GENERAL DESCRIPTION

The IS32LT3175 is a single channel linear programmable current regulator capable of up to 150mA. It integrates a debounce and latch circuit on the channel enable pin (EN) to facilitate the use of a low cost momentary contact switch. The PWM pin can be interfaced to a logic level “courtesy light” signal to directly drive the LED channel. The IS32LT3175 accepts a positive polarity PWM signal while the IS32LT3175N accepts a negative polarity PWM signal.

The device operates as a stand-alone LED driver configurable with external resistors; no microcontroller is required. A single external resistor programs the current level, while two separate resistors independently program the fade in and fade out ramp rate for the channel.

The device integrates a 63 step fade in and fade out algorithm (Gamma correction) which causes the output LED current to gradually ramp up to the full source value after the EN pin is pulsed. The same controller causes the LED current to gradually ramp down to zero if the EN pin is pulsed while the output channel is ON. The fade ramp can be interrupted mid-cycle before completion of the ramp cycle. The EN pin will accept either a momentary contact switch or logic level signal pulsed low.

The IS32LT3175 is targeted at the automotive market with end applications to include map and dome lighting as well as exterior accent lighting. For 12V automotive applications the low dropout driver can support 1 to 3 LEDs (VF = 3.2V) per channel. It is offered in a small thermally enhanced SOP-8-EP package.

FEATURES

- Operating voltage 5V to 42V
- Single channel current source
  - Programmable current via a single external resistor
  - Configurable from 20mA to 150mA
- Momentary contact button EN input
  - Input is debounced and latched
  - Higher priority than PWM input
- Gamma corrected Fade In/Out algorithm
- Pull down resistors set independent fade IN and OUT ramp time
- PWM input pin driven by external PWM source
  - PWM directly drives the current source
  - IS32LT3175P – Positive polarity
  - IS32LT3175N – Negative polarity
- Fault Protection:
  - OUT pin shorted to GND
  - ISET pin shorted to GND
  - Over temperature
- SOP-8-EP package
- Automotive Grade:
  - IS32LT3175P – AEC-Q100
  - IS32LT3175N – AEC-Q100
- Operating temperature range from -40°C ~ +125°C

APPLICATIONS

- Automotive Interior:
  - Map/Dome light
  - Puddle lamp in doors
  - Glove box
  - Vanity mirror

TYPICAL APPLICATION CIRCUIT

![Typical Application Circuit](image)

Note: The resistor \( R_{PWM} \) is a fixed value. Please don’t change it. \( C_{PWM} \) is optional. Add it for robust electromagnetic susceptibility.
## PIN DESCRIPTION

<table>
<thead>
<tr>
<th>No.</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EN</td>
<td>Internally debounced input pin for control of LED current. A negative going pulse on this pin will toggle the state of the OUT current. The pin condition is constantly monitored after the debounce time period.</td>
</tr>
<tr>
<td>2</td>
<td>ISET</td>
<td>Output current setting for channel. Connect a resistor between this pin and GND to set the maximum output current.</td>
</tr>
<tr>
<td>3</td>
<td>TSET_UP</td>
<td>Timing control for the Fade In feature. Connect a resistor between this pin and GND to set the Fade In time. Connect this pin directly to ground to disable the fade function for instant ON.</td>
</tr>
<tr>
<td>4</td>
<td>TSET_DN</td>
<td>Timing control for the Fade Out feature. Connect a resistor between this pin and GND to set the Fade Out time. Connect this pin directly to ground to disable the fade function for instant OFF.</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground pin for the device.</td>
</tr>
<tr>
<td>6</td>
<td>OUT</td>
<td>Output current source channel.</td>
</tr>
<tr>
<td>7</td>
<td>VCC</td>
<td>Power supply input pin. A capacitor on this pin will help maintain EN latch status during low voltage conditions.</td>
</tr>
<tr>
<td>8</td>
<td>PWM</td>
<td>PWM (or BCM) signal via a 10kΩ to drive OUT pin. Pin condition is ignored if EN pin has latched and activated OUT pin. IS32LT3175P positive polarity, IS32LT3175N negative polarity.</td>
</tr>
<tr>
<td></td>
<td>Thermal Pad</td>
<td>Connect to GND.</td>
</tr>
</tbody>
</table>
## ORDERING INFORMATION

