The LT®3760 is an 8-channel LED driver with a step-up DC/DC controller capable of driving up to 45V of LEDs. Each channel contains an accurate current sink with ±2% current matching. Channels follow a master programmable current to allow between 20mA to 100mA of LED current per string. Channels can be paralleled for higher LED current. Output voltage adapts to variations in LED V₉ for optimum efficiency and open LED faults do not affect the operation of connected LED strings.

The LT3760 allows a PWM dimming range up to 3000:1 and an analog dimming range up to 25:1. Operating frequency can be programmed from 100kHz up to 1MHz using a single resistor or synchronized to an external clock.

Additional features include: programmable maximum VOUT for open LED protection, a fault flag for open LED, programmable LED current derating vs temperature, micropower shutdown and internal soft-start. The LT3760 is available in a thermally enhanced 28-pin TSSOP package.

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**ABSOLUTE MAXIMUM RATINGS**

(Notes 1)

V\text{OUT}, \text{LED1-8} .............................................................. 60V  
V\text{IN}, \text{SHDN/UVLO, FAULT} ........................................... 40V  
\text{INTV}_{\text{CC}} ................................................................. +13V  
\text{INTV}_{\text{CC}} \text{ above } V\text{IN} ....................................... +0.3V  
P\text{WM, CTRL, SYNC} ....................................................... 6V  
V\text{C} ................................................................. 3V  
V_{\text{REF}}, R\text{T}, I_{\text{SET}}, T_{\text{SET}}, O\text{VP}_{\text{SET}} ........... 2V  
\text{SENSE} ................................................................. 0.4V  

Operating Junction Temperature Range  
(Notes 2,3) .......................................................... \(-40°C \) to 125°C  
Storage Temperature Range .......................... \(-65°C \) to 150°C  
Lead Temperature (Soldering, 10 sec) ................. 300°C  

**ORDER INFORMATION**

<table>
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<tr>
<th>LEAD FREE FINISH</th>
<th>TAPE AND REEL</th>
<th>PART MARKING*</th>
<th>PACKAGE DESCRIPTION</th>
<th>TEMPERATURE RANGE</th>
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<tbody>
<tr>
<td>LT3760EFE#PBF</td>
<td>LT3760EFE#TRPBF</td>
<td>LT3760FE</td>
<td>28-Lead Plastic TSSOP</td>
<td>(-40°C ) to 125°C</td>
</tr>
<tr>
<td>LT3760IFE#PBF</td>
<td>LT3760IFE#TRPBF</td>
<td>LT3760FE</td>
<td>28-Lead Plastic TSSOP</td>
<td>(-40°C ) to 125°C</td>
</tr>
</tbody>
</table>

Consult LTC Marketing for parts specified with wider operating temperature ranges.  *The temperature grade is identified by a label on the shipping container.  Consult LTC Marketing for information on non-standard lead based finish parts.

For more information on lead free part marking, go to: [http://www.linear.com/leadfree/](http://www.linear.com/leadfree/)
For more information on tape and reel specifications, go to: [http://www.linear.com/tapeandreel/](http://www.linear.com/tapeandreel/)
## Electrical Characteristics

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$, $V_{IN} = V_{OUT} = 6\text{V}$, $R_{SET} = 14.7\text{k}$ unless otherwise noted.

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<thead>
<tr>
<th>PARAMETER</th>
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<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
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<tbody>
<tr>
<td><strong>INPUT BIAS, REFERENCE</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Operational $V_{IN}$ (To Allow GATE Switching)</td>
<td>$V_C = 1.5\text{V}$</td>
<td>●</td>
<td>4.2</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{IN} = INTV_{CC}$ (Shorted)</td>
<td>●</td>
<td>5.5</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>Operative $V_{IN}$</td>
<td>$V_{IN} = INTV_{CC}$ (Shorted)</td>
<td></td>
<td>4.5</td>
<td>13</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{IN} = INTV_{CC}$</td>
<td></td>
<td>6</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{IN}$ Quiescent Current</td>
<td>CTRL = 0.1V, PWM = 0V</td>
<td></td>
<td>4.2</td>
<td>5.7</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>CTRL = 0.1V, PWM = 1.5V, (Not Switching)</td>
<td></td>
<td>9.5</td>
<td>12</td>
<td>mA</td>
</tr>
<tr>
<td>$V_{IN}$ Shutdown Current ($V_{IN} = INTV_{CC}$) (Not Shorted)</td>
<td>$SHDN/UVLO = 0V$, $V_{IN} = 6\text{V}$</td>
<td></td>
<td>0.1</td>
<td>2</td>
<td>µA</td>
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<tr>
<td></td>
<td>$SHDN/UVLO = 0V$, $V_{IN} = 40\text{V}$</td>
<td></td>
<td>10</td>
<td>20</td>
<td>µA</td>
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<tr>
<td>$V_{IN}$ Shutdown Current ($V_{IN} = INTV_{CC}$) (Not Shorted)</td>
<td>$SHDN/UVLO = 0V$, $V_{IN} = INTV_{CC} = 4.5\text{V}$</td>
<td></td>
<td>10</td>
<td>20</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td>$SHDN/UVLO = 0V$, $V_{IN} = INTV_{CC} = 13\text{V}$</td>
<td></td>
<td>20</td>
<td>40</td>
<td>µA</td>
</tr>
<tr>
<td>$SHDN/UVLO$ Threshold (Micropower) (Falling) ($V_{SD}$)</td>
<td>$I_{VIN} &lt; 20\mu\text{A}$</td>
<td>●</td>
<td>0.3</td>
<td>0.7</td>
<td>V</td>
</tr>
<tr>
<td>$SHDN/UVLO$ Threshold (UVLO) (Falling) (Stop Switching) ($V_{UV}$)</td>
<td></td>
<td>●</td>
<td>1.414</td>
<td>1.476</td>
<td>1.538</td>
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<tr>
<td>$SHDN/UVLO$ Pin Current</td>
<td>$SHDN/UVLO = V_{UV} - 50\text{mV}$</td>
<td>●</td>
<td>1.6</td>
<td>2.4</td>
<td>3.2</td>
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<tr>
<td></td>
<td>$SHDN/UVLO = V_{UV} + 50\text{mV}$</td>
<td></td>
<td>0</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$V_{REF}$ Voltage</td>
<td>$I_{VREF} = 0\mu\text{A}$</td>
<td>●</td>
<td>1.450</td>
<td>1.485</td>
<td>1.524</td>
</tr>
<tr>
<td>$V_{REF}$ Line Regulation</td>
<td>$I_{VREF} = 0\mu\text{A}$, $6\text{V} &lt; V_{IN} &lt; 40\text{V}$</td>
<td></td>
<td>0.01</td>
<td>0.05</td>
<td>%/V</td>
</tr>
<tr>
<td>$V_{REF}$ Load Regulation</td>
<td>$0 &lt; I_{VREF} &lt; 150\mu\text{A}$ (Max)</td>
<td></td>
<td>2</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td><strong>Oscillator</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency: $f_{OSC}$ (100kHz)</td>
<td>$RT = 523k$</td>
<td>●</td>
<td>92</td>
<td>101</td>
<td>112</td>
</tr>
<tr>
<td>Frequency: $f_{OSC}$ (1MHz)</td>
<td>$RT = 39.2k$</td>
<td>●</td>
<td>0.90</td>
<td>1</td>
<td>1.10</td>
</tr>
<tr>
<td>$f_{OSC}$ (1MHz) Line Regulation</td>
<td>$RT = 39.2k$, $6\text{V} &lt; V_{IN} &lt; 40\text{V}$</td>
<td></td>
<td>0.1</td>
<td>0.2</td>
<td>%/V</td>
</tr>
<tr>
<td>$RT$ Pin Voltage</td>
<td>$RT = 39.2k$</td>
<td></td>
<td>1.6</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Minimum Off-Time</td>
<td>(Note 5)</td>
<td></td>
<td>170</td>
<td>250</td>
<td>nS</td>
</tr>
<tr>
<td>Minimum On-Time</td>
<td>(Note 5)</td>
<td></td>
<td>190</td>
<td>250</td>
<td>nS</td>
</tr>
<tr>
<td>SYNC Input High Threshold</td>
<td></td>
<td></td>
<td>2.2</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>SYNC Input Low Threshold</td>
<td></td>
<td></td>
<td>0.6</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>SYNC Input Current</td>
<td>SYNC = 0V</td>
<td></td>
<td>0</td>
<td></td>
<td>µA</td>
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<td></td>
<td>SYNC = 5V</td>
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<td>25</td>
<td></td>
<td>µA</td>
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<tr>
<td>SYNC Frequency Range</td>
<td>$RT = 523k$</td>
<td></td>
<td>0.12</td>
<td>1.5</td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td>$RT = 39.2k$</td>
<td></td>
<td>1.2</td>
<td>1.5</td>
<td>MHz</td>
</tr>
<tr>
<td><strong>Linear Regulator (INTV_{CC})</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>INTV_{CC} Regulation Voltage</td>
<td>$V_{IN} = 12\text{V}$</td>
<td></td>
<td>6.65</td>
<td>7</td>
<td>7.35</td>
</tr>
<tr>
<td>Dropout ($V_{IN} - INTV_{CC}$)</td>
<td>$I_{INTV_{CC}} = 10\text{mA}$</td>
<td></td>
<td>250</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>INTV_{CC} UVLO (+)</td>
<td>(Start Switching)</td>
<td></td>
<td>3.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>INTV_{CC} UVLO (−)</td>
<td>(Stop Switching)</td>
<td></td>
<td>3.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>INTV_{CC} Current Limit</td>
<td></td>
<td>●</td>
<td>40</td>
<td>57</td>
<td>mA</td>
</tr>
<tr>
<td><strong>OVP/LED Error Amplifiers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transconductance (OVP)</td>
<td>$\Delta I_{VC} = \pm 2.5\mu\text{A}$</td>
<td></td>
<td>4</td>
<td></td>
<td>µmhos</td>
</tr>
<tr>
<td>Voltage Gain (OVP)</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td>V/V</td>
</tr>
<tr>
<td>Transconductance (LED)</td>
<td>$\Delta I_{VC} = \pm 2.5\mu\text{A}$</td>
<td></td>
<td>33</td>
<td></td>
<td>µmhos</td>
</tr>
</tbody>
</table>
## ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25°C$, $V_{IN} = V_{OUT} = 6V$, $R_{SET} = 14.7k$ unless otherwise noted.

