

### FEATURES

- Up to 1A Output Current
- 70uA Operating Supply Current
- Excellent Line Regulation: 0.05%/V
- Low Dropout: 350mV@1A(VOUT=3.3V)
- High Power Supply Rejection Ratio
- Wide Operating Voltage Range: 2.5V to 6.0V
- 1V to 5V Factory-Preset Output
- High Accuracy:  $\pm 1\%$  or  $\pm 2\%$
- Built-in Auto Discharge Function
- 500mA in-rush Current Limit
- Fold-back Current Limit Protection
- Thermal Shutdown Protection
- DFN-6, SOT-89-5, SOT-89-3, SOT-223-5, SOT-223-3, TO-263-3, TO-220-3, TO-252-3 and TO-252-5 Package
- RoHS Compliant and 100% Lead (Pb)-Free

### APPLICATIONS

- Portable Communication Equipment
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments

- PCMCIA Cards and Wireless LAN
- Electrical appliances such as cameras, VCRS

### DESCRIPTION

The BL9110 is a low-dropout regulator that operates the input voltage from 2.5V to 6V and delivers 1A load current. The BL9110 is available in two types, either fixed or adjustable output voltage. The output voltage of the fixed types is preset at an internally trimmed voltage 1V, 1.2V, 1.3V, 1.5V, 1.8V, 2.5V, 2.7V, 2.8V, 2.85V, 3.0V, 3.2V, 3.3V, 5V or can be made with options of the output range from 1V to 5V in 50mV increments. The output range of adjustable types is from 1V to 5V. The BL9110 consists of a voltage reference, an error amplifier, resistor net for setting output voltage, a current limit circuit for over-current and a thermal-shutdown circuit.

A standby mode with ultra low supply current can be realized with the chip enable function. Since the packages for BL9110 are DFN-6, SOT-89-5, SOT-223-5, SOT-223-3, TO-263-3, TO-220-3, SOT-89-3, TO-252-3, TO92-3 and TO-252-5 with high power dissipation, high density mounting of the IC on board is possible.

### ORDERING INFORMATION

BL9110-VVV X X XX



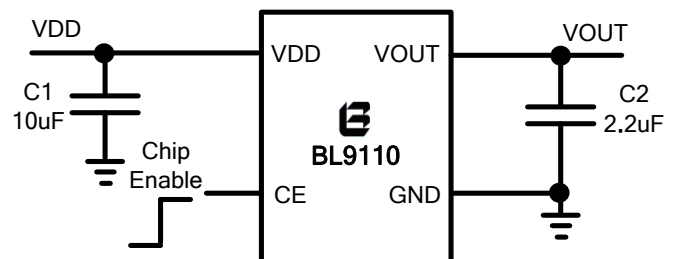
Package:  
 AA: DFN-6 BB: SOT-89-5-B  
 BA: SOT-89-5-A  
 CA: TO-252-5 DA: SOT-223-5  
 EA: TO-252-3-A EB: TO-252-3-B  
 FA: SOT-223-3-A FB: SOT-223-3-B  
 FC: SOT-223-3-C FD: SOT-223-3-D  
 GA: TO-263-3-A GB: TO-263-3-B  
 GC: TO-263-3-C  
 HA: TO-220-3  
 IA: SOT-89-3-A IB: SOT-89-3-B  
 IC: SOT-89-3-C  
 JA: TO92-3

Features:  
 P: Standard (default, lead free)  
 C: Customized

Output Voltage Accuracy  
 A:  $\pm 1\%$   
 B:  $\pm 2\%$

Output Voltage  
 100:1.0V 120:1.2V 130:1.3V 150:1.5V  
 180:1.8V 250:2.5V 270:2.7V 280:2.8V  
 285:2.85V 300:3.0V 320:3.2V 330:3.3V  
 500:5.0V  
 ADJ: adjustable

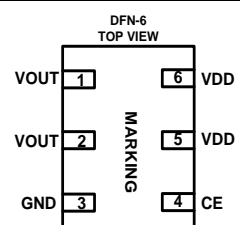
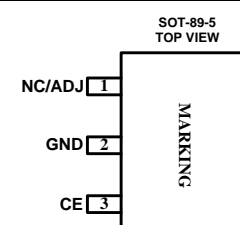
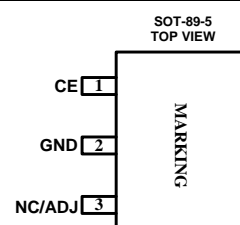
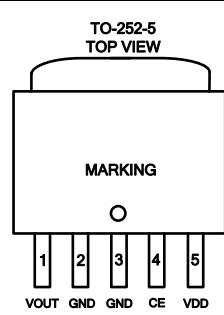
### TYPICAL APPLICATION

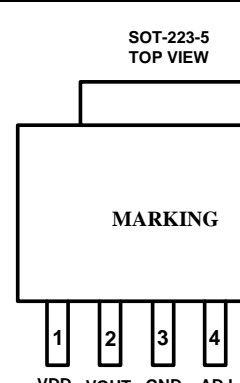
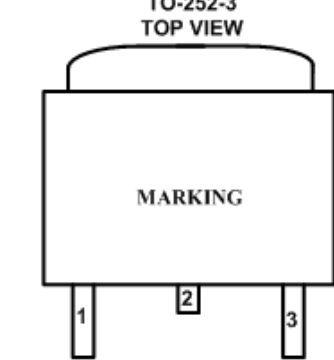
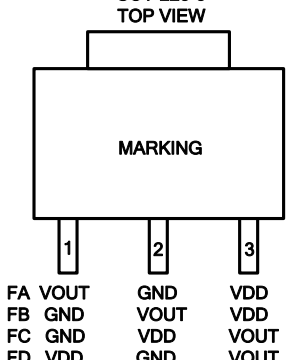
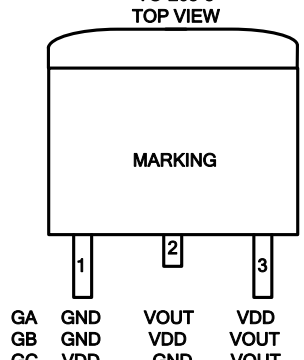


### Absolute Maximum Rating (Note 1)

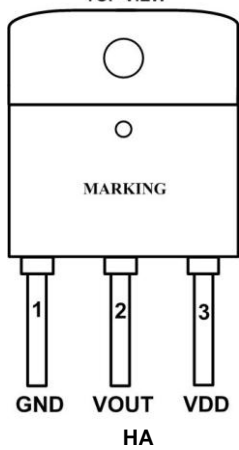
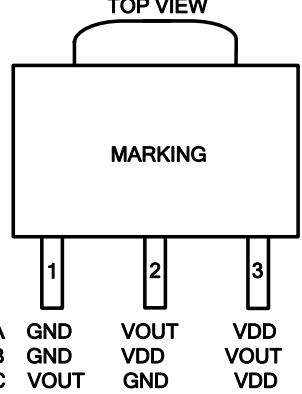
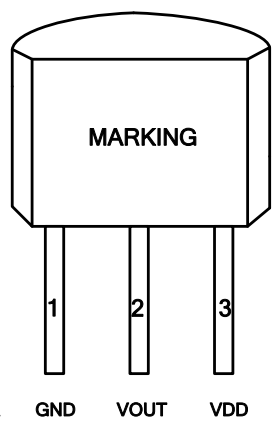
|                                   |                        |  |                |
|-----------------------------------|------------------------|--|----------------|
| Input Supply Voltage ( $V_{DD}$ ) | -0.3V to +7V           | Maximum Junction Temperature                       | 125°C          |
| CE Input Voltage                  | -0.3V to +7V           | Operating Temperature Range <small>(Note2)</small> | -40°C to 85°C  |
| Output Voltage                    | -0.3V to $V_{IN}+0.3V$ | Storage Temperature Range                          | -65°C to 125°C |
| Output Current                    | 1.4A                   | Lead Temperature (Soldering, 10s)                  | 300°C          |

### Package Information

| DFN-6<br>TOP VIEW  | SOT-89-5<br>TOP VIEW   | SOT-89-5<br>TOP VIEW  | TO-252-5<br>TOP VIEW  |
|--|--|---|---|
|  <p>VOUT 1 6 VDD<br/>VOUT 2 5 VDD<br/>GND 3 4 CE</p> <p>MARKING</p> <p>AA</p> |  <p>NC/ADJ 1 5 VOUT<br/>GND 2 4 VDD<br/>CE 3</p> <p>MARKING</p> <p>BA</p> |  <p>CE 1 5 VOUT<br/>GND 2 4 VDD<br/>NC/ADJ 3</p> <p>MARKING</p> <p>BB</p> |  <p>MARKING</p> <p>1 2 3 4 5<br/>VOUT GND GND CE VDD</p> <p>CA</p> |
| Part Number  | Top Mark   | Temp Range  |   |
| BL9110-VVVXXAA   | BL9110AA<br>YWSS VVV <small>(Note3)</small>  | -40°C to +85°C  |   |
| BL9110-VVVXXBA/B   | BL9110BA/B<br>YWSS VVV   | -40°C to +85°C  |   |
| BL9110-VVVXXCA   | BL9110CA<br>YWSS VVV   | -40°C to +85°C  |   |

| SOT-223-5<br>TOP VIEW   | TO-252-3<br>TOP VIEW  | SOT-223-3<br>TOP VIEW  | TO-263-3<br>TOP VIEW  |
|---|---|--|---|
|  <p>MARKING</p> <p>1 2 3 4 5<br/>VDD VOUT GND ADJ CE</p> |  <p>MARKING</p> <p>1 2 3<br/>EA GND VOUT VDD<br/>EB VDD GND VOUT</p> |  <p>MARKING</p> <p>1 2 3<br/>FA VOUT GND VDD<br/>FB GND VDD VDD<br/>FC GND VOUT VOUT<br/>FD VDD GND VOUT</p> |  <p>MARKING</p> <p>1 2 3<br/>GA GND VOUT VDD<br/>GB GND VDD VOUT<br/>GC VDD GND VOUT</p> |
| Part Number   | Top Mark  | Temp Range   |   |
| BL9110-VVVXXDA  | BL9110DA  | -40°C to +85°C   |   |

|                      |                                   |                |
|----------------------|-----------------------------------|----------------|
|                      | <b>YWSS VVV</b>                   |                |
| BL9110-VVVXXEA/B     | BL9110EA/B<br><b>YWSS VVV</b>     | -40°C to +85°C |
| BL9110-VVVXXFA/B/C/D | BL9110FA/B/C/D<br><b>YWSS VVV</b> | -40°C to +85°C |
| BL9110-VVVXXGA/B/C   | BL9110GA/B/C<br><b>YWSS VVV</b>   | -40°C to +85°C |

|                     |   |   |   |
|---------------------|---|---|---|
| DA                  |  <p>TO-220-3<br/>TOP VIEW</p> <p>MARKING</p> <p>1 2 3</p> <p>GND VOUT VDD</p> <p>HA</p> |  <p>SOT-89-3<br/>TOP VIEW</p> <p>MARKING</p> <p>1 2 3</p> <p>IA GND VOUT VDD<br/>IB GND VDD VOUT<br/>IC VOUT GND VDD</p> |  <p>TO92<br/>TOPVIEW</p> <p>MARKING</p> <p>1 2 3</p> <p>JA GND VOUT VDD</p> |
|                     | Part Number   | Top Mark  | Temp Range  |
| BL9110-VVVXXHA      | BL9110HA<br><b>YWSS VVV</b>   | -40°C to +85°C  |   |
| BL9110-VVVXXI/A/B/C | BL9110IA/B/C<br><b>YWSS VVV</b>   | -40°C to +85°C  |   |
| BL9110-VVVXXJA      | BL9110JA<br><b>YWSS VVV</b>   | -40°C to +85°C  |   |

### Pin Descriptions

| Symbol | Description                   |
|--------|-------------------------------|
| VOUT   | Output Pin                    |
| GND    | Ground Pin                    |
| CE     | Chip Enable Pin (High active) |
| VDD    | Input Pin                     |
| ADJ/NC | Adjustable/No Connection      |

|             |     |     |     |     |      |     |      |     |            |
|-------------|-----|-----|-----|-----|------|-----|------|-----|------------|
| VVV         | 100 | 120 | 130 | ... | 285  | ... | 495  | 500 | ADJ        |
| Voltage (V) | 1.0 | 1.2 | 1.3 | ... | 2.85 | ... | 4.95 | 5.0 | Adjustable |

|      |      |      |      |      |      |       |
|------|------|------|------|------|------|-------|
| Y    | 0    | 1    | 2    | 3    | 4    | ...   |
| Year | 2010 | 2011 | 2012 | 2013 | 2014 | ..... |

|      |    |   |     |    |           |           |     |           |
|------|----|---|-----|----|-----------|-----------|-----|-----------|
| W    | 01 | 2 | ... | 26 | 27        | 28        | ... | 52        |
| Week | A  | B | ... | Z  | $\bar{A}$ | $\bar{B}$ | ... | $\bar{Z}$ |

### Thermal Resistance <sup>(Note 4)</sup>:

| Package   | $\Theta_{JA}$ | $\Theta_{JC}$ |
|-----------|---------------|---------------|
| DFN-6     | 95°C/W        | 10°C/W        |
| SOT-89-5  | 160°C/W       | 45°C/W        |
| TO-252-5  | 90°C/W        | 10°C/W        |
| SOT-223-5 | 160°C/W       | 20°C/W        |
| TO-252-3  | 90°C/W        | 10°C/W        |
| SOT-223-3 | 160°C/W       | 20°C/W        |
| TO-263-3  | 65°C/W        | 7°C/W         |
| TO-220-3  | 50°C/W        | 7°C/W         |
| SOT89-3   | 180°C/W       | 50°C/W        |

**Note 1:** Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

**Note 2:** The BL9110 is guaranteed to meet performance specifications from 0°C to 70°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

