

AN-2194 TPS92551 450mA 60V LED Driver Micro-Module Evaluation Board

1 Introduction

The TPS92551 Constant Current Buck LED Driver Micro-Module drives maximum 450mA LED current up to 16 LEDs in a single string (maximum 23W). It integrates all the power components including the power inductor. The TPS92551 provides a full turn-key, highly efficient solution for wide range of single string LED lighting applications with up to 95% power efficiency. The TPS92551 accepts an input voltage ranging from 4.5V to 60V and delivers a 350mA LED current as default. The LED current is adjustable from 300mA to 450mA by charging a single external resistor.

The module operates at constant switching frequency (800kHz) with low Electro Magnetic Interference(EMI) complying with EN55015 standard. The module has fast control loop to realize fine LED current pulse yielding 256–step PWM dimming resolution at 240Hz for general lighting. Protection features include thermal shutdown, input under-voltage lockout, LED open-circuit and short-circuit protections. The TPS92551 Micro-Module is available in PFM 7 pin power package.

2 Board Specifications

- $V_{IN} = 4.5V$ to 60V
- $I_{LED} = 350mA$ (default I_{LED} setting, refer to [Table 4](#) for other I_{LED} settings)
- $I_{LED} = 300mA$ to 450mA
- Designed on two layers, all two layers are 2oz. copper weight.

3 Evaluation Board Design For I_{LED} Setting and EMI

The evaluation board schematic is shown as [Figure 3](#). The default LED current is set at 350mA. By proper setting the resistor values of RIADJ or RVREF (They are not in place but solder pads are reserved), the LED current can be adjusted from 300mA to 450mA, please refer to [Figure 1](#) and [Figure 2](#) for their setting values. The evaluation board is tested and passes radiated emissions standards (EN55015); please refer to [Figure 30](#), [Figure 31](#), [Figure 33](#), [Figure 34](#), [Figure 36](#), and [Figure 37](#) for the performance.

NOTE: The COUT capacitor (2.2uF) on board is critical to suppress the Electro Magnetic Interference(EMI) for the performance as shown.

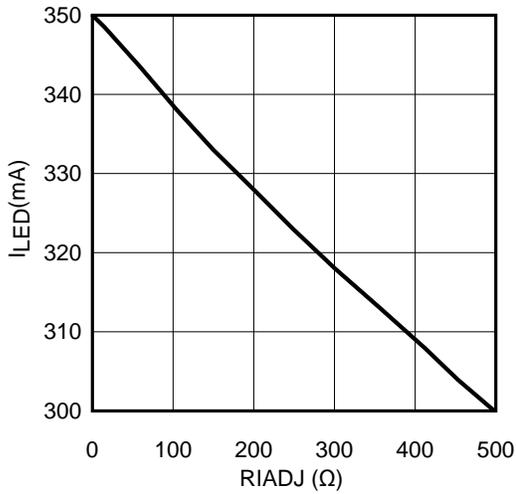


Figure 1. LED current vs. RIADJ
RVREF = open

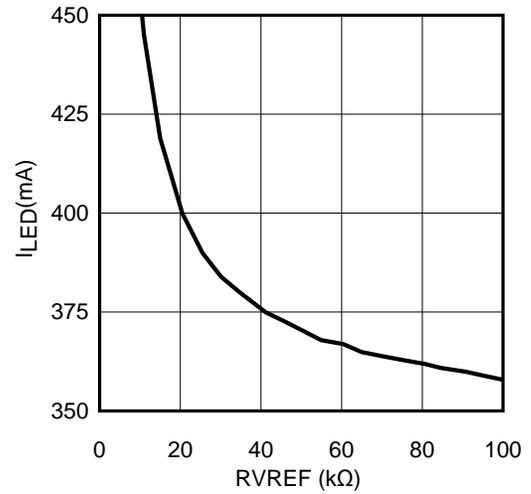


Figure 2. LED current vs. RVREF
RIADJ = 0Ω

4 Complete Circuit Schematic

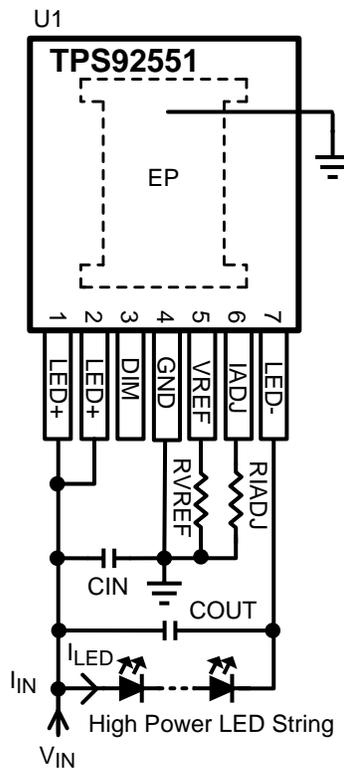


Figure 3. Complete Evaluation Board Schematic

Table 1. Bill of Materials for Evaluation Board, $V_{IN} = 48V$, $I_{LED} = 300mA$, No of LED = 5–13

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	LED Micro-Module Driver	PFM-7	Texas Instruments	TPS92551	1
CIN	2.2 μF , X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
COU	2.2 μF , X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
RIADJ	499 Ω	0603	Vishay	CRCW0603499RFKEA	1
RVREF	No connection	N/A	N/A	N/A	0

Table 2. Bill of Materials for Evaluation Board, $V_{IN} = 48V$, $I_{LED} = 350mA$, No of LED = 5–13

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	LED Micro-Module Driver	PFM-7	Texas Instruments	TPS92551	1
CIN	2.2 μF , X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
COU	2.2 μF , X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
RIADJ	0 Ω	0603	Vishay	CRCW06030000Z0EA	1
RVREF	No connection	N/A	N/A	N/A	0

Table 3. Bill of Materials for Evaluation Board, $V_{IN} = 48V$, $I_{LED} = 450mA$, No of LED = 5–13

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	LED Micro-Module Driver	PFM-7	Texas Instruments	TPS92551	1
CIN	2.2 μF , X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
COU	2.2 μF , X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
RIADJ	0 Ω	0603	Vishay	CRCW06030000Z0EA	1
RVREF	10.5k Ω	0603	Vishay	CRCW060310K5FKEA	1