<table>
<thead>
<tr>
<th>PARAMETER</th>
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<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
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<tbody>
<tr>
<td>Voltage Gain (LED)</td>
<td></td>
<td>45</td>
<td></td>
<td></td>
<td>V/V</td>
</tr>
<tr>
<td>$V_C$ Source Current (Out of Pin)</td>
<td>$V_C = 1.5V, V_{LEDx} = 0.8V, OVPSET = 1.5V$</td>
<td>10</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$V_C$ Sink Current (OVP)</td>
<td>$V_C = 1.5V, V_{LEDx} = 0.8V, OVPSET = 0V$</td>
<td>15</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$V_C$ Sink Current (LED)</td>
<td>$V_C = 1.5V, V_{LEDx} = 1.2V, OVPSET = 1.5V$</td>
<td>9</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$V_C$ Output High (clamp) ($V_{CDH}$)</td>
<td></td>
<td>2.3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_C$ Output Low (clamp) ($V_{CDL}$)</td>
<td></td>
<td>0.8</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_C$ Switching Threshold ($V_{CSW}$)</td>
<td></td>
<td>1.1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

### SENSE AMP

<table>
<thead>
<tr>
<th>PARAMETER</th>
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<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENSE Input Current (Out of Pin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>SENSE Current Limit Threshold</td>
<td>●</td>
<td>44</td>
<td>52</td>
<td>60</td>
<td>mV</td>
</tr>
<tr>
<td>Current Mode Gain</td>
<td>$\Delta V(V_C)/\Delta V(\text{SENSE})$</td>
<td>6</td>
<td></td>
<td></td>
<td>V/V</td>
</tr>
<tr>
<td>SENSE Over Current Limit Threshold</td>
<td>●</td>
<td>90</td>
<td>100</td>
<td>110</td>
<td>mV</td>
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### LED CURRENT / CONTROL

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<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{SET}$ Pin Voltage</td>
<td>$\text{CTRL} = 1.5V$</td>
<td>1.00</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>LEDx Current (40mA) ($R_{SET} = 14.7k$)</td>
<td>$V_{LEDx} = 1V, \text{CTRL} = 1.5V$</td>
<td>38.3</td>
<td>40.1</td>
<td>41.9</td>
<td>mA</td>
</tr>
<tr>
<td>LEDx Current Matching (40mA) ($R_{SET} = 14.7k$)</td>
<td>$V_{LEDx} = 1V, \text{CTRL} = 1.5V$</td>
<td></td>
<td>±0.7</td>
<td>±2</td>
<td>%</td>
</tr>
<tr>
<td>LEDx Current (100mA) ($R_{SET} = 5.76k$)</td>
<td>$V_{LEDx} = 1V, \text{CTRL} = 1.5V$</td>
<td>95.5</td>
<td>100.7</td>
<td>105.9</td>
<td>mA</td>
</tr>
<tr>
<td>LED Pin Regulation Voltage</td>
<td></td>
<td>1.1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$T_{SET}$ Threshold</td>
<td></td>
<td>630</td>
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<td></td>
<td>mV</td>
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### ANALOG DIMMING

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<tr>
<td>CTRL Input Current (Out of Pin)</td>
<td>$\text{CTRL} = 1V$</td>
<td>40</td>
<td>200</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$\text{CTRL} = 0.04V$</td>
<td></td>
<td>50</td>
<td>200</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>LEDx Current (Dimming 25:1)</td>
<td>$V_{LEDx} = 1V, \text{CTRL} = 0.04V$</td>
<td>1.6</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>

### PWM DIMMING

<table>
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<tr>
<td>PWM Input Low Threshold</td>
<td></td>
<td>0.7</td>
<td>1</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>PWM Input High Threshold</td>
<td></td>
<td>1.1</td>
<td>1.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>PWM Input Current</td>
<td>$\text{PWM} = 1.5V$</td>
<td>6</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$\text{PWM} = 6V$</td>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$V_{OUT}$ Pin Current in PWM Mode $V(V_{OUT}) = 60V$</td>
<td>$\text{PWM} = 1.5V, V_{LEDx} = 1V$</td>
<td>370</td>
<td></td>
<td></td>
<td>µA</td>
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<tr>
<td>$\text{PWM} = 0V, V_{LEDx} = 1V$</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>LEDx Leakage Current (PWM = 0V)</td>
<td>$V_{LEDx} = 1V, V_{OUT} = 12V$</td>
<td>0.1</td>
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<td></td>
<td>µA</td>
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<tr>
<td>$V_{LEDx} = 50V, V_{OUT} = 60V$</td>
<td></td>
<td>0.1</td>
<td></td>
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<td>µA</td>
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</tbody>
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### FAULT DIAGNOSTICS

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</thead>
<tbody>
<tr>
<td>FAULT Output Sink Current</td>
<td>LED1 = Open, $V_{FAULT} = 0.3V$</td>
<td>0.3</td>
<td>0.6</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>LEDx Short Threshold ($V_{SH}$) ($V_{OUT} - V_{LEDx}$)</td>
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<td>6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>LED Open Detection Threshold</td>
<td>$V_{OUT} = 12V$</td>
<td>6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

3760c

LT3760
ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at TA = 25°C. VIN = VOUT = 6V, RSET = 14.7kΩ unless otherwise noted.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GATE DRIVER</td>
<td>GATE Driver Output Rise Time</td>
<td>VIN = 12V, CL = 3300pF (Note 4)</td>
<td>30</td>
<td>nS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GATE Driver Output Fall Time</td>
<td>VIN = 12V, CL = 3300pF (Note 4)</td>
<td>30</td>
<td>nS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GATE Output Low</td>
<td>IGATE = 0µA</td>
<td>0.1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GATE Output High</td>
<td>INTVCC = VIN = 7V, IGATE = 0µA</td>
<td>6.95</td>
<td>V</td>
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</table>

<table>
<thead>
<tr>
<th>OUTPUT VOLTAGE</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOUT Over Voltage Protection (OVP) Regulation Voltage</td>
<td>OVPSET = 0.22V</td>
<td>12.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OVPSET = 1V</td>
<td>57</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OVPSET Input Current (Out of Pin)</td>
<td>OVPSET = 0.22V, VOUT = 12V</td>
<td>40</td>
<td>200</td>
<td>nA</td>
</tr>
</tbody>
</table>

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The LT3760E is guaranteed to meet performance specifications from 0°C to 125°C junction temperature. Specifications over the –40°C to 125°C operating junction temperature range are assured by design, characterization and correlation with statistical process controls. The LT3760I is guaranteed to meet performance specifications from –40°C to 125°C junction temperature.

Note 3: For Maximum Operating Ambient Temperature, see Thermal Calculations in the Applications Information section.

Note 4: GATE rise and fall times are measured between 10% and 90% of INTVCC voltage.

Note 5: See Duty Cycle Considerations in the Applications Information.

TYPICAL PERFORMANCE CHARACTERISTICS

TA = 25°C, unless otherwise noted.
TYPICAL PERFORMANCE CHARACTERISTICS  \( T_A = 25^\circ C \), unless otherwise noted.

**LED Current Waveforms**  
3000:1 PWM Dimming (100Hz)

**SHDN/UVLO Pin (Hysteresis)**  
Current vs Junction Temperature

**VIN Shutdown Current**  
vs Junction Temperature

**VIN Quiescent Current**  
vs Junction Temperature

**VIN** Quiescent Current vs Junction Temperature

**Switching Frequency**  
vs Junction Temperature

**VC High Clamp, Active and Low Clamp Levels**  
vs Junction Temperature

---

**VREF vs Junction Temperature**

**SHDN/UVLO Threshold vs Junction Temperature**

---

**VIN** = 6V, SHDN/UVLO = 0V

PWM = 1.5V, NO SWITCHING, 
V(LED1-8) = 1.2V, CTRL = 0.1V

PWM = 0V, CTRL = 0.1V

---

**RSET = 14.7k**

---

**WAVEFORMS**

---

**PWM = 0V, CTRL = 0.1V**

---

**RT = 39.2k**

---

**VC HIGH CLAMP**

**VC ACTIVE (SWITCHING)**

**VC LOW CLAMP**
TYPICAL PERFORMANCE CHARACTERISTICS  \( T_A = 25^\circ C , \) unless otherwise noted.

- **INTVCC vs Current, Junction Temperature**
- **INTVCC Current Limit vs Junction Temperature**
- **SENSE Threshold vs Junction Temperature**
- **Overvoltage Protection (OVP) Level vs Junction Temperature**
- **VOUT – V(LEDx) Short Threshold vs Junction Temperature**
- **Minimum ON and OFF Times vs Junction Temperature**
- **GATE Rise/Fall Times vs GATE Capacitance**
**PIN FUNCTIONS**

**CTRL (Pin 1):** CTRL pin voltage below 1V controls LED current. CTRL voltage can be set by a resistor divider from V_IN, V_REF or an external voltage source. LED current derating versus temperature is achievable if the voltage programmed at the CTRL pin has a negative temperature coefficient using an external resistor divider from V_REF pin to GND with temperature dependent resistance.