**Note 3:** Y: Year of assembly manufacturing

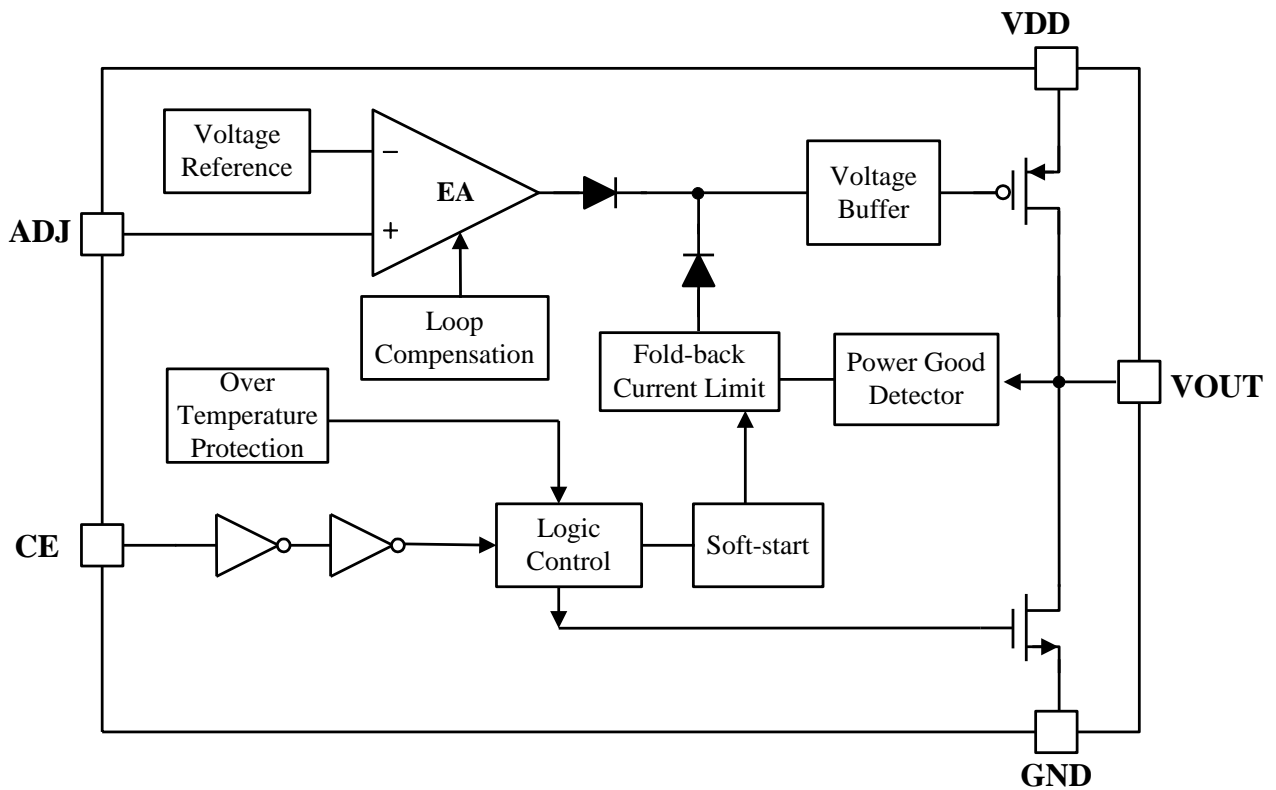
W: Week of assembly manufacturing

SS: Lot ID (the 7<sup>th</sup> and 8<sup>th</sup> number of Lot numbers)

VVV: Voltage code (for example 100 stands for 1.0V)

**Note 4:** Thermal Resistance is specified with approximately 1 square of 1 oz copper.

## Block Diagram



### Electrical Characteristics (Note 5)

#### BL9110-1.2V Electrical Characteristics

( $V_{DD}=2.5V$ ,  $V_{OUT}=1.2V$ ,  $C_E=V_{DD}$ ,  $C_{IN}=2.2\mu F$ ,  $C_{OUT}=2.2\mu F$ ,  $T_A=25^\circ C$ , unless otherwise noted.)

| Parameter  | Symbol                            | Conditions  | MIN   | TYP       | MAX  | unit            |
|--|-----------------------------------|---|---|-----------|------|-----------------|
| Input Voltage                                    | $V_{DD}$                          |   | 2.5   |           | 6    | V               |
| Output Voltage Accuracy (Note 6)                 | $\Delta V_{OUT}$                  | $I_{OUT}=1mA$   | -1  |           | +1   | %               |
|  |                                   |   | -2  |           | +2   |                 |
| Current Limit                                    | $I_{LIM}$                         |   | 1.0   | 1.3       |      | A               |
| Short Circuit Current                            | $I_{SCC}$                         | $V_{OUT}=0$   |   | 250       |      | mA              |
| Quiescent Current                                | $I_Q$                             | $I_{OUT}=0mA$   |   | 70        | 120  | $\mu A$         |
| Standby Current                                  | $I_{STBY}$                        | $V_{CE}=GND$ , Shutdown                                 |   | 0.01      | 1    | $\mu A$         |
| Dropout Voltage (note 7)                         | $V_{DROP}$                        | $I_{OUT}=300mA$   |   | 420       | 715  | mV              |
|  |                                   | $I_{OUT}=1A$  |   | 870       | 1310 |                 |
| Line Regulation (Note 8)                         | $\Delta V_{LINE}$                 | $2.5V \leq V_{DD} \leq 6V$ , $I_{OUT}=100mA$            |   | 0.05      | 0.5  | %/V             |
| Load Regulation (Note 9)                         | $\Delta V_{LOAD}$                 | $1mA \leq I_{OUT} \leq 1A$                              |   | 20        |      | mV              |
| Output Voltage Temperature Coefficient (Note 10) | $TC_{VOUT}$                       | $I_{OUT}=100mA$<br>$-40^\circ C \leq T \leq 85^\circ C$ |   | $\pm 100$ |      | ppm/ $^\circ C$ |
| CE Input Threshold                               | Logic Low                         | $V_{IL}$  |   |           | 0.4  | V               |
|  | Logic High                        | $V_{IH}$  |   | 1.0       |      | V               |
| CE Pull-down Resistance                          | $R_{CE}$                          |   |   | 5         |      | M $\Omega$      |
| Output Noise Voltage                             | $e_{NO}$                          | 10Hz to 100KHz, $I_{OUT}=1mA$                           |   | 45        |      | $\mu V_{RMS}$   |
| Power Supply Rejection Ratio                     | f=1kHz<br>( $V_{OUT} \leq 3.3V$ ) | PSRR  | 0.2V <sub>P-P</sub> Ripple<br>$I_{OUT}=100mA$ |           | 70   | dB              |
|  | f=1kHz<br>( $V_{OUT} > 3.3V$ )    |   |   |           | 60   |                 |
| Thermal Shutdown Temperature                     | $T_{SD}$                          | Shutdown, Temp increasing                               |   | 165       |      | $^\circ C$      |
| Thermal Shutdown Hysteresis                      | $T_{SDHY}$                        |   |   | 30        |      | $^\circ C$      |
| Output Discharge Resistance                      | $R_{DSC}$                         |   |   | 50        |      | $\Omega$        |

**Note 5:** 100% production test at  $+25^\circ C$ . Specifications over the temperature range are guaranteed by design and characterization.

**Note 6:** This IC includes two kinds of output voltage accuracy versions. A:  $\pm 1\%$ , B:  $\pm 2\%$ .

**Note 7:** The required minimum input operating voltage is equal to  $V_{OUT} + V_{DROP}$ , and if  $V_{OUT} + V_{DROP} < 2.5V$ , the required minimum input operating voltage must be set to 2.5V.  $V_{OUT}$  is the normal output voltage, e.g.  $V_{OUT}=2.8V$  for 2.8V fixed output version.

**Note 8:** Line regulation is calculated by 
$$\Delta V_{LINE} = \left( \frac{V_{OUT1} - V_{OUT2}}{\Delta V_{DD} \times V_{OUT}} \right) \times 100$$

Where  $V_{OUT1}$  is the output voltage when  $V_{DD1}=6.0V$ ,  $V_{OUT2}$  is the output voltage when  $V_{DD2} = \max(V_{OUT} + 0.5V, 2.5V)$ .  $\Delta V_{DD} = V_{DD1} - V_{DD2}$ .

**Note 9:** Load regulation is calculated by 
$$\Delta V_{LOAD} = V_{OUT1} - V_{OUT2}$$

Where  $V_{OUT1}$  is the output voltage when  $I_{OUT1}=1mA$ , and  $V_{OUT2}$  is the output voltage when  $I_{OUT2}=1A$ .

**Note 10:** The temperature coefficient is calculated by 
$$TC_{VOUT} = \frac{\Delta V_{OUT}}{\Delta T \times V_{OUT}}$$

### BL9110-1.5V Electrical Characteristics

( $V_{DD}=2.5V$ ,  $V_{OUT}=1.5V$ ,  $CE=V_{DD}$ ,  $C_{IN}=2.2\mu F$ ,  $C_{OUT}=2.2\mu F$ ,  $T_A=25^\circ C$ , unless otherwise noted.)

| Parameter  | Symbol                            | Conditions  | MIN   | TYP       | MAX  | unit            |
|--|-----------------------------------|---|---|-----------|------|-----------------|
| Input Voltage                                    | $V_{DD}$                          |   | 2.5   |           | 6    | V               |
| Output Voltage Accuracy (Note 6)                 | $\Delta V_{OUT}$                  | $I_{OUT}=1mA$   | -1  |           | +1   | %               |
|  |                                   |   | -2  |           | +2   |                 |
| Current Limit                                    | $I_{LIM}$                         |   | 1.0   | 1.3       |      | A               |
| Short Circuit Current                            | $I_{SCC}$                         | $V_{OUT}=0$   |   | 250       |      | mA              |
| Quiescent Current                                | $I_Q$                             | $I_{OUT}=0mA$   |   | 70        | 120  | $\mu A$         |
| Standby Current                                  | $I_{STBY}$                        | $V_{CE}=GND$ , Shutdown                                 |   | 0.01      | 1    | $\mu A$         |
| Dropout Voltage (note 7)                         | $V_{DROP}$                        | $I_{OUT}=300mA$   |   | 260       | 445  | mV              |
|  |                                   | $I_{OUT}=1A$  |   | 700       | 1050 |                 |
| Line Regulation (Note 8)                         | $\Delta V_{LINE}$                 | $2.5V \leq V_{DD} \leq 6V$ , $I_{OUT}=100mA$            |   | 0.05      | 0.5  | %/V             |
| Load Regulation (Note 9)                         | $\Delta V_{LOAD}$                 | $1mA \leq I_{OUT} \leq 1A$                              |   | 20        |      | mV              |
| Output Voltage Temperature Coefficient (Note 10) | $TC_{VOUT}$                       | $I_{OUT}=100mA$<br>$-40^\circ C \leq T \leq 85^\circ C$ |   | $\pm 100$ |      | ppm/ $^\circ C$ |
| Input Threshold                                  | CE Logic Low                      | $V_{IL}$  |   |           | 0.4  | V               |
|  | CE Logic High                     | $V_{IH}$  |   | 1.0       |      | V               |
| CE Pull-down Resistance                          | $R_{CE}$                          |   |   | 5         |      | $M\Omega$       |
| Output Noise Voltage                             | $e_{NO}$                          | 10Hz to 100KHz, $I_{OUT}=1mA$                           |   | 45        |      | $\mu V_{RMS}$   |
| Power Supply Rejection Ratio                     | f=1kHz<br>( $V_{OUT} \leq 3.3V$ ) | PSRR  | 0.2V <sub>P-P</sub> Ripple<br>$I_{OUT}=100mA$ |           | 70   | dB              |
|  | f=1kHz<br>( $V_{OUT} > 3.3V$ )    |   |   |           | 60   |                 |
| Thermal Shutdown Temperature                     | $T_{SD}$                          | Shutdown, Temp increasing                               |   | 165       |      | $^\circ C$      |
| Thermal Shutdown Hysteresis                      | $T_{SDHY}$                        |   |   | 30        |      | $^\circ C$      |
| Output Discharge Resistance                      | $R_{DSC}$                         |   |   | 50        |      | $\Omega$        |

**Note 5:** 100% production test at +25 $^\circ C$ . Specifications over the temperature range are guaranteed by design and characterization.

**Note 6:** This IC includes two kinds of output voltage accuracy versions. A:  $\pm 1\%$ , B:  $\pm 2\%$ .

**Note 7:** The required minimum input operating voltage is equal to  $V_{OUT}+V_{DROP}$ , and if  $V_{OUT}+V_{DROP} < 2.5V$ , the required minimum input operating voltage must be set to 2.5V.  $V_{OUT}$  is the normal output voltage, e.g.  $V_{OUT}=2.8V$  for 2.8V fixed output version.

**Note 8:** Line regulation is calculated by 
$$\Delta V_{LINE} = \left( \frac{V_{OUT1} - V_{OUT2}}{\Delta V_{DD} \times V_{OUT}} \right) \times 100$$

Where  $V_{OUT1}$  is the output voltage when  $V_{DD1}=6.0V$ ,  $V_{OUT2}$  is the output voltage when  $V_{DD2} = \max(V_{OUT}+0.5V, 2.5V)$ .  
 $\Delta V_{DD} = V_{DD1} - V_{DD2}$ .

**Note 9:** Load regulation is calculated by 
$$\Delta V_{LOAD} = V_{OUT1} - V_{OUT2}$$

Where  $V_{OUT1}$  is the output voltage when  $I_{OUT1}=1mA$ , and  $V_{OUT2}$  is the output voltage when  $I_{OUT2}=1.0A$ .

