High Efficiency PWM Buck LED Driver Controller

General Description

The RT8458A is a PWM controller with an integrated high side gate driver. It is used for step down converters by well controlling the external MOSFET and regulating a constant output current. The output duty cycle of the RT8458A can be up to 100% for wider input voltage application, such as E27 and PAR30 off-line LED lighting products.

The RT8458A also features a 47kHz fixed frequency oscillator, an internal −220mV precision reference, and a PWM comparator with latching logic. The accurate output LED current is achieved by an averaging current feedback loop and the LED current dimming can be easily controlled via the ACTL pin. The RT8458A also has multiple features to protect the controller from fault conditions, including Under Voltage Lockout (UVLO), Over Current Protection (OCP) and Over Voltage Protection (OVP). Additionally, to ensure the system reliability, the RT8458A is built with the thermal protection function.

The RT8458A is housed in a TSOT-23-6 package. Thus, the components in the whole LED driver system can be made very compact.

Features

- Low Cost and Efficient Buck Converter Solution
- Universal Input Voltage Range with Off-Line Topology
- Programmable Constant LED Current
- Dimmable LED Current by ACTL
- Output LED String Open Protection
- Output LED String Short Protection
- Output LED String Over Current Protection
- Built-in Thermal Protection
- TSOT-23-6 Package
- RoHS Compliant and Halogen Free

Applications

- E27, PAR30, Offline LED Lights

Marking Information

07=DNN

07= : Product Code
DNN : Date Code

Simplified Application Circuit
Functional Pin Description

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Name</th>
<th>Pin Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VCC</td>
<td>Supply Voltage Input of the Chip. For good bypass, a ceramic capacitor near the VCC pin is required.</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground of the Chip.</td>
</tr>
<tr>
<td>3</td>
<td>GATE</td>
<td>Gate Driver Output for External MOSFET Switch.</td>
</tr>
<tr>
<td>4</td>
<td>ACTL</td>
<td>Analog Dimming Control Input. The effective dimming range is between 0.1V to 1.2V. If ( V_{ACTL} ) is greater than 1.2V, the ACTL dimming signal high is internally clamped around 1.3V. If dimming is not used, a pull up resistor or a voltage holding capacitor between ACTL and GND pins should be used.</td>
</tr>
<tr>
<td>5</td>
<td>VC</td>
<td>PWM Loop Compensation Node.</td>
</tr>
<tr>
<td>6</td>
<td>SENSE</td>
<td>LED Current Sense Input. The Typical sensing threshold is (-220\text{mV}) between the SENSE and GND pin.</td>
</tr>
</tbody>
</table>
Operation

The RT8458A is a Buck PWM current mode controller with an integrated high side gate driver. The start up voltage of RT8458A is around 17V. Once VCC is above 17V, RT8458A will maintain operation until VCC drops below 8V.

The RT8458A's main control loop consists of a 47kHz fixed frequency oscillator, an internal $-220\text{mV}$ precision current sense threshold OPAMP (OP1), and a PWM comparator (CCOMP) with latching logic. In normal operation, the GATE turns high when the gate driver is set by the oscillator (OSC). The lower the average of the sensed current is below the loop-regulated $-220\text{mV}$ threshold, the higher the VC pin voltage (OP1 output) will go high. Higher the VC voltage means longer the GATE turn-on period. The GATE of RT8458A can turn on more than 100% duty. It is not always that the GATE turns low in each OSC cycle. The GATE turns low until the current comparator (CCOMP) resets the gate driver. The GATE will be set high again by OSC and the next switching cycle repeats.

The adjustment of the regulated sense current threshold (dimming) can be achieved by varying ACTL pin voltage. The typical range of ACTL voltage adjustment is between 0.1V and 1.2V.

The RT8458A is equipped with protection from several fault conditions, including input voltage Under Voltage Lockout (UVLO), Over Current Protection (OCP) and VIN/VOUT Over Voltage Protection (OVP). Additionally, to ensure the system reliability, the RT8458A is built with internal thermal protection function.
Absolute Maximum Ratings  (Note 1)

- Supply Input Voltage, VCC: -0.3V to 40V
- GATE Voltage (Note 8): -0.3V to 17V
- ACTL Voltage (Note 6): -0.3V to 8V
- VC Voltage: -0.3V to 6V
- SENSE Voltage: -1V to 0.3V
- Power Dissipation, P_D @ T_A = 25°C: 0.392W

- Package Thermal Resistance (Note 2)
  - TSOT-23-6, θJA: 255°C/W
  - TSOT-23-6, θJC: 135°C/W