**T_SET (Pin 2):** Programs LT3760 junction temperature breakpoint past which LED current will begin to derate. Program using a resistor divider from V_REF to GND.

**V_REF (Pin 3):** 1.485V Reference Output Pin. This pin can supply up to 150µA. Can be used to program CTRL, T_SET and OVP_SET pin voltages using resistor dividers to GND.

**I_SET (Pin 4):** Resistor to GND Programs LED pin current. See Table 6 in the Applications Information Section.

**NC (Pin 5):** No Connect. Okay to leave open or to connect to GND.

**LEDx (Pins 6 to 9, 20 to 23):** 8 LED Driver Outputs. Each output contains an open collector constant current sink. LED currents are programmable from 20mA to 100mA using a single resistor at the I_SET pin. Connect the cathode of each LED string to an LED pin. Connect the anode of each LED string to V_OUT. Channels can be paralleled for greater LED current or individually disabled (connect LED to V_OUT).

**PGND (Pins 10, 19, Exposed Pad Pin 29):** Power grounds for the IC and the converter. The package has an exposed pad (Pin 29) underneath the IC which is the best path for heat out of the package. Pin 29 should be soldered to a continuous copper ground plane under the device to reduce die temperature and increase the power capability of the LT3760.

**SENSE (Pin 11):** The Current Sense Input for the Control Loop. Connect this pin to the sense resistor in the source of the external power MOSFET.

**GATE (Pin 12):** Drives the gate of an N-channel MOSFET from 0V to INTV_CC.

**INTV_CC (Pin 13):** A 7V LDO supply generated from V_IN and used to power the GATE driver and some control circuitry. Must be bypassed with a 4.7µF capacitor to PGND.

**VIN (Pin 14):** Input Supply Pin. Must be locally bypassed with a 1µF capacitor to PGND.

**SHDN/UVLO (Pin 15):** The SHDN/UVLO pin has an accurate 1.476V threshold and can be used to program an under voltage lockout (UVLO) threshold for system input supply using a resistor divider from supply to GND. A 2.4µA pin current hysteresis allows programming of UVLO hysteresis. SHDN/UVLO above 1.476V turns the part on and removes a 2.4µA sink current from the pin. SHDN/UVLO < 0.7V reduces VIN current < 20µA. If the shutdown function is not required, it should be forced above 1.476V or connected directly to V_IN.

**FAULT (Pin 16):** Active low if any or all LED strings have an open fault. If fault(s) removed, FAULT flag returns high. Fault status is only updated during PWM high state and latched during PWM low.

**SYNC (Pin 17):** Allows synchronization of boost converter switching frequency to an external clock. RT resistor should be programmed for fOSC 20% below SYNC frequency. If unused, connect to GND.

**V_OUT (Pin 18):** Boosted Output Voltage of the Converter. Connect a capacitor from this pin to PGND. Connect the anode of each LED (string) to V_OUT.

**GND (Pin 24):** Signal Ground.

**RT (Pin 25):** A resistor to GND programs switching frequency fOSC between 0.1MHz and 1MHz.

**V_C (Pin 26):** Output of Both Transconductance Error Amplifiers for the Converter Regulation Loop. The most commonly used gm error amplifier (LED) regulates VOUT to ensure no LED pin falls below 1V. The other gm error amplifier (OVP) is activated if all LEDs fail open and a regulated maximum VOUT is required. Connect a resistor and capacitor in series from the V_C pin to GND.

**PWM (Pin 27):** Input Pin for PWM Dimming Control. Above 1.4V allows converter switching and below 0.7V disables switching. The PWM signal can be driven from 0V to 6V. If unused, connect to V_REF.

**OVP_SET (Pin 28):** Programs maximum allowed VOUT regulation level if all LEDs are open circuit. Program using a resistor divider from V_REF to GND.
The operation of the LT3760 is best understood by referring to the typical application circuit on the front page and the Block Diagram in Figure 1. The LT3760 drives 8 strings of LEDs by using a constant switching frequency, current mode boost controller to generate a single output voltage $V_{OUT}$ for the top (anode) of all LED strings. LED string current is generated and controlled by connection of the bottom LED in each string (cathode) to a current source contained in each corresponding LED pin. Each LED pin contains an accurate current sink to ground, programmable between 20mA to 100mA using a single resistor at the $I_{SET}$ pin. LED channels can be paralleled to achieve higher LED currents. For applications requiring less than 8 strings of LEDs, channels can be paralleled or disabled (connect LED pin to $V_{OUT}$ before startup). For optimum efficiency, $V_{OUT}$ regulates to the lowest possible voltage allowable to maintain regulated current in each LED string. Any OPEN LED fault is indicated by the FAULT pin driven low without effecting the operation of the connected LED strings.

The Block Diagram in Figure 1 illustrates the key functions of the LT3760. It can be seen that two external supplies, $V_{REF}$ and INTVCC, are generated by the LT3760. The $V_{REF}$ pin provides a precision 1.485V output for use with external resistors to program the CTRL, OVPSET and $T_{SET}$ input pins. The INTVCC pin provides a regulated 7V output to supply the gate driver for the boost controller GATE pin. An accurate 1.476V threshold on the SHDN/UVLO pin combined with a SHDN/UVLO pin current hysteresis allows a programmable resistor divider from $V_{IN}$ to SHDN/UVLO.
to define the turn on/off voltages for $V_{IN}$, SHDN/UVLO pin current switches from 2.4$\mu$A to 0$\mu$A when SHDN/UVLO pin voltage exceeds 1.476V.

The LT3760 constant switching frequency is programmable from 100kHz up to 1MHz using a single resistor at the RT pin to ground. A SYNC pin is also provided to allow an external clock to define the converter switching frequency. The GATE output provides a ±0.8A peak gate drive for an external N-channel power MOSFET to generate a boosted output voltage $V_{OUT}$ using a single inductor, Schottky diode and output capacitor. With LED strings connected from $V_{OUT}$ to every LED pin, the lowest voltage on each LED pin is monitored and compared to an internal 1V reference. $V_{OUT}$ is regulated to ensure the lowest LED pin voltage of any connected LED string is maintained at 1V. If any of the LED strings are open, the LT3760 will ignore the open LED pin. If all of the LED strings are open $V_{OUT}$ charges up until a user programmable OVP (overvoltage protection) level is reached. This programmable OVP level allows the user to protect against LED damage when the LED strings are opened and then reconnected.

Since the LT3760 boost controller uses a current mode topology, the $V_{C}$ pin voltage determines the peak current in the inductor of the converter and hence the duty cycle of the GATE switching waveform. The basic loop uses a pulse from an internal oscillator to set an RS flip-flop and turn on the external power MOSFET. Current increases in the MOSFET and inductor until the $V_{C}$ commanded peak switch current is exceeded and the MOSFET is then turned off. Inductor current is sensed during the GATE on period by a sense resistor RS in the source of the external N-channel power MOSFET. As with all current mode converters, slope compensation is added to the control path to ensure stability for duty cycles above 50%. Any over current fault condition in the MOSFET turns off the MOSFET and triggers soft start internally. In this fault mode the LT3760 only allows MOSFET turn-on approximately every 2ms. This hiccup mode significantly reduces the power rating required for the MOSFET.

LED current programming and dimming can be achieved using the ISET, CTRL and PWM pins. A single resistor at the ISET pin programs LED current. Analog dimming of LED brightness is achieved using the CTRL pin below 1V. PWM dimming of LED brightness is achieved by controlling the duty cycle of the PWM pin.

For robust operation the LT3760 monitors system conditions and performs soft start for startup after any of the following faults: $V_{IN}$, SHDN or INTVCC voltages too low or MOSFET current too high. The LT3760, when entering these faults, discharges an internal soft start node and prevents switching at the GATE pin. When exiting these faults the LT3760 ramps up an internal soft start node to control $V_{C}$ pin voltage rise and hence control MOSFET peak switch current rise. In addition the soft start period gradually ramps up switching frequency from approximately 33% to 100% of full scale.

The LT3760 monitors each LED pin voltage. If the LED string has an open fault ($V(LEDX)$<0.5V) the FAULT flag is pulled low.

For LED protection, the LT3760 CTRL pin allows an LED current derating curve to be programmed versus the ambient temperature of the LED strings. An NTC resistor placed close to the LEDs decreases CTRL pin voltage and hence decreases LED current as LED ambient temperature increases.