**Note 10:** The temperature coefficient is calculated by 
$$TC_{VOUT} = \frac{\Delta V_{OUT}}{\Delta T \times V_{OUT}}$$

### BL9110-1.8V Electrical Characteristics

( $V_{DD}=2.8V$ ,  $V_{OUT}=1.8V$ ,  $CE=V_{DD}$ ,  $C_{IN}=2.2\mu F$ ,  $C_{OUT}=2.2\mu F$ ,  $T_A=25^\circ C$ , unless otherwise noted.)

| Parameter  | Symbol                            | Conditions  | MIN   | TYP       | MAX | unit            |
|--|-----------------------------------|---|---|-----------|-----|-----------------|
| Input Voltage                                    | $V_{DD}$                          |   | 2.5   |           | 6   | V               |
| Output Voltage Accuracy (Note 6)                 | $\Delta V_{OUT}$                  | $I_{OUT}=1mA$   | -1  |           | +1  | %               |
|  |                                   |   | -2  |           | +2  |                 |
| Current Limit                                    | $I_{LIM}$                         |   | 1.0   | 1.3       |     | A               |
| Short Circuit Current                            | $I_{SCC}$                         | $V_{OUT}=0$   |   | 250       |     | mA              |
| Quiescent Current                                | $I_Q$                             | $I_{OUT}=0mA$   |   | 70        | 120 | $\mu A$         |
| Standby Current                                  | $I_{STBY}$                        | $V_{CE}=GND$ , Shutdown                                 |   | 0.01      | 1   | $\mu A$         |
| Dropout Voltage (note 7)                         | $V_{DROP}$                        | $I_{OUT}=300mA$   |   | 180       | 308 | mV              |
|  |                                   | $I_{OUT}=1A$  |   | 570       | 855 |                 |
| Line Regulation (Note 8)                         | $\Delta V_{LINE}$                 | $2.5V \leq V_{DD} \leq 6V$ , $I_{OUT}=100mA$            |   | 0.05      | 0.5 | %/V             |
| Load Regulation (Note 9)                         | $\Delta V_{LOAD}$                 | $1mA \leq I_{OUT} \leq 1A$                              |   | 20        |     | mV              |
| Output Voltage Temperature Coefficient (Note 10) | $TC_{VOUT}$                       | $I_{OUT}=100mA$<br>$-40^\circ C \leq T \leq 85^\circ C$ |   | $\pm 100$ |     | ppm/ $^\circ C$ |
| Input Threshold                                  | CE Logic Low                      | $V_{IL}$  |   |           | 0.4 | V               |
|  | CE Logic High                     | $V_{IH}$  |   | 1.0       |     | V               |
| CE Pull-down Resistance                          | $R_{CE}$                          |   |   | 5         |     | $M\Omega$       |
| Output Noise Voltage                             | $e_{NO}$                          | 10Hz to 100KHz, $I_{OUT}=1mA$                           |   | 45        |     | $\mu V_{RMS}$   |
| Power Supply Rejection Ratio                     | f=1kHz<br>( $V_{OUT} \leq 3.3V$ ) | PSRR  | 0.2V <sub>P-P</sub> Ripple<br>$I_{OUT}=100mA$ |           | 70  | dB              |
|  | f=1kHz<br>( $V_{OUT} > 3.3V$ )    |   |   |           | 60  |                 |
| Thermal Shutdown Temperature                     | $T_{SD}$                          | Shutdown, Temp increasing                               |   | 165       |     | $^\circ C$      |
| Thermal Shutdown Hysteresis                      | $T_{SDHY}$                        |   |   | 30        |     | $^\circ C$      |
| Output Discharge Resistance                      | $R_{DSC}$                         |   |   | 50        |     | $\Omega$        |

**Note 5:** 100% production test at  $+25^\circ C$ . Specifications over the temperature range are guaranteed by design and characterization.

**Note 6:** This IC includes two kinds of output voltage accuracy versions. A:  $\pm 1\%$ , B:  $\pm 2\%$ .

**Note 7:** The required minimum input operating voltage is equal to  $V_{OUT} + V_{DROP}$ , and if  $V_{OUT} + V_{DROP} < 2.5V$ , the required minimum input operating voltage must be set to 2.5V.  $V_{OUT}$  is the normal output voltage, e.g.  $V_{OUT}=2.8V$  for 2.8V fixed output version.

**Note 8:** Line regulation is calculated by 
$$\Delta V_{LINE} = \left( \frac{V_{OUT1} - V_{OUT2}}{\Delta V_{DD} \times V_{OUT}} \right) \times 100$$

Where  $V_{OUT1}$  is the output voltage when  $V_{DD1}=6.0V$ ,  $V_{OUT2}$  is the output voltage when  $V_{DD2} = \max(V_{OUT} + 0.5V, 2.5V)$ .  
 $\Delta V_{DD} = V_{DD1} - V_{DD2}$ .

**Note 9:** Load regulation is calculated by 
$$\Delta V_{LOAD} = V_{OUT1} - V_{OUT2}$$

Where  $V_{OUT1}$  is the output voltage when  $I_{OUT1}=1mA$ , and  $V_{OUT2}$  is the output voltage when  $I_{OUT2}=1.0A$ .

**Note 10:** The temperature coefficient is calculated by 
$$TC_{VOUT} = \frac{\Delta V_{OUT}}{\Delta T \times V_{OUT}}$$



### BL9110-2.5V Electrical Characteristics

( $V_{DD}=3.5V$ ,  $V_{OUT}=2.5V$ ,  $C_E=V_{DD}$ ,  $C_{IN}=2.2\mu F$ ,  $C_{OUT}=2.2\mu F$ ,  $T_A=25^\circ C$ , unless otherwise noted.)

| Parameter  | Symbol                            | Conditions  | MIN   | TYP       | MAX | unit            |
|--|-----------------------------------|---|---|-----------|-----|-----------------|
| Input Voltage                                    | $V_{DD}$                          |   | 2.5   |           | 6   | V               |
| Output Voltage Accuracy (Note 6)                 | $\Delta V_{OUT}$                  | $I_{OUT}=1mA$   | -1  |           | +1  | %               |
|  |                                   |   | -2  |           | +2  |                 |
| Current Limit                                    | $I_{LIM}$                         |   | 1.0   | 1.3       |     | A               |
| Short Circuit Current                            | $I_{SCC}$                         | $V_{OUT}=0$   |   | 250       |     | mA              |
| Quiescent Current                                | $I_Q$                             | $I_{OUT}=0mA$   |   | 70        | 120 | $\mu A$         |
| Standby Current                                  | $I_{STBY}$                        | $V_{CE}=GND$ , Shutdown                                 |   | 0.01      | 1   | $\mu A$         |
| Dropout Voltage (note 7)                         | $V_{DROP}$                        | $I_{OUT}=300mA$   |   | 140       | 240 | mV              |
|  |                                   | $I_{OUT}=1A$  |   | 440       | 660 |                 |
| Line Regulation (Note 8)                         | $\Delta V_{LINE}$                 | $3.0V \leq V_{DD} \leq 6V$ , $I_{OUT}=100mA$            |   | 0.05      | 0.5 | %/V             |
| Load Regulation (Note 9)                         | $\Delta V_{LOAD}$                 | $1mA \leq I_{OUT} \leq 1A$                              |   | 20        |     | mV              |
| Output Voltage Temperature Coefficient (Note 10) | $TC_{VOUT}$                       | $I_{OUT}=100mA$<br>$-40^\circ C \leq T \leq 85^\circ C$ |   | $\pm 100$ |     | ppm/ $^\circ C$ |
| Input Threshold                                  | CE Logic Low                      | $V_{IL}$  |   |           | 0.4 | V               |
|  | CE Logic High                     | $V_{IH}$  |   | 1.0       |     | V               |
| CE Pull-down Resistance                          | $R_{CE}$                          |   |   | 5         |     | $M\Omega$       |
| Output Noise Voltage                             | $e_{NO}$                          | 10Hz to 100KHz, $I_{OUT}=1mA$                           |   | 45        |     | $\mu V_{RMS}$   |
| Power Supply Rejection Ratio                     | f=1kHz<br>( $V_{OUT} \leq 3.3V$ ) | PSRR  | 0.2V <sub>P-P</sub> Ripple<br>$I_{OUT}=100mA$ |           | 70  | dB              |
|  | f=1kHz<br>( $V_{OUT} > 3.3V$ )    |   |   |           | 60  |                 |
| Thermal Shutdown Temperature                     | $T_{SD}$                          | Shutdown, Temp increasing                               |   | 165       |     | $^\circ C$      |
| Thermal Shutdown Hysteresis                      | $T_{SDHY}$                        |   |   | 30        |     | $^\circ C$      |
| Output Discharge Resistance                      | $R_{DSC}$                         |   |   | 50        |     | $\Omega$        |

**Note 5:** 100% production test at +25 $^\circ C$ . Specifications over the temperature range are guaranteed by design and characterization.

**Note 6:** This IC includes two kinds of output voltage accuracy versions. A:  $\pm 1\%$ , B:  $\pm 2\%$ .

**Note 7:** The required minimum input operating voltage is equal to  $V_{OUT}+V_{DROP}$ , and if  $V_{OUT}+V_{DROP} < 2.5V$ , the required minimum input operating voltage must be set to 2.5V.  $V_{OUT}$  is the normal output voltage, e.g.  $V_{OUT}=2.8V$  for 2.8V fixed output version.

**Note 8:** Line regulation is calculated by 
$$\Delta V_{LINE} = \left( \frac{V_{OUT1} - V_{OUT2}}{\Delta V_{DD} \times V_{OUT}} \right) \times 100$$

Where  $V_{OUT1}$  is the output voltage when  $V_{DD1}=6.0V$ ,  $V_{OUT2}$  is the output voltage when  $V_{DD2} = \max(V_{OUT}+0.5V, 2.5V)$ .  
 $\Delta V_{DD} = V_{DD1} - V_{DD2}$ .

**Note 9:** Load regulation is calculated by 
$$\Delta V_{LOAD} = V_{OUT1} - V_{OUT2}$$

Where  $V_{OUT1}$  is the output voltage when  $I_{OUT1}=1mA$ , and  $V_{OUT2}$  is the output voltage when  $I_{OUT2}=1.0A$ .

**Note 10:** The temperature coefficient is calculated by 
$$TC_{VOUT} = \frac{\Delta V_{OUT}}{\Delta T \times V_{OUT}}$$

### BL9110-3.3V Electrical Characteristics

( $V_{DD}=4.3V$ ,  $V_{OUT}=3.3V$ ,  $C_E=V_{DD}$ ,  $C_{IN}=2.2\mu F$ ,  $C_{OUT}=2.2\mu F$ ,  $T_A=25^\circ C$ , unless otherwise noted.)

| Parameter  | Symbol                            | Conditions  | MIN   | TYP       | MAX | unit            |
|--|-----------------------------------|---|---|-----------|-----|-----------------|
| Input Voltage                                    | $V_{DD}$                          |   | 2.5   |           | 6   | V               |
| Output Voltage Accuracy (Note 6)                 | $\Delta V_{OUT}$                  | $I_{OUT}=1mA$   | -1  |           | +1  | %               |
|  |                                   |   | -2  |           | +2  |                 |
| Current Limit                                    | $I_{LIM}$                         |   | 1.0   | 1.3       |     | A               |
| Short Circuit Current                            | $I_{SCC}$                         | $V_{OUT}=0$   |   | 250       |     | mA              |
| Quiescent Current                                | $I_Q$                             | $I_{OUT}=0mA$   |   | 70        | 120 | $\mu A$         |
| Standby Current                                  | $I_{STBY}$                        | $V_{CE}=GND$ , Shutdown                                 |   | 0.01      | 1   | $\mu A$         |
| Dropout Voltage (note 7)                         | $V_{DROP}$                        | $I_{OUT}=300mA$   |   | 110       | 188 | mV              |
|  |                                   | $I_{OUT}=1A$  |   | 350       | 525 |                 |
| Line Regulation (Note 8)                         | $\Delta V_{LINE}$                 | $3.8V \leq V_{DD} \leq 6V$ , $I_{OUT}=100mA$            |   | 0.05      | 0.5 | %/V             |
| Load Regulation (Note 9)                         | $\Delta V_{LOAD}$                 | $1mA \leq I_{OUT} \leq 1A$                              |   | 20        |     | mV              |
| Output Voltage Temperature Coefficient (Note 10) | $TC_{VOUT}$                       | $I_{OUT}=100mA$<br>$-40^\circ C \leq T \leq 85^\circ C$ |   | $\pm 100$ |     | ppm/ $^\circ C$ |
| Input Threshold                                  | CE Logic Low                      | $V_{IL}$  |   |           | 0.4 | V               |
|  | CE Logic High                     | $V_{IH}$  |   | 1.0       |     | V               |
| CE Pull-down Resistance                          | $R_{CE}$                          |   |   | 5         |     | M $\Omega$      |
| Output Noise Voltage                             | $e_{NO}$                          | 10Hz to 100KHz, $I_{OUT}=1mA$                           |   | 45        |     | $\mu V_{RMS}$   |
| Power Supply Rejection Ratio                     | f=1kHz<br>( $V_{OUT} \leq 3.3V$ ) | PSRR  | 0.2V <sub>P-P</sub> Ripple<br>$I_{OUT}=100mA$ |           | 70  | dB              |
|  | f=1kHz<br>( $V_{OUT} > 3.3V$ )    |   |   |           | 60  |                 |
| Thermal Shutdown Temperature                     | $T_{SD}$                          | Shutdown, Temp increasing                               |   | 165       |     | $^\circ C$      |
| Thermal Shutdown Hysteresis                      | $T_{SDHY}$                        |   |   | 30        |     | $^\circ C$      |
| Output Discharge Resistance                      | $R_{DSC}$                         |   |   | 50        |     | $\Omega$        |

**Note 5:** 100% production test at +25 $^\circ C$ . Specifications over the temperature range are guaranteed by design and characterization.

**Note 6:** This IC includes two kinds of output voltage accuracy versions. A:  $\pm 1\%$ , B:  $\pm 2\%$ .

**Note 7:** The required minimum input operating voltage is equal to  $V_{OUT}+V_{DROP}$ , and if  $V_{OUT}+V_{DROP} < 2.5V$ , the required minimum input operating voltage must be set to 2.5V.  $V_{OUT}$  is the normal output voltage, e.g.  $V_{OUT}=2.8V$  for 2.8V fixed output version.

**Note 8:** Line regulation is calculated by 
$$\Delta V_{LINE} = \left( \frac{V_{OUT1} - V_{OUT2}}{\Delta V_{DD} \times V_{OUT}} \right) \times 100$$

Where  $V_{OUT1}$  is the output voltage when  $V_{DD1}=6.0V$ ,  $V_{OUT2}$  is the output voltage when  $V_{DD2} = \max(V_{OUT}+0.5V, 2.5V)$ .  
 $\Delta V_{DD} = V_{DD1} - V_{DD2}$ .

