

FEATURES

- Ultra-low Noise
- Ultra-Fast Transient Response
- High PSRR: -87dB @ 217Hz
-83dB @ 1KHz
-54dB @ 1MHz
- 0.1 μ A Standby Current When Shutdown
- Low Dropout: 240mV@500mA ($V_{OUT}=2.8V$)
- Wide Operating Voltage Ranges:
1.8V to 5.5V
- Current Limiting and Short Circuit Current Protection
- Thermal Shutdown Protection
- Only 1 μ F Output Capacitor Required for Stability
- Fast output discharge
- Available in SOT23-5, SC70-5 and DFN1X1-4L Packages

- PCMCIA Cards
- Portable Information Appliances

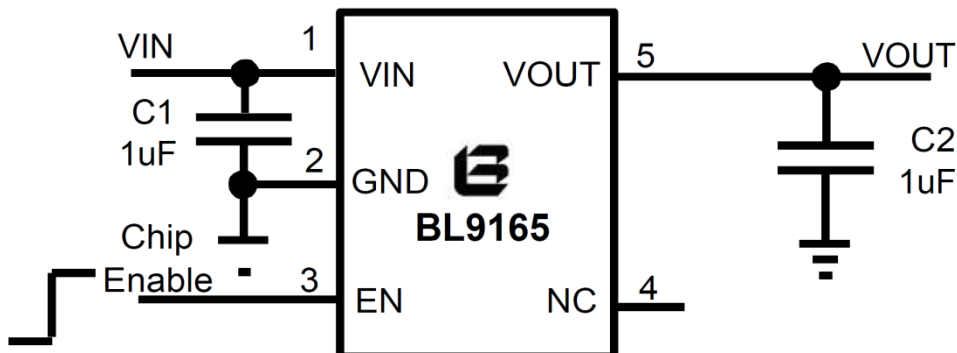
DESCRIPTION

The BL9165 is designed for portable applications with demanding performance and space requirements. The BL9165 performance is optimized for battery-powered systems to deliver ultra-low noise and low quiescent current. Regulator ground current increases only slightly in dropout, further prolonging the battery life. The BL9165 also works with low-ESR ceramic capacitors, reducing the amount of board space necessary for power applications, critical in hand-held wireless devices. The BL9165 consumes only 0.1 μ A current in shutdown mode and has fast turn-on time (Typical 100 μ s). The other features include ultra-low dropout voltage, high output accuracy, current limiting protection, and high ripple rejection ratio.

APPLICATIONS

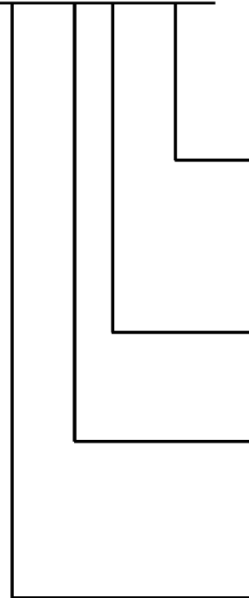
- Cellular and Smart Phones
- Cordless Telephones
- Camera and Machine Vision Modules
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments

TYPICAL APPLICATION



ORDERING INFORMATION

BL9165 - XXX X X XXX



Package:

RN: SOT23-5

URN: SC70-5

DRN: DFN1x1-4L

Enable Option:

A: active high with internal pull down

Output Voltage Accuracy:

B: $\pm 2\%$

Output Voltage:

100:1.0V 105:1.05V 110:1.1V 115:1.15V

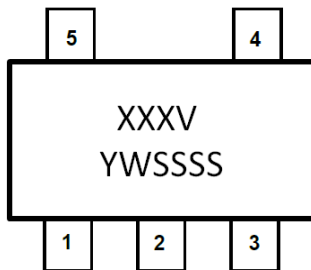
120:1.2V 150:1.5V 180:1.8V 250:2.5V

260:2.6V 280:2.8V 300:3.0V 330:3.3V

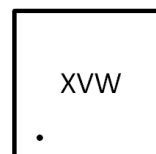
360:3.6V 400:4.0V

Package Marking

SOT23-5 & SC70-5



DFN1×1-4L



V: Output voltage

Y: Data code—Year

W: Data code—Week

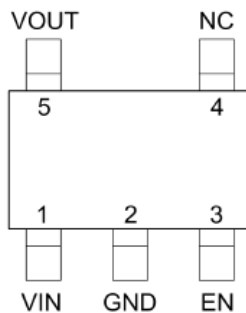
| Output Voltage | V | | Output Voltage | V | |
|----------------|-----------|--------------------|----------------|---------|--------------------|
| | SOT23-5 | SC70-5 & DFN1X1-4L | | SOT23-5 | SC70-5 & DFN1X1-4L |
| 1.0V | B | A | 2.5V | E | P |
| 1.05V | \bar{B} | \bar{A} | 2.6V | T | Q |
| 1.1V | F | B | 2.8V | G | S |
| 1.15V | \bar{F} | \bar{B} | 3.0V | I | U |
| 1.2V | A | C | 3.3V | K | X |
| 1.5V | C | F | 3.6V | Y | Y |
| 1.8V | D | I | 4.0V | Z | Z |

| | | | | | | | |
|------|------|------|------|-----|------|------|-----|
| Y | 4 | 5 | 6 | ... | 0 | 1 | ... |
| Year | 2014 | 2015 | 2016 | ... | 2020 | 2021 | ... |

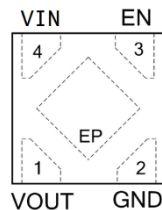
| | | | | | | | | |
|------|---|-----|----|----|----|-----|----|----|
| W | A | ... | Y | Z | a | ... | y | z |
| Week | 1 | ... | 25 | 26 | 27 | ... | 51 | 52 |

PIN CONFIGURATIONS

SOT23-5 & SC70-5
(TOP VIEW)



DFN1X1-4L
(TOP VIEW)



Thermal Resistance (Note3)

| Package | Θ_{JA} | Θ_{JC} |
|---------|---------------|---------------|
| SOT23-5 | 250°C/W | 130°C/W |
| SC70-5 | 333°C/W | 170°C/W |

Pin Description

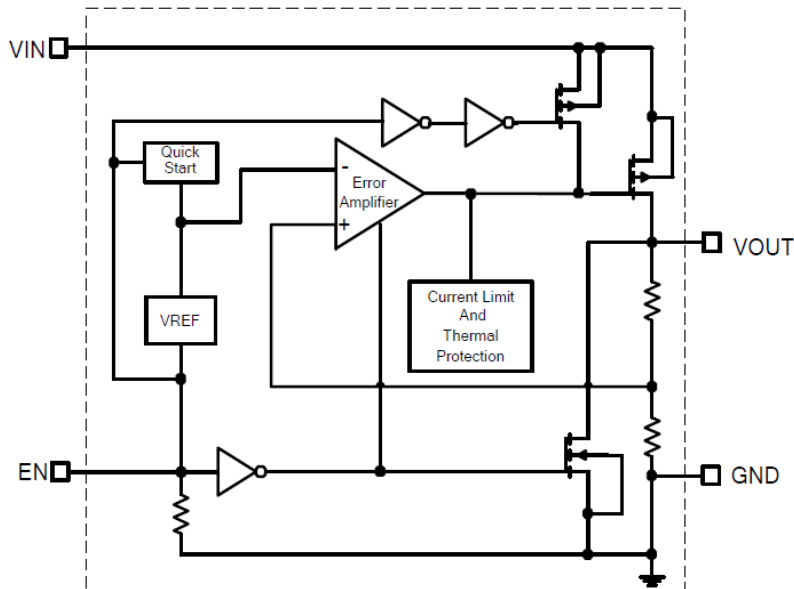
SOT23-5 & SC70-5

| PIN | NAME | FUNCTION |
|-----|------|--|
| 1 | VIN | Power Input Voltage. |
| 2 | GND | Ground. |
| 3 | EN | Chip Enable Pin, This pin has an internal pull-down resistor |
| 4 | NC | No Connection. |
| 5 | VOUT | Output Voltage. |