- Junction Temperature: 150°C
- Lead Temperature (Soldering, 10 sec.): 260°C
- Storage Temperature Range: -65°C to 150°C
- ESD Susceptibility (Note 3)
  - HBM (Human Body Model): 2kV
  - MM (Machine Model): 200V

Recommended Operating Conditions  (Note 4)

- Supply Input Voltage, VCC: 17V to 31V
- Junction Temperature Range: -40°C to 125°C

Electrical Characteristics
(VCC = 24VDC, T_A = 25°C, unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Start-Up Voltage</td>
<td>V_ST</td>
<td>--</td>
<td>17</td>
<td>19</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Minimum Operation Voltage After Start-Up</td>
<td>V_IN(MIN)</td>
<td>--</td>
<td>8</td>
<td>9</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Maximum Startup Current in VCC Hiccup Operation</td>
<td>I_ST(MAX)</td>
<td>Maximum ICC to cause VCC stop hiccup at low end of VCC hysteresis level</td>
<td>--</td>
<td>250</td>
<td>300</td>
<td>μA</td>
</tr>
<tr>
<td>Input Supply Current</td>
<td>I_CC</td>
<td>After Start-Up, V_CC = 24V</td>
<td>--</td>
<td>2</td>
<td>5</td>
<td>mA</td>
</tr>
<tr>
<td>Input Shutdown Current</td>
<td>I_QC</td>
<td>Before Start-Up, V_CC = 5V</td>
<td>--</td>
<td>1</td>
<td>5</td>
<td>μA</td>
</tr>
</tbody>
</table>

Oscillator

- Switching Frequency | f_SW | 38 | 47 | 56 | kHz |
- Maximum Duty in Transient Operation | D_MAX(TR) | V_C = 3V | -- | -- | 100 | % |
- Maximum Duty in Steady State Operation | D_MAX | -- | 97 | -- | % |
- Blanking Time | t_BLANK (Note 7) | -- | 300 | -- | ns |
- Minimum Off Time | t_OFF(MIN) (Note 7) | -- | 600 | -- | ns |
### Absolute Maximum Ratings

- **Stresses beyond those listed** "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 conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

### Thermal Protection

- **Thermal Shutdown Temperature** $T_{SD}$
  
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GATE Driver Output</td>
<td>$V_{GATE}$</td>
<td>No Load at GATE Pin</td>
<td>--</td>
<td>12.6</td>
<td>16</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{GATE_H}$</td>
<td>$I_{GATE} = -50mA$</td>
<td>10.5</td>
<td>12.1</td>
<td>14</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{GATE_L}$</td>
<td>$I_{GATE} = -100\mu A$</td>
<td>--</td>
<td>12.5</td>
<td>--</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$I_{GATE} = 50mA$</td>
<td>0.01</td>
<td>0.75</td>
<td>1.2</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_{GATE} = 100\mu A$</td>
<td>--</td>
<td>0.5</td>
<td>--</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GATE Drive Rise Time</td>
<td>1nF Load at GATE</td>
<td>--</td>
<td>60</td>
<td>150</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>GATE Drive Fall Time</td>
<td>1nF Load at GATE</td>
<td>--</td>
<td>30</td>
<td>100</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>GATE Drive Source Peak Current</td>
<td>1nF Load at GATE</td>
<td>--</td>
<td>0.25</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>GATE Driver Sink Peak Current</td>
<td>1nF Load at GATE</td>
<td>--</td>
<td>0.5</td>
<td>0.8</td>
<td>A</td>
</tr>
</tbody>
</table>

### LED Dimming

- **Analog Dimming ACTL Pin Input Current** $I_{ACTL} V_{ACTL} = 1.2V$
  
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_{ACTL}$</td>
<td>No Load at GATE Pin</td>
<td>--</td>
<td>1</td>
<td>5</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td>$V_{ACTL_{On}}$</td>
<td>--</td>
<td>1.2</td>
<td>1.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{ACTL_{Off}}$</td>
<td>--</td>
<td>0.1</td>
<td>0.2</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

### OVP

- **Over Voltage Protection** $V_{OVP}$ $V_{CC}$ Pin
  
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_{OVP}$</td>
<td>$V_{CC}$ Pin</td>
<td>32</td>
<td>35</td>
<td>38</td>
<td>V</td>
</tr>
</tbody>
</table>

### Notes

**Note 1.** Stresses beyond those listed "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 conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

**Note 2.** $\theta_{JA}$ is measured at $T_A = 25^\circ C$ on a low effective thermal conductivity single-layer test board per JEDEC 51-3. $\theta_{JC}$ is measured at the exposed pad of the package.