**Note 9:** Load regulation is calculated by 
$$\Delta V_{LOAD} = V_{OUT1} - V_{OUT2}$$

Where  $V_{OUT1}$  is the output voltage when  $I_{OUT1}=1mA$ , and  $V_{OUT2}$  is the output voltage when  $I_{OUT2}=1.0A$ .

**Note 10:** The temperature coefficient is calculated by 
$$TC_{VOUT} = \frac{\Delta V_{OUT}}{\Delta T \times V_{OUT}}$$
.

### BL9110-5.0V Electrical Characteristics

( $V_{DD}=6.0V$ ,  $V_{OUT}=5.0V$ ,  $C_E=V_{DD}$ ,  $C_{IN}=2.2\mu F$ ,  $C_{OUT}=2.2\mu F$ ,  $T_A=25^\circ C$ , unless otherwise noted.)

| Parameter  | Symbol                            | Conditions  | MIN   | TYP       | MAX | unit            |
|--|-----------------------------------|---|---|-----------|-----|-----------------|
| Input Voltage                                    | $V_{DD}$                          |   | 2.5   |           | 6   | V               |
| Output Voltage Accuracy (Note 6)                 | $\Delta V_{OUT}$                  | $I_{OUT}=1mA$   | -1  |           | +1  | %               |
|  |                                   |   | -2  |           | +2  |                 |
| Current Limit                                    | $I_{LIM}$                         |   | 1.0   | 1.3       |     | A               |
| Short Circuit Current                            | $I_{SCC}$                         | $V_{OUT}=0$   |   | 250       |     | mA              |
| Quiescent Current                                | $I_Q$                             | $I_{OUT}=0mA$   |   | 70        | 120 | $\mu A$         |
| Standby Current                                  | $I_{STBY}$                        | $V_{CE}=GND$ , Shutdown                                 |   | 0.01      | 1   | $\mu A$         |
| Dropout Voltage (note 7)                         | $V_{DROP}$                        | $I_{OUT}=300mA$   |   | 100       | 170 | mV              |
|  |                                   | $I_{OUT}=1A$  |   | 340       | 510 |                 |
| Line Regulation (Note 8)                         | $\Delta V_{LINE}$                 | $5.5V \leq V_{DD} \leq 6V$ , $I_{OUT}=100mA$            |   | 0.05      | 0.5 | %/V             |
| Load Regulation (Note 9)                         | $\Delta V_{LOAD}$                 | $1mA \leq I_{OUT} \leq 1A$                              |   | 20        |     | mV              |
| Output Voltage Temperature Coefficient (Note 10) | $TC_{VOUT}$                       | $I_{OUT}=100mA$<br>$-40^\circ C \leq T \leq 85^\circ C$ |   | $\pm 100$ |     | ppm/ $^\circ C$ |
| CE Input Threshold                               | Logic Low                         | $V_{IL}$  |   |           | 0.4 | V               |
|  | Logic High                        | $V_{IH}$  |   | 1.0       |     | V               |
| CE Pull-down Resistance                          | $R_{CE}$                          |   |   | 5         |     | $M\Omega$       |
| Output Noise Voltage                             | $e_{NO}$                          | 10Hz to 100KHz, $I_{OUT}=1mA$                           |   | 45        |     | $\mu V_{RMS}$   |
| Power Supply Rejection Ratio                     | f=1kHz<br>( $V_{OUT} \leq 3.3V$ ) | PSRR  | 0.2V <sub>P-P</sub> Ripple<br>$I_{OUT}=100mA$ |           | 70  | dB              |
|  | f=1kHz<br>( $V_{OUT} > 3.3V$ )    |   |   |           | 60  |                 |
| Thermal Shutdown Temperature                     | $T_{SD}$                          | Shutdown, Temp increasing                               |   | 165       |     | $^\circ C$      |
| Thermal Shutdown Hysteresis                      | $T_{SDHY}$                        |   |   | 30        |     | $^\circ C$      |
| Output Discharge Resistance                      | $R_{DSC}$                         |   |   | 50        |     | $\Omega$        |

**Note 5:** 100% production test at +25 $^\circ C$ . Specifications over the temperature range are guaranteed by design and characterization.

**Note 6:** This IC includes two kinds of output voltage accuracy versions. A:  $\pm 1\%$ , B:  $\pm 2\%$ .

**Note 7:** The required minimum input operating voltage is equal to  $V_{OUT}+V_{DROP}$ , and if  $V_{OUT}+V_{DROP} < 2.5V$ , the required minimum input operating voltage must be set to 2.5V.  $V_{OUT}$  is the normal output voltage, e.g.  $V_{OUT}=2.8V$  for 2.8V fixed output version.

**Note 8:** Line regulation is calculated by 
$$\Delta V_{LINE} = \left( \frac{V_{OUT1} - V_{OUT2}}{\Delta V_{DD} \times V_{OUT}} \right) \times 100$$

Where  $V_{OUT1}$  is the output voltage when  $V_{DD1}=6.0V$ ,  $V_{OUT2}$  is the output voltage when  $V_{DD2} = \max(V_{OUT}+0.5V, 2.5V)$ .  
 $\Delta V_{DD} = V_{DD1} - V_{DD2}$ .

**Note 9:** Load regulation is calculated by 
$$\Delta V_{LOAD} = V_{OUT1} - V_{OUT2}$$

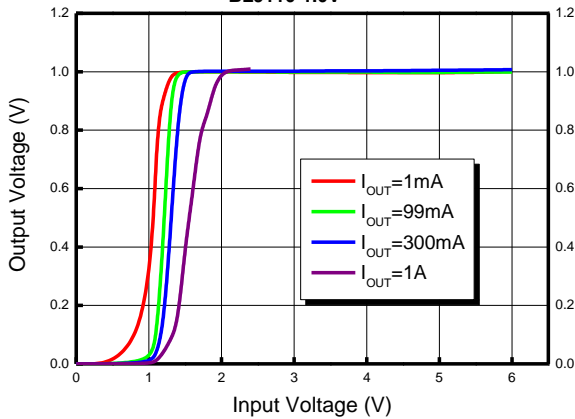
Where  $V_{OUT1}$  is the output voltage when  $I_{OUT1}=1mA$ , and  $V_{OUT2}$  is the output voltage when  $I_{OUT2}=1.0A$ .

**Note 10:** The temperature coefficient is calculated by 
$$TC_{VOUT} = \frac{\Delta V_{OUT}}{\Delta T \times V_{OUT}}$$
.

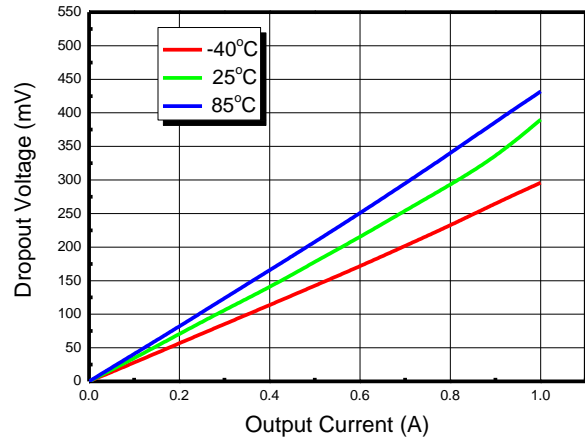
## Typical Performance Characteristic

( $V_{DD}=V_{OUT}+1V$ , and if  $V_{OUT}<1.5V$ ,  $V_{DD}=2.5V$   $C_E=V_{DD}$ ,  $C_{IN}=2.2\mu F$ ,  $C_{OUT}=2.2\mu F$ ,  $T_A=25^\circ C$ , unless otherwise noted.)

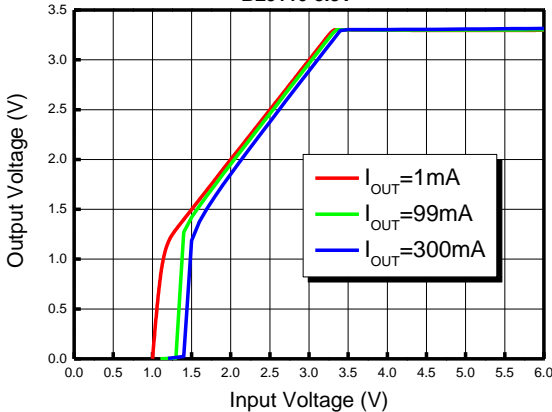
**Output Voltage VS. Input Voltage**  
BL9110-1.0V



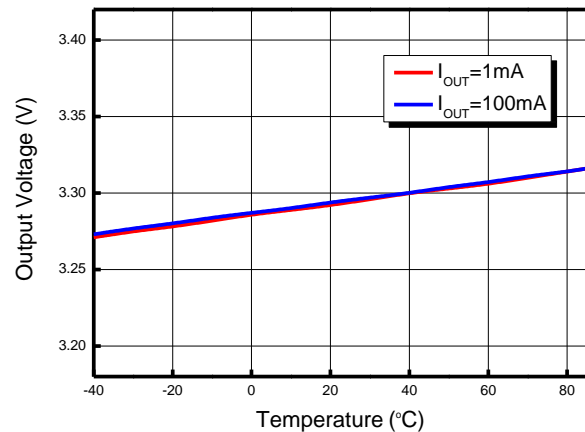
**Dropout Voltage VS. Output Current**  
BL9110-3.3V



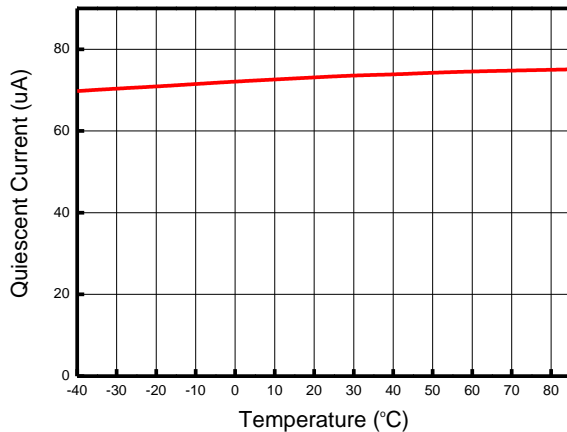
**Output Voltage VS. Input Voltage**  
BL9110-3.3V



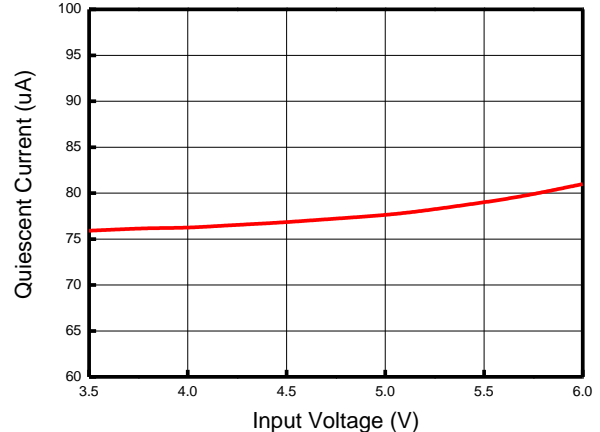
**Output Voltage VS. Temperature**  
BL9110-3.3V



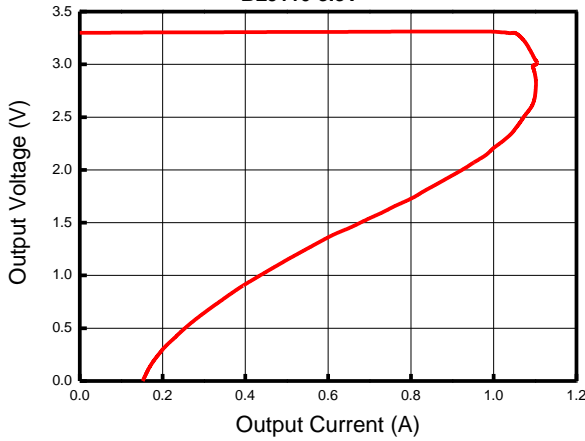
**Quiescent Current VS. Temperature**  
BL9110-3.3V



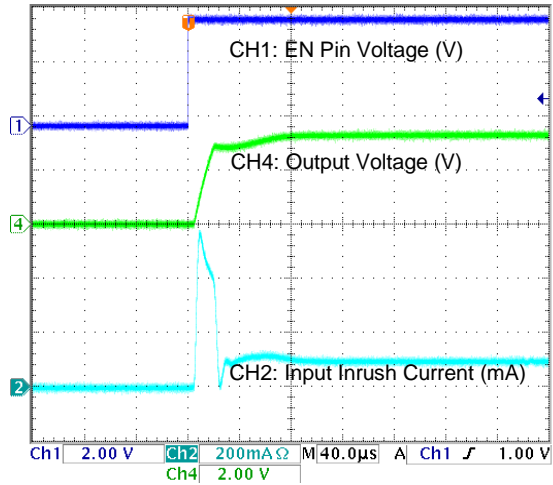
**Quiescent Current VS. Input Voltage**  
BL9110-3.3V



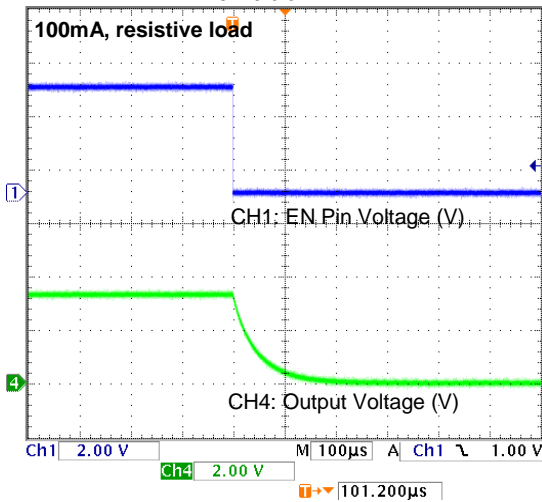
**Output Voltage VS. Output Current**  
BL9110-3.3V