The LT3760 also allows it’s own junction temperature to be monitored and regulated by derating LED currents when a junction temperature programmed by the TSET pin is exceeded.
APPLICATIONS INFORMATION

INTVCC Regulator Bypassing and Operation

The INTVCC pin is the output of an internal linear regulator driven from VIN and is the supply for the LT3760 gate driver. The INTVCC pin should be bypassed with a 10V rated 4.7µF low ESR, X7R or X5R ceramic capacitor to ensure stability and to provide enough charge for the gate driver. For high enough VIN levels the INTVCC pin provides a regulated 7V supply. Make sure INTVCC voltage does not exceed the VGS rating of the external MOSFET driven by the GATE pin. For low VIN levels the INTVCC level will depend on VIN and the voltage drop of the regulator. The INTVCC regulator has an undervoltage lockout which prevents gate driver switching until INTVCC reaches 3.8V and maintains switching until INTVCC falls below 3.4V. This feature prevents excessive power dissipation in the external MOSFET by ensuring a minimum gate drive level to keep RDS(ON) low. The INTVCC regulator has a current limit of 40mA to limit power dissipation inside the I.C. This current limit should be considered when choosing the N-channel power MOSFET and the switching frequency. The average current load on the INTVCC pin due to the LT3760 gate driver can be calculated as:

\[ I_{INTVCC} = Q_g \times f_{OSC} \]

where \( Q_g \) is the gate charge (at \( V_{GS} = INTVCC \)) specified for the MOSFET and \( f_{OSC} \) is the switching frequency of the LT3760 boost converter. It is possible to drive the INTVCC pin from a variety of external sources in order to remove power dissipation from the LT3760 and/or to remove the INTVCC current limitation of 40mA. An external supply for INTVCC should never exceed the VIN pin voltage or the maximum INTVCC pin rating of 13V. If INTVCC is shorted to the VIN pin, VIN operational range is 4.5V to 13V.

Inductor

A list of inductor manufacturers is given in Table 1. However, there are many other manufacturers and inductors that can be used. Consult each manufacturer for more detailed information and their entire range of parts. Ferrite cores should be used to obtain the best efficiency. Choose an inductor that can handle the necessary peak current without saturating. Also ensure that the inductor has a low DCR (copper-wire resistance) to minimize I²R power losses. Values between 2.2µH and 33µH will suffice for most applications. The typical inductor value required for a given application (assuming 50% inductor ripple current for example) can be calculated as:

\[ L = \frac{1}{\left(1 - \frac{1}{V_{OUT}} \cdot \frac{f_{OSC}}{V_{IN}}\right) \cdot \frac{I_{LEDx}}{8}} \]

where:

\[ V_{OUT} = (N \cdot V_F) + 1V \]

(\( N = \) number of LEDs per string),
\[ V_F = \) LED forward voltage drop,
\[ I_{LEDx} = \) LED current per string

Example: For a 12W LED driver application requiring 8 strings of 10 LEDs each driven with 40mA, and choosing \( V_{IN} = 12V, V_{OUT} = (3.75V \cdot 10) + 1V = 38.5V, I_{LEDx} = 40mA \) and \( f_{OSC} = 1MHz \) the value for \( L \) is calculated as

\[ L = \frac{(1 - \frac{1}{3.2}) \cdot \frac{1}{10^6} \cdot 12V}{0.5 \cdot 3.2 \cdot 40mA \cdot 8} = 16.5\mu H \]
Table 1. Inductor Manufacturers

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>PHONE NUMBER</th>
<th>WEB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sumida</td>
<td>408-321-9660</td>
<td><a href="http://www.sumida.com">www.sumida.com</a></td>
</tr>
<tr>
<td>Würth Elektronik</td>
<td>605-886-4385</td>
<td><a href="http://www.we-online.com">www.we-online.com</a></td>
</tr>
<tr>
<td>Vishay</td>
<td>402-563-6866</td>
<td><a href="http://www.vishay.com">www.vishay.com</a></td>
</tr>
<tr>
<td>Coilcraft</td>
<td>847-639-6400</td>
<td><a href="http://www.coilcraft.com">www.coilcraft.com</a></td>
</tr>
<tr>
<td>Coiltronics</td>
<td>561-998-4100</td>
<td><a href="http://www.cooperet.com">www.cooperet.com</a></td>
</tr>
</tbody>
</table>

Input Capacitor

The input capacitor of the LT3760 boost converter will supply the transient input current of the power inductor. Values between 2.2µF and 10µF will work well for the LT3760. Use only X5R or X7R ceramic capacitors to minimize variation over voltage and temperature. If inductor input voltage is required to operate near the minimum allowed operational V\textsubscript{IN} for the I.C., a larger capacitor value may be required. This is to prevent excessive input voltage ripple causing dips below the minimum operating input voltage.

Output Capacitor

Low ESR ceramic capacitors should be used at the LT3760 converter output to minimize output ripple voltage. Use only X5R or X7R dielectrics as these materials retain their capacitance over wider voltage and temperature ranges than other dielectrics. The output capacitance requirements for several LED driver application circuits are shown in the Applications Information section for various I\textsubscript{LED}, V\textsubscript{IN}, V\textsubscript{OUT}, L and f\textsubscript{OSC} values. Some suggested capacitor manufacturers are listed in Table 2.

Table 2. Ceramic Capacitor Manufacturers

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>PHONE NUMBER</th>
<th>WEB</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDK</td>
<td>516-535-2600</td>
<td><a href="http://www.tdk.com">www.tdk.com</a></td>
</tr>
<tr>
<td>Kemet</td>
<td>408-986-0424</td>
<td><a href="http://www.kemet.com">www.kemet.com</a></td>
</tr>
<tr>
<td>Murata</td>
<td>814-237-1431</td>
<td><a href="http://www.murata.com">www.murata.com</a></td>
</tr>
<tr>
<td>Taiyo Yuden</td>
<td>408-573-4150</td>
<td>t-yuden.com</td>
</tr>
<tr>
<td>AVX</td>
<td>843-448-9411</td>
<td><a href="http://www.avxcorp.com">www.avxcorp.com</a></td>
</tr>
</tbody>
</table>

Schottky Rectifier

The external diode for the LT3760 boost converter must be a Schottky diode, with low forward voltage drop and fast switching speed. Table 3 lists several Schottky manufacturers. The diodes average current rating must exceed the application’s average output current. The diode’s maximum reverse voltage must exceed the maximum output voltage of the application. For PWM dimming applications be aware of the reverse leakage of the Schottky diode. Lower leakage current will drain the output capacitor less during PWM low periods, allowing for higher PWM dimming ratios. The companies below offer Schottky diodes with high voltage and current ratings.

Table 3. Schottky Rectifier Manufacturers

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>PHONE NUMBER</th>
<th>WEB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diodes, Inc.</td>
<td>805-446-4800</td>
<td><a href="http://www.microsemi.com">www.microsemi.com</a></td>
</tr>
<tr>
<td>On Semiconductor</td>
<td>888-743-7826</td>
<td><a href="http://www.onsemi.com">www.onsemi.com</a></td>
</tr>
<tr>
<td>Zetex</td>
<td>631-360-2222</td>
<td><a href="http://www.zetex.com">www.zetex.com</a></td>
</tr>
<tr>
<td>Vishay Siliconix</td>
<td>402-563-6866</td>
<td><a href="http://www.vishay.com">www.vishay.com</a></td>
</tr>
</tbody>
</table>

Power MOSFET Selection

Several MOSFET vendors are listed in Table 4. Consult the factory applications department for other recommended MOSFETs. The power MOSFET selected should have a V\textsubscript{DS} rating which exceeds the maximum Overvoltage Protection (OVP) level programmed for the application. (See “Programming OVP level” in the Applications Information section). The MOSFET should also have a low enough total gate charge Q\textsubscript{G} (at 7V V\textsubscript{GS}) and a low enough switching frequency (f\textsubscript{OSC}) to not exceed the INTV\textsubscript{CC} regulator current limit, where loading on INTV\textsubscript{CC} pin due to gate switching should obey,

\[ I_{\text{GATE}} = Q_g \cdot f_{\text{OSC}} \leq 40\text{mA} \]
APPLICATIONS INFORMATION

In addition, the current drive required for GATE switching should also be kept low in the case of high V_in voltages (see “Thermal Considerations” in the Applications Information section). The R_DS(ON) of the MOSFET will determine d.c. power losses but will usually be less significant compared to switching losses. Be aware of the power dissipation within the MOSFET by calculating d.c. and switching losses and deciding if the thermal resistance of the MOSFET package causes the junction temperature to exceed maximum ratings.