Automotive Range: -40°C to +125°C

<table>
<thead>
<tr>
<th>Order Part No.</th>
<th>Package</th>
<th>QTY/Reel</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS32LT3175P-GRLA3-TR</td>
<td>SOP-8-EP, Lead-free</td>
<td>2500</td>
</tr>
<tr>
<td>IS32LT3175N-GRLA3-TR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

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a.) the risk of injury or damage has been minimized;

b.) the user assume all such risks; and

c.) potential liability of Integrated Silicon Solution, Inc is adequately protected under the circumstances.
### ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC, OUT, PWM</td>
<td>VCC, OUT, PWM</td>
<td>-0.3V</td>
<td>+45V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN, ISET, TSET_UP, TSET_DN</td>
<td>EN, ISET, TSET_UP, TSET_DN</td>
<td>-0.3V</td>
<td>+7.0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient operating temperature, (T_a=T_J)</td>
<td>Ambient operating temperature, (T_a=T_J)</td>
<td>-40°C</td>
<td>+125°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum continuous junction temperature, (T_{J(MAX)})</td>
<td>Maximum continuous junction temperature, (T_{J(MAX)})</td>
<td>150°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature range, (T_{STG})</td>
<td>Storage temperature range, (T_{STG})</td>
<td>-55°C</td>
<td>+150°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum power dissipation, (P_{DMAX})</td>
<td>Maximum power dissipation, (P_{DMAX})</td>
<td>1.96W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESD (HBM)</td>
<td>ESD (HBM)</td>
<td>±2kV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESD (CDM)</td>
<td>ESD (CDM)</td>
<td>±750V</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:
Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### THERMAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Conditions</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package Thermal Resistance (Junction to Ambient), (\theta_{JA})</td>
<td>On 4-layer PCB based on JEDEC standard at 1W, (T_a=25^\circ)C</td>
<td>50.98°C/W</td>
</tr>
<tr>
<td>Package Thermal Resistance (Junction to Pad), (\theta_{JP})</td>
<td></td>
<td>2.24°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS

\(T_J = -40^\circ\)C ~ +125°C, \(V_{CC}=12\)V, refer to each condition description. Typical values are at \(T_J = 25^\circ\)C.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{CC})</td>
<td>Supply voltage range</td>
<td></td>
<td>5</td>
<td>42</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{DO})</td>
<td>Minimum dropout voltage</td>
<td>(V_{CC} – V_{OUT}, I_{OUT}= -150mA (Note 1))</td>
<td>900 mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{CC} – V_{OUT}, I_{OUT}= -100mA (Note 2))</td>
<td>700 mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_{CC})</td>
<td>Quiescent supply current</td>
<td>PWM pin floating. EN disables the output. (R_{ISET}= 15k\Omega), EN enable the output, PWM floating, OUT floating</td>
<td>0.1</td>
<td>1</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{CC}=4.2V, EN enable the output. (V_{PWM}=4V) for IS32LT3175P and (V_{PWM}=GND) for IS32LT3175N.)</td>
<td>2.3</td>
<td>3.8</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>(t_{ON})</td>
<td>Startup time</td>
<td>(V_{CC}&gt; 6V) to (I_{OUT}&lt; -5mA) (Note 4)</td>
<td>400 (\mu)s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_{OUT_LIM})</td>
<td>Output limit current</td>
<td>(V_{CC} – V_{OUT}=1V, OUT sourcing current, ISET pin connected to GND.)</td>
<td>-240</td>
<td>-205</td>
<td>-160</td>
<td>mA</td>
</tr>
<tr>
<td>(I_{OUT})</td>
<td>Output current (\text{(Note 3)})</td>
<td>(R_{ISET}= 15k\Omega, V_{CC} – V_{OUT}=1V, -40^\circ)C(&lt; T_J&lt; +125^\circ)C (\text{C})</td>
<td>-105</td>
<td>-100</td>
<td>-95</td>
<td>mA</td>
</tr>
<tr>
<td>(E_{OUT})</td>
<td>Absolute current accuracy (\text{(Note 3)})</td>
<td>(-50mA\leq I_{OUT}\leq20mA, V_{CC} – V_{OUT}=1V, -40^\circ)C(&lt; T_J&lt; +125^\circ)C (\text{C})</td>
<td>-8</td>
<td>8</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-150mA\leq I_{OUT}\leq50mA, V_{CC} – V_{OUT}=1V, -40^\circ)C(&lt; T_J&lt; +125^\circ)C (\text{C})</td>
<td>-6</td>
<td>6</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>(g_{LINE})</td>
<td>Output current line regulation</td>
<td>(I_{OUT} = -50mA, 6V&lt;V_{CC}&lt;18V, V_{OUT} = V_{CC} -2V) (Note 4)</td>
<td>-0.2</td>
<td>0.2</td>
<td>mA/V</td>
<td></td>
</tr>
<tr>
<td>(g_{LOAD})</td>
<td>Output current load regulation</td>
<td>(2.5V&lt; V_{OUT} &lt; V_{CC}-2.0V, I_{OUT} = -50mA) (Note 4)</td>
<td>-0.2</td>
<td>0.2</td>
<td>mA/V</td>
<td></td>
</tr>
<tr>
<td>(t_{SL})</td>
<td>Current slew time</td>
<td>Current rise/fall between (0%\sim100%, V_{TSET} = 0V)</td>
<td>45</td>
<td>70</td>
<td>100</td>
<td>(\mu)s</td>
</tr>
<tr>
<td>(t_{TD_ON})</td>
<td>PWM current latency</td>
<td>Delay time between PWM rising edge to 10% of (I_{OUT})</td>
<td>10</td>
<td>17</td>
<td>(\mu)s</td>
<td></td>
</tr>
</tbody>
</table>
## ELECTRICAL CHARACTERISTICS (CONTINUE)