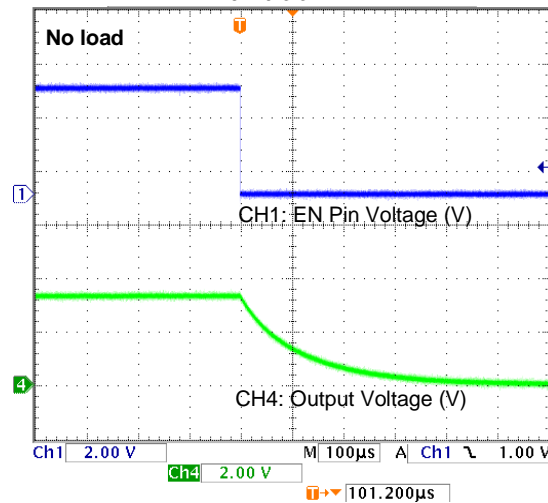
**Turn on Transient Response**  
BL9110-3.3V



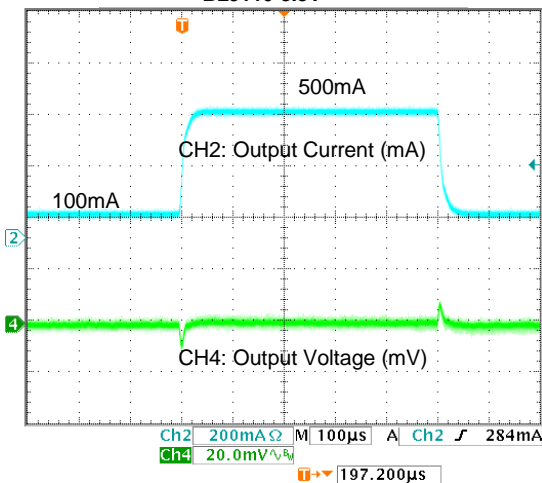
**Turn off Transient Response**  
BL9110-3.3V



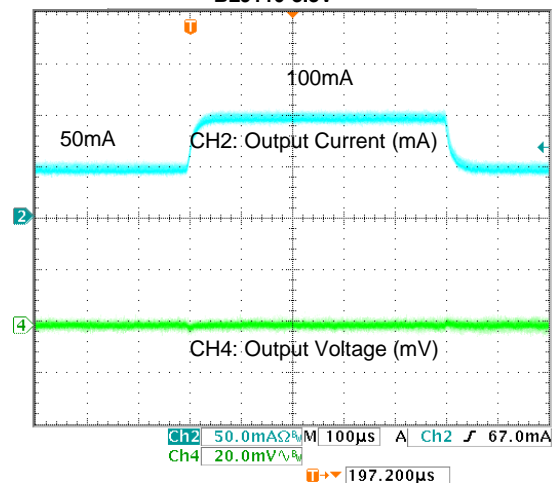
**Turn off Transient Response**  
BL9110-3.3V



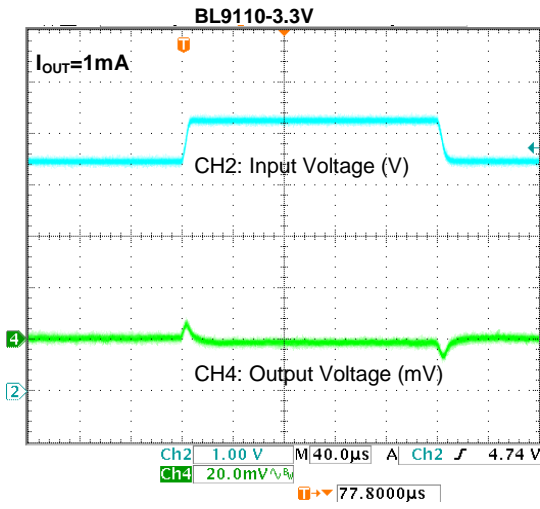
**Load Transient Response**  
BL9110-3.3V



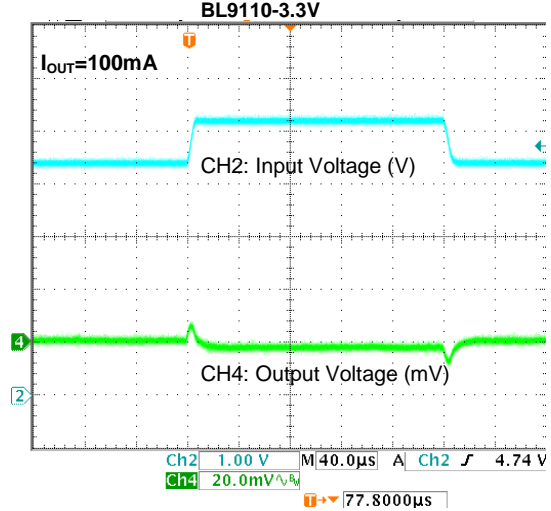
**Load Transient Response**  
BL9110-3.3V



Line Transient Response



Line Transient Response



### Applications Information

The BL9110 is a low dropout CMOS-based positive voltage regulator that operates the input voltage from +2.5V to 6.0V. Output voltages are optional ranging from 1.0V to 5.0V, and can supply current up to 1.0 A.

#### Enable Function

The BL9110 is shutdown by pulling the CE input low, and turn on by driving the input high. If this feature is not be used, the CE input should be floating or tied to VDD to keep the regulator on at all times.

#### Programming the BL9110 Adjustable LDO regulator

The BL9110 is available in two types, either fixed or adjustable output voltage. The output range of the adjustable types is from 1V to 5V. The output voltage of the BL9110 adjustable regulator is programmed using an external resistor divider as show in Figure as below. The output voltage is calculated using equation as below:

$$V_{OUT} = V_{REF} \times \left( 1 + \frac{R1}{R2} \right)$$

Where  $V_{REF}=1V$  is the internal reference voltage.

Resistors R1 and R2 should be chosen for approximately 50uA divider current. Lower value resistors can be used for improved noise performance, but the solution consumes more power. Higher resistor values should be avoided as leakage current at ADJ increases the output voltage error. The recommended design procedure

is to choose  $R2=20k\Omega$  to set the divider current at 50uA, and then calculate R1 using Equation as below:

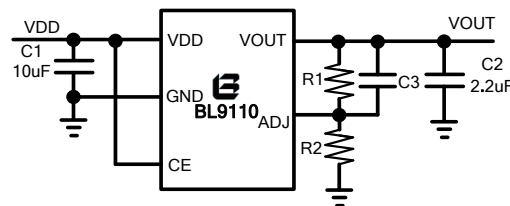
$$R1 = \left( \frac{V_{OUT}}{V_{REF}} - 1 \right) \times R2$$

A small compensation capacitor C3 placed between VOUT and ADJ may improve the stability of the adjustable. The suggested value of this capacitor is about 10pF to 22pF.

#### OUTPUT VOLTAGE PROGRAMMING GUIDE

| OUTPUT VOLTAGE | R1    | R2    |
|----------------|-------|-------|
| 1.8V           | 16 kΩ | 20 kΩ |
| 2.5V           | 30 kΩ | 20 kΩ |
| 3.3V           | 51 kΩ | 22 kΩ |
| 3.6V           | 62 kΩ | 24 kΩ |

#### BL9110 Adjustable LDO regulator Programming



#### Thermal Protection

Thermal overload protection limits total power dissipation in the BL9110. When the junction temperature exceeds  $T_j=165^\circ C$ , the OTP circuit starts the thermal shutdown function and turns the pass element off allowing the IC to cool. The OTP circuit turns on the pass element again after IC's junction temperature cool by  $30^\circ C$ , result in a pulsed output during continuous thermal



overload conditions. Thermal-overloaded protection is designed to protect the BL9110 in the event of fault conditions. Do not exceed the absolute maximum junction temperature rating of  $T_J=125^{\circ}\text{C}$  for continuous operation. The build-in fold-back current limit protection circuit will reduce current value as output voltage drops. When output is shorted to ground, current limit is reduced to 250mA, avoiding damaging the device.

### Operating Region and Power Dissipation

The maximum power dissipation of BL9110 depends on the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The power dissipation across the device is

$$P_D = (V_{DD} - V_{OUT}) \times I_{OUT} + V_{DD} \times I_Q$$

The maximum power dissipation is:

$$P_D(\text{MAX}) = (T_J(\text{MAX}) - T_A) / \theta_{JA}$$

Where  $T_J(\text{MAX})$  is the maximum operation junction temperature  $125^{\circ}\text{C}$ ,  $T_A$  is the ambient temperature and the  $\theta_{JA}$  is the junction to ambient thermal resistance. The GND pin of the BL9110 performs the dual function of providing an electrical connection to ground and channeling heat away. Connect the GND pin to ground using a large pad or ground plane.

### Capacitor Selection and Regulator Stability

Like any low-dropout regulator, the external

capacitors used with the BL9110 must be carefully selected for regulator stability and performance. The BL9110 requires an output capacitor between the VOUT and GND pins for phase compensation. Using a capacitor whose value is  $\geq 1\mu\text{F}$  on the BL9110 input and the amount of capacitance can be increased without limit. The input capacitor must be located a distance of not more than 0.5 inch from the input pin of the IC and returned to a clean analog ground. Any good quality ceramic or tantalum can be used for this capacitor. The capacitor with larger value and lower ESR (equivalent series resistance) provides better PSRR and line-transient response. The output capacitor must meet both requirements for minimum amount of capacitance and ESR in all LDO applications. The BL9110 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. In the BL9110, phase compensation is made with the output capacitor for securing stable operation even if the load current is varied. For this purpose, use a 2.2uF capacitor between VOUT pin and GND pin as close as possible.

### Load-Transient Considerations

The BL9110 load-transient response graphs show two components of the output response: a DC shift from the output impedance due to the load current change, and the transient response. The DC shift is quite small due to the excellent load regulation of the IC. Typical output voltage transient spike for a step change in the load current from 0mA to 50mA is tens of mV,



depending on the ESR of the output capacitor. Increasing the output capacitor's value and decreasing the ESR attenuates the overshoot.

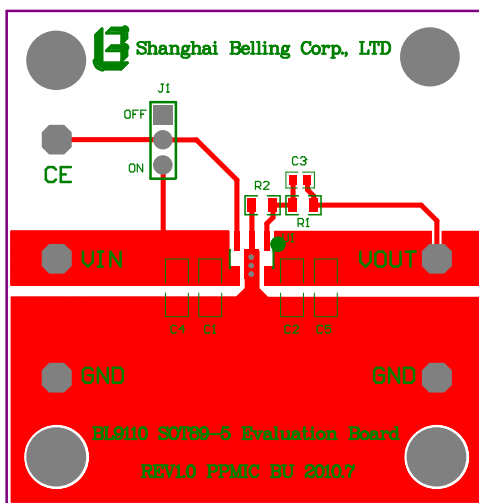
### Input-Output (Dropout) Voltage

A regulator's minimum input-output voltage differential (or dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. Because the BL9110 uses a P-Channel MOSFET pass transistor, the dropout voltage is a function of drain-to-source on resistance  $[R_{DS(ON)}]$  multiplied by the load current.

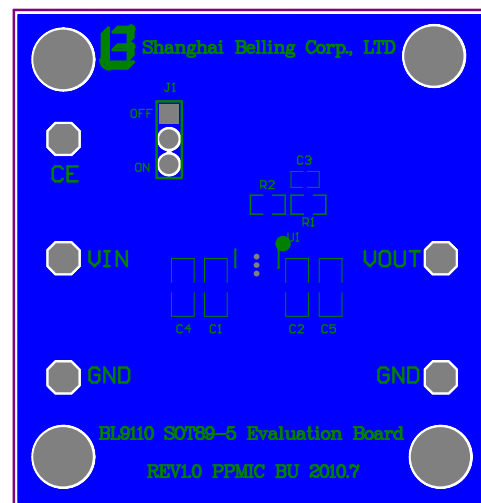
### BL9110 SOT89-5 PCB Layout for Reference

### Layout Considerations

To improve AC performance such as PSRR, output noise, and transient response, it is recommended that the PCB be designed with separate ground planes for VDD and VOUT, with each ground plane connected only at the GND pin of the device. Make VDD and GND lines sufficiently wide. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 between VDD and GND pin, as close as possible to the pins. Set external components, especially the output capacitor C2, as close as possible to the IC, and make wiring as short as possible.