Table 4. Example for I_{LED} Setting

$R_{IADJ}(\Omega)$	$R_{VREF}(\Omega)$	$I_{LED}(mA)$
499	OPEN	300
SHORT	OPEN	350
SHORT	10.5k	450

5 Connection Diagram

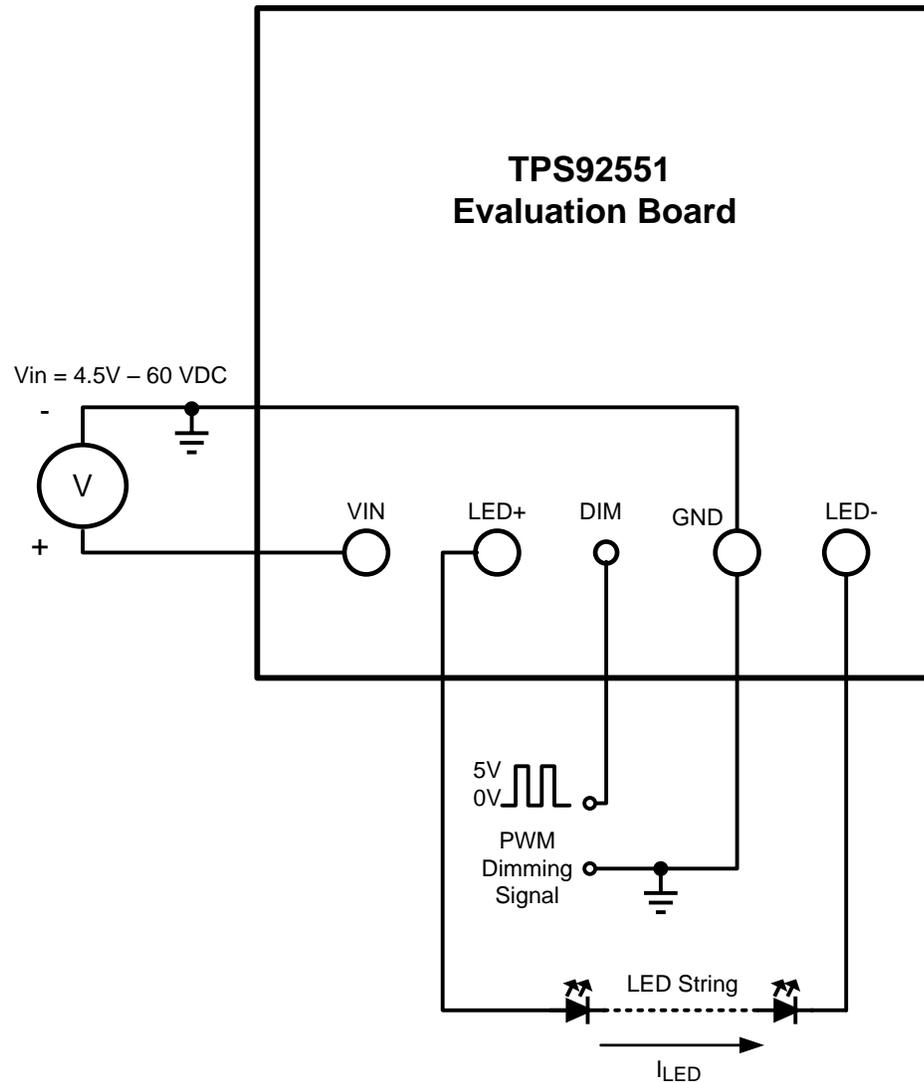


Figure 4. Connection Diagram Setup

Terminal Designation	Description
VIN	Power Supply positive(+ve) connection
GND	Power supply negative(-ve) connection
LED+	Connect to cathode of the serial LED string
LED-	Connect to anode of the serial LED string
DIM	PWM dimming signal input

6 Typical Performance Characteristics

Unless otherwise specified, the following conditions apply: $V_{IN} = 48V$, C_{IN} is a 2.2 μF 100V X7R ceramic capacitor for driving 5–13 power LEDs with $I_{LED} = 350mA$. Single LED forward voltage used is 3.2V. $T_A = 25^\circ C$ for efficiency curves and waveforms.