**Note 3.** Devices are ESD sensitive. Handling precaution is recommended.

**Note 4.** The device is not guaranteed to function outside its operating conditions.

**Note 5.** The RT8458A achieves precise LED average current with a current feedback loop to sense the average LED current, in the deep discontinuous mode operation especially when a small inductor is used small current offset might occur due to current waveform distortion of the nature of the discontinuous operation. This offset current is consistent over production.

**Note 6.** If a $1M\Omega$ resistor is connected between the control input and ACTL pin, the control input voltage can be up to 36V.

**Note 7.** Guaranteed by design, not subjected to production test.

**Note 8.** The GATE voltage is internally clamped and varies with operating conditions.

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DS8458A-09 August 2014 www.richtek.com
**Typical Application Circuit**

VIN AC: 85V to 264V  
VOUT: 30V  
IOUT: 350mA
Typical Operating Characteristics

**Efficiency vs. Input Voltage**

- Input Voltage (V) vs. Efficiency (%)
- VIN\_AC = 85V to 264V, I\_OUT = 350mA, LED3 to LED10 pcs

**LED Current vs. Output Voltage**

- Output Voltage (V) vs. LED Current (mA)
- VIN\_AC = 110V, I\_OUT = 350mA, LED3 to LED10 pcs

**SENSE Threshold vs. Input Voltage**

- Input Voltage (V) vs. SENSE Threshold (mV)
- VIN\_AC = 85V to 264V, LED10 pcs

**SENSE Threshold vs. Temperature**

- Temperature (°C) vs. SENSE Threshold (mV)
- VIN\_AC = 85V to 264V, LED10 pcs
Application Information

The RT8458A is a high efficiency PWM Buck LED driver controller for high brightness LED application. Its high side floating gate driver is used to control the Buck converter via an external MOSFET and regulate the constant output current.

The RT8458A can achieve high accuracy LED output current via the average current feedback loop control. The internal sense voltage (−220mV typ.) is used to set the average output current. The oscillator’s frequency is fixed at 47kHz to get better switching performance. Once the average current is set by the external resistor, $R_S$, the output LED current can be dimmed by varying the ACTL voltage.

Under Voltage Lockout (UVLO)

The RT8458A includes a UVLO feature with 9V hysteresis. The GATE terminal turns on when $V_{IN}$ rises over 17V (typ.). The GATE terminal turns off when $V_{IN}$ falls below 8V (typ.).

Setting Average Output Current

The output current that flows through the LED string is set by an external resistor, $R_S$, which is connected between the GND and SENSE pins. With ACTL pin voltage greater than 1.2V, the relationship between output current, $I_{OUT}$, and $R_S$ is shown below:

$$I_{OUT} = \frac{0.22}{R_S} \text{ (A)}$$

Analog Dimming Control

The ACTL terminal is driven by an external voltage, $V_{ACTL}$, to adjust the output current to an average value set by $R_S$. The voltage range for $V_{ACTL}$ to adjust the output current is from 0.1V to 1.2V. For $V_{ACTL}$ between 0.1V to 1.2V, the output current value will be determined by the following formula:

$$I_{OUT_{avg}} = \frac{(0.22V/R_S) \times V_{ACTL} - 0.1}{1.1}$$

Component Selection

For component selection, an example is shown below for a typical RT8458A application, where $V_{IN} = 110$ to 90VAC/60Hz, LED output voltage = 30V, and output current = 200mA. The user can follow this procedure to design applications with wider AC voltage input and DC output voltage as well.

Start-up Resistor

Start-up resistor should be chosen not to exceed the maximum start-up current. Otherwise, the RT8458A may latch low and will never start. Start-up current = 130V/R1 for 110VAC regions, 260V/R1 for 220VAC regions. The typical start-up current is 250μA.

Input Diode Bridge Rectifier Selection

The current rating of the input bridge rectifier is dependent on the $V_{OUT}/V_{IN}$ transformation ratio. The voltage rating of the input bridge rectifier, $V_{BR}$, on the other hand, is only dependent on the input voltage. Thus, the $V_{BR}$ rating is calculated as below:

$$V_{BR} = 1.2 \times (\sqrt{2} \times V_{AC(MAX)})$$

where $V_{AC,Max}$ is the maximum input voltage (RMS) and the parameter 1.2 is used for safety margin.