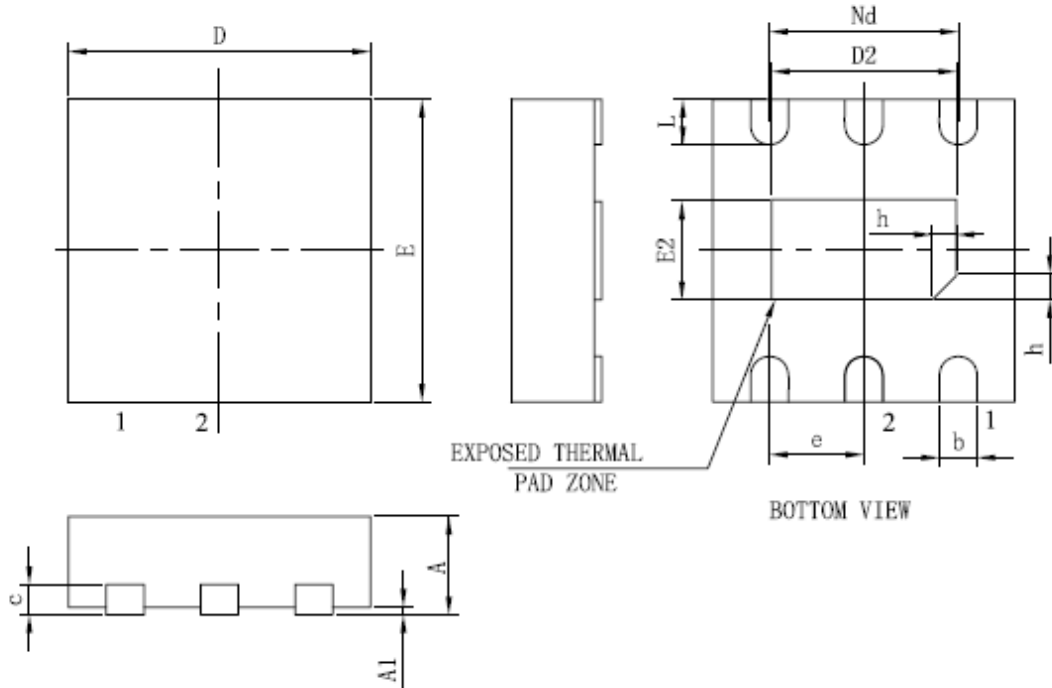
Top Layer



Bottom Layer

## Package Description

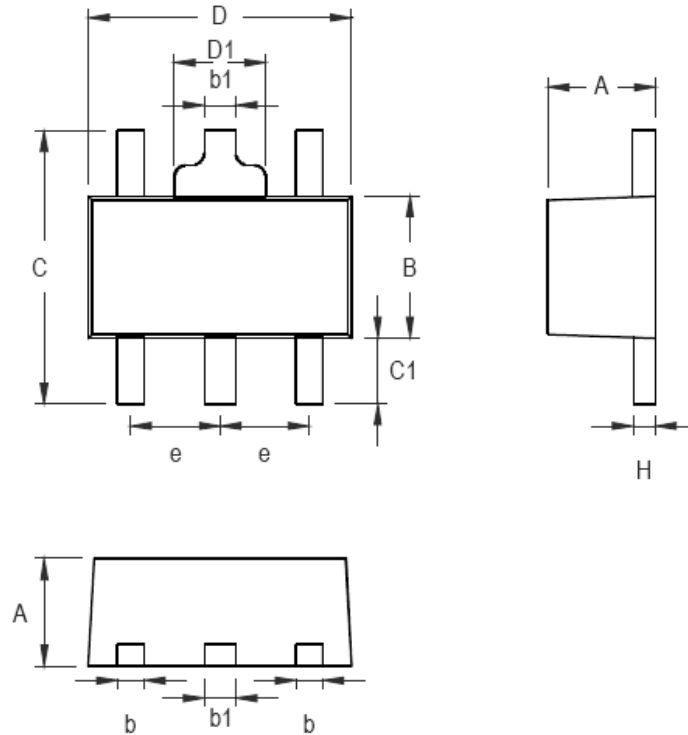
### DFN-6



| Symbol | Dimensions In Millimeters |      |      |
|--------|---------------------------|------|------|
|        | Min                       | NOM  | Max  |
| A      | 0.7                       | 0.75 | 0.8  |
| A1     |                           | 0.02 | 0.05 |
| b      | 0.25                      | 0.3  | 0.35 |
| c      | 0.18                      | 0.2  | 0.25 |
| D      | 1.95                      | 2    | 2.05 |
| D2     | 1                         |      | 1.45 |
| e      | 0.65BSC                   |      |      |
| Nd     | 1.30BSC                   |      |      |
| E      | 1.95                      | 2    | 2.05 |
| E2     | 0.50                      |      | 0.85 |
| L      | 0.25                      | 0.30 | 0.40 |
| h      | 0.1                       | 0.15 | 0.2  |

DFN-6 Surface Mount Package

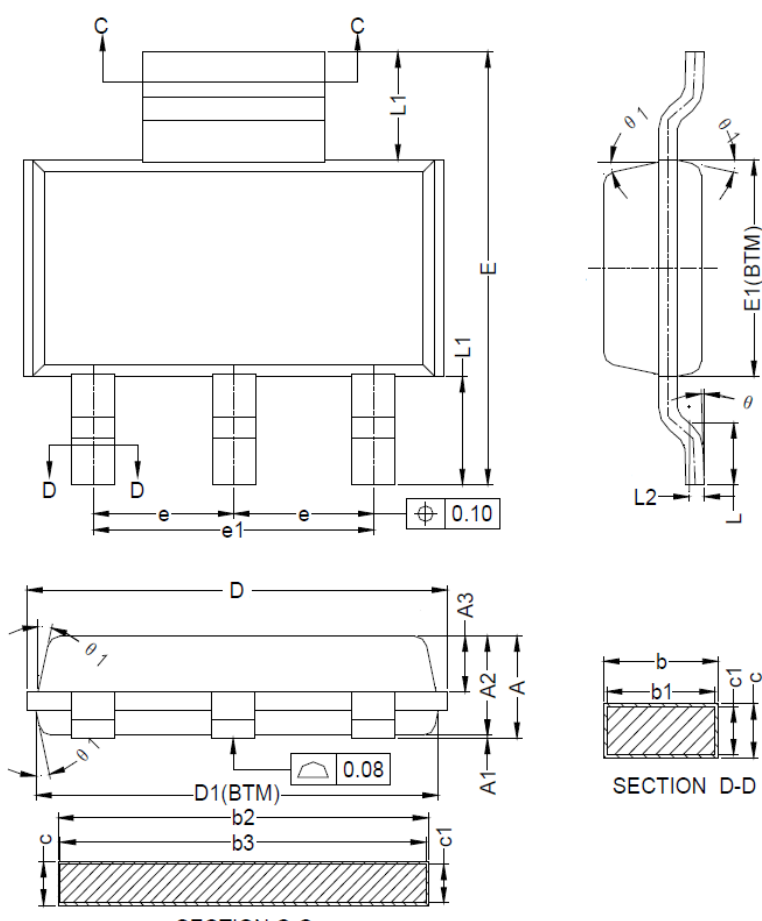
**SOT89-5**



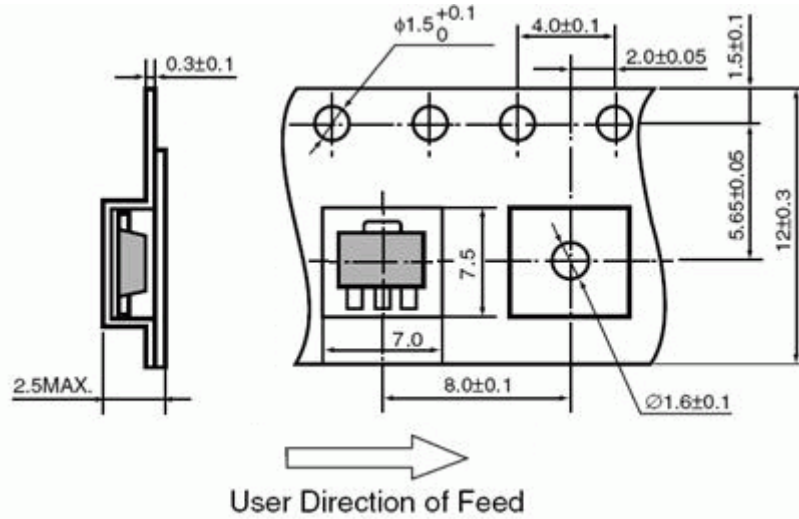
| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 1.397                     | 1.600 | 0.055                | 0.063 |
| b      | 0.356                     | 0.508 | 0.014                | 0.020 |
| b1     | 0.406                     | 0.533 | 0.016                | 0.021 |
| B      | 2.388                     | 2.591 | 0.094                | 0.102 |
| C      | 3.937                     | 4.242 | 0.155                | 0.167 |
| C1     | 0.787                     | 1.194 | 0.031                | 0.047 |
| D      | 4.394                     | 4.597 | 0.173                | 0.181 |
| D1     | 1.397                     | 1.702 | 0.055                | 0.067 |
| e      | 1.500 TYP.                |       | 0.060 TYP.           |       |
| H      | 0.356                     | 0.432 | 0.014                | 0.017 |

SOT89-5 Surface Mount Package

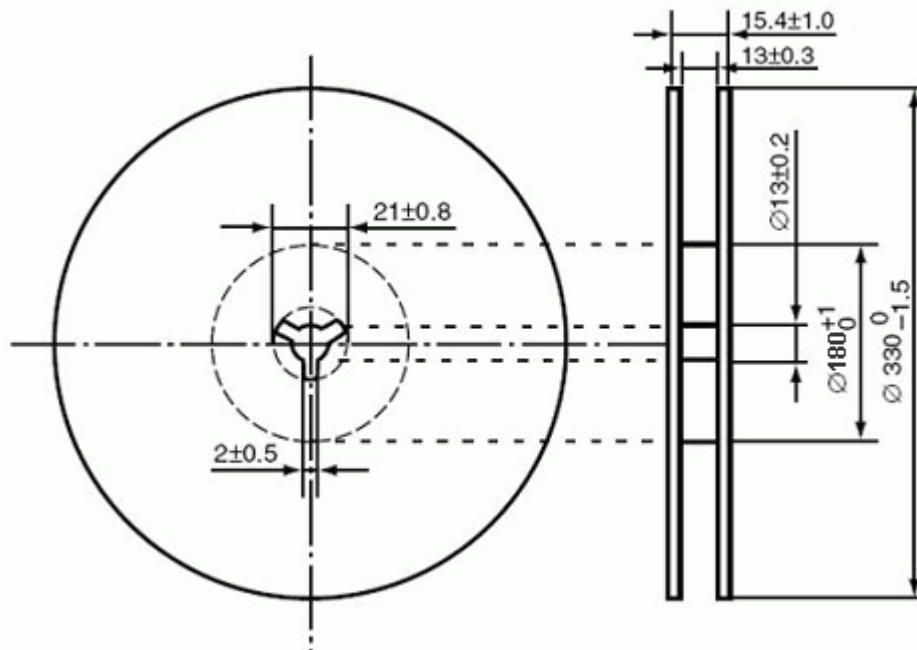
## SOT-223-3

| Package  | SOT-223 | Devices per reel | 2500   | Unit | mm |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
|--|---------|------------------|--|------|----|--|-----|-----|-----|---|------|------|------|----|------|------|------|----|------|------|------|----|------|------|------|---|------|---|------|----|------|------|------|----|------|---|------|----|------|------|------|---|------|---|------|----|------|------|------|---|------|---|------|----|------|------|------|---|------|------|------|----|------|------|------|---|---------|--|--|----|---------|--|--|---|------|------|------|----|---------|--|--|----|---------|--|--|-------|----|---|----|---------|-----|-----|-----|
| Package specification:   |         |                  |  |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
|  |         |                  | <table border="1"> <thead> <tr> <th></th> <th>MIN</th> <th>NOM</th> <th>MAX</th> </tr> </thead> <tbody> <tr><td>A</td><td>1.50</td><td>1.65</td><td>1.80</td></tr> <tr><td>A1</td><td>0.02</td><td>0.06</td><td>0.10</td></tr> <tr><td>A2</td><td>1.45</td><td>1.60</td><td>1.75</td></tr> <tr><td>A3</td><td>0.80</td><td>0.90</td><td>1.00</td></tr> <tr><td>b</td><td>0.67</td><td>-</td><td>0.80</td></tr> <tr><td>b1</td><td>0.66</td><td>0.71</td><td>0.75</td></tr> <tr><td>b2</td><td>2.96</td><td>-</td><td>3.09</td></tr> <tr><td>b3</td><td>2.95</td><td>3.00</td><td>3.05</td></tr> <tr><td>c</td><td>0.30</td><td>-</td><td>0.35</td></tr> <tr><td>c1</td><td>0.29</td><td>0.30</td><td>0.31</td></tr> <tr><td>D</td><td>6.35</td><td>-</td><td>7.05</td></tr> <tr><td>D1</td><td>6.30</td><td>6.50</td><td>6.70</td></tr> <tr><td>E</td><td>6.80</td><td>7.00</td><td>7.20</td></tr> <tr><td>E1</td><td>3.40</td><td>3.50</td><td>3.60</td></tr> <tr><td>e</td><td colspan="3">2.30BSC</td></tr> <tr><td>e1</td><td colspan="3">4.60BSC</td></tr> <tr><td>L</td><td>0.80</td><td>1.00</td><td>1.20</td></tr> <tr><td>L1</td><td colspan="3">1.75REF</td></tr> <tr><td>L2</td><td colspan="3">0.25BSC</td></tr> <tr><td>theta</td><td>0°</td><td>-</td><td>8°</td></tr> <tr><td>theta 1</td><td>10°</td><td>12°</td><td>14°</td></tr> </tbody> </table> |      |    |  | MIN | NOM | MAX | A | 1.50 | 1.65 | 1.80 | A1 | 0.02 | 0.06 | 0.10 | A2 | 1.45 | 1.60 | 1.75 | A3 | 0.80 | 0.90 | 1.00 | b | 0.67 | - | 0.80 | b1 | 0.66 | 0.71 | 0.75 | b2 | 2.96 | - | 3.09 | b3 | 2.95 | 3.00 | 3.05 | c | 0.30 | - | 0.35 | c1 | 0.29 | 0.30 | 0.31 | D | 6.35 | - | 7.05 | D1 | 6.30 | 6.50 | 6.70 | E | 6.80 | 7.00 | 7.20 | E1 | 3.40 | 3.50 | 3.60 | e | 2.30BSC |  |  | e1 | 4.60BSC |  |  | L | 0.80 | 1.00 | 1.20 | L1 | 1.75REF |  |  | L2 | 0.25BSC |  |  | theta | 0° | - | 8° | theta 1 | 10° | 12° | 14° |
|  | MIN     | NOM              | MAX  |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| A  | 1.50    | 1.65             | 1.80   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| A1   | 0.02    | 0.06             | 0.10   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| A2   | 1.45    | 1.60             | 1.75   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| A3   | 0.80    | 0.90             | 1.00   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| b  | 0.67    | -                | 0.80   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| b1   | 0.66    | 0.71             | 0.75   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| b2   | 2.96    | -                | 3.09   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| b3   | 2.95    | 3.00             | 3.05   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| c  | 0.30    | -                | 0.35   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| c1   | 0.29    | 0.30             | 0.31   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| D  | 6.35    | -                | 7.05   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| D1   | 6.30    | 6.50             | 6.70   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| E  | 6.80    | 7.00             | 7.20   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| E1   | 3.40    | 3.50             | 3.60   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| e  | 2.30BSC |                  |  |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| e1   | 4.60BSC |                  |  |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| L  | 0.80    | 1.00             | 1.20   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| L1   | 1.75REF |                  |  |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| L2   | 0.25BSC |                  |  |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| theta  | 0°      | -                | 8°   |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |
| theta 1  | 10°     | 12°              | 14°  |      |    |  |     |     |     |   |      |      |      |    |      |      |      |    |      |      |      |    |      |      |      |   |      |   |      |    |      |      |      |    |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |   |      |    |      |      |      |   |      |      |      |    |      |      |      |   |         |  |  |    |         |  |  |   |      |      |      |    |         |  |  |    |         |  |  |       |    |   |    |         |     |     |     |