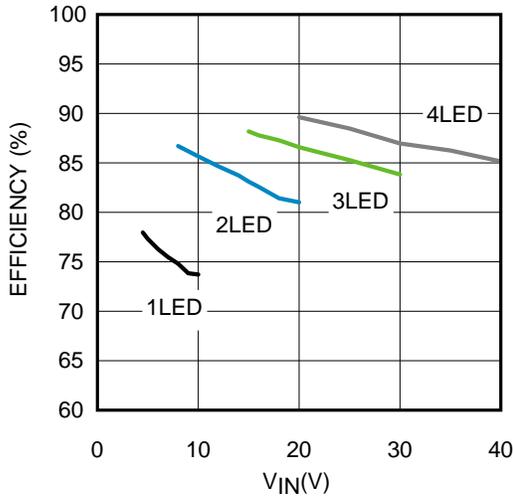


Figure 5. Efficiency vs. V_{IN} ,
 $I_{LED} = 350mA$

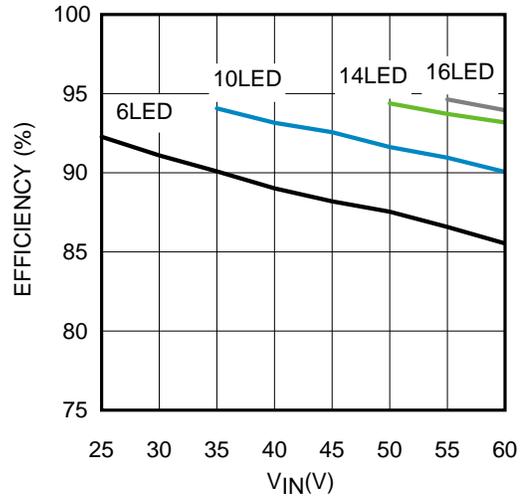


Figure 6. Efficiency vs. V_{IN} ,
 $I_{LED} = 350mA$

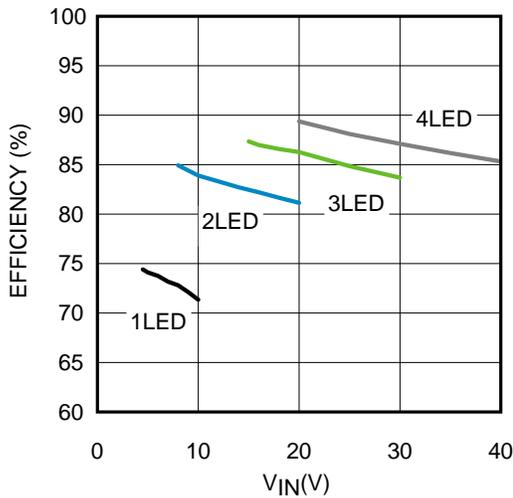


Figure 7. Efficiency vs. V_{IN} ,
 $I_{LED} = 450mA$

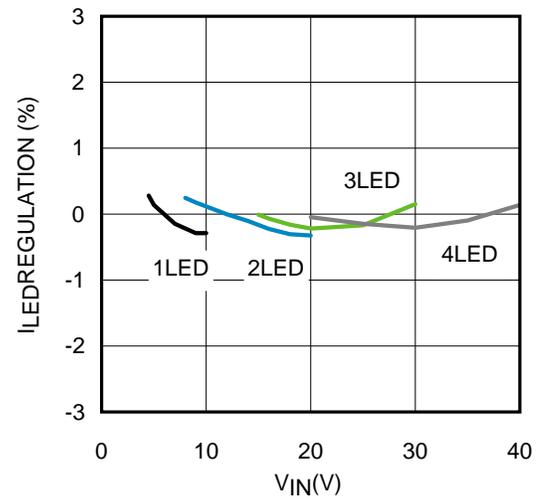


Figure 8. I_{LED} Regulation vs. V_{IN} ,
 $I_{LED} = 350mA$

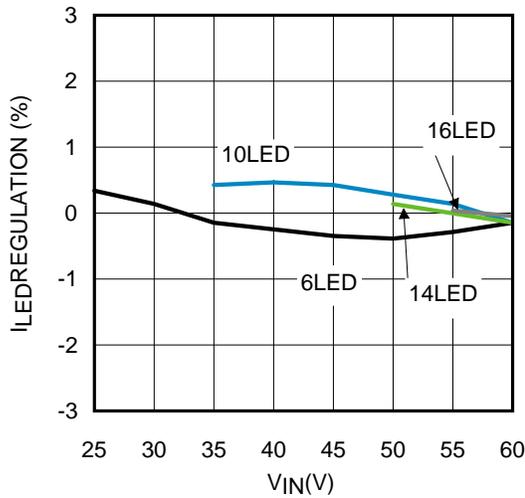


Figure 9. I_{LED} Regulation vs. V_{IN} ,
 $I_{LED} = 350mA$

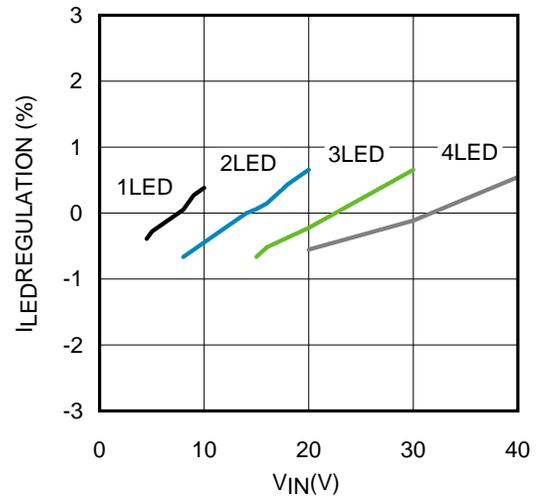


Figure 10. I_{LED} Regulation vs. V_{IN} ,
 $I_{LED} = 450mA$

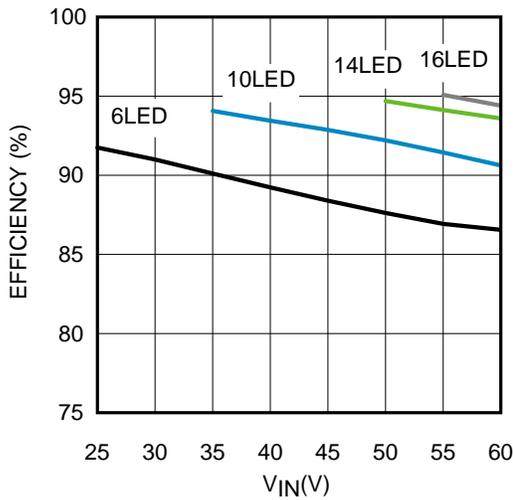


Figure 11. Efficiency vs. V_{IN} ,
 $I_{LED} = 450mA$

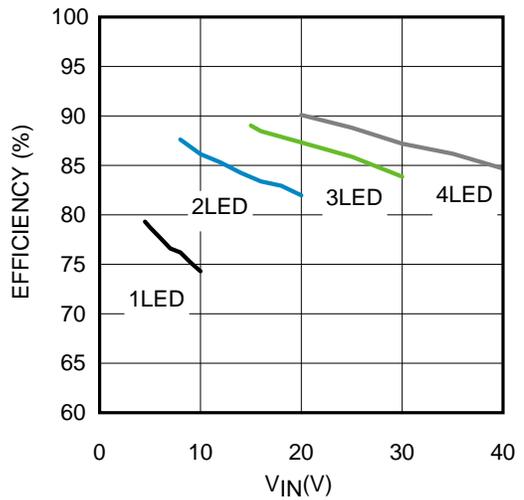
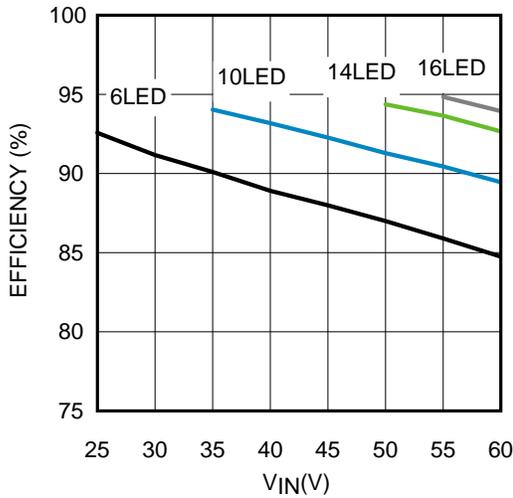
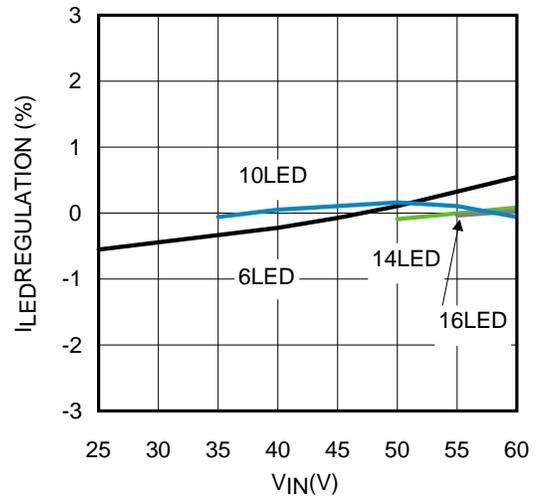


