# TPS92512EVM-001 High-Current Buck Regulator With Analog and PWM Dimming for High Brightness LEDs

## 1 Introduction

The TPS92512EVM-001 evaluation module (EVM) helps designers evaluate the operation and performance of the TPS92512HV buck switching regulator designed for high-current LED-drive applications. The TPS92512HV device is designed to control the drive of high-brightness light emitting diodes and features a wide input voltage range (4.5 V to 60 V), PWM dimming capability, analog dimming capability, adjustable/syncable switching frequency, and input undervoltage protection.

## 2 Warnings

Observe the following precautions when using the TPS92512EVM-001.

**WARNING**

**DO NOT STARE DIRECTLY INTO THE LED LIGHT SOURCE. Intense light sources have a high-secondary blinding effect. A temporary reduction in visual acuity and afterimages can occur, leading to irritation, annoyance, visual impairment, and even accidents—depending on the situation. Always consider the use of light filtering and darkening protective eyewear and be fully aware of surrounding laboratory-type set-ups when viewing intense light sources to minimize or eliminate such risks in order to avoid accidents related to temporary blindness.**

**WARNING**

**Do not stare at the operating LED (Risk Group1 [RG1]). See IEC32471-1 ed1.0:2009-08 for risk group definitions.**

## 3 Description

The TPS92512EVM-001 provides a high-brightness LED driver based on the TPS92512HV buck regulator. It is designed to operate with an input voltage in the range of 12 V to 48 V. The EVM is set up for a default output current of 1.5 A for an LED stack between approximately 5 V and 25 V. The TPS92512 device helps provide high efficiency, good line regulation, low output ripple, and a wide dimming range.

### *3.1 Typical Applications*

This converter design describes an application of the TPS92512HV device as an LED driver with the specifications described in Table 1. For applications with a different input voltage range or different output voltage range refer to the TPS92512 data sheet.


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## 3.2 Features

### 3.2.1 Connector Description

This section describes the connectors and test points on the EVM and how to properly connect, setup, and use the TPS92512EVM-001.

#### 3.2.1.1 J1, LED+, LED-

The screw-down connector, J1, and the test posts marked LED+ and LED- are for connecting the LED load to the board. The leads to the LED load should be twisted and kept as short as possible to minimize voltage drop, inductance, and EMI transmission. This design is for approximately 2 to 7 white LEDs.

#### 3.2.1.2 J2, VIN, GND

The screw-down connector, J2, and the test posts marked VIN and GND are for connecting the EVM to the DC input voltage supply. The input supply ground should be connected to J2 or the GND test post directly next to J2. One other GND test point is provided on the board that can also be used for all purposes but input power.

#### 3.2.1.3 UVLO

The test point UVLO connects directly to the UVLO pin of the TPS92512 device. The voltage range is 0 V to 4.5 V if driven externally. The UVLO resistor divider should be used for the UVLO function, but the UVLO voltage can be monitored with this test point. Pulling UVLO to GND will also serve to disable the part and put it into low power shutdown mode.

#### 3.2.1.4 PDIM

The PDIM test point connects directly to the PDIM pin of the TPS92512 device. Leave open for normal operation. If PWM dimming is used, apply a square wave with a low level of GND and a high level of between 2 V and 4.5 V. The dimming frequency range is 100 Hz to 1 kHz.

#### 3.2.1.5 SYNC

The SYNC test point is AC coupled to the RT/CLK pin of the TPS92512 device through a 4.02-kΩ resistor in series with a 470-pF capacitor. Apply a square wave with a low level of GND and a high level of 3.3 V to synchronize the switching frequency to the applied frequency. The frequency range of SYNC is 200 kHz to 2 MHz.

#### 3.2.1.6 IADJ

The IADJ test point connects directly to the IADJ pin of the TPS92512 device. The default is pulled high through a 10M resistor to VIN resulting in an ISENSE voltage of 300mV. The range on the IADJ pin is 180 mV to 1.8 V and the corresponding ISENSE voltage is $V_{IADJ}$ / 6.

