

AN-1407 LM3502/03 Evaluation Board

National Semiconductor
Application Note 1407
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General Description

The LM3502/03 evaluation board is a working demonstration of a step up DC-DC converter. The LM3502/03 is a white LED driver for lighting applications. The LM3502/03 contains two LED strings designed for dual displays with independence EN pins. The LM3502 LED current can be adjusted with PWM signal while the LM3503 LED current can be adjusted with a DC voltage or RC filtered PWM (pulse-width-modulated) signal at the Cntrl pin. The LM3502/03 can drive up to 10 white LEDs. Both devices feature internal over voltage protection (OVP) and under voltage protection (UVP). For evaluation purpose, the evaluation board is assembled in micro SMD package for 25V version (LM3503ITL) and 44V version (LM3502ITL). The LM3502/03

are also available in 16-LLP package (see ordering information). For further information on boost converter topology, device electrical characteristics, and component selection, please refer to the LM3502 and LM3503 datasheets.

Operating Conditions

- V_{IN} range: $2.5V \leq V_{IN} \leq 5.5V$
- OVP options: 16V, 25V, 35V & 44V (see ordering information)
- 10 Bump MicroSMD or 16 Pin LLP package
- Ambient temperature (T_A) range: $-30C$ to $+85C$
- Junction temperature (T_J) range: $-30C$ to $+125C$

Typical Application

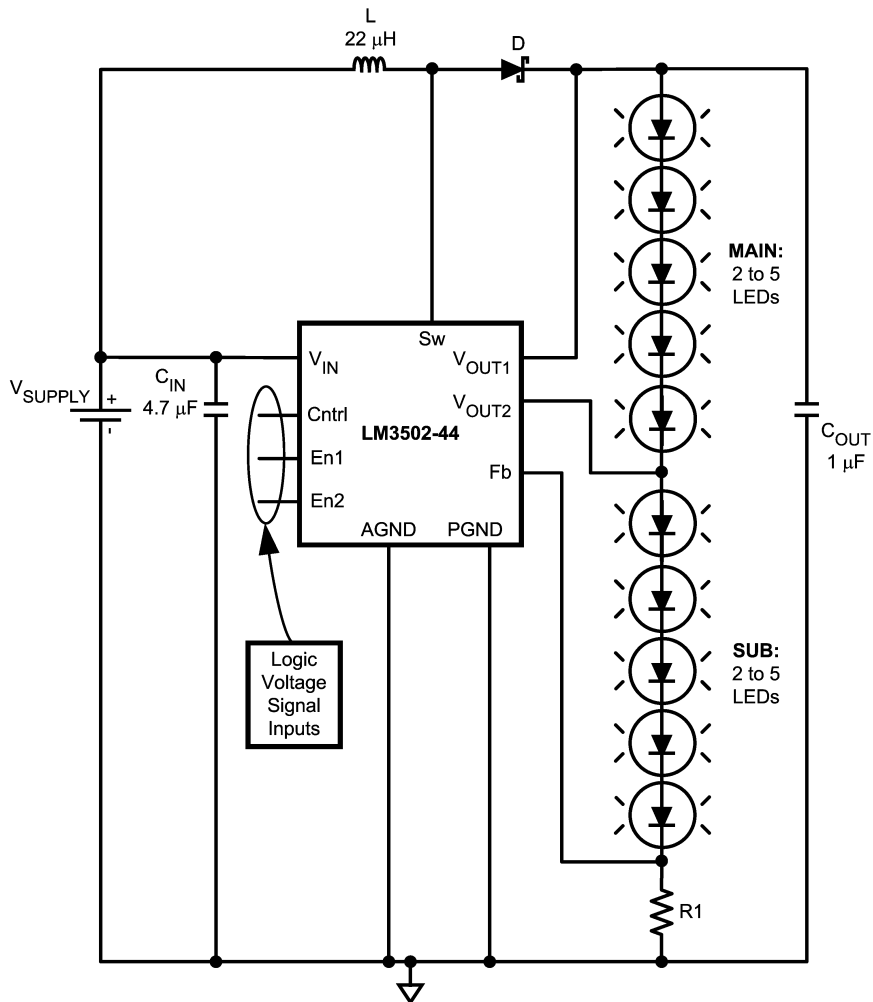


FIGURE 1. Typical Application Circuit LM3502

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Typical Application (Continued)