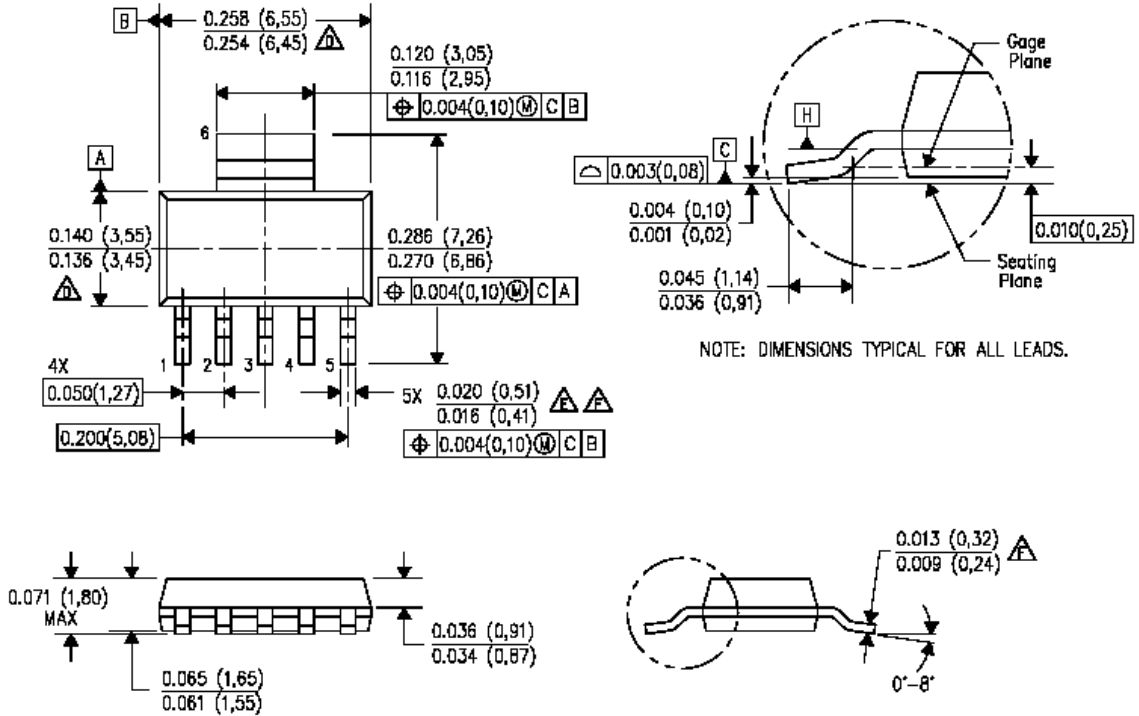
Taping dimension:



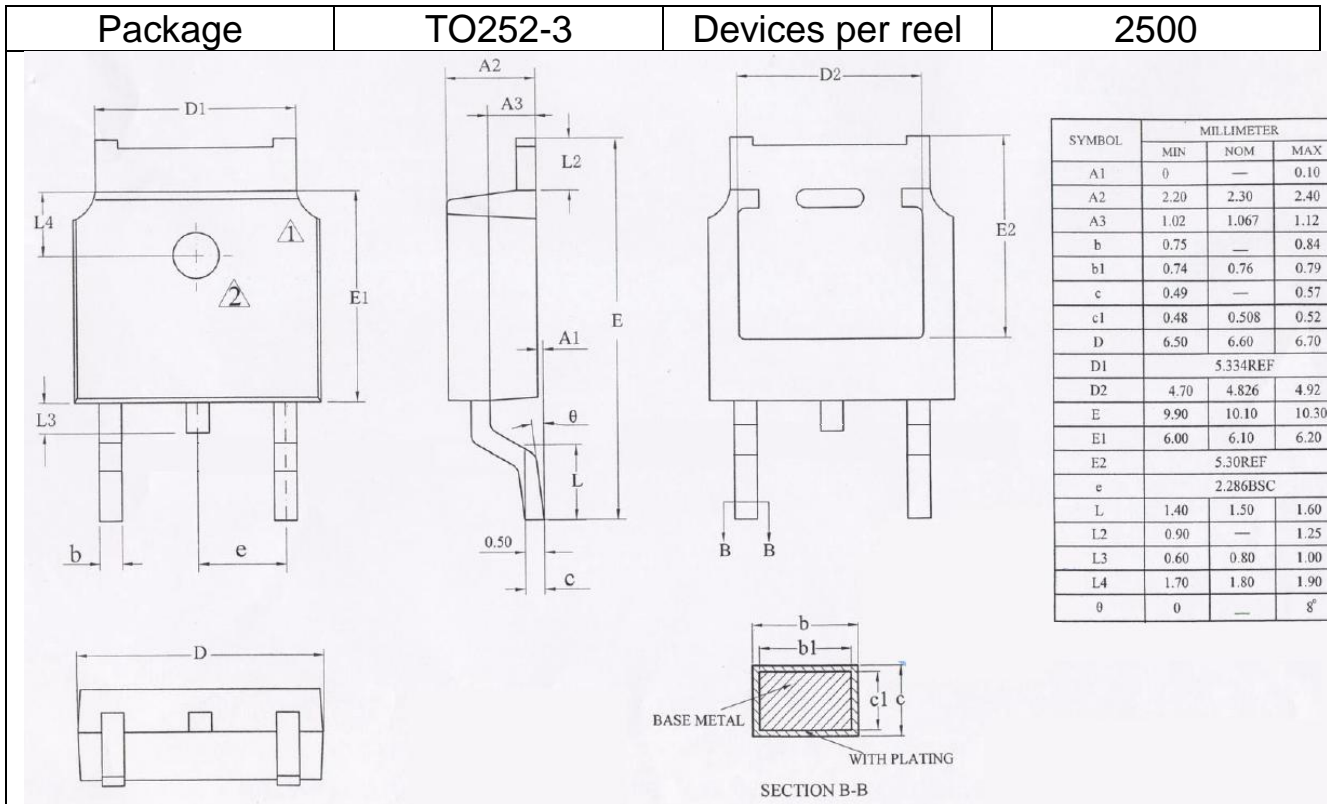
Taping reel dimension:



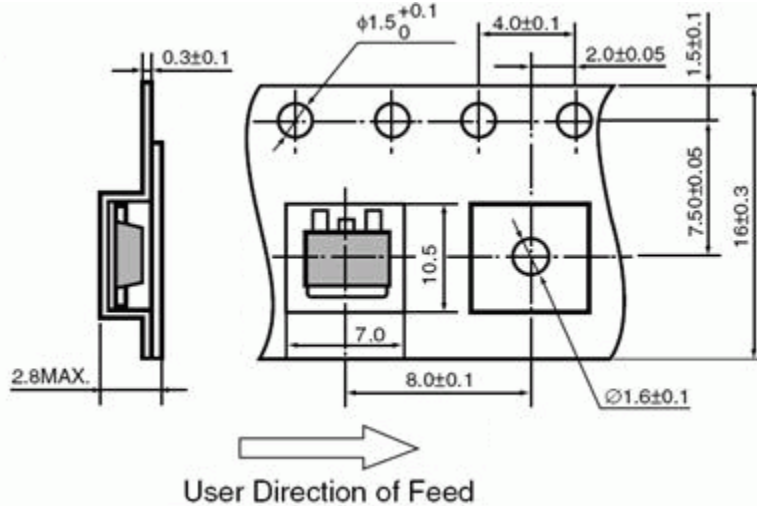
**SOT-223-5**

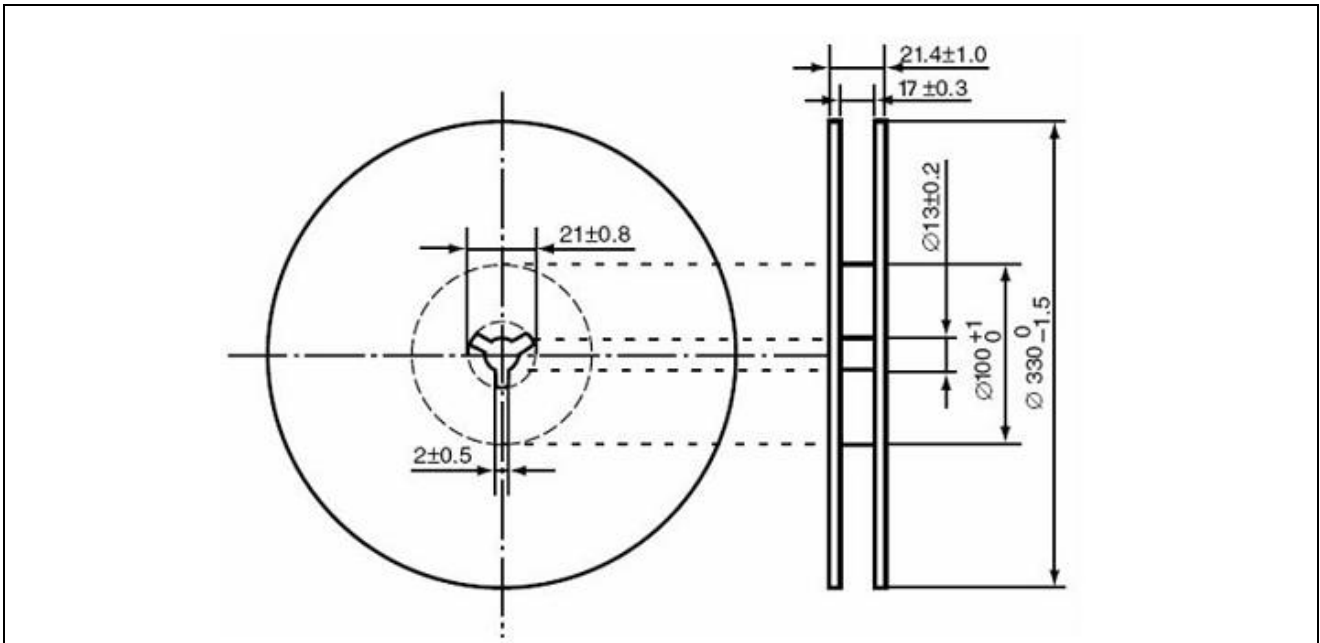


**TO-252-3**



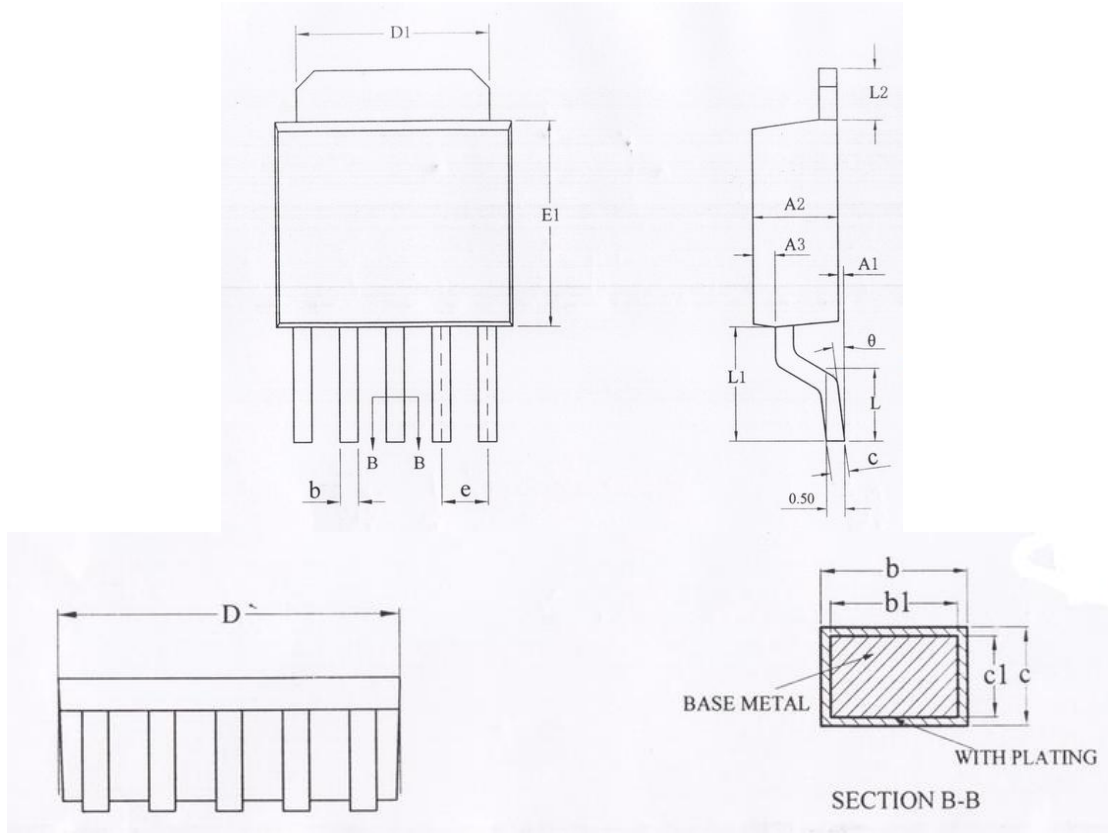
Taping dimension:





## TO-252-5

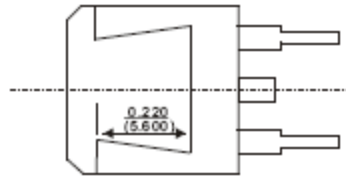
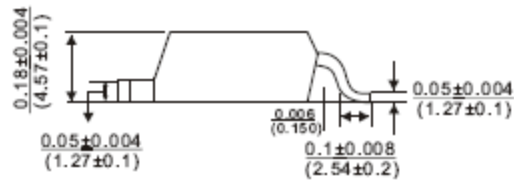
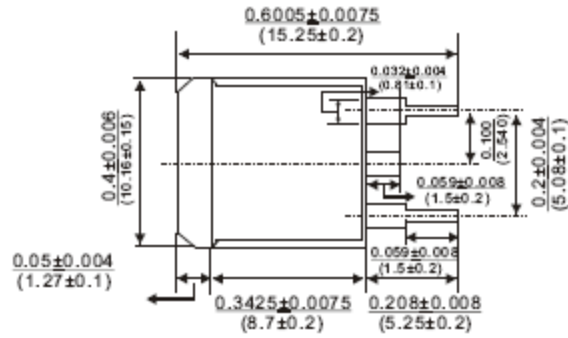