#### 3.2.1.7 PH

A large via, labelled *PH*, is included and sized specifically to receive the probe tip of a standard 10x probe. Use this via to monitor the switching waveform at the PH pin of the device.


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# 4 Electrical Performance Specifications

**Table 1. TPS92512EVM-001 Electrical Performance Specifications**

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| **INPUT CHARACTERISTICS** | | | | | |
| Voltage range | | 12 | | 48 | V |
| Maximum input current | | | 1.5 | | A |
| Input UVLO setting | | | 11.5 | | V |
| **OUTPUT CHARACTERISTICS** | | | | | |
| Output voltage, VOUT | LED+ to LED- | 5 | | 25 | V |
| Output current | | 1.425 | 1.5 | 1.575 | A |
| Output current ripple | | | 20 | | mApp |
| Analog dimming range | IADJ = 180 mV to 1.8 V | 10:1 | | | |
| PWM dimming range | 250-Hz PWM | 100:1 | | | |
| **SYSTEMS CHARACTERISTICS** | | | | | |
| Efficiency | Input voltage = 24 V, 4 LEDs | | 93% | | |
| Switching frequency | | | 570 | | kHz |

# 5 Schematic

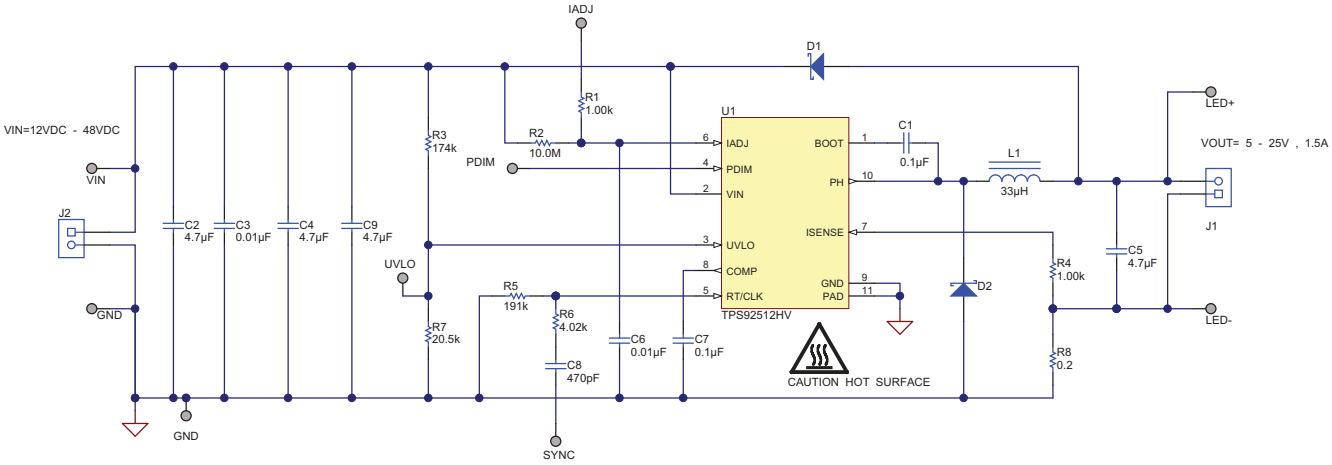


**Figure 1. TPS92512EVM-001 Schematic**


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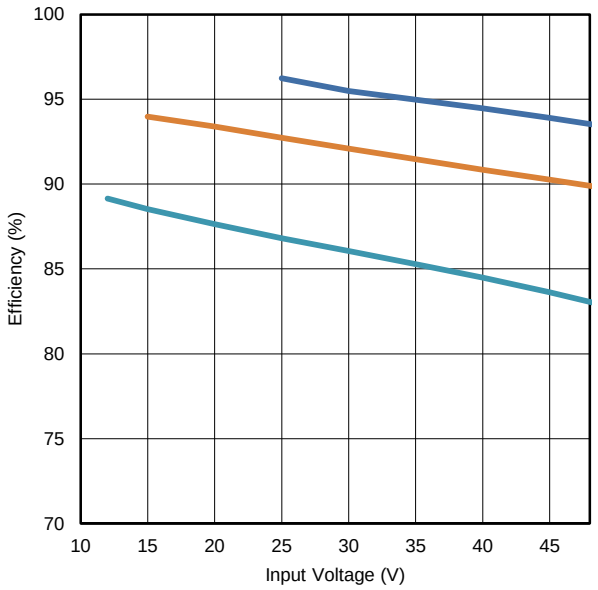
# 6 Performance Data and Typical Characteristic Curves

Figure 2 through Figure 8 show the typical performance curves for the TPS92512EVM-001. Unless otherwise noted, $V_{IN}$ = 24 V and 3 LED output.