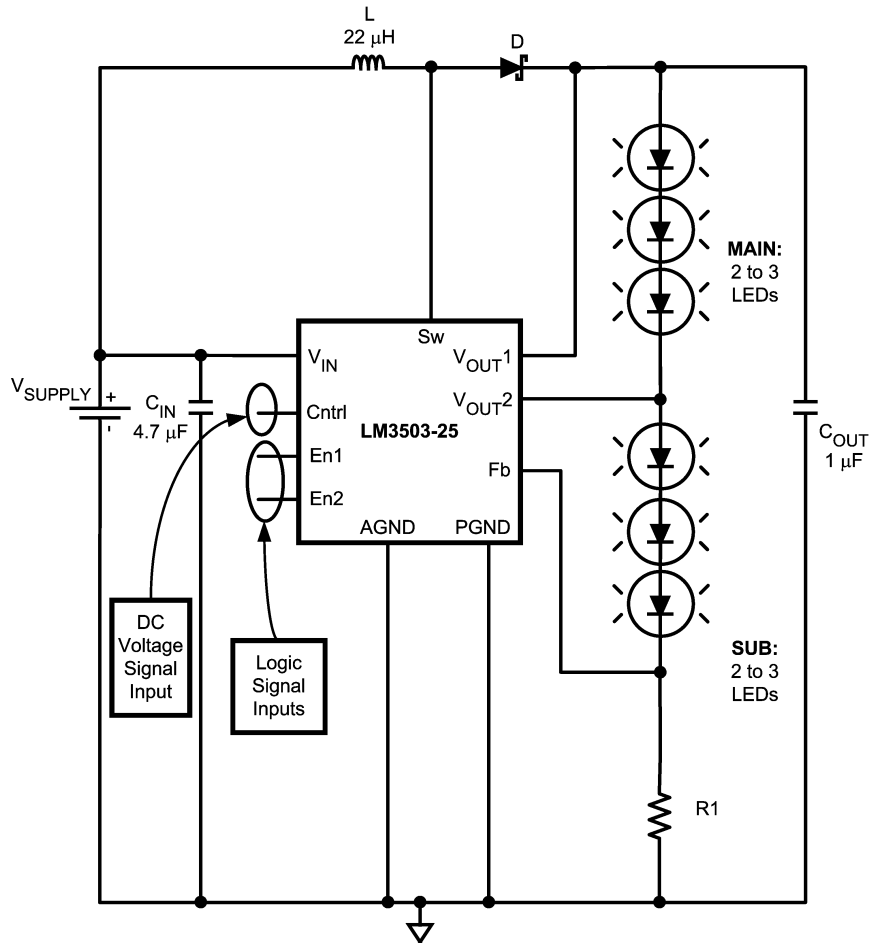


FIGURE 2. Typical Application Circuit for LM3503

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PWM Dimming

If PWM dimming is desired to control the brightness of the LED string, care must be taken to balance the tradeoffs between audible noise and brightness control. For best PWM duty cycle vs current linearity, the recommended PWM frequency should be between 200Hz to 500Hz for the LM3502.

Similarly if PWM dimming is desired to control the brightness, a RC filter is necessary at the control pin for the LM3503(see Figure 3). To select the PWM frequency, use equations below.

$$F_{\text{PWM}} > 10 * F_{\text{RC}}$$

$$F_{\text{RC}} = \frac{1}{2 * \pi * R * C}$$

F_{PWM} : PWM Singal Frequency

F_{RC} : RC Filter Bandwidth Cutoff Frequency

R: Chosen Filter Resistor

C: Chosen Filter Capacitor

PWM Dimming (Continued)