For this example:

$$V_{BR} = 1.2 \times (\sqrt{2} \times 110) = (1.2 \times \sqrt{2} \times 110) = 187V$$

If the input source is universal, $V_{BR}$ will reach 448V. In this case, a 600V, 0.5A bridge rectifier can be chosen.

Input Capacitor Selection

The input capacitor supplies the peak current to the inductor and flattens the current ripple on the input. The low ESR condition is required to avoid increasing power loss. The ceramic capacitor is recommended due to its excellent high frequency characteristic and low ESR. For maximum stability over the entire operating temperature range, capacitors with better dielectric are suggested. The minimum capacitor is given by:

$$C_{IN} \geq \frac{V_{OUT(MAX)} \times I_{OUT(MAX)}}{[(\sqrt{2} \times V_{AC(MIN)})^2 - V_{DC(MIN)}^2] \times \eta \times f_{AC}}$$

where $f_{AC}$ is the AC input source frequency and $\eta$ is the efficiency of the whole system.

Notice that $V_{DC(MIN)}$ is the minimum voltage at bridge rectifier, output and $V_{DC(MIN)}$ should be larger than 2 x $V_{OUT(MAX)}$.

For a 90 to 264VAC universal input range, the $V_{DC(MIN)}$ is 90V, therefore the LED string voltage $V_{OUT(MAX)}$ should be less than 45V.
Thus, a 22μF / 250V electrolytic capacitor can be chosen in this case. Due to its large ESR, the electrolytic capacitor is not suggested for high current ripple applications.

**Inductor Selection**

The inductor value and operating frequency determine the ripple current according to a specific input and output voltage. The ripple current, ΔIL, increases with higher VIN and decreases with higher inductance, as shown in the following equation:

\[
\Delta I_L = \frac{V_{OUT}}{f \times L} \times \left[1 - \frac{V_{OUT}}{V_{IN}}\right]
\]

To optimize the ripple current, the RT8458A operates the Buck converter in BCM (Boundary-Condition Mode). The largest ripple current will occur at the highest VIN. To guarantee that the ripple current stays below the specified value, the inductor value should be chosen according to the following equation:

\[
L = \frac{V_{OUT} \times T_S \times (1 - D)}{2 \times I_{OUT} \times 0.2}
\]

where D is the duty cycle and T_S is the switching period.

**Forward Diode Selection**

When the power switch turns off, the path for the current is through the diode connected between the switch output and ground. This forward biased diode must have minimum voltage drop and recovery time. The reverse voltage rating of the diode should be greater than the maximum input voltage and the current rating should be greater than the maximum load current.

In reality, the peak current through the diode is more than the maximum output current. This component current rating should be greater than 1.2 times the maximum load current and the diode reverse voltage rating should be greater than 1.2 times the maximum input voltage, assuming a ±20% output current ripple.

The peak voltage stress of diode is:

\[
V_D = 1.2 \times (\sqrt{2} \times V_{AC(MAX)}) = 1.2 \times (\sqrt{2} \times 110) = 187V
\]

The current rating of diode is:

\[
I_D = 1.2 \times I_{OUT,PK} = 1.2 \times 2 = 2.88A
\]

If the input source is universal (VIN = 90V to 264V), V_D will reach 448V. A 600V, 2A ultra-fast diode can be used in this example.

**MOSFET Selection**

The peak current through this MOSFET will be over the maximum output current. This component current rating should be greater than 1.2 times the maximum load current and the reverse voltage rating of the MOSFET should be greater than 1.2 times the maximum input voltage, assuming a ±20% output current ripple.

The peak voltage rating of the MOSFET is:

\[
V_Q = 1.2 \times (\sqrt{2} \times V_{AC(MAX)}) = 1.2 \times (\sqrt{2} \times 110) = 187V
\]

The current rating of MOSFET is:

\[
I_Q = 1.2 \times I_{OUT,PK} = 1.2 \times 2 = 2.88A
\]

If the input source is universal (VIN = 90V to 264V), V_Q will reach 448V. A 600V, 2A N-MOSFET can be chosen for this example.