## 6.1 Efficiency




Top = 7 LEDs Middle = 4 LEDs Bottom = 2 LEDs

**Figure 2. Efficiency vs Input Voltage**

## 6.2 Line Regulation

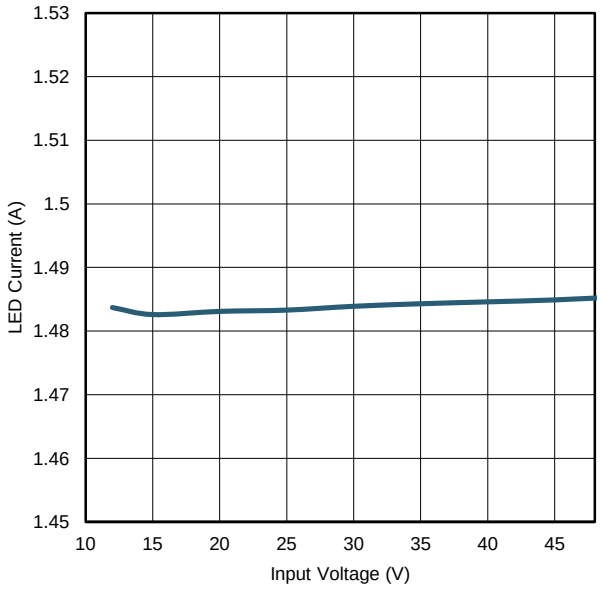



**Figure 3. Output Current vs Input Voltage**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## 6.3 PWM Dimming

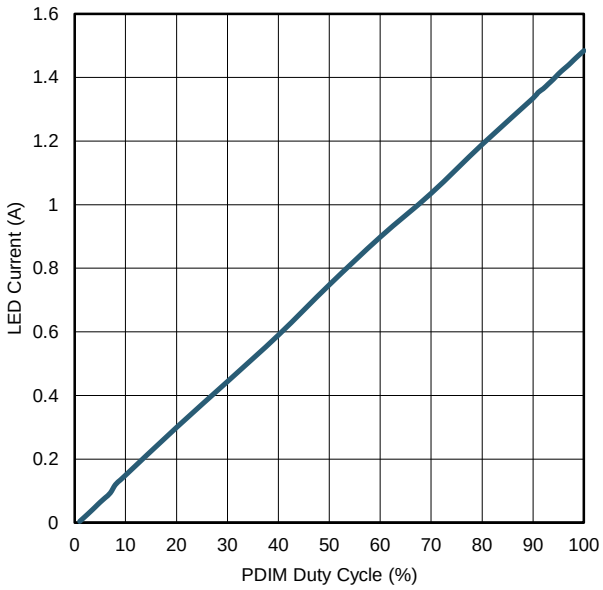