Table 4. MOSFET Manufacturers

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
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<th>WEB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vishay Siliconix</td>
<td>402-563-6866</td>
<td><a href="http://www.vishay.com">www.vishay.com</a></td>
</tr>
<tr>
<td>International Rectifier</td>
<td>310-252-7105</td>
<td><a href="http://www.irf.com">www.irf.com</a></td>
</tr>
<tr>
<td>Fairchild</td>
<td>972-910-8000</td>
<td><a href="http://www.fairchildsemi.com">www.fairchildsemi.com</a></td>
</tr>
</tbody>
</table>

Power MOSFET: Current Sense Resistor

The LT3760 current mode boost converter controls peak current in the inductor by controlling peak MOSFET current in each switching cycle. The LT3760 monitors current in the external N-channel power MOSFET by sensing the voltage across a sense resistor (RS) connected between the source of the FET and the power ground in the application. The length of these tracks should be minimized and a Kelvin sense should be taken from the top of RS to the sense pin. A 52mV sense pin threshold combined with the value of RS sets the maximum cycle-by-cycle peak MOSFET current. The low 52mV threshold improves efficiency and determines the value for RS given by:

\[
RS \leq \frac{52\text{mV} \cdot 0.7}{I_L(\text{PEAK})}
\]

where

\[
I_L(\text{PEAK}) = \left( \frac{1}{1-D} \right) \cdot 8 \cdot I_{\text{LEDx}} \cdot \left( 1 + \frac{0.5}{2} \right)
\]

\[
D = \text{MOSFET duty cycle} = 1 - \left( \frac{V_{\text{IN(MIN)}}}{V_{\text{OUT(MAX)}}} \right)
\]

\[
V_{\text{OUT(MAX)}} = (N \cdot V_{\text{F(MAX)}}) + 1\text{V}
\]

N = number of LEDs in each string,

V_{\text{F(MAX)}} = maximum LED forward voltage drop,

V_{\text{IN(MIN)}} = minimum input voltage to the inductor,

I_{\text{LED}} = current in each LED pin,

and the 0.5 term represents an inductor peak-to-peak ripple current of 50% of average inductor current.

The scale factor of $\cdot 0.7$ ensures the boost converter can meet the peak inductor requirements of the loop by accounting for the combined errors of the 52mV sense threshold, $I_{\text{LEDx}}$, RS and circuit efficiency.

Example: For a 12W LED driver application requiring 8 strings of 10 LEDs each driven with 40mA, and choosing $V_{\text{IN(MIN)}} = 8\text{V}, V_{\text{OUT(MAX)}} = (4\text{V} \cdot 10) + 1\text{V} = 41\text{V}$ and $I_{\text{LEDx}} = 40\text{mA}$, the value for RS is chosen as:

\[
RS \leq \frac{52\text{mV} \cdot 0.7}{I_L(\text{PEAK})} \leq \frac{52\text{mV} \cdot 0.7}{\left( \frac{41 \cdot 8 \cdot 0.04}{8} \right) \cdot (1 + 0.25)} \leq \frac{52\text{mV} \cdot 0.7}{2.05} \leq 17.7 \text{ m\Omega}
\]
The power rating of RS should be selected to exceed the I^2R losses in the resistor. The peak inductor current should be recalculated for the chosen RS value to ensure the chosen inductor will not saturate.

**Power MOSFET: Overcurrent and Hiccup Mode**

For severe external faults which may cause the external MOSFET to reach currents greater than the peak current defined by RS and the 52mV sense pin threshold described above, the LT3760 has an overcurrent comparator which triggers soft start and turns off the MOSFET driver for currents exceeding,

\[ I_{\text{OVERCURRENT}} = \frac{100\text{mV}}{\text{RS}} \]

In this fault mode the LT3760 only allows MOSFET turn on for approximately 100ns every 2ms. This hiccup mode significantly reduces the power rating required for the MOSFET.

**Soft Start**

To limit inductor inrush current and output voltage during startup or recovery from a fault condition, the LT3760 provides a soft start function. The LT3760 when entering these faults will discharge an internal soft start node and prevent switching at the GATE pin for any of the following faults: V_{IN}, SHDN/UVLO or INTV_{CC} voltages too low or MOSFET current too high (see the timing diagram in Figure 2). When exiting these faults the LT3760 ramps up an internal soft start node at approximately 0.5V/ms to control V_C pin voltage rise and hence control MOSFET switch current rise. In addition the soft start period gradually ramps up switching frequency from approximately 33% to 100% of full scale.

The conditions required to exit all faults and allow a soft start ramp of the V_C pin are listed in Figure 2. An added feature of the LT3760 is that it waits for the first PWM pin active high (minimum 200ns pulse width) before it allows

![Figure 2. LT3760 Fault Detection and Soft Start Timing for V_C Pin and Internal SS Node](image-url)
the soft start of $V_C$ pin to begin. This feature ensures that during startup of the LT3760 the soft start ramp has not timed out before PWM is asserted high. Without this ‘wait for PWM high’ feature, systems which apply PWM after $V_{IN}$ and SHDN/UVLO are valid, can potentially turn on without soft start and experience high inductor currents during wake up of the converter’s output voltage. It is important to note that when PWM subsequently goes low, the soft start ramp is not held at its present voltage but continues to ramp upwards. If the soft start ramp voltage was held every time PWM goes low, this would cause very slow startup of LED displays for applications using very high PWM Dimming ratios.

**Shutdown and Programming Undervoltage Lockout**

The LT3760 has an accurate 1.476V shutdown threshold at the SHDN/UVLO pin. This threshold can be used in conjunction with a resistor divider from the system input supply to define an accurate undervoltage lockout (UVLO) threshold for the system (Figure 3). An internal hysteresis current at the SHDN/UVLO pin allows programming of hysteresis voltage for this UVLO threshold. Just before part turn on, an internal 2.4µA flows from the SHDN/UVLO pin. After part turn on, 0µA flows from the SHDN/UVLO pin. Calculation of the turn on/off thresholds for a system input supply using the LT3760 SHDN/UVLO pin can be made as follows:

\[
V_{\text{SUPPLY \, OFF}} = 1.476 \left(1 + \frac{R_1}{R_2}\right)
\]

\[
V_{\text{SUPPLY \, ON}} = V_{\text{SUPPLY \, OFF}} + (2.4\mu A \cdot R_1).
\]

An open drain transistor can be added to the resistor divider network at the SHDN/UVLO pin to independently control the turn off of the LT3760.

**Programming Switching Frequency**

The switching frequency of the LT3760 boost converter can be programmed between 100kHz and 1MHz using a single resistor ($R_T$) connected from the RT pin to ground (Figure 4). Connect the $R_T$ resistor as close as possible to the RT pin to minimize noise pick up and stray capacitance (see “Circuit Layout Considerations” in the Applications Information section). Table 5 shows the typical $R_T$ values required for a range of frequencies.

![Figure 3. Programming Undervoltage Lockout (UVLO) with Hysteresis](image_url)

![Figure 4. Switching Frequency vs RT](image_url)
Selecting the optimum frequency depends on several factors. Higher frequency allows reduction of inductor size but efficiency drops due to higher switching losses. Lower frequency allows higher operational duty cycles to drive a larger number of LEDs per string from a low input supply but require larger magnetics. In each application the switching frequency can be tailored to provide the optimum solution.

### Table 5. Switching Frequency vs. RT (1% resistors)

<table>
<thead>
<tr>
<th>SWITCHING FREQUENCY (kHz)</th>
<th>RT (kΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>523</td>
</tr>
<tr>
<td>200</td>
<td>249</td>
</tr>
<tr>
<td>300</td>
<td>158</td>
</tr>
<tr>
<td>400</td>
<td>115</td>
</tr>
<tr>
<td>500</td>
<td>90.9</td>
</tr>
<tr>
<td>600</td>
<td>73.2</td>
</tr>
<tr>
<td>700</td>
<td>60.4</td>
</tr>
<tr>
<td>800</td>
<td>51.1</td>
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<tr>
<td>900</td>
<td>44.2</td>
</tr>
<tr>
<td>1000</td>
<td>39.2</td>
</tr>
</tbody>
</table>

### Duty Cycle Considerations

When designing the LT3760 LED driver for a given application, the duty cycle requirements should be considered and compared to the minimum/maximum achievable duty cycles for the LT3760 GATE pin. If required, the LT3760 switching frequency can be programmed to a lower value to meet the duty cycle requirements. In general, the minimum/maximum GATE duty cycles required for a particular application are given by:

- MIN Duty Cycle = GATE Minimum On-Time • Switching Frequency f OSC
- MAX Duty Cycle = 1 – (GATE Minimum Off-Time • Switching Frequency f OSC)

The typical values for LT3760 GATE pin minimum on and off times versus temperature are shown in the Typical Performance Characteristics. The range of GATE pin minimum on time and off times are given in the electrical specifications.

### Table 6. LED Current vs. R ISET (1% resistors)

<table>
<thead>
<tr>
<th>LED CURRENT PER CHANNEL (mA)</th>
<th>R ISET (kΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>29.4</td>
</tr>
<tr>
<td>40</td>
<td>14.7</td>
</tr>
<tr>
<td>60</td>
<td>9.76</td>
</tr>
<tr>
<td>80</td>
<td>7.32</td>
</tr>
<tr>
<td>100</td>
<td>5.76</td>
</tr>
</tbody>
</table>

An extra 50ns should be added to these tested timings to account for errors in the rise/fall times of the GATE and DRAIN of the external MOSFET and the d.c. resistance of the external MOSFET and inductor.

### Synchronizing to an External Clock

The SYNC pin allows the LT3760 oscillator to be synchronized to an external clock. The SYNC pin can be driven from a logic level output, requiring less than 0.6V for a logic level low and greater than 2.2V for a logic level high. SYNC pin high or low periods should exists for at least 100ns. If unused, the SYNC pin should be tied to ground. To avoid loss of slope compensation during synchronization, the free running oscillator frequency (f OSC) of the LT3760 should be programmed to 80% of the external clock frequency.