$T_J = -40^\circ C \sim +125^\circ C$, $V_{CC}=12V$, the detail refer to each condition description. Typical values are at $T_J = 25^\circ C$.

### Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit
---|---|---|---|---|---|---
UVLO | Release from under voltage lock out $V_{CC}$ voltage | $V_{CC}$ rising release from UVLO | 4.6 | 4.8 | | V
| Into under voltage lock out $V_{CC}$ voltage | $V_{CC}$ falling into UVLO | 4.1 | 4.5 | 4.7 | V

### Logic Input TSET_UP, TSET_DN

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit
---|---|---|---|---|---|---
VTSET | Voltage reference | *Neglecting the RTSET Tolerance* $R_{TSET\_UP}=100\, \Omega$, $T_J = 25^\circ C$ | 1 | | | V
TACC | Fade timing accuracy | -5 | 5 | | %

### Logic Input PWM – Active High (IS32LT3175P)

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit
---|---|---|---|---|---|---
VIL | Input low voltage | | 0.8 | | | V
VIH | Input high voltage | | 2 | | | V
VIN_HY | Input hysteresis | (Note 4) | 150 | 350 | | mV
IPD | Internal pull-down current $V_{PWM}=12V$ | | 15 | 28 | 46 | μA

### Logic Input PWM – Active Low (IS32LT3175N)

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit
---|---|---|---|---|---|---
VIL | Input low voltage | | 0.8 | | | V
VIH | Input high voltage | | 2 | | | V
VIN_HY | Input hysteresis | (Note 4) | 150 | 350 | | mV
IPU | Internal pull-up current $V_{PWM}=GND$ | | 20 | 38 | 58 | μA

### Logic Input EN

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit
---|---|---|---|---|---|---
VIL | Input low voltage | | 0.8 | | | V
VIH | Input high voltage | | 2 | | | V
VIN_HY | Input hysteresis | (Note 4) | 150 | 350 | | mV
RPU | Internal pull-up resistor | (Note 4) | 50 | | | kΩ
IPU | Internal pull-up current $V_{EN}=0$ | | 55 | 75 | 95 | μA
TSW | EN input debounce time | EN pin must not change state within this time to be interpreted as a switch press or release | 25 | 37 | 50 | ms