**Figure 4. Output Current vs PWM Duty Cycle (250Hz)**

## 6.4 Analog Dimming

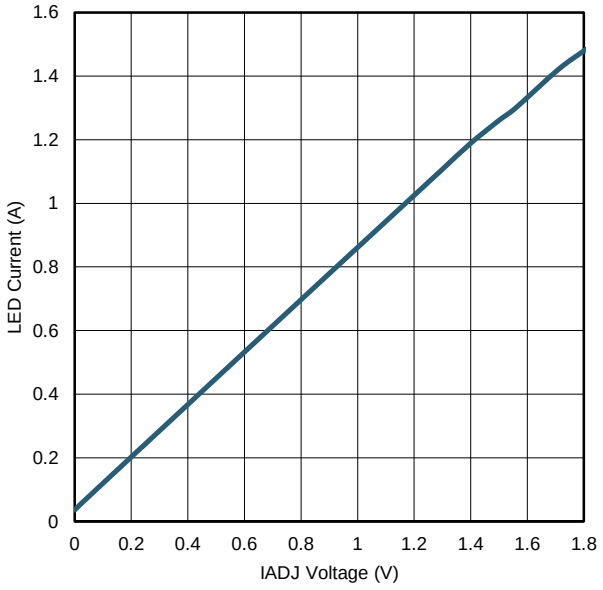


**Figure 5. Output Current vs IADJ Voltage**


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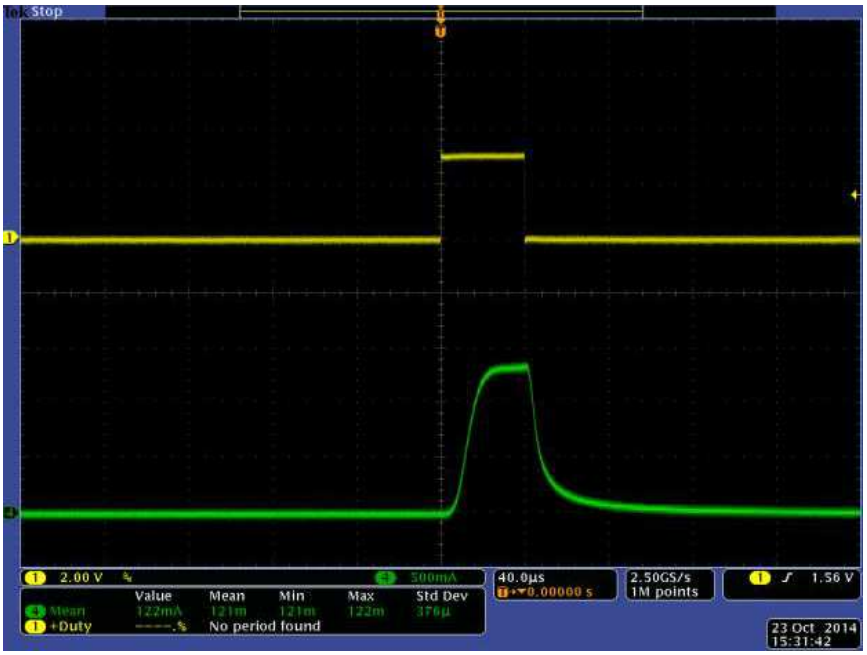
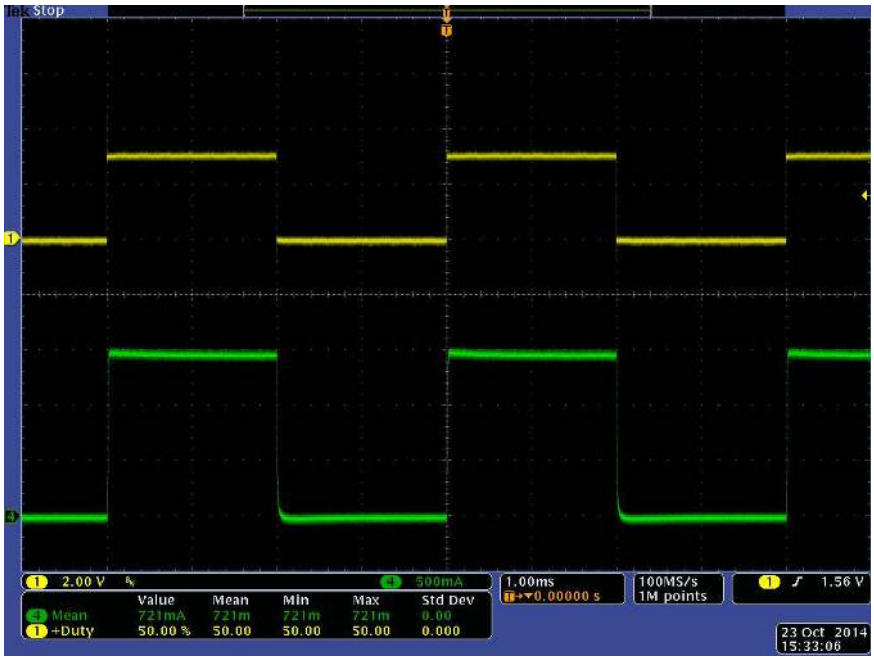
## 6.5 PWM Dimming Waveforms