### Programming LED Current

The current source to ground at each LED pin is programmed using a single resistor R ISET connected from the ISET pin to ground according to the following equation:

\[ I(\text{LED}_x) \approx \frac{590}{R_{ISET}} \times (A)(\text{CTRL} > 1.1V) \]

See Table 6 for resistor values and corresponding programmed LED.
APPLICATIONS INFORMATION

Analog Dimming
The LT3760 allows for LED dimming (brightness reduction) by analog dimming or by PWM dimming. Analog dimming uses the CTRL pin voltage below 1V to reduce LED brightness by reducing LED current. For CTRL pin voltage below 1V, the current in each LED pin is given by:

\[ I_{(LED_x)} = CTRL \cdot \frac{590}{R_{\text{SET}}} \quad (0.04 < CTRL < 1V) \]

For CTRL pin voltages below 40mV (greater than 25:1 dimming) the LED current will approach zero current. The CTRL pin voltage can be derived from a resistor divider from V_{REF} pin to ground or generated from an external source. If analog dimming is not required, the pin can be directly connected to the V_{REF} pin. The only drawback of analog dimming is that reducing LED current to reduce the brightness of the LED also changes the perceived color of the LED.

PWM Dimming
Many applications require an accurate control of the brightness of the LED(s). In addition, being able to maintain a constant color over the entire dimming range can be just as critical. For constant color LED dimming the LT3760 provides a PWM pin and special internal circuitry to achieve up to a 3000:1 wide PWM dimming range. This is achieved by operating the LED at its programmed current and then controlling the on time of that LED current. The duty cycle of the PWM pin controls the on time of each LED pin current source (Figure 5). For maximum PWM dimming ratios (low PWM duty cycles) it is important to be able to turn LED currents on/off as quickly as possible. For PWM low, the LT3760 turns off the boost converter, turns off all LED channel currents and disconnects the V_{C} pin and internal V_{OUT} resistor divider connected to the OVP error amplifier. This allows the part to quickly return to the last state of operation when the PWM pin is returned high.

Some general guidelines for LED current dimming using the PWM pin (see Figure 5):

1. PWM Dimming Ratio (PDR) = 1/(PWM Duty Cycle) = \(1/T_{\text{ON(PWM)}} \cdot f_{\text{PWM}}\)
2. Lower PWM frequency (f_{\text{PWM}}) allows higher PWM dimming ratios (Typically choose 100Hz to maximize PDR and to avoid visible flicker which can occur for display systems with refresh rates at frequencies below 80Hz)
3. Higher f_{\text{OSC}} value improves PDR (allows lower T_{\text{ON(PWM)}}) but will reduce efficiency and increase internal heating. In general, minimum operational T_{\text{ON(PWM)}} = 3 \cdot (1/f_{\text{OSC}})
4. Lower inductor value improves PDR
5. Higher output capacitor value improves PDR
6. Choose the Schottky diode for the LT3760 boost converter for minimum reverse leakage current.

Programming LED Current Derating (Breakpoint and Slope) versus LED Ambient Temperature (CTRL Pin)
LED data sheets provide curves of maximum allowed LED current versus ambient temperature to warn against damaging of the LED (Figure 6). The LT3760 LED driver improves the utilization and reliability of the LED(s) by al-
The programming of an LED current derating curve versus the ambient temperature of the LED(s) is important to obtain a resistor's exact values over temperature from the manufacturer. Hand calculations of CTRL voltage can then be performed at each given temperature and the resulting CTRL voltage plotted versus temperature.

Table 7. NTC Resistor Manufacturers

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>WEB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murata Electronics North America</td>
<td><a href="http://www.murata.com">www.murata.com</a></td>
</tr>
<tr>
<td>TDK Corporation</td>
<td><a href="http://www.tdk.com">www.tdk.com</a></td>
</tr>
<tr>
<td>Digi-key</td>
<td><a href="http://www.digikey.com">www.digikey.com</a></td>
</tr>
</tbody>
</table>

If calculation of CTRL voltage at various temperatures gives a downward slope that is too strong, alternative resistor networks can be chosen (B, C, D in Figure 7) which use temperature independent resistance to reduce the effects of the NTC resistor over temperature. Murata Electronics provides a selection of NTC resistors with complete data over a wide range of temperatures. In addition, a software tool is available which allows the user to select from different resistor networks and NTC resistor values and then simulate the exact output voltage curve (CTRL pin behavior) over temperature. Referred to on the website as the ‘Murata Chip NTC Thermistor Output Voltage Simulator’,
**APPLICATIONS INFORMATION**

Users can log onto [www.murata.com/designlib](http://www.murata.com/designlib) and download the software followed by instructions for creating an output voltage \(V_{\text{OUT}}\) (LT3760 CTRL pin voltage) from a specified \(V_{\text{CC}}\) supply (LT3760 \(V_{\text{REF}}\) pin voltage). At any time during selection of circuit parameters the user can access data on the chosen NTC resistor by clicking on the link to the Murata catalog. For a detailed example of hand calculations using an NTC type resistor divider to program CTRL pin voltage, read the LT3478 LED driver data sheet section *Programming LED Current Derating vs Temperature* under Applications Information.

**Using the TSET Pin for Thermal Protection**

The LT3760 contains a special programmable thermal regulation loop that limits the internal junction temperature of the part. Since the LT3760 topology consists of a single boost controller with eight linear current sources, any LED string voltage mismatch will cause additional power to be dissipated in the package. This topology provides excellent current matching between LED strings and allows a single power stage to drive a large number of LEDs, but at the price of additional power dissipation inside the part (which means a higher junction temperature). Being able to limit the maximum junction temperature allows the benefits of this topology to be fully realized. This thermal regulation feature provides important protection at high ambient temperatures, and allows a given application to be optimized for typical, not worst-case, ambient temperatures with the assurance that the LT3760 will automatically protect itself and the LED strings under worst-case conditions.

The operation of the thermal loop is simple. As the ambient temperature increases, so does the internal junction temperature of the part. Once the programmed maximum junction temperature is reached, the LT3760 begins to linearly reduce the LED current, as needed, to try and maintain this temperature. This can only be achieved when the ambient temperature stays below the desired maximum junction temperature. If the ambient temperature continues to rise past the programmed maximum junction temperature, the LEDs current will be reduced to approximately 5% of the full LED current.

While this feature is intended to directly protect the LT3760, it can also be used to derate the LED current at high temperatures. Since there is a direct relationship between the LED temperature and LT3760 junction temperature, the TSET function also provides some LED current derating at high temperatures.

Two external resistors program the maximum IC junction temperature using a resistor divider from the \(V_{\text{REF}}\) pin, as shown in Figure 9. Choose the ratio of \(R_1\) and \(R_2\) for the desired junction temperature. Figure 10 shows the relationship of \(T_{\text{SET}}\) voltage to junction temperature, and Table 8 shows commonly used values for \(R_1\) and \(R_2\).

### Figure 9. Programming the TSET Pin

![Figure 9. Programming the TSET Pin](image)

### Figure 10. Programming the TSET Pin Threshold

![Figure 10. Programming the TSET Pin Threshold](image)

### Table 8. Resistor Values to Program Maximum IC Junction Temperature (\(V_{\text{REF}}\) (Typical) = 1.485V)

<table>
<thead>
<tr>
<th>(T_J) (°C)</th>
<th>(R_1) (kΩ)</th>
<th>(R_2) (kΩ)</th>
<th>(T_{\text{SET}}) (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>24.9</td>
<td>20</td>
<td>0.824</td>
</tr>
<tr>
<td>115</td>
<td>28.0</td>
<td>20</td>
<td>0.866</td>
</tr>
<tr>
<td>130</td>
<td>30.9</td>
<td>20</td>
<td>0.902</td>
</tr>
</tbody>
</table>
**APPLICATIONS INFORMATION**

**Programming Overvoltage Protection (OVP) Level**

The LT3760 LED driver provides optimum protection to the LEDs and the external MOSFET by providing a programmable maximum regulated output voltage limit using the OVP\textsubscript{SET} pin. The Overvoltage Protection (OVP) level is programmed as:

\[
\text{OVP(\text{MAXIMUM REGULATED V}_{\text{OUT}})} = 57 \cdot \text{OVP}_{\text{SET}}
\]

If every LED string fails open or the multiple string LED display becomes disconnected the LT3760 LED driver loop regulates to the programmed OVP level. The OVP level should be programmed to a level high enough to regulate the LED strings but low enough to prevent damage to the power switch and to minimize the voltage across the LED pins upon reconnection of the LED strings. Recommended OVP level is given by:

\[
\text{OVP(RECOMMENDED)} = 1.2 \cdot ((N \cdot V_F) + 1V)
\]

where:

- \(N\) = number of LEDs in each string,
- \(V_F\) = maximum LED forward voltage drop

and the scaling factor of 1.2 accounts for variation in the generation of OVP from OVP\textsubscript{SET} pin voltage and startup logic requirements.

Example: For a converter operating with 10 LEDs per string at a maximum forward voltage of 4V per LED, the OVP level should be programmed to:

\[
\text{OVP(RECOMMENDED)} = 1.2 \cdot ((10 \cdot 4) + 1V) = 49.2V
\]

For OVP = 49.2V, OVP\textsubscript{SET} = \(\frac{49.2}{57} = 0.863V\)

The OVP\textsubscript{SET} pin voltage can be generated using a resistor divider from the REF pin.