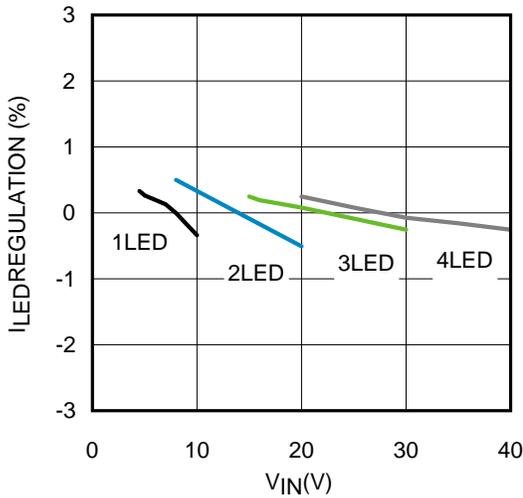
Figure 12. Efficiency vs. V_{IN} ,
 $I_{LED} = 300mA$



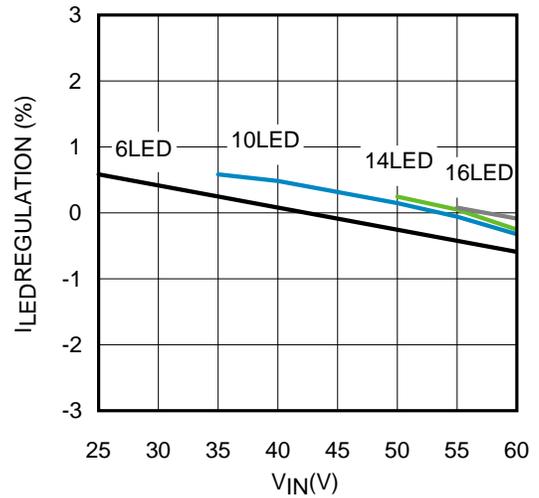
**Figure 13. Efficiency vs. V_{IN},
I_{LED} = 300mA**



**Figure 14. I_{LED} Regulation vs. V_{IN},
I_{LED} = 450mA**



**Figure 15. I_{LED} Regulation vs. V_{IN},
I_{LED} = 300mA**



**Figure 16. I_{LED} Regulation vs. V_{IN},
I_{LED} = 300mA**

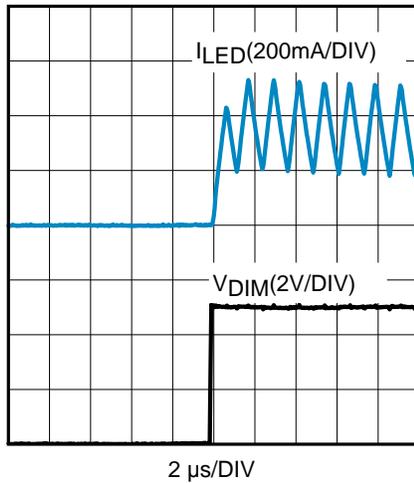


Figure 17. LED Current with PWM Dimming V_{DIM} Rising (without COU capacitor)

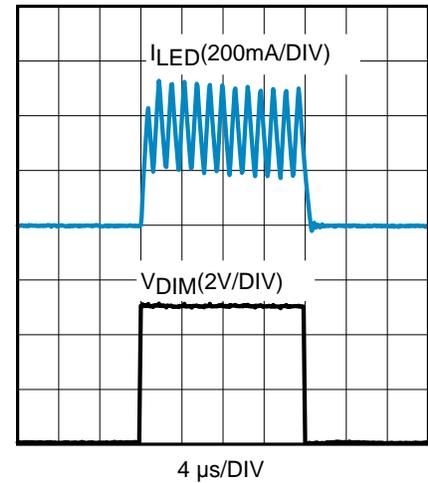


Figure 18. LED Current with PWM Dimming $16\mu s$ dimming pulse (without COU capacitor)

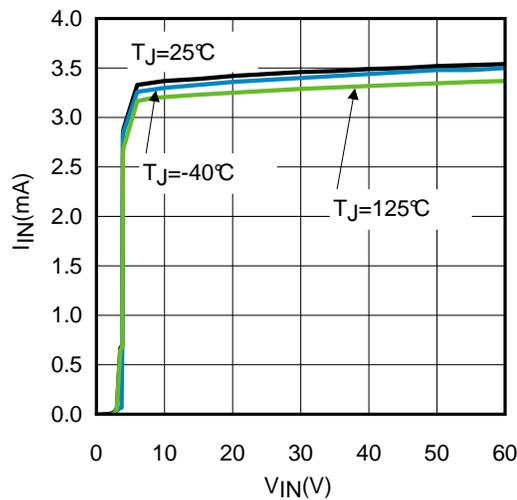


Figure 19. I_{IN} vs. V_{IN} LED = open, DIM = open

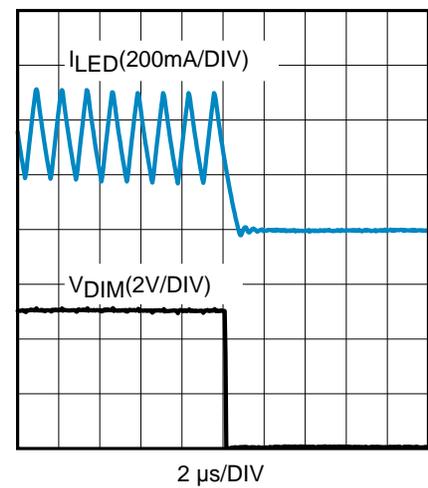


Figure 20. LED Current with PWM Dimming V_{DIM} Falling (without COU capacitor)