Top = PDIM Bottom = LED Current

**Figure 6. 1% Duty Cycle, 250-Hz PWM Dimming**




Top = PDIM Bottom = LED Current

**Figure 7. 50% Duty Cycle, 250-Hz PWM Dimming**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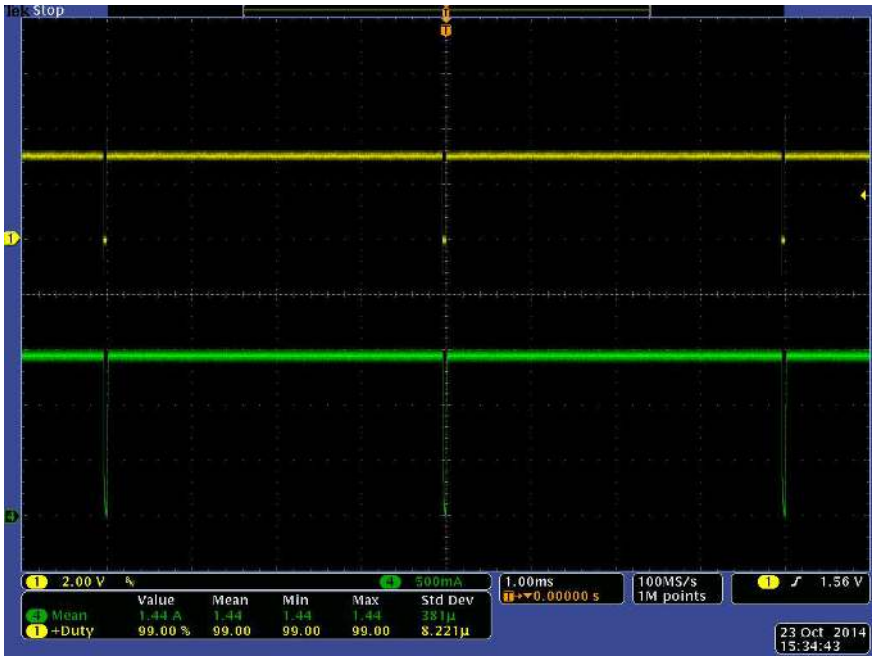


Top = PDIM Bottom = LED Current

**Figure 8. 99% Duty Cycle, 250-Hz PWM Dimming**


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## 7 TPS92512EVM-001 PCB layout

Figure 9 and Figure 10 show the design of the TPS92512EVM-001 printed circuit board.