DFN1X1-4L

| PIN | NAME | FUNCTION |
|-------------|------|--|
| 1 | VOUT | Output Voltage. |
| 2 | GND | Ground. |
| 3 | EN | Chip Enable Pin, This pin has an internal pull-down resistor |
| 4 | VIN | Power Input Voltage. |
| Exposed Pad | | The exposed pad should be connected to a large ground plane to maximize thermal performance. |

Block Diagram



Absolute Maximum Rating ^(Note 1)

| | | | |
|----------------------------|-------------------|--|----------------|
| Input Supply Voltage (VIN) | -0.3V to +6V | Maximum Junction Temperature | 150°C |
| EN Pin Input Voltage | -0.3V to VIN | Operating Temperature Range ^(Note2) | -40°C to 85°C |
| Output Voltages | -0.3V to VIN+0.3V | Storage Temperature Range | -65°C to 125°C |
| Output Current | 500mA | Lead Temperature (Soldering, 10s) | 300°C |

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

Note 2: The BL9165 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: Thermal Resistance is specified with approximately 1 square of 1 ozcopper.

Electrical Characteristics (Note 4)

($V_{IN}=V_{OUT}+1V$, $EN=V_{IN}$, $C_{IN}=C_{OUT}=1\mu F$, $T_A=25^\circ C$, unless otherwise noted.)

| Parameter | Symbol | Conditions | MIN | TYP | MAX | unit |
|---|-------------------|--|---|----------|------|-----------------|
| Input Voltage | V_{IN} | | 1.8 | | 5.5 | V |
| Output Voltage Accuracy | ΔV_{OUT} | $V_{IN}=V_{OUT}+1V$, $I_{OUT}=1mA$ | -2 | | +2 | % |
| Current Limit | I_{LIM} | $R_{LOAD}=1\Omega$ | 550 | | | mA |
| Short Circuit Current | I_{SHORT} | $V_{OUT}=0V$ | | 200 | | mA |
| Quiescent Current | I_Q | $V_{EN}>1.2V$, $I_{OUT}=0mA$ | | 45 | 70 | μA |
| Dropout Voltage | V_{DROP} | $I_{OUT}=500mA$, $V_{OUT}=3.3V$ | | 220 | 320 | mV |
| | | $I_{OUT}=500mA$, $V_{OUT}=2.8V$ | | 240 | 360 | |
| | | $I_{OUT}=500mA$, $V_{OUT}=1.8V$ | | 360 | 520 | |
| | | $I_{OUT}=500mA$, $V_{OUT}=1.0V$ | | 700 | 1000 | |
| Line Regulation <small>(Note 5)</small> | ΔV_{LINE} | $V_{IN}=V_{OUT}+1V$ to 5.5V $I_{OUT}=1mA$ | | 0.03 | 0.17 | %/V |
| Load Regulation <small>(Note 6)</small> | ΔV_{LOAD} | $1mA < I_{OUT} < 300mA$ $V_{IN}=V_{OUT}+1V$ | | 0.002 | | %mA |
| Output Voltage Temperature Coefficient <small>(Note 7)</small> | $TC_{V_{OUT}}$ | $I_{OUT}=1mA$ | | ± 60 | | ppm/ $^\circ C$ |
| Standby Current | I_{STBY} | $V_{EN}=GND$, Shutdown | | 0.1 | 1 | μA |
| EN Input Bias Current | I_{IBSD} | $V_{EN}=GND$ or V_{IN} | | 0.1 | 1 | μA |
| EN Input Threshold | Logic Low | V_{IL} | $V_{IN}=3V$ to 5.5V, Shutdown | | 0.4 | V |
| | Logic High | V_{IH} | $V_{IN}=3V$ to 5.5V, Start up | 1.2 | | V |
| Output Noise Voltage | e_{NO} | 10 to 100kHz; $C_{OUT}=1\mu F$ $I_{OUT}=100mA$; $V_{OUT}=2.8V$ | | 50 | | μV_{RMS} |
| | | 10 to 100kHz; $C_{OUT}=1\mu F$ $I_{OUT}=100mA$; $V_{OUT}=1.8V$ | | 38 | | |
| Power Supply Rejection Ratio | $f=217Hz$ | PSRR | $I_{OUT}=10mA$ $V_{OUT}=1.8V$ $V_{IN}=2.8V$ | | -87 | dB |
| | $f=1KHz$ | | | | -83 | |
| | $f=10KHz$ | | | | -72 | |
| | $f=1MHz$ | | | | -54 | |
| Thermal Shutdown Temperature | T_{SD} | Shutdown, Temp increasing | | 170 | | $^\circ C$ |
| Thermal Shutdown Hysteresis | T_{SDHY} | | | 25 | | $^\circ C$ |