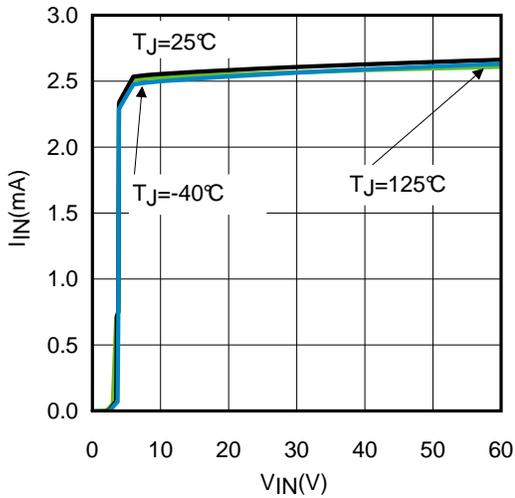


Figure 21. I_{IN} vs. V_{IN}
 $V_{DIM} = 0V$

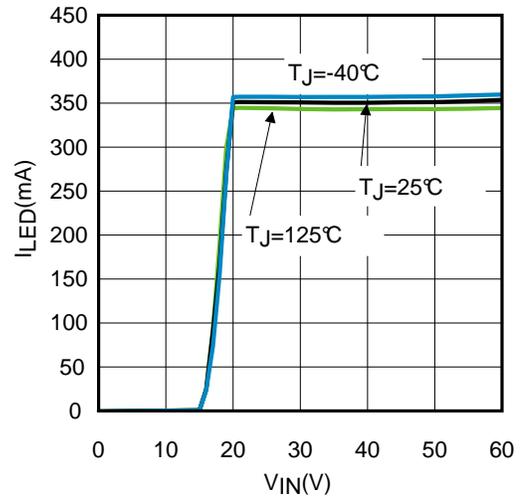


Figure 22. I_{LED} vs. V_{IN}
6LED

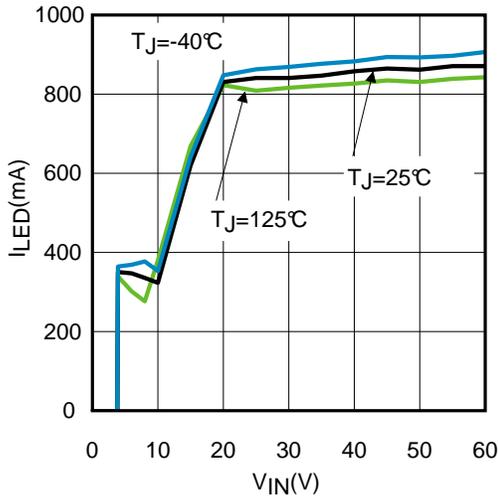


Figure 23. I_{LED} vs. V_{IN}
 $V_{LED} = 0V$, DIM = open

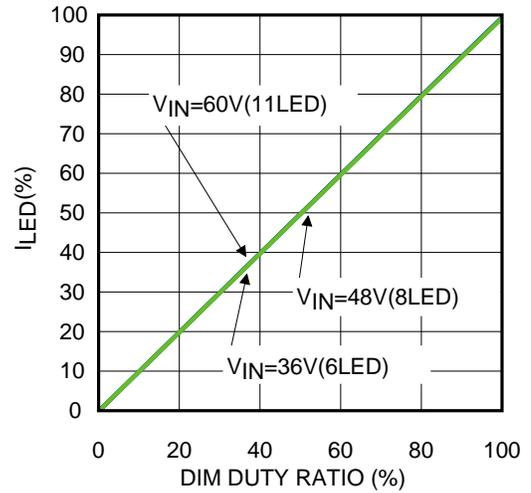


Figure 24. I_{LED} vs. Dimming Duty Ratio

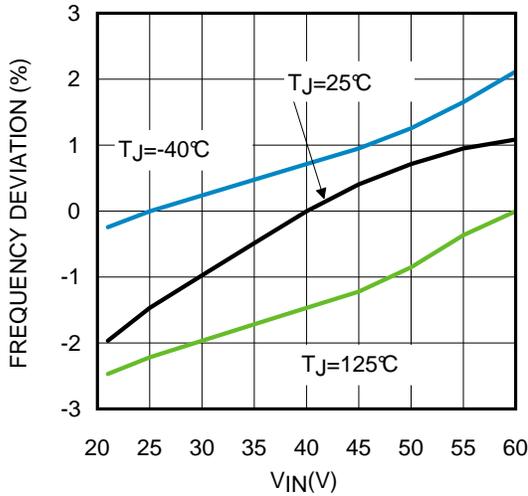


Figure 25. Frequency Deviation vs. V_{IN}
800kHz

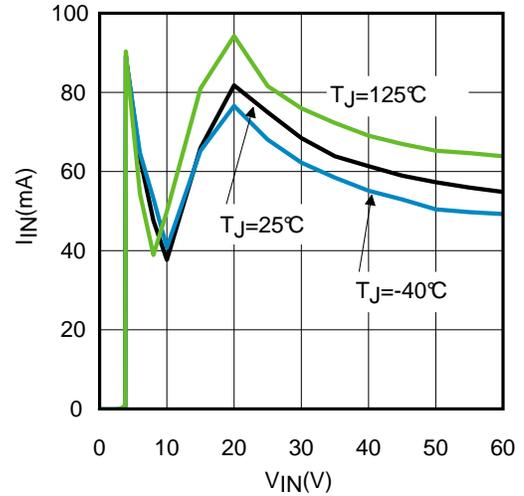


Figure 26. I_{IN} vs. V_{IN}
 $V_{LED} = 0V$, DIM = open

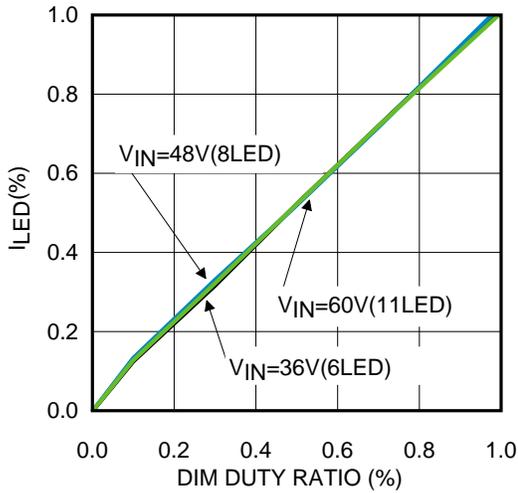


Figure 27. I_{LED} vs. Dimming Duty Ratio

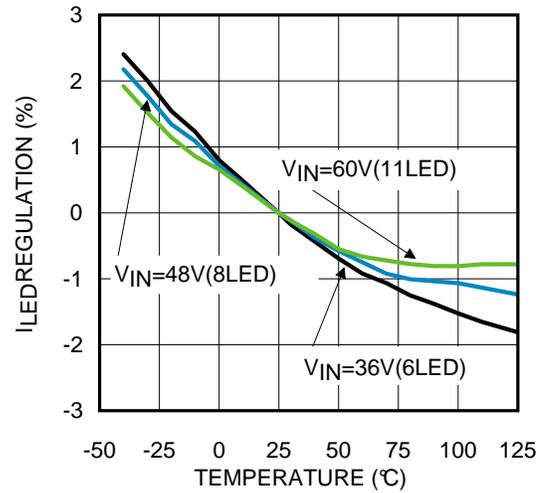


Figure 28. I_{LED} Regulation vs. Temperature

7 Circuit Example 1 : Complies with EN55015 Radiated Emissions

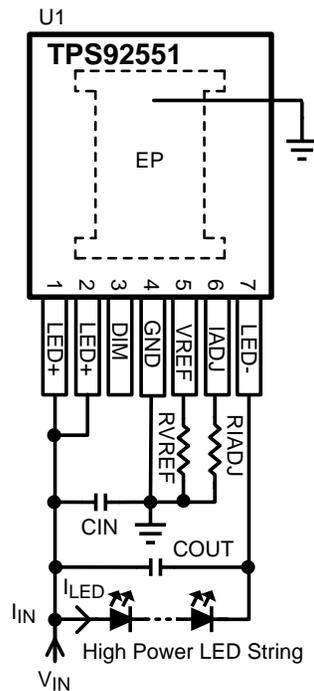


Figure 29. Component Schematic, $V_{IN} = 60V$, $I_{LED} = 300mA$, No. of LED = 16, Complies with EN55015 Radiated Emissions

Table 5. Bill of Materials

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	LED Micro-Module Driver	PFM-7	Texas Instruments	TPS92551	1
CIN	2.2 μ F, X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