**LED Open Circuit and PWM Dimming Ratios**

The LT3760 monitors each LED pin voltage to determine if the LED string has an open fault (LED pin voltage < 0.5V). If an open LED fault occurs, the FAULT flag is pulled low. To avoid false detection of faults during the initial converter startup when \(V_{\text{OUT}}\) is low, the LT3760 ignores low LED pin voltages until \(V_{\text{OUT}}\) reaches 90% of its maximum allowed OVP level. Once this condition is met, the LT3760 monitors all LED pins for open LED faults. To avoid false detection of faults during PWM dimming edges (where LED pins can possibly ring and trip fault detection levels) the LT3760 only monitors/updates fault conditions during PWM high (and only after a blank duration of 2\(\mu\)s following each PWM rising edge).

**LED Short Circuit**

A short circuit fault between the positive terminal of an LED string (\(V_{\text{OUT}}\)) and the negative terminal of the LED string (LED\textsubscript{x} pin) causes the channel to be disabled in order to protect the internal current source. A resistive short is allowed as long as \((V_{\text{OUT}}-V_{\text{LEDx}}) < 6V\).

**Loop Compensation**

Be sure to check the stability of the loop with the LEDs connected (LED regulation loop) and disconnected (Overvoltage Protection (OVP) regulation loop). Various application circuits are shown in the data sheet which cover a range of \(V_{\text{IN}}, V_{\text{OUT}}, f_{\text{OSC}}, \) output power and inductor current ripple values. For application requirements which deviate from the circuits shown in the data sheet be sure to check the stability of the final application over the full \(V_{\text{IN}}\) range, LED current range (if analog dimming) and temperature range. Be aware that if the \(V_C\) pin components represent a dominant pole for the converter loop and they have been adjusted to achieve stability, the \(V_C\) pin might move more slowly during load transient conditions such as an all-LEDs-open fault. A slower moving \(V_C\) pin will add to \(V_{\text{OUT}}\) overshoot during an all-LEDs-open fault. An alternative compensation approach is to place the dominant pole of the converter loop at the output. This requires an increased output capacitor value but will allow \(V_C\) to move more quickly and \(V_{\text{OUT}}\) to move more slowly resulting in less overshoot during an all-LEDs-open fault.
Thermal Considerations

The internal power dissipation of the LT3760 comes from 3 main sources: VIN quiescent current (I_{Q\text{ total}}), VIN current for GATE switching (I_{GATE}) and the LT3760 LED current sources. Since the maximum operational VIN voltage is 40V, care should be taken when selecting the switching frequency and type of external power MOSFET since the current required from VIN for GATE switching is given by,

\[ I_{GATE} = f_{OSC} \cdot Q_g \]

where \( Q_g \) is the gate charge (at \( V_{GS} = INTV_{CC} \)) specified for the MOSFET and \( f_{OSC} \) is the programmed switching frequency for the LT3760. A low \( Q_g \) MOSFET should always be used when operating the LT3760 from high VIN voltages. The internal junction temperature of the LT3760 can be estimated as:

\[ T_J = T_A + [Vin \cdot (I_{QTOTAL} + (f_{OSC} \cdot Q_g)) + (8 \cdot I(LED_X) \cdot 1.1V)] \cdot \theta_{JA} \]

where, \( T_A \) is the ambient temperature for the LT3760, \( I_{QTOTAL} \) represents the VIN quiescent current for the LT3760 (not switching, PWM = 1.5V and CTRL = 0.1V) - illustrated in the Typical Characteristics Graphs - plus the base currents of active channels (typically \( 8 \cdot I(LED)/75 \)). \( \theta_{JA} \) is the thermal resistance of the package (28°C/W for the 28-pin TSSOP package).

Example: For a 12W LED driver application requiring 8 strings of 10 LEDs each driven with 40mA, VIN = 24V, \( f_{OSC} = 1MHz \), \( Q_g \) (at 7V \( V_{GS} \)) = 15nC, \( I(LED_X) = 40mA \), and an 85°C ambient temperature for the LT3760 IC, the LT3760 junction temperature can be approximated as:

\[ T_J = 85°C + [(24 \cdot (9.5mA + (8 \cdot 40mA/75) + (1MHz \cdot 15nC)) + (8 \cdot 40mA \cdot 1.1V)) \cdot 34 \]

\[ = 85°C + [(24 \cdot 28.8mA) + (320mA \cdot 1.1V)] \cdot 34 \]

\[ = 85°C + (0.691W + 0.35W) \cdot 34 \]

\[ = 85°C + 35°C \]

\[ T_J = 120°C \]

The exposed pad on the bottom of the package must be soldered to the ground plane. The ground plane should be connected to an internal copper ground plane with vias placed directly under the package to spread out the heat generated by the LT3760.

Circuit Layout Considerations

As with all switching regulators, careful attention must be given to PCB layout and component placement to achieve optimal thermal, electrical and noise performance. The exposed pad of the LT3760 should be soldered to a continuous copper ground plane underneath the device to reduce die temperature and maximize the power capability of the IC. The signal ground (GND, pin 24) is down bonded to the exposed pad near the RT and V_C pins. \( I_{SET} \), \( R_T \) and \( V_C \) components should be connected to an area of ground copper connected to pin 24. The OVP_{SET} track should be kept away from fast moving signals and not loaded with an external capacitor. GATE pin turn off currents escape through a down bond to the exposed pad and exit the PGND pin 10. This area of copper and pin 10 should be the power ground (PGND) connection for the inductor input capacitor, INTV_{CC} capacitor and output capacitor. A separate bypass capacitor for the VIN pin of the IC may be required close the VIN pin and connected to the copper area associated with signal ground, pin 24. To minimize MOSFET peak current sensing errors the sense resistor (RS) should have Kelvin connections to the SENSE pin and the power ground copper area near the pin. The MOSFET drain rise and fall times are designed to be as short as possible for maximum efficiency. To reduce the effects of both radiated and conducted noise, the area of the copper trace for the MOSFET drain should be kept as small as possible. Use a ground plane under the switching regulator to minimize interplane coupling. The Schottky diode and output capacitor should be placed as close as possible to the drain node to minimize this high switching frequency path.
92% Efficient, 36W LED Driver, 1MHz Boost, 8 Strings, 100mA Per String

LT3760

TYPICAL APPLICATIONS

PWM DIMMING
ANALOG DIMMING

L1: SUMIDA CDRH8D38
M1: VISHAY SILICONIX Si7850DP
D1: DIODES, INC. PDS360

LED Current Waveforms
3000:1 PWM Dimming (100Hz)
TYPICAL APPLICATIONS

28W LED Driver, 750kHz Boost, 8 Strings, 80mA Per String

LT3760

11V TO 18V

4.7µF

25V

1M

100k

10µH

L1

D1

2.2µF

100V

×7

INTVCC

PGND

VOUT

GATE

SENSE

LT3760

VIN

4.7µF

10V

FAULT

SHDN/UVLO

CTRL

GND

SYNC

PWM

VREF

ISET

VOUT

DVPSET

RT

ISET

VC

PWM DIMMING

ANALOG DIMMING

SHDN

FAULT

SYNC

PWM

VREF

ISET

VC

10k

4.7nF

4.7µF

10V

1M

20k

10k

30.9k

16.9k

56.2k

7.32k

10k

10k

PWM DIMMING

ANALOG DIMMING

SHDN

FAULT

SYNC

PWM

VREF

ISET

VC

10k

4.7nF

3760 TA04

L1: SUMIDA CDRH8D38

M1: VISHAY SILICONIX Si7308DN

D1: DIODES, INC. DFLS160

UP TO 44V OF LEDS PER STRING

20k

30.9k

16.9k

56.2k

7.32k

10k

4.7nF

3760c

23
LT3760

TYPICAL APPLICATIONS

15W LED Driver, 750kHz Boost, 8 Strings, 55mA Per String

L1: SUMIDA CDRH8D28
M1: VISHAY SILICONIX Si7308DN
D1: DIODES, INC. DFLS160

*MAXIMUM PWM DIMMING RATIO:
(a) $f_{PWM} = 20\text{kHz}$
   $= 20:1 (V_{IN} > 10V)$
   $= 5:1 (V_{IN} = 8V)$
(b) $f_{PWM} = 100\text{Hz}$
   $= 3000:1 (V_{IN} > 10V)$
   $= 750:1 (V_{IN} = 8V)$
TYPICAL APPLICATIONS

29W LED Driver, 400kHz Boost, 2 Strings, 350mA Per String

VIN (8V TO 36V)