Note 4: Production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

Note 5: Line regulation is calculated by
$$\Delta V_{LINE} = \left| \left(\frac{V_{OUT1} - V_{OUT2}}{\Delta V_{IN} \times V_{OUT(normal)}} \right) \right| \times 100$$

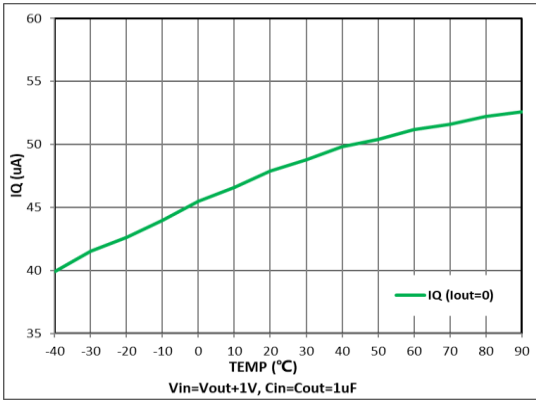
Where V_{OUT1} is the output voltage when $V_{IN}=5.5V$, and V_{OUT2} is the output voltage when $V_{IN}=4.3V$, $\Delta V_{IN}=1.2V$. $V_{OUT(normal)}=3.3V$.

Note 6: Load regulation is calculated by
$$\Delta V_{LOAD} = \left| \left(\frac{V_{OUT1} - V_{OUT2}}{\Delta I_{OUT} \times V_{OUT(normal)}} \right) \right| \times 100$$

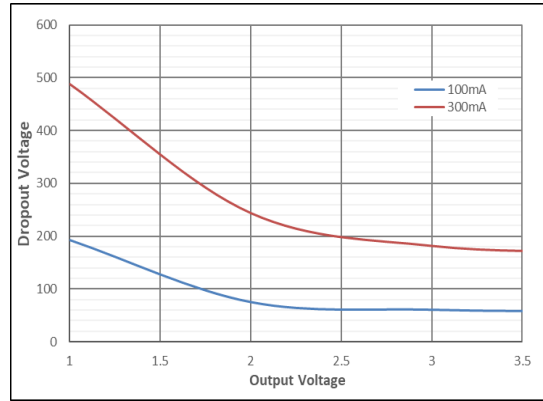
Where V_{OUT1} is the output voltage when $I_{OUT}=1mA$, and V_{OUT2} is the output voltage when $I_{OUT}=300mA$. $\Delta I_{OUT}=299mA$, $V_{OUT(normal)}=2.8V$.