COUT	2.2 μ F, X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
RIADJ	499 Ω	0603	Vishay	CRCW0603499RFKEA	1
RVREF	No connection	N/A	N/A	N/A	0

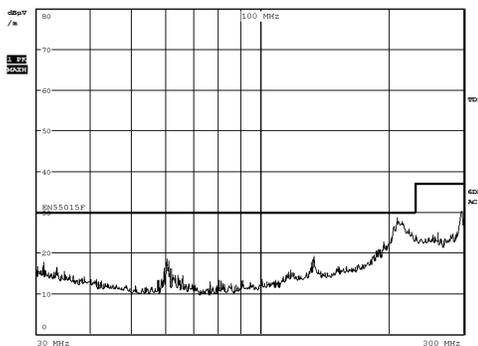


Figure 30. Complies with EN55015 Radiated Emissions
(HORI. / HEIGHT=3.0m / RANGE=10m)
 $V_{IN} = 60V$, $I_{LED} = 300mA$, No. of LED = 16
Tested on TPS92551 Evaluation Board

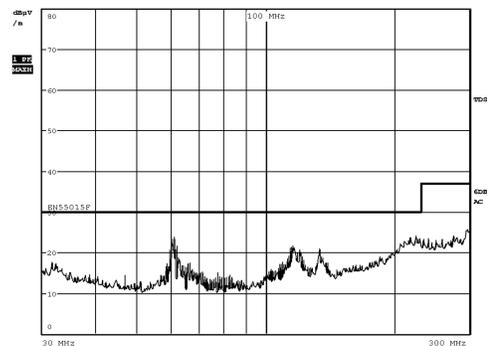


Figure 31. Complies with EN55015 Radiated Emissions
(VERT. / HEIGHT=1.0m / RANGE=10m)
 $V_{IN} = 60V$, $I_{LED} = 300mA$, No. of LED = 16
Tested on TPS92551 Evaluation Board

8 Circuit Example 2: Complies with EN55015 Radiated Emissions

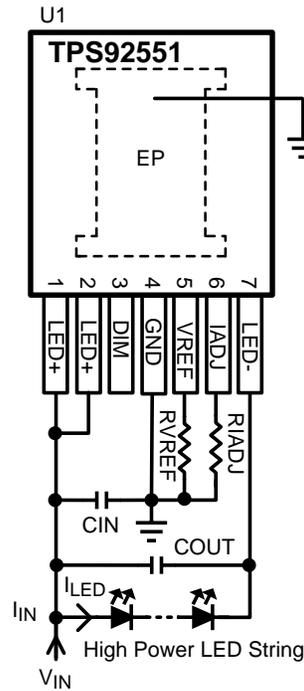


Figure 32. Component Schematic, $V_{IN} = 60V$, $I_{LED} = 350mA$, No. of LED = 16, Complies with EN55015 Radiated Emissions

Table 6. Bill of Materials

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	LED Micro-Module Driver	PFM-7	Texas Instruments	TPS92551	1
CIN	2.2 μF , X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
COUT	2.2 μF , X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
RIADJ	0 Ω	0603	Vishay	CRCW06030000Z0EA	1
RVREF	No connection	N/A	N/A	N/A	0

