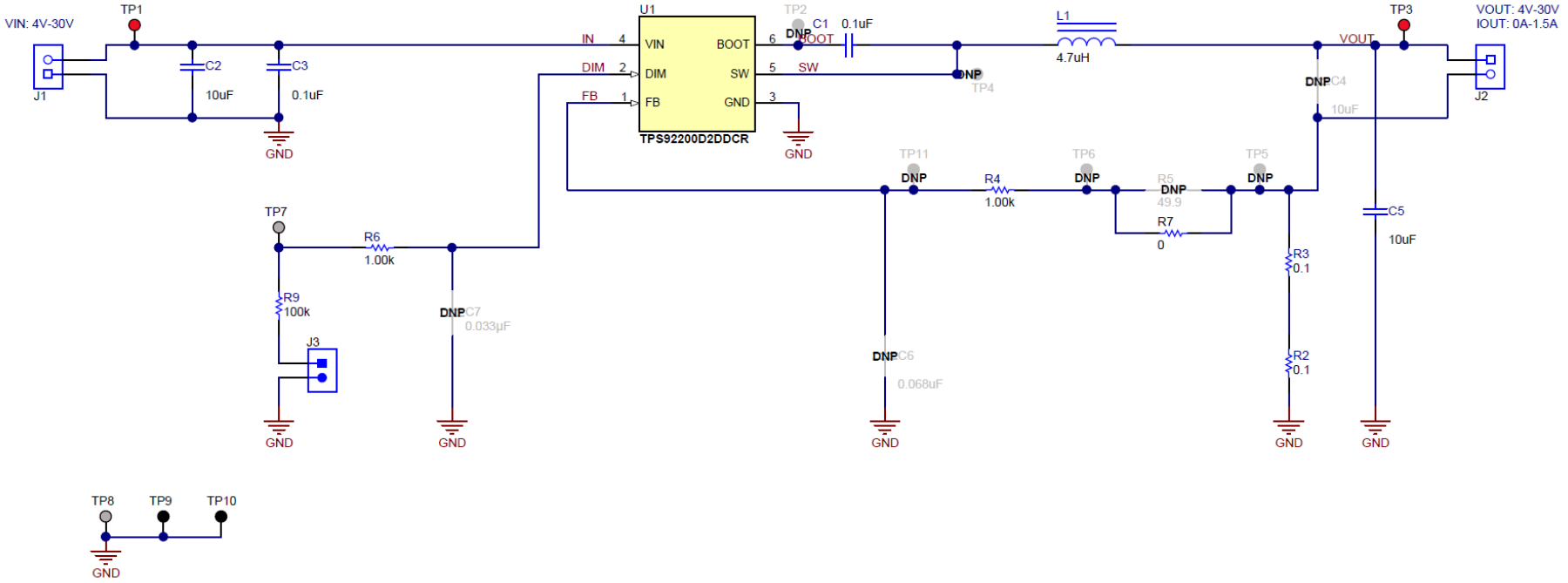

Figure 12. TPS92200D2EVM Schematic

6 TPS92200D1/D2EVM PCB Layout

Figure 13 and Figure 14 show the design of the TPS92200D1/D2EVM printed-circuit board.

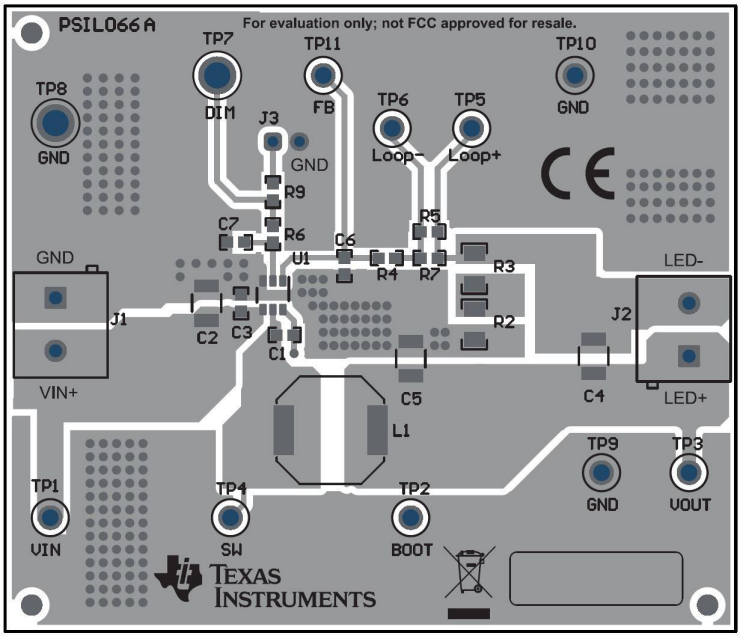

Figure 13. Top Layer and Top Overlay (Top View)