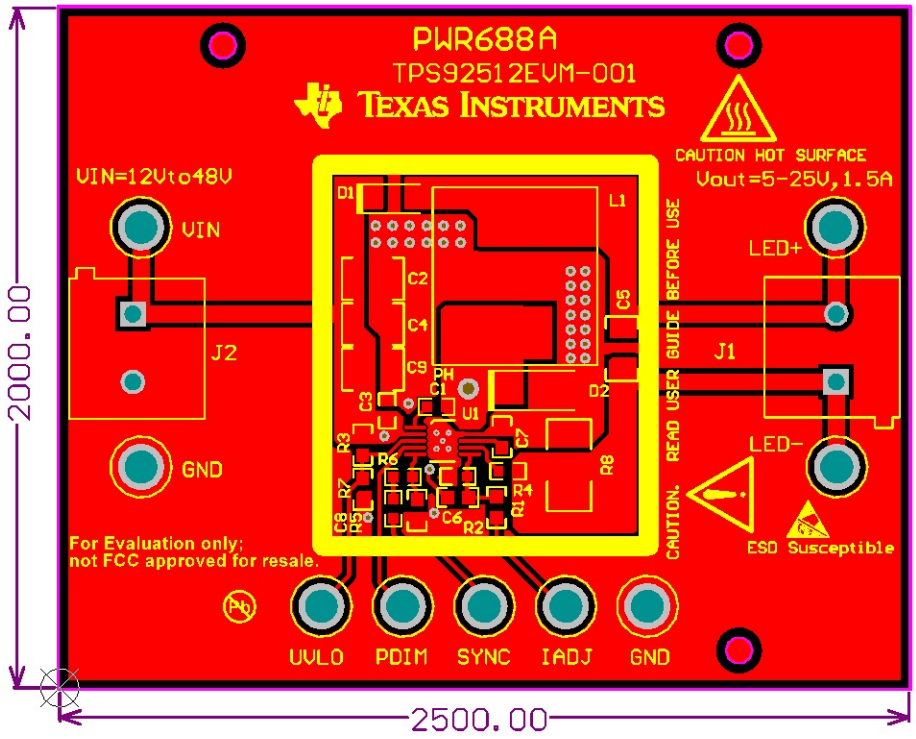


**Figure 9. Top Layer and Top Overlay (Top View)**

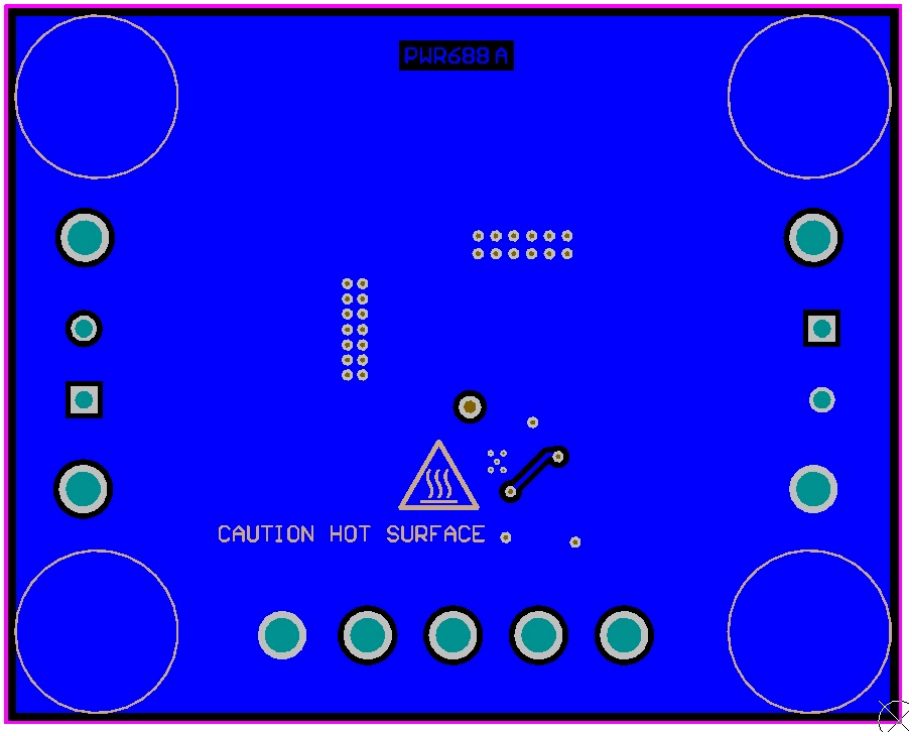


**Figure 10. Bottom Layer and Bottom Overlay (Bottom View)**


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## 8 Bill of Materials

Table 2 lists the TPS92512EVM-001 components list according to the schematic shown in Figure 1.