### Protection

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit
---|---|---|---|---|---|---
VSCD | Short detect voltage | Measured at OUT | 1.2 | 1.8 | | V
VSCD_HY | Short detect voltage hysteresis | Measured at OUT | | | 220 | mV
TFD | Fault detect persistence time | (Note 4) | | | 5 | ms
TRO | Thermal roll off threshold | (Note 4) | | | 145 | °C
TSD | Thermal shutdown threshold | Temperature increasing (Note 4) | | | 175 | °C
THY | Over temperature hysteresis | Recovery $= T_{SHT} - T_{J\_HY}$ (Note 4) | | | 30 | °C

Note 1: IOUT output current in case of $V_{CC}-V_{OUT}=V_{DD}$ called IOUT_VDD. IOUT output current in case of $V_{CC}-V_{OUT}=2V$ called IOUT_VDD2V, $V_{DD}$ accuracy is computed as $|I_{OUT\_VDD}-I_{OUT\_VDD2V}|/I_{OUT\_VDD2V}<5%$.

Note 2: IOUT output current in case of $V_{CC}-V_{OUT}=V_{DD}$ called IOUT_VDD. IOUT output current in case of $V_{CC}-V_{OUT}=1V$ called IOUT_VDD1V, $V_{DD}$ accuracy is computed as $|I_{OUT\_VDD}-I_{OUT\_VDD1V}|/I_{OUT\_VDD1V}<5%$.

Note 3: Output current accuracy is not intended to be guaranteed at output voltages less than 1.8V.

Note 4: Guaranteed by design.

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Rev.A, 07/19/2016
TYPICAL PERFORMANCE CHARACTERISTICS

**Figure 2** Supply Current vs. Supply Voltage

Supply Current (mA) vs. Supply Voltage (V)

**Figure 3** Output Current vs. Supply Voltage

Output Current (mA) vs. Supply Voltage (V)

**Figure 4** Output Current vs. \(R_{\text{SET}}\)

Output Current (mA) vs. \(R_{\text{SET}}\) (kΩ)

**Figure 5** Output Current vs. PWM Duty Cycle

Output Current (mA) vs. Duty Cycle (%)

**Figure 6** Fade Time vs. Supply Voltage

Fade Time (ms) vs. Supply Voltage (V)

**Figure 7** Fade Time vs. Temperature

Fade Time (ms) vs. Temperature (°C)
Figure 8  Supply Current vs. Temperature

Figure 9  Output Current vs. Temperature

Figure 10  PWM On Delay Time (For IS32LT3175P Only)

Figure 11  PWM Off Delay Time (For IS32LT3175P Only)

Figure 12  Instant on

Figure 13  Instant Off
Figure 14  $V_{EN}$ vs. $I_{OUT}$

Figure 15  $V_{EN}$ vs. $I_{OUT}$

Figure 16  $V_{EN}$ vs. $I_{OUT}$

Figure 17  $V_{EN}$ vs. $I_{OUT}$

Figure 18  $V_{EN}$ vs. $I_{OUT}$

Figure 19  $V_{EN}$ vs. $I_{OUT}$
**Figure 20** Output Current vs. Headroom Voltage
Note: IS32LT3175P does not invert the PWM input.
APPLICATION INFORMATION

The IS32LT3175 is a single channel linear current driver optimized to drive an automotive interior LED map light, or other interior lamp which is frequently toggled between the In and Out condition. The device integrates a debounce input circuit to enable use of a low cost momentary contact switch for controlling In/Out an external LED. In addition, a programmable fade ramp timing function provides flexibility in setting different Fade In and Fade Out ramp duration periods. The fade ramp cycle can be interrupted mid-cycle before the ramp has completed, Figure 21.

The regulated LED current (up to 150mA) is set by a single reference resistor ($R_{\text{SET}}$).

**OUTPUT CURRENT SETTING**

A single programming resistor ($R_{\text{SET}}$) controls the maximum output current for output channel simultaneously. The programming resistor may be computed using the following Equation (1):

$$R_{\text{SET}} = \frac{1500}{I_{\text{SET}}}$$

(10kΩ≤$R_{\text{SET}}$≤75kΩ)

The device is protected from an output overcurrent condition caused by an accidental short circuit of the ISET pin, by internally limiting the maximum current in the event of an ISET short circuit to 205mA (Typ.).