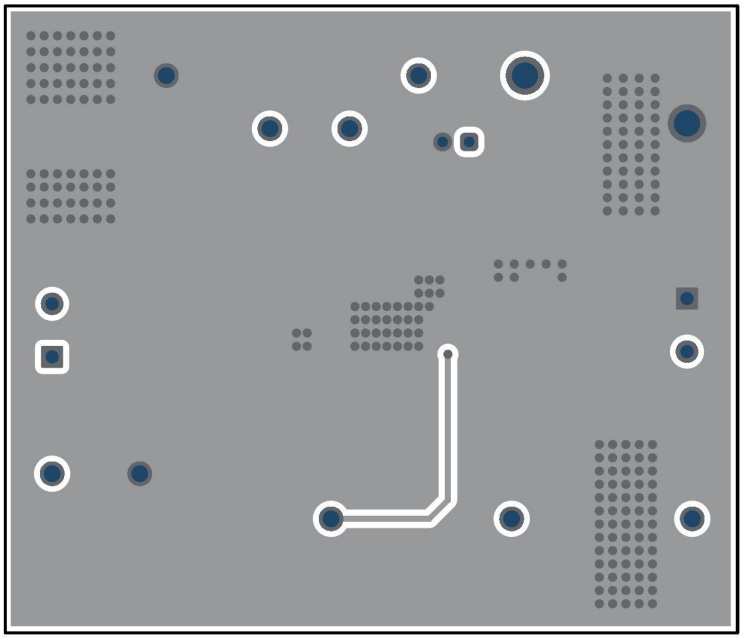

Figure 14. Bottom Layer and Bottom Overlay (Bottom View)

7 Bill of Materials

Table 3 displays the TPS92200D1/D2EVM components list according to the schematic in Figure 11.

Table 3. TPS92200D1/D2EVM Components List

Designator	Qty	Value	Description	Package	Part Number	Manufacturer
C1, C3	2	0.1uF	CAP, CERM, 0.1 μF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A	AVX
C2, C5	2	10uF	CAP, CERM, 10 μF, 35 V, +/- 10%, X7R, AEC-Q200 Grade 1, 1210	1210	CGA6P3X7S1H106K250AB	TDK
C7	1	0.033uF	CAP, CERM, 0.033 μF, 16 V, +/- 10%, X7R, 0603(TPS92200D1EVM Only)	0603	CL10B333KO8NNNC	Samsung Electro-Mechanics
J1, J2	2		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J3	1		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
L1	1	4.7uH	Inductor, Shielded Drum Core, Ferrite, 4.7 μH, 4.2 A, 0.02 ohm, SMD	WE-TPC-XLH2	7440650047	Wurth Elektronik
R1, R7	2	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R2, R3	0.1	0.1	RES, 0.1, 1%, 0.5W, 1206	1206	CSR1206FKR100	Stackpole Electronics Inc
R4, R6	2	1.00k	RES, 1.00k, 0.5%, 0.1 W, 0603	0603	RT0603DRE071KL	Yageo America
R9	1	100k	RES, 100 k, 0.1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERA-3AEB104V	Panasonic
TP1, TP3	2		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP7, TP8	2		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
TP9, TP10	2		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
U1	1		4.0V TO 30V INPUT VOLTAGE, 1.5 A OUTPUT CURRENT, SYNCHRONOUS BUCK WLED Driver, SOT-23-THIN(6)	SOT-23-THIN(6)	TPS92200D1DDCR(TPS92200D1EVM) / TPS92200D2DDCR(TPS92200D2EVM)	Texas Instruments

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