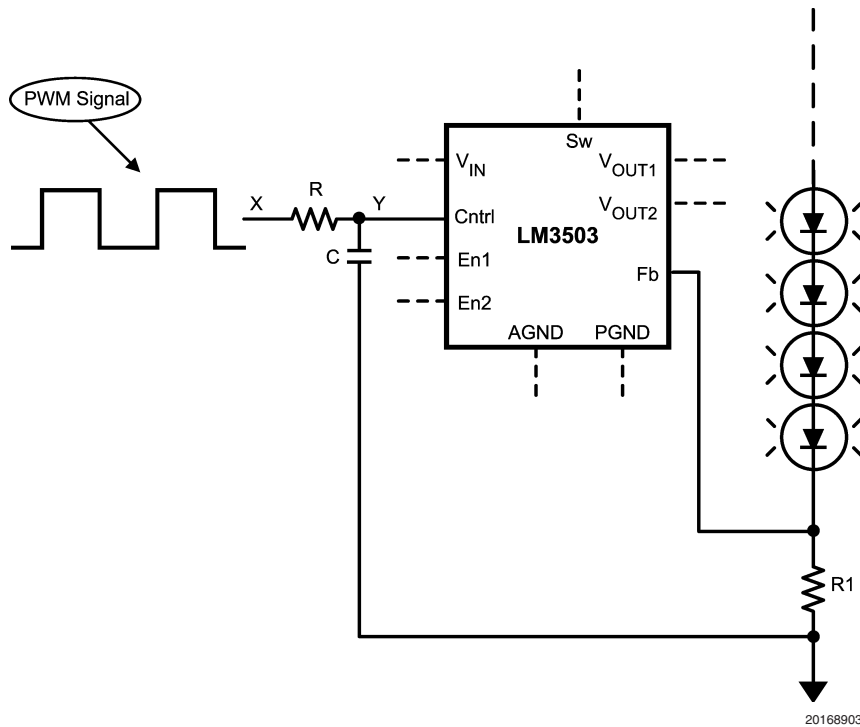


FIGURE 3. Typical Circuit for PWM Dimming (LM3503)

LED Current Setting

LED current is set using the following equation for LM3502/LM3503:

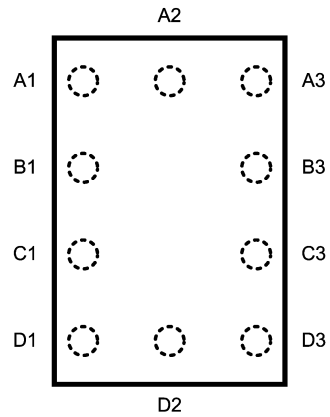
$$I_{LED} = \frac{V_{Fb}}{R1}$$

If analog control is used for brightness control in the LM3503, the relationship between V_{FB} and V_{CNTRL} can be determined by using the following equation:

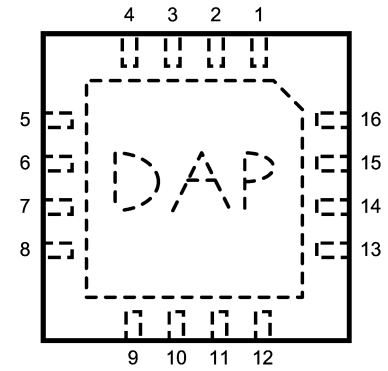
$$V_{FB} = (0.156) * (V_{Cntrl})$$

For LM3502, the typical V_{FB} is 0.25V to solve for I_{LED} , or by rearranging I_{LED} equation to solve for R_1 .

Connection Diagram and Package Mark Information



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FIGURE 4. 10 bump MicroSMD Package



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FIGURE 5. 16-Thin Leadless Leadframe Package (SQA16A)

Samples Ordering Information

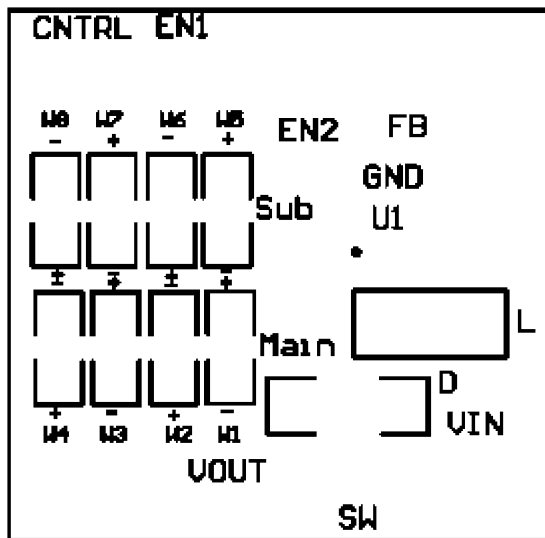
| Voltage Option (V) | Order Number LM3502 | Package Marking | Order Number LM3503 | Package Marking | Supplied As |
|--------------------|---------------------|-----------------|---------------------|-----------------|----------------|
| 16 | LM3502ITL-16 | SANB | LM3503ITL-16 | SBHB | 250 units T&R |
| 16 | LM3502ITLX-16 | SANB | LM3503ITLX-16 | SBHB | 3000 units T&R |
| 16 | LM3502SQ-16 | L00048B | LM3503SQ-16 | L00045B | 1000 units T&R |
| 16 | LM3502SQX-16 | L00048B | LM3503SQX-16 | L00045B | 4500 units T&R |
| 25 | LM3502ITL-25 | SAPB | LM3503ITL-25 | SBJB | 250 units T&R |
| 25 | LM3502ITLX-25 | SAPB | LM3503ITLX-25 | SBJB | 3000 units T&R |
| 25 | LM3502SQ-25 | L00049B | LM3503SQ-25 | L00046B | 1000 units T&R |
| 25 | LM3502SQX-25 | L00049B | LM3503SQX-25 | L00046B | 4500 units T&R |
| 35 | LM3502ITL-35 | SARB | LM3503ITL-35 | SBKB | 250 units T&R |
| 35 | LM3502ITLX-35 | SARB | LM3503ITLX-35 | SBKB | 3000 units T&R |
| 35 | LM3502SQ-35 | L00044B | LM3503SQ-35 | L00047B | 1000 units T&R |
| 35 | LM3502SQX-35 | L00044B | LM3503SQX-35 | L00047B | 4500 units T&R |
| 44 | LM3502ITL-44 | SDLB | LM3503ITL-44 | SDNB | 250 units T&R |
| 44 | LM3502ITLX-44 | SDLB | LM3503ITLX-44 | SDNB | 3000 units T&R |
| 44 | LM3502SQ-44 | L00050B | LM3503SQ-44 | L00053B | 1000 units T&R |
| 44 | LM3502SQX-44 | L00050B | LM3503SQX-44 | L00053B | 4500 units T&R |