**EN PIN OPERATION**

The EN pin has in integrated pull-up source so that no external components are required to provide the input high level to the pin.

The output channel powers up in the ‘OFF’ condition. Toggling the EN pin from high to low for a period of time that exceeds the debounce time will cause the output to be toggled and latched from the OFF condition to the current source condition. When this happens, the output current gradually ramps up from zero mA to the programmed value (set by $R_{\text{SET}}$) over the time set by the resistor ($R_{\text{TSET,UP}}$) attached to the TSET_UP pin. Conversely, if it is already in the source condition, and the EN pin is toggled low, then the output current will begin to ramp down towards zero mA in the time period as programmed by the resistor ($R_{\text{SET, DN}}$) attached to the TSET_DN pin.

Debounce – Output control is provided by a debounced switch input, providing an ON/OFF toggle action for various switch or button characteristics. An internal debounce circuit will condition the EN input signal so a single press of the mechanical switch doesn’t appear like multiple presses. The EN input is debounced by typically 37ms.

Note: The debounce time applies to both falling and rising edges of the EN signal.

**FADE IN AND FADE OUT DIMMING**

The LED fade function can be accomplished in one of two methods; 1) by applying a PWM control signal to the PWM pin, or 2) when the EN pin is pulled low.

**PWM Dimming** – The PWM pin can be driven by an external PWM signal source to accomplish LED dimming. The integrated gamma correction and fade IN/OUT ramp functions are disabled when actively driving the PWM pin. The PWM pin input is ignored if the LED channel was previously active due to the EN pin. The EN pin will override the PWM function; it can be used to toggle the LED channel from its previous state even though the PWM pin is active.

The recommended PWM signal frequency range is 50Hz-300Hz. The duty cycle can be 0-100%. The output current of the PWM dimming is given by:

$$I_{\text{OUT}} = \frac{1500}{R_{\text{SET}}} \times D_{\text{PWM}}$$

Where, $D_{\text{PWM}}$ is the duty cycle of the PWM. Please refer to Figure 10 and 11 for the delay time of PWM edge to current change edge. Figure 24 and 25 show the PWM polarity difference of IS32LT3175P and IS32LT3175N.
EN Dimming — The LED output current will gradually ramp up from zero to the final value as programmed by the resistor \( R_{\text{SET}} \) connected to the ISET pin. The time period over which the ramping happens is determined by the resistor \( R_{\text{TSET,UP}} \) connected to the TSET_UP pin for Fade In time and by resistor \( R_{\text{TSET,DN}} \) connected to TSET_DN pin for Fade Out time. The output current will ramp up (or down) in 63 steps, with integrated gamma correction for an extremely visual linear lumen output of the LED. The ramp time can be interrupted mid-cycle each time the EN pin is pulled low.

The EN function has priority over the PWM function; if the LED has been turned on due to the EN function then the PWM dimming pin input is ignored.

**UNDervoltage LOCKOUT**

IS32LT3175N/P integrates an undervoltage lockout function to prevent mis-operation of the device during low input voltage conditions.

Should the VCC pin voltage fall below 4.5V (Typ.), the device will turn OFF the current source and maintain the EN latch status as long as the VCC pin voltage remains above 3.8V. An external capacitor (Figure 23) is necessary to help maintain the VCC pin voltage >3.8V and to supply current to the device status latch circuitry. However, should the voltage drop below 3.8V, the internal latch will be reset to the power on default status (LED initial off state).

The current source will be turned ON when the input voltage is re-applied and the VCC pin rises above 4.6V (Typ.).

Note: In order to get the optimized effect, the recommended fading time is between 1.5s \( (R_{\text{SET}}=600k\Omega) \) and 0.25s \( (R_{\text{SET}}=100k\Omega) \).

If either the TSET_UP or TSET_DN pin is tied directly to GND, the corresponding fade function is canceled and the ramp time is about 70\( \mu \)s, or ‘instant on’. However, the debounce feature of the EN pin is not disabled.

The EN function has priority over the PWM function; if the LED has been turned on due to the EN function then the PWM dimming pin input is ignored.