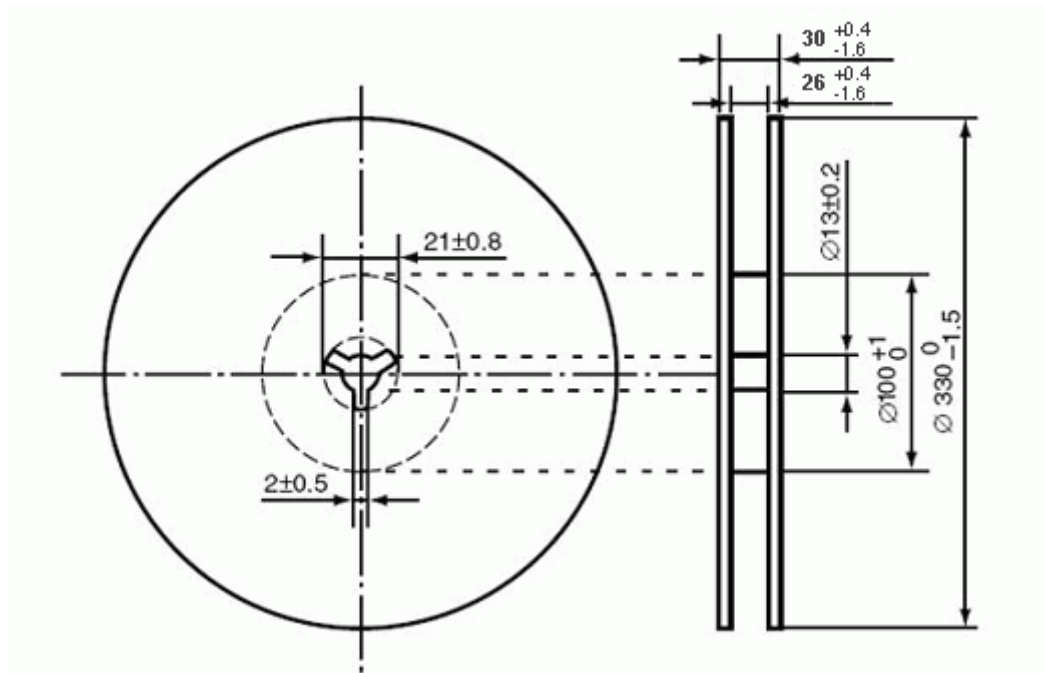
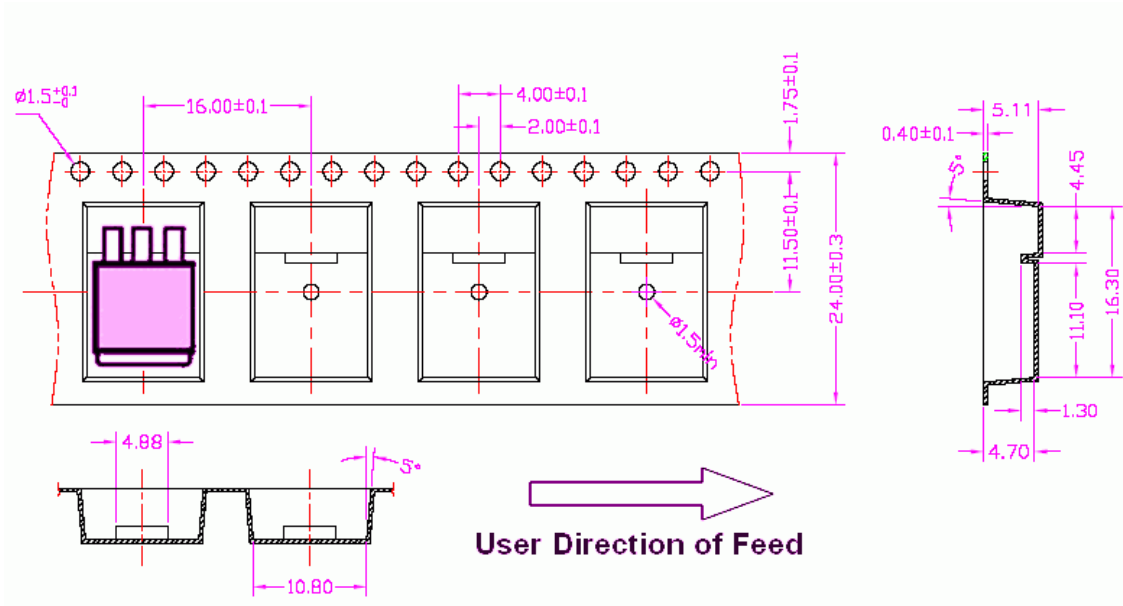


| Symbol | Dimensions In Millimeters |      |      |
|--------|---------------------------|------|------|
|        | MIN                       | NOM  | MAX  |
| A1     | 0.05                      | 0.15 | 0.25 |
| A2     | 2.1                       | 2.3  | 2.5  |
| A3     | 0.5                       | 0.6  | 0.7  |
| b      | 0.46                      |      | 0.6  |
| b1     | 0.45                      | 0.5  | 0.55 |
| c      | 0.49                      |      | 0.56 |
| c1     | 0.48                      | 0.5  | 0.52 |
| D      | 6.3                       | 6.5  | 6.7  |
| D1     | 5.30 REF                  |      |      |
| E1     | 5.30                      | 5.50 | 5.70 |
| e      | 1.27BSC                   |      |      |
| L      | 1.40                      | 1.50 | 1.60 |
| L1     | 3.0                       | 3.1  | 3.2  |
| L2     | 1.40BSC                   |      |      |
| θ      | 0                         |      | 8°   |

**TO-263-3**

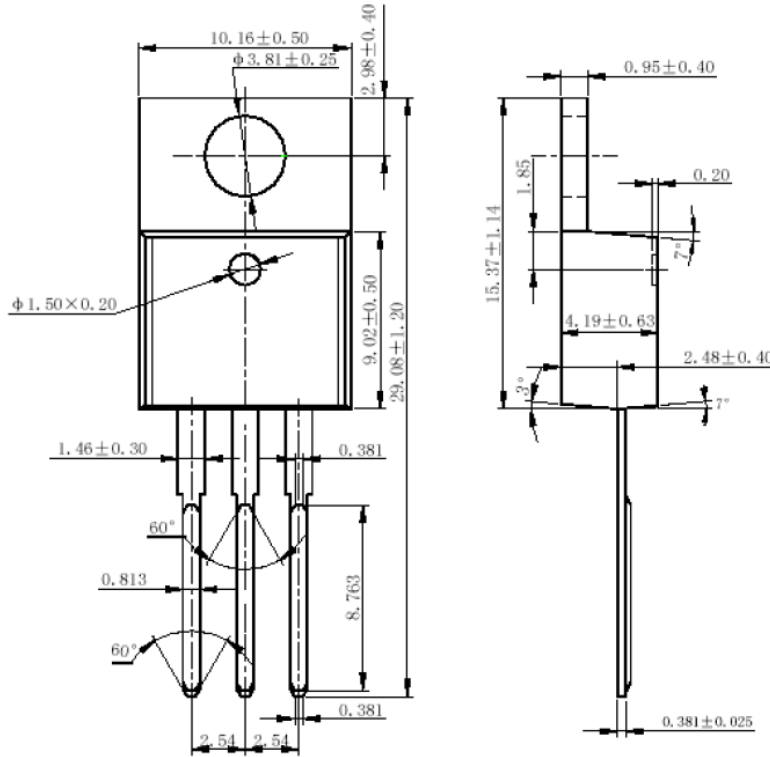
TO-263





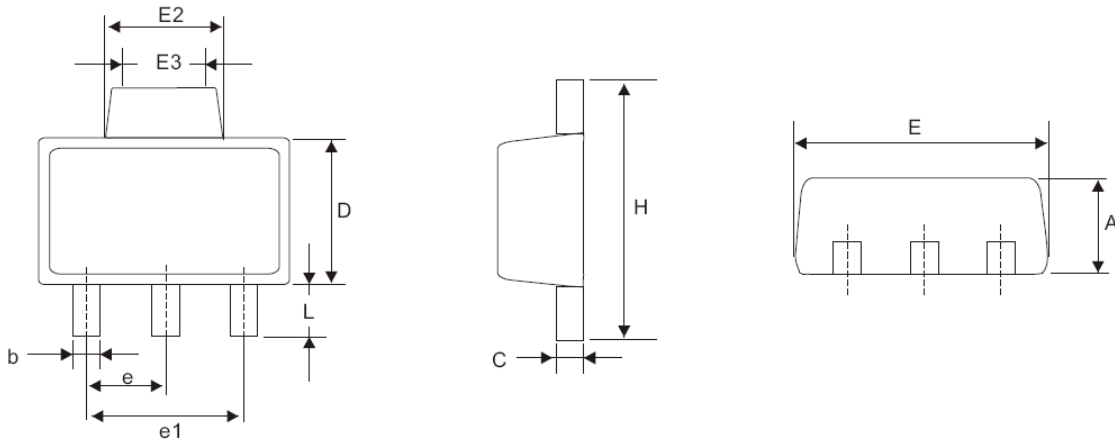
**TO-220-3**

Package specification:



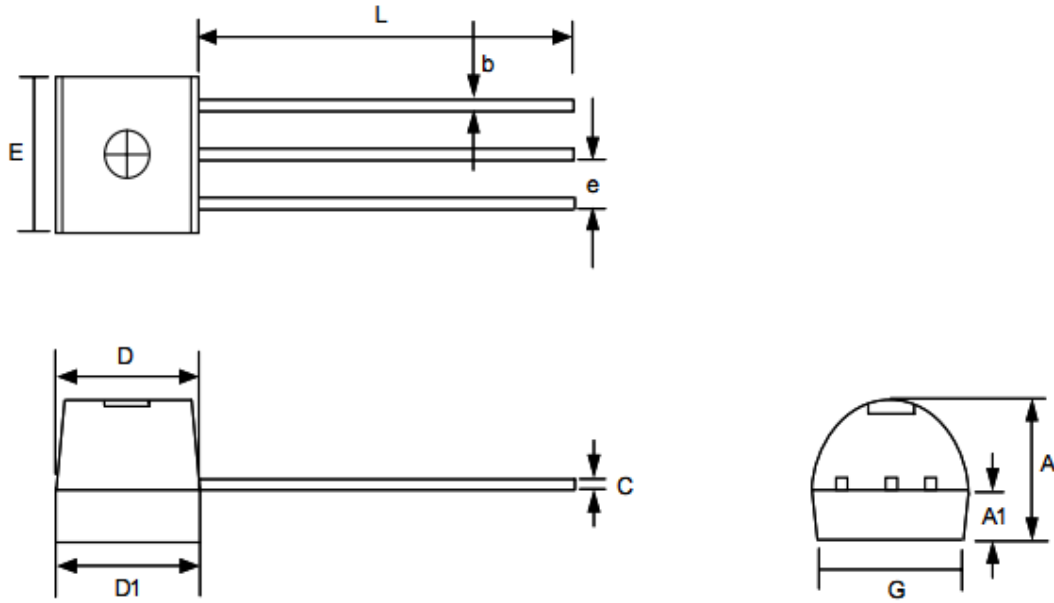
**SOT-89-3**

**SOT-89-3L**



| SYMBOL | MILLIMETERS |       | INCHES    |       |
|--------|-------------|-------|-----------|-------|
|        | MIN         | MAX   | MIN       | MAX   |
| A      | 1.450       | 1.500 | 0.057     | 0.061 |
| b      | 0.440       | 0.480 | 0.017     | 0.019 |
| C      | 0.360       | 0.400 | 0.014     | 0.016 |
| E      | 4.450       | 4.550 | 0.175     | 0.179 |
| E2     | 1.500       | 1.700 | 0.059     | 0.067 |
| E3     | 1.400 Ref   |       | 0.055 Ref |       |
| e      | 1.500 BSC   |       | 0.059 BSC |       |
| e1     | 3.000 BSC   |       | 0.118 BSC |       |
| D      | 2.450       | 2.550 | 0.096     | 0.100 |
| H      | 4.150       | 4.250 | 0.163     | 0.167 |
| L      | 0.900       | 1.100 | 0.035     | 0.043 |

**TO92-3**



**TO-92 (TD) Package**

| SYMBOL | MILLIMETER |       | INCH  |       |
|--------|------------|-------|-------|-------|
|        | MIN        | MAX   | MIN   | MAX   |
| A      | 3.35       | 3.86  | 0.132 | 0.152 |
| A1     | 1.0414     | 1.55  | 0.041 | 0.061 |
| b      | 0.254      | 0.508 | 0.010 | 0.020 |
| E      | 4.34       | 4.85  | 0.171 | 0.191 |
| C      | 0.254      | 0.508 | 0.010 | 0.020 |
| L      | 14.53      | 15.04 | 0.572 | 0.592 |
| e      | 1.143      | 1.397 | 0.045 | 0.055 |
| G      | 3.683      | 4.191 | 0.145 | 0.165 |
| D      | 4.29       | 4.80  | 0.169 | 0.189 |
| D1     | 4.34       | 4.85  | 0.171 | 0.191 |

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[714954EB](#) [ZMR500QFTA](#) [LV5680P-E](#) [L78M15CV-DG](#) [L79M05T-E](#) [MIC5283-5.0YML-T5](#) [TLS202A1MBVHTSA1](#) [L78LR05D-MA-E](#)  
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[TCR3DF335,LM\(CT](#) [ZXTR2012K-13](#) [TLE42994E V33](#) [ZXTR2008K-13](#)