LT3760

VOUT

GATE

SENSE

PGND

VOUT

INTVCC

LT3760

FAULT

SRDN/UVLO

GND

SYNC

PWM

CTRL

VREF

TSET

OVPSET

RT

ISET

VC

LED1

LED2

LED3

LED4

LED5

LED6

LED7

LED8

SYNC

GND

PWM DIMMING

ANALOG DIMMING

PGND

2.2µF 100V
× 10

0.007Ω

L1: COOPER BUSSMANN HC9-100-R
M1: VISHAY SILICONIX Si7850DP
D1: DIODES, INC. PDS560

UP TO 42V OF LEDS PER STRING

29W LED Driver, 400kHz Boost, 2 Strings, 350mA Per String
LT3760

TYPICAL APPLICATIONS

25W LED Driver, 400kHz Boost, 3 Strings, 200mA Per String

VIN: 8V TO 36V

L1: COOPER BUSSMANN HC9-100-R
M1: VISHAY SILICONIX Si7850DP
D1: DIODES, INC. PDS560

L10µH

D1: DIODES, INC. PDS560

2.2µF 100V x10

LT3754

GATE
SENSE
PGND
VOUT
LED8
LED7
LED6
LED5
LED4
LED3
LED2
LED1
LED0

PWM DIMMING
ANALOG DIMMING
CTRL
VREF
TSET
OVPSET
RT
ISET
VC

SYNC
GND

PWM

FAULT
SHDN/UVLO

VOUT

SENSE

GATE

VOUT

INTVCC

Vin

L1

10µH

D1

UP TO 42V OF LEDs PER STRING

PGND

0.007Ω

VOUT

2.2µF 100V x10

LED8

LED7

LED6

LED5

LED4

LED3

LED2

LED1

LED0

25W LED Driver, 400kHz Boost, 3 Strings, 200mA Per String
TYPICAL APPLICATIONS

29W LED Driver, 700kHz Boost, 4 Strings, 160mA Per String

VIN
10V TO 18V

L1
15µH

D1

UP TO 45V OF LEDs PER STRING

GATE

M1

0.02Ω

0.02µF
100V
× 5

VAUX

SENSE

VOUT

LED1

LED2

LED3

LED4

LED5

LED6

LED7

LED8

CTRL

SYNC

GND

PWM

VREF

OVPSET

TSET

RT

ISET

VC

VIN

10V TO 18V

L1: SUMIDA CDRH8D38
M1: VISHAY SILICONIX Si7308DN
D1: DIODES, INC. DFLS160

VOUT

SENSE

LED1

LED2

LED3

LED4

LED5

LED6

LED7

LED8

CTRL

SYNC

GND

PWM

VREF

OVPSET

TSET

RT

ISET

VC

VIN

10V TO 18V

L1: SUMIDA CDRH8D38
M1: VISHAY SILICONIX Si7308DN
D1: DIODES, INC. DFLS160
**TYPICAL APPLICATIONS**

14W LED Driver, 700kHz Boost, 4 Strings, 80mA Per String (For Machine Vision Systems with Very Long Off-Times)
PACKAGE DESCRIPTION

Please refer to http://www.linear.com/designtools/packaging/ for the most recent package drawings.

FE Package
28-Lead Plastic TSSOP (4.4mm)
(Reference LTC DWG # 05-08-1663)
Exposed Pad Variation EB

NOTE:
1. CONTROLLING DIMENSION: MILLIMETERS
2. DIMENSIONS ARE IN MILLIMETERS (INCHES)
3. DRAWING NOT TO SCALE
4. RECOMMENDED MINIMUM PCB METAL SIZE FOR EXPOSED PAD ATTACHMENT
   *DIMENSIONS DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.150mm (.006") PER SIDE

RECOMMENDED SOLDER PAD LAYOUT
EXPOSED PAD HEAT SINK ON BOTTOM OF PACKAGE

SEE NOTE 4

NOTE 4:
RECOMMENDED MINIMUM PCB METAL SIZE FOR EXPOSED PAD ATTACHMENT

*DIMENSIONS DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.150mm (.006") PER SIDE

Please refer to http://www.linear.com/designtools/packaging/ for the most recent package drawings.
# REVISION HISTORY

<table>
<thead>
<tr>
<th>REV</th>
<th>DATE</th>
<th>DESCRIPTION</th>
<th>PAGE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1/11</td>
<td>Revised FAULT pin description.</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>10/11</td>
<td>Updated Features section.</td>
<td>1</td>
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<tr>
<td></td>
<td></td>
<td>Updated equation in “Power MOSFET: Current Sense Resistor” section.</td>
<td>13</td>
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<tr>
<td></td>
<td></td>
<td>Updated “Programming LED Current Derating (Breakpoint and Slope) versus LED Ambient Temperature (CTRL Pin)” section.</td>
<td>18</td>
</tr>
<tr>
<td>C</td>
<td>3/12</td>
<td>Corrected the inductor value formula.</td>
<td>11</td>
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</table>

Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.
<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>LT3755/LT3755-1/ LT3755-2</td>
<td>High Side 40V, 1MHz LED Controller with True Color 3,000:1 PWM Dimming</td>
<td>$V_{IN} = 4.5V$ to $40V$, $V_{OUT(MAX)} = 75V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, 3mm × 3mm QFN-16 MSOP-16E</td>
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<tr>
<td>LT3756/LT3756-1/ LT3756-2</td>
<td>High Side 100V, 1MHz LED Controller with True Color 3,000:1 PWM Dimming</td>
<td>$V_{IN} = 6V$ to $100V$, $V_{OUT(MAX)} = 100V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, 3mm × 3mm QFN-16 MSOP-16E</td>
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<tr>
<td>LT3598</td>
<td>44V, 1.5A, 2.5MHz Boost 6-Channel 20mA LED Driver</td>
<td>$V_{IN} = 3V$ to $30V$ (40V MAX), $V_{OUT(MAX)} = 44V$, 1,000:1 True Color PWM Dimming, $ISD = &lt;20µA$, 4mm × 4mm QFN-24</td>
</tr>
<tr>
<td>LT3599</td>
<td>44V, 2A, 2.5MHz Boost 4-Channel 100mA LED Driver</td>
<td>$V_{IN} = 3V$ to $30V$ (40V MAX), $V_{OUT(MAX)} = 44V$, 1,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, 4mm × 4mm QFN-24</td>
</tr>
<tr>
<td>LT3595</td>
<td>45V, 2.5MHz 16-Channel Full Featured LED Driver</td>
<td>$V_{IN} = 4.5V$ to $45V$, $V_{OUT(MAX)} = 45V$, 5,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, 5mm × 9mm QFN-56</td>
</tr>
<tr>
<td>LTC3783</td>
<td>High Side 36V, 1MHz LED Controller with True Color 3,000:1 PWM Dimming</td>
<td>$V_{IN} = 3V$ to $36V$, $V_{OUT(MAX)} = 40V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;20µA$, 4mm × 5mm DFN-16 TSSOP-16</td>
</tr>
<tr>
<td>LT3517</td>
<td>1.5A, 2.5MHz High Current LED Driver with 3,000:1 Dimming</td>
<td>$V_{IN} = 3V$ to $30V$, $V_{OUT(MAX)} = 45V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, 4mm × 4mm QFN-16</td>
</tr>
<tr>
<td>LT3518</td>
<td>2.3A, 2.5MHz High Current LED Driver with 3,000:1 Dimming</td>
<td>$V_{IN} = 3V$ to $30V$, $V_{OUT(MAX)} = 45V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, 4mm × 4mm QFN-16</td>
</tr>
<tr>
<td>LT3519/LT3519-1/ LT3519-2</td>
<td>750mA, 2.2MHz High Current LED Driver</td>
<td>$V_{IN} = 3V$ to $30V$, $V_{OUT(MAX)} = 45V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, MSOP-16E</td>
</tr>
<tr>
<td>LT3486</td>
<td>Dual 1.3A, 2MHz High Current LED Driver</td>
<td>$V_{IN} = 5V$ to $40V$, $V_{OUT(MAX)} = 36V$, 1,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, 5mm × 3mm QFN-16 TSSOP-16</td>
</tr>
<tr>
<td>LT3478/LT3478-1</td>
<td>4.5A, 2MHz High Current LED Driver with 3,000:1 Dimming</td>
<td>$V_{IN} = 2.8V$ to $36V$, $V_{OUT(MAX)} = 60V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;10µA$, 5mm × 7mm QFN-10</td>
</tr>
<tr>
<td>LT3496</td>
<td>Triple Output 750mA, 2.1 MHz High Current LED Driver with 3,000:1 Dimming</td>
<td>$V_{IN} = 3V$ to $30V$, $V_{OUT(MAX)} = 40V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, 4mm × 5mm QFN-28</td>
</tr>
<tr>
<td>LT3474/LT3474-1</td>
<td>36V, 1A ($I_{LED}$), 2MHz, Step-Down LED Driver</td>
<td>$V_{IN} = 4V$ to $36V$, $V_{OUT(MAX)} = 13.5V$, 400:1 True Color PWM Dimming, $ISD = &lt;1µA$, TSSOP-16</td>
</tr>
<tr>
<td>LT3475/LT3475-1</td>
<td>Dual 1.5A($I_{LED}$), 36V, 2MHz, Step-Down LED Driver</td>
<td>$V_{IN} = 4V$ to $36V$, $V_{OUT(MAX)} = 13.5V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;1µA$, TSSOP-20</td>
</tr>
<tr>
<td>LT3476</td>
<td>Quad Output 1.5A, 2MHz High Current LED Driver with 1,000:1 Dimming</td>
<td>$V_{IN} = 2.8V$ to $16V$, $V_{OUT(MAX)} = 36V$, 1,000:1 True Color PWM Dimming, $ISD = &lt;10µA$, 5mm × 7mm QFN-10</td>
</tr>
<tr>
<td>LT3754</td>
<td>16-Channel × 50mA LED Driver</td>
<td>$V_{IN} = 6V$ to $40V$, $V_{OUT(MAX)} = 60V$, 3,000:1 True Color PWM Dimming, $ISD = &lt;2µA$, 5mm × 5mm QFN-32</td>
</tr>
</tbody>
</table>