**Output Capacitor Selection**

The selection of COUT is determined by the required ESR to minimize output voltage ripple. Moreover, the amount of bulk capacitance is also a key for COUT selection to ensure that the control loop is stable. Loop stability can be checked by viewing the load transient response. The output voltage ripple, ΔVOUT, is determined by:

\[
\Delta V_{OUT} \leq \Delta L \left[ ESR + \frac{1}{8f_{OSC}C_{OUT}} \right]
\]

where fOSC is the switching frequency and ΔL is the inductor ripple current. The output voltage ripple will be the highest at the maximum input voltage since ΔL increases with input voltage. Multiple capacitors placed in parallel may be needed to meet the ESR and RMS current handling requirement. Dry tantalum, special polymer,
aluminum electrolytic and ceramic capacitors are all common selections and available in surface mount packages. Tantalum capacitors have the highest capacitance density, but it is important to only use ones that pass the surge test for use in switching power supplies. Special polymer capacitors offer very low ESR value, but with the trade-off of lower capacitance density. Aluminum electrolytic capacitors have significantly higher ESR, but still can be used in cost-sensitive applications for ripple current rating and long term reliability considerations.

**Layout Considerations**

For best performance of the RT8458A, the following layout guidelines should be strictly followed.

- The hold up capacitor, $C_{VCC}$, must be placed as close as possible to the VCC pin.
- The output capacitor, $C_{OUT}$, must be placed as close as possible to the LED terminal.
- The power GND should be connected to a strong ground plane.
- RS should be connected between the GND pin and SENSE pin.
- The main current traces should be kept as short and wide as possible.
- Place L1, Q1, RS, and D1 as close to each other as possible.

**Thermal Protection**

A thermal protection feature is included to protect the RT8458A from excessive heat damage. When the junction temperature exceeds a threshold of 150°C, the thermal protection will turn off the GATE terminal.

**Soldering Process of Pb-free Package Plating**

To meet the current RoHS requirements, pure tin is selected to provide forward and backward compatibility with both the current industry standard SnPb-based soldering processes and higher temperature Pb-free processes. In the whole Pb-free soldering processes pure tin is required with a maximum 260°C (<10s) for proper soldering on board, referring to J-STD-020 for more information.

**Thermal Considerations**

For continuous operation, do not exceed absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated by the following formula:

$$P_{D(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}}$$

where $T_{J(MAX)}$ is the maximum junction temperature, $T_A$ is the ambient temperature, and $\theta_{JA}$ is the junction to ambient thermal resistance.

For recommended operating condition specifications, the maximum junction temperature is 125°C. The junction to ambient thermal resistance, $\theta_{JA}$, is layout dependent. For TSOT-23-6 package, the thermal resistance, $\theta_{JA}$, is 255°C/W on a standard JEDEC 51-3 single-layer thermal test board. The maximum power dissipation at $T_A = 25°C$ can be calculated by the following formula:

$$P_{D(MAX)} = \frac{(125°C - 25°C)}{(255°C/W)} = 0.392W$$

The maximum power dissipation depends on the operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance, $\theta_{JA}$. The derating curve in Figure 1 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

![Figure 1. Derating Curve of Maximum Power Dissipation](image)

**Layout Considerations**

For best performance of the RT8458A, the following layout guidelines should be strictly followed.

- The hold up capacitor, $C_{VCC}$, must be placed as close as possible to the VCC pin.
- The output capacitor, $C_{OUT}$, must be placed as close as possible to the LED terminal.
- The power GND should be connected to a strong ground plane.
- RS should be connected between the GND pin and SENSE pin.
- Keep the main current traces as short and wide as possible.
- Place L1, Q1, RS, and D1 as close to each other as possible.
Figure 2. PCB Layout Guide

- Place the compensation components as close as possible to the IC.
- Place the capacitor CVCC as close as possible to the VCC pin.
- Narrow trace to avoid the switching noise.
- Place the output capacitor COUT as close as possible to LED terminal.
- Narrow trace to avoid the switching noise.
Outline Dimension

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimensions In Millimeters</th>
<th>Dimensions In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>A</td>
<td>0.700</td>
<td>1.000</td>
</tr>
<tr>
<td>A1</td>
<td>0.000</td>
<td>0.100</td>
</tr>
<tr>
<td>B</td>
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<tr>
<td>b</td>
<td>0.300</td>
<td>0.559</td>
</tr>
<tr>
<td>C</td>
<td>2.591</td>
<td>3.000</td>
</tr>
<tr>
<td>D</td>
<td>2.692</td>
<td>3.099</td>
</tr>
<tr>
<td>e</td>
<td>0.838</td>
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<tr>
<td>H</td>
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<td>0.254</td>
</tr>
<tr>
<td>L</td>
<td>0.300</td>
<td>0.610</td>
</tr>
</tbody>
</table>

TSOT-23-6 Surface Mount Package

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