**SETTING THE FADE TIME**

The fade time is set by two external programming resistors; \( R_{\text{TSET,UP}} \) and \( R_{\text{TSET,DN}} \). The \( R_{\text{TSET,UP}} \) connected to the TSET_UP pin configures the fade ramp ON time while the \( R_{\text{TSET,DN}} \) connected to the TSET_DN pin configures the fade ramp out time. The fade time (In or Out) is programmable by Equation (2):

\[
t \approx R_{\text{SET}} \times 2.5\mu s
\]

For example, \( R_{\text{SET}}=100k\Omega \), Fade In/Out time is about 0.25s.
GAMMA CORRECTION

In order to perform a better visual LED breathing effect we recommend using a gamma corrected value to set the LED intensity. This results in a reduced number of steps for the LED intensity setting, but causes the change in intensity to appear more linear to the human eye.

Gamma correction, also known as gamma compression or encoding, is used to encode linear luminance to match the non-linear characteristics of display. Gamma correction will vary the step size of the current such that the fading of the light appears linear to the human eye. Even though there may be 1000 linear steps for the fading algorithm, when gamma corrected, the actual number of steps could be as low as 63.

Table 1  63 Gamma Steps Correction

<table>
<thead>
<tr>
<th>C(0)</th>
<th>C(1)</th>
<th>C(2)</th>
<th>C(3)</th>
<th>C(4)</th>
<th>C(5)</th>
<th>C(6)</th>
<th>C(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>20</td>
<td>24</td>
<td>28</td>
<td>32</td>
<td>36</td>
<td>42</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>60</td>
<td>66</td>
<td>72</td>
<td>80</td>
<td>88</td>
<td>96</td>
<td>104</td>
<td>112</td>
</tr>
<tr>
<td>120</td>
<td>130</td>
<td>140</td>
<td>150</td>
<td>160</td>
<td>170</td>
<td>180</td>
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<td>760</td>
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<td>836</td>
<td>874</td>
<td>914</td>
<td>956</td>
<td>1000</td>
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</table>
THERMAL CONSIDERATIONS

The package thermal resistance, $\theta_JA$, determines the amount of heat that can pass from the silicon die to the surrounding ambient environment. The $\theta_JA$ is a measure of the temperature rise created by power dissipation and is usually measured in degree Celsius per watt ($^\circ\text{C/W}$). The junction temperature, $T_J$, can be calculated by the rise of the silicon temperature, $\Delta T$, the power dissipation, $P_D$, and the package thermal resistance, $\theta_JA$, as in Equation (3):

$$P_D = V_{CC} \times I_{CC} + (V_{CC} - V_{LED}) \times I_{OUT}$$

and,

$$T_J = T_A + \Delta T = T_A + P_D \times \theta_JA$$

Where $I_{CC}$ is the IC quiescent current, $V_{CC}$ is the supply voltage, $V_{LED}$ is the voltage across $V_{CC}$ to OUT and $T_A$ is the ambient temperature.

When operating the chip at high ambient temperatures, or when driving maximum load current, care must be taken to avoid exceeding the package power dissipation limits. The maximum power dissipation can be calculated using the following Equation (5):

$$P_{D(MAX)} = \frac{125^\circ\text{C} - 25^\circ\text{C}}{\theta_JA}$$

So,

$$P_{D(MAX)} = \frac{125^\circ\text{C} - 25^\circ\text{C}}{50.98^\circ\text{C/W}} \approx 1.96W$$

Figure 28, shows the power derating of the IS32LT3175 on a JEDEC board (in accordance with JESD 51-5 and JESD 51-7) standing in still air.

EMI AT THE CABLE AND INTERCONNECT LEVEL

Vehicle electronics can be affected by electromagnetic interference (EMI) caused by ‘stray’ magnetic and electric fields from automotive inductive load switching. Running throughout the vehicle are wiring harnesses which behave as “hidden antennas” and pickup these harmonic frequencies.

Because the IS32LT3175 is usually connected with a long wire to the vehicle’s central computer, it could be susceptible to EMI transients. For example, a coupled EMI transient on the wiring harness connected to the IS32LT3175’s PWM pin 8 can be passed through and cause a slight LED flicker.