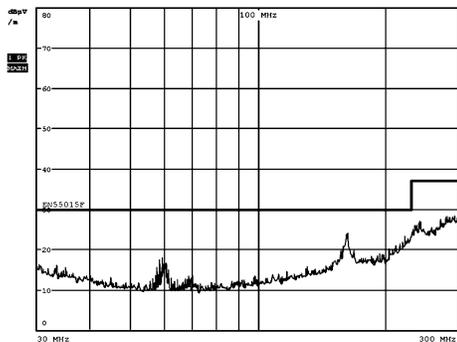


Figure 33. Complies with EN55015 Radiated Emissions (HORI. / HEIGHT=3.0m / RANGE=10m) $V_{IN} = 60V$, $I_{LED} = 350mA$, No. of LED = 16 Tested on TPS92551 Evaluation Board

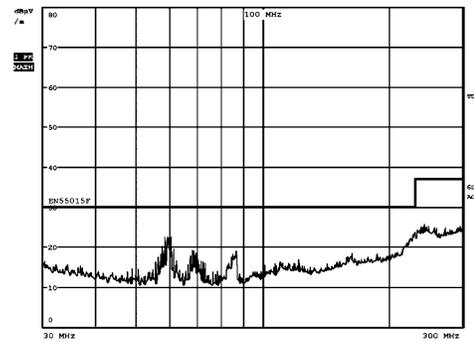


Figure 34. Complies with EN55015 Radiated Emissions (VERT. / HEIGHT=1.0m / RANGE=10m) $V_{IN} = 60V$, $I_{LED} = 350mA$, No. of LED = 16 Tested on TPS92551 Evaluation Board

9 Circuit Example 3: Complies with EN55015 Radiated Emissions

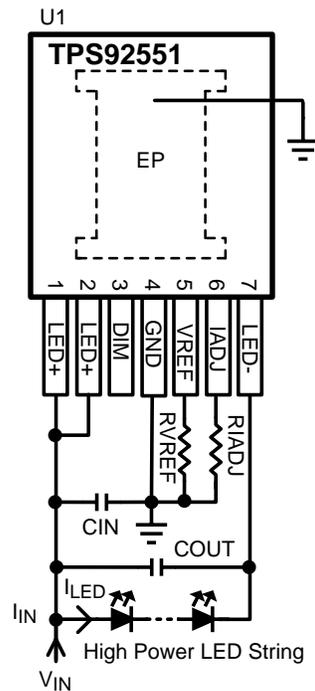


Figure 35. Component Schematic, $V_{IN} = 60V$, $I_{LED} = 450mA$, No. of LED = 16, Complies with EN55015 Radiated Emissions

Table 7. Bill of Materials

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	LED Micro-Module Driver	PFM-7	Texas Instruments	TPS92551	1
CIN	2.2 μ F, X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
COUT	2.2 μ F, X7R, 100V	1210	Murata	GRM32ER72A225KA35L	1
RIADJ	0 Ω	0603	Vishay	CRCW06030000Z0EA	1
RVREF	10.5k Ω	0603	Vishay	CRCW060310K5FKEA	1

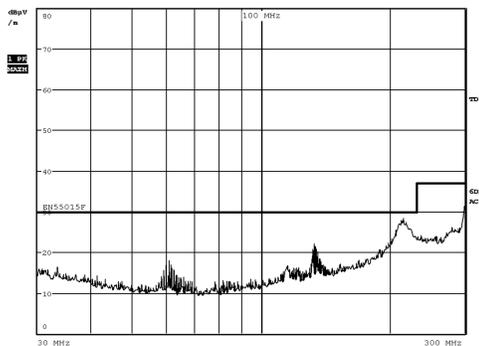


Figure 36. Complies with EN55015 Radiated Emissions
(HORI. / HEIGHT=3.0m / RANGE=10m)
 $V_{IN} = 60V$, $I_{LED} = 450mA$, No. of LED = 16
Tested on TPS92551 Evaluation Board

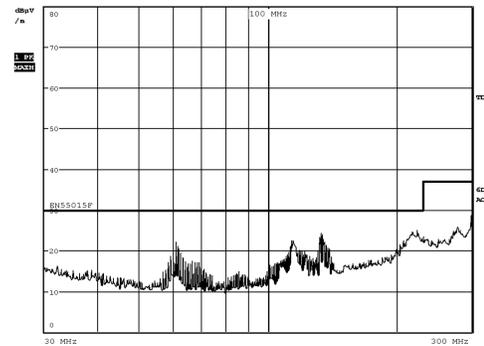


Figure 37. Complies with EN55015 Radiated Emissions
(VERT. / HEIGHT=1.0m / RANGE=10m)
 $V_{IN} = 60V$, $I_{LED} = 450mA$, No. of LED = 16
Tested on TPS92551 Evaluation Board