**Table 2. Bill of Materials**

| REFERENCE DESIGNATOR | QTY | VALUE | DESCRIPTION | SIZE | PART NUMBER | MFR |
|---|---|---|---|---|---|---|
| C1 | 1 | 0.1 µF | CAP, CERM, 0.1 µF, 25 V, ±10%, X5R | 0603 | 885012206071 | Wurth |
| C2, C4, C9 | 3 | 4.7 µF | CAP, CERM, 4.7 µF, 100 V, ± 10%, X7S | 1210 | C3225X7S2A475K200AB | TDK |
| C3, C6 | 2 | 0.01 µF | CAP, CERM, 0.01 µF, 100 V, ±10%, X7R | 0603 | 06031C103KAT2A | AVX |
| C5 | 1 | 4.7 µF | CAP, CERM, 4.7 µF, 25 V, ± 10%, X7R | 1206 | 885012208068 | Wurth |
| C7 | 1 | 0.1 µF | CAP, CERM, 0.1 µF, 50 V, ± 10%, X7R | 0603 | 885012206095 | Wurth |
| C8 | 1 | 470 pF | CAP, CERM, 470 pF, 50 V, ±10%, X7R | 0603 | 885012206081 | Wurth |
| D1 | 1 | 800 mV at 500 mA | DIODE SCHOTTKY 80 V 0.5 A | SOD-123 | MBR0580-TP | Micro Commercial Co |
| D2 | 1 | 850 mV at 2 A | DIODE SCHOTTKY 80 V 2 A | DO-214AC, SMA | CDBA280-G | Comchip Technology |
| L1 | 1 | 33 µH | Inductor, Shielded Drum Core, Ferrite, 33 µH | 1246 | 744771133 | Wurth |
| J1, J2 | 2 | | Connector, rising clamp, 2 pins, 5mm pitch | | 691123710002 | Wurth |
| R1, R4 | 1 | 1 kΩ | RES, 1 kΩ, 1%, 0.1W | 0603 | CRCW06031K00FKEA | Vishay-Dale |
| R2 | 1 | 10 MΩ | RES, 10 MΩ, 1%, 0.1 W | 0603 | CRCW060310M0FKEA | Vishay-Dale |
| R3 | 1 | 174 kΩ | RES, 174 kΩ, 1%, 0.1 W | 0603 | CRCW0603174KFKEA | Vishay-Dale |
| R5 | 1 | 191 kΩ | RES, 191 kΩ, 1%, 0.1 W | 0603 | CRCW0603191KFKEA | Vishay-Dale |
| R6 | 1 | 4.02 kΩ | RES, 4.02 kΩ, 1%, 0.1W | 0603 | CRCW06034K02FKEA | Vishay-Dale |
| R7 | 1 | 20.5 kΩ | RES, 20.5 kΩ, 1%, 0.1 W | 0603 | CRCW060320K5FKEA | Vishay-Dale |
| R8 | 1 | 0.2 | RES, 0.2, 1%, 1 W | 2010 | CSRN2010FKR200 | Stackpole Electronics Inc |
| U1 | 1 | | TPS92512 2.5A Buck Current Regulator for High-Brightness LEDs with Integrated Analog Current Adjust | DGQ0010D | TPS92512HV | Texas Instruments |


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# Revision History

| Changes from Original (February 2015) to A Revision | Page |
|---|---|
| • Changed the PART NUMBER and MFR of C1, C5, C7, C8, and L1 in Table 2 | 9 |
| • Added J1, J2 to Table 2 | 9 |

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.


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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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