To avoid this, an RC low-pass filter can be implemented to attenuate high frequency signals at the PWM pin. The low-pass filter will allow only low frequency signals from 0Hz to its cut-off frequency ($f_c$) to pass while attenuating frequencies above this cut-off frequency.

The formula to calculate the cut-off frequency of an RC filter is:

$$f_c = \frac{1}{2\pi \times R_{PWM} \times C_{PWM}}$$

As shown in Figure 30, typical values for $R_{PWM}=10k\Omega$ and $C_{PWM}=3.3nF$. For the IS32LT3175 the value of $R_{PWM}$ is fixed at 10k$\Omega$ (must always be installed) while $C_{PWM}$ is optional and its value can vary depending on the vehicle’s EMI environment.
Figures 30 and 31 show the effectiveness of the RC filter for PWM EMI attenuation and the low-pass filter gain-magnitude frequency response, respectively.

The frequency response of the RC filter can be calculated as follows:

\[
f_c = \frac{1}{2\pi \times 10k\Omega \times 3.3nF} \approx 4.7kHz
\]

Frequencies above 4.7kHz will be attenuated while frequencies below 4.7kHz will pass through without attenuation.
CLASSIFICATION REFLOW PROFILES

<table>
<thead>
<tr>
<th>Profile Feature</th>
<th>Pb-Free Assembly</th>
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<tbody>
<tr>
<td>Preheat &amp; Soak</td>
<td></td>
</tr>
<tr>
<td>Temperature min (Tsmin)</td>
<td>150°C</td>
</tr>
<tr>
<td>Temperature max (Tmax)</td>
<td>200°C</td>
</tr>
<tr>
<td>Time (Tsmin to Tmax) (ts)</td>
<td>60-120 seconds</td>
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<tr>
<td>Average ramp-up rate (Tmax to Tp)</td>
<td>3°C/second max.</td>
</tr>
<tr>
<td>Liquidous temperature (TL)</td>
<td>217°C</td>
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<tr>
<td>Time at liquidous (tL)</td>
<td>60-150 seconds</td>
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<tr>
<td>Peak package body temperature (Tp)*</td>
<td>Max 260°C</td>
</tr>
<tr>
<td>Time (tp)** within 5°C of the specified classification temperature (Tc)</td>
<td>Max 30 seconds</td>
</tr>
<tr>
<td>Average ramp-down rate (Tp to Tmax)</td>
<td>6°C/second max.</td>
</tr>
<tr>
<td>Time 25°C to peak temperature</td>
<td>8 minutes max.</td>
</tr>
</tbody>
</table>

Figure 30  Classification Profile
PACKAGE INFORMATION

SOP-8-EP

**NOTE:**

1. CONTROLLING DIMENSION : MM
2. DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION.
4. REFERENCE DOCUMENT: JEDEC MS-012
5. THE SHAPE OF BODY AND THERMAL PAD SHOW DIFFERENT SHAPE AMONG DIFFERENT FACTORIES.
Note:
1. Land pattern complies to IPC-7351.
2. All dimensions in MM.
3. This document (including dimensions, notes & specs) is a recommendation based on typical circuit board manufacturing parameters. Since land pattern design depends on many factors unknown (e.g. User’s board manufacturing specs), user must determine suitability for use.
## REVISION HISTORY

<table>
<thead>
<tr>
<th>Revision</th>
<th>Detail Information</th>
<th>Date</th>
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<tbody>
<tr>
<td>0A</td>
<td>Initial release</td>
<td>2016.05.04</td>
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</table>
| 0B       | 1. Update typical application circuit  
          | 2. Add UVLO description  
          | 3. Update Figure 24 and 25 | 2016.03.31 |
| 0C       | 1. Update functional block  
          | 2. Update EC table  
          | 3. Update Gamma Correction section  
          | 4. Update Figure 10 and 11  
          | 5. Update Automotive Grade | 2016.05.27 |
| A        | 1. Update Typical Application Circuit with RC on PWM pin  
          | 2. Add description of PWM pin EMI considering  
          | 3. Update Automotive Grade | 2016.07.19 |