Note 7: The temperature coefficient is calculated by
$$TC_{V_{OUT}} = \frac{\Delta V_{OUT}}{\Delta T \times V_{OUT}}$$

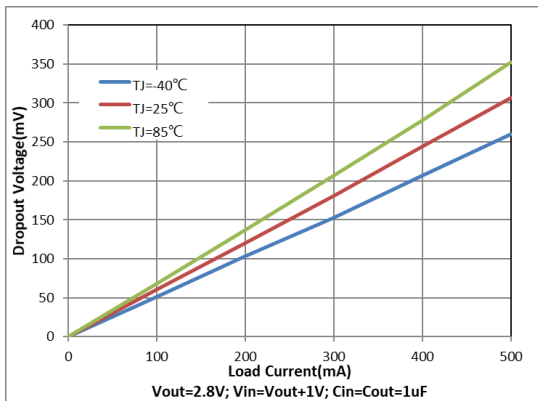
Typical Performance Characteristics



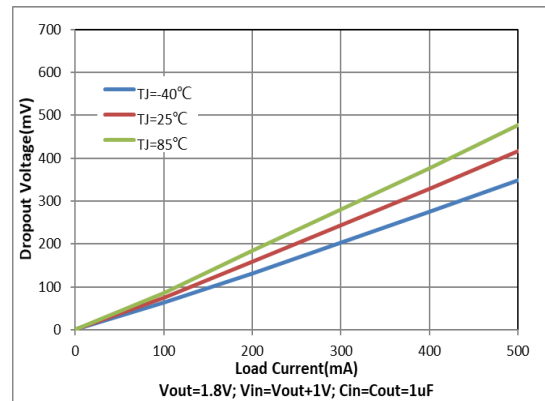
Quiescent Current vs Temperature



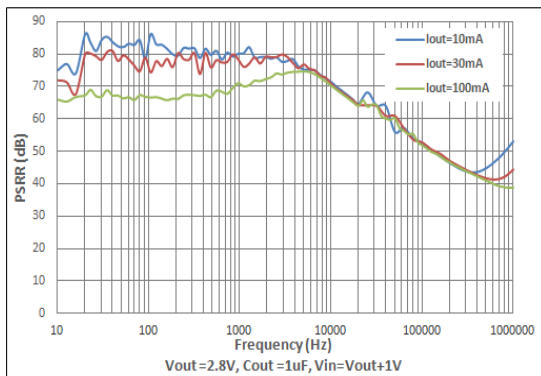
Dropout Voltage vs Output



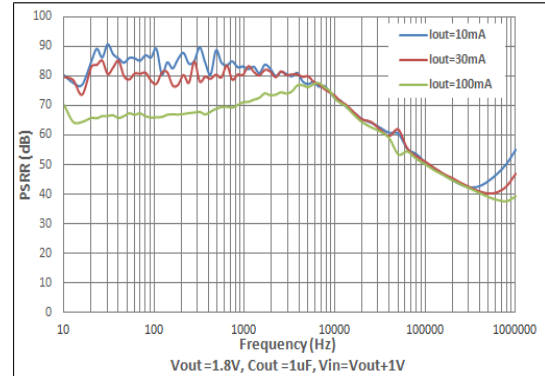
Output Dropout Voltage vs Load Current (Vout=2.8V)



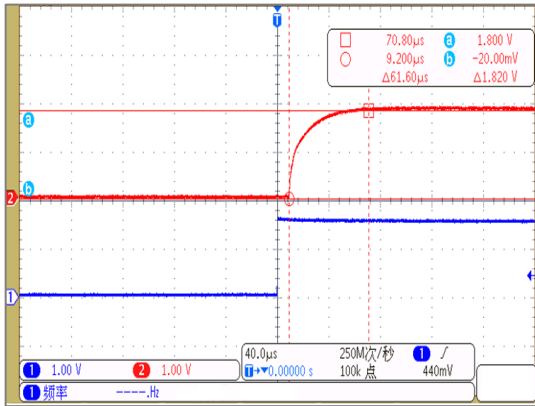
Dropout Voltage vs Load Current (Vout=1.8V)