Pin Descriptions

| Bump # | LLP Pin # | Name | Description |
|--------|-----------|------------|--|
| A1 | 9 | Cntrl | LED Current Control Connection |
| B1 | 7 | Fb | Feedback Voltage Connection ($0.2V < V_{CNTRL} < 3.5V$) |
| C1 | 6 | V_{OUT2} | Drain Connections of the NMOS and PMOS Field Transistor (FET) Switches. Connect 100nF at V_{OUT2} node if V_{OUT2} is not used |
| D1 | 4 | V_{OUT1} | Over-Voltage Protection (OVP) and source connection of the PMOS FET switch |
| D2 | 2 & 3 | SW | Drain Connection of Power NMOS Switch |
| D3 | 15 & 16 | Pgnd | Power Ground Connection |
| C3 | 14 | Agnd | Analog Ground Connection |
| B3 | 13 | V_{IN} | Input Voltage Connection |
| A3 | 12 | En1 | NMOS FET Switch Control Connection |
| A2 | 10 | En2 | PMOS FET Switch Control Connection |
| | 1 | NC | No connect |
| | 5 | NC | No connect |
| | 8 | NC | No connect |
| | 11 | NC | No connect |
| | DAP | DAP | Die Attache Pad (DAP), to be soldered to the printed circuit board's ground plane for enhanced thermal dissipation |

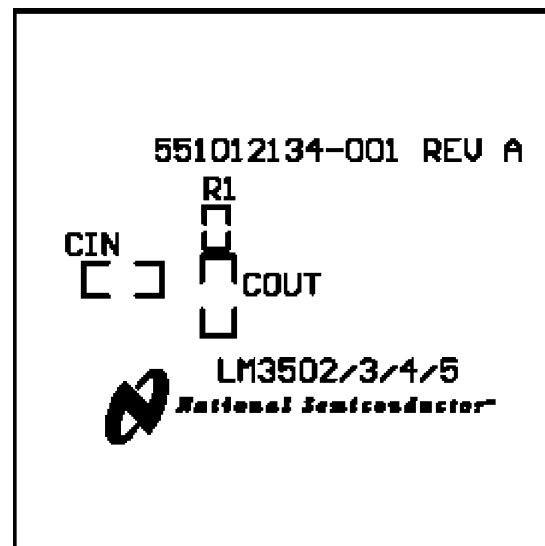
Printed Circuit Board (PCB) Layout

Top Silk Screen



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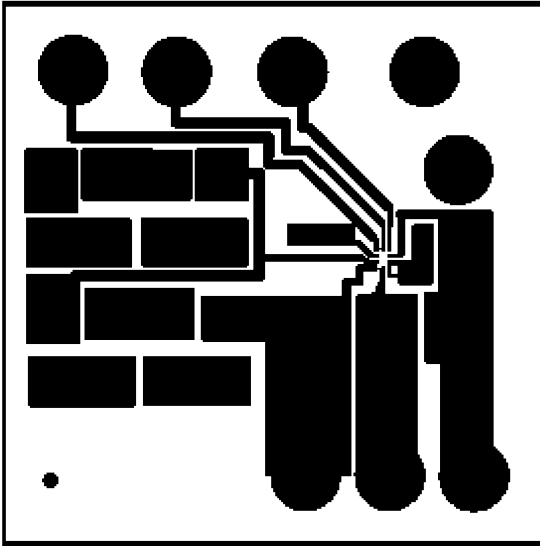
Bottom Silk Screen