10 PCB Layout Diagram

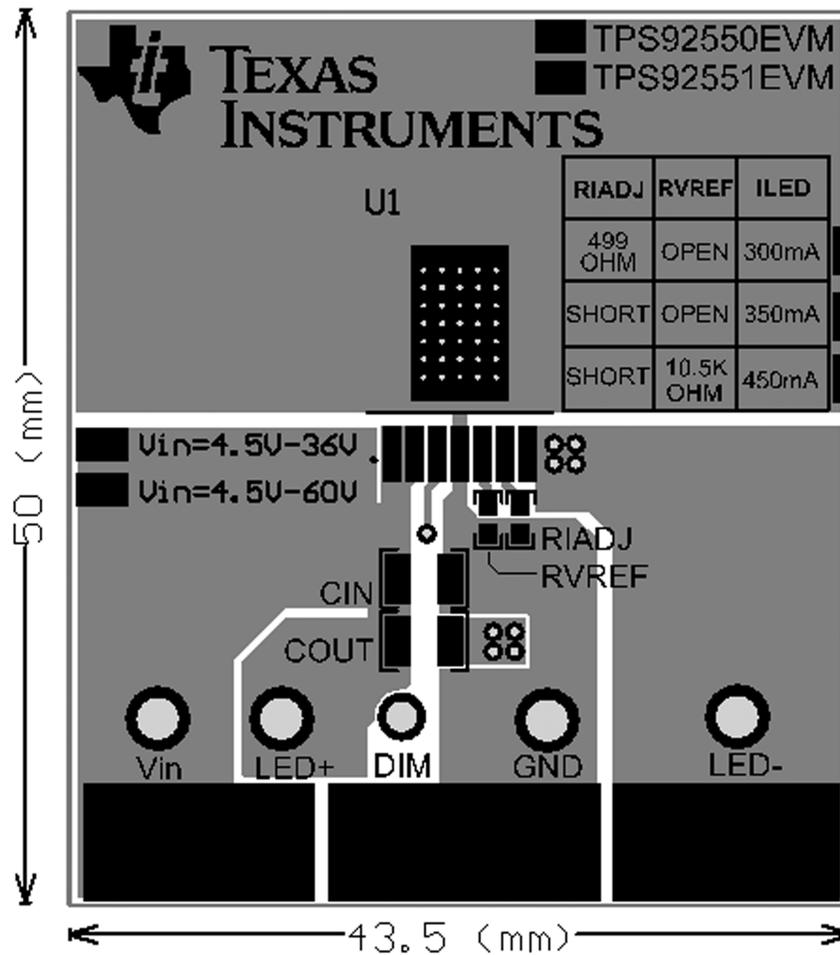


Figure 38. Top Layer and Top Overlay

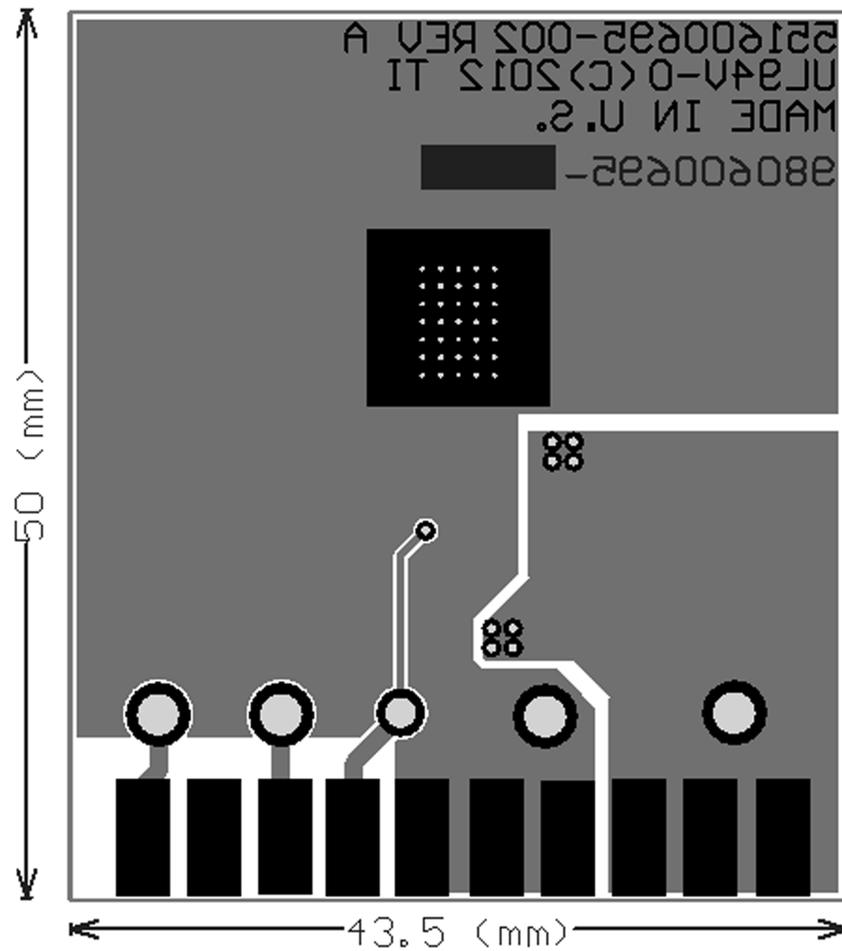


Figure 39. Bottom Layer and Bottom Overlay

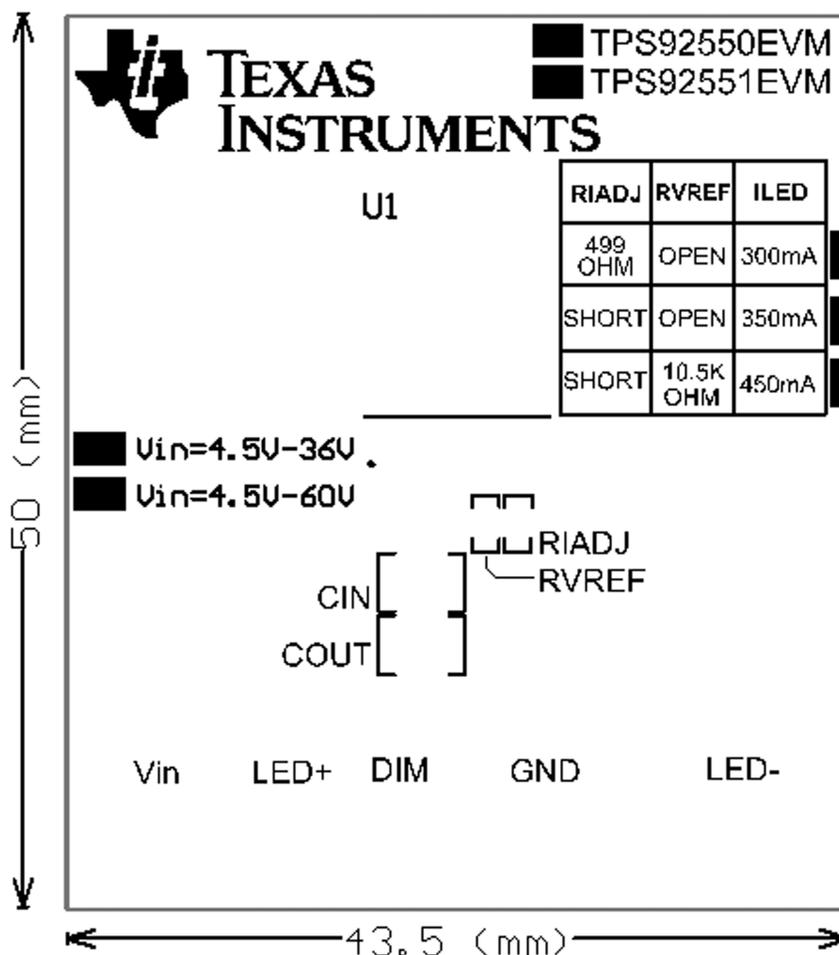


Figure 40. Top Overlay

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