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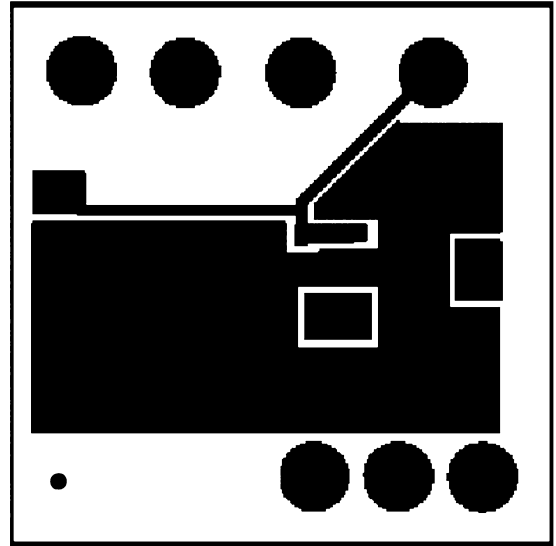
Printed Circuit Board (PCB) Layout (Continued)

Top Traces



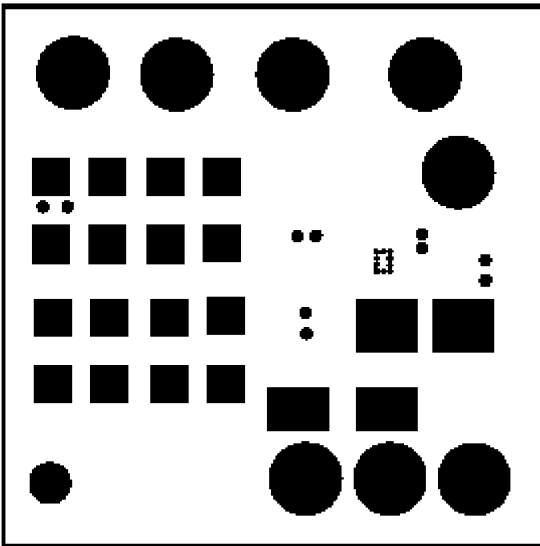
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Bottom Traces



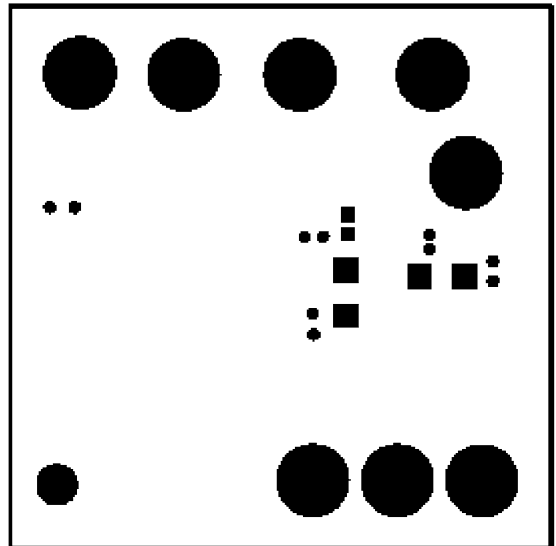
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Top Pads



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Bottom Pads



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Printed Circuit Board (PCB) Layout (Continued)**Bill of Materials for LM3502ITL & LM3503ITL**

| Device | Description | Manufacture # |
|---|-----------------------------------|------------------------|
| LM3502ITL-44 | 44V version (Drive up to 10 LEDs) | National Semiconductor |
| LM3503ITL-25 | 25V Version (Drive up to 6 LEDs) | National Semiconductor |
| C _{IN} | 4.7μF, 16V (3216X7R1C475K) | TDK |
| C _{OUT} | 1μF, 50V (3216X7R1H105K) | TDK |
| R1 | CRCW060328R0F (28 ohms) | Vishay |
| DIODE | SS16 | Vishay |
| WHITE LED | LTW67C | Osram |
| INDUCTOR | DO1608C-223C (22μH) | Coilcraft |
| Test pins: VOUT, SW, VIN, FB, CNTRL, EN1, EN2 & GND | Turret 0.09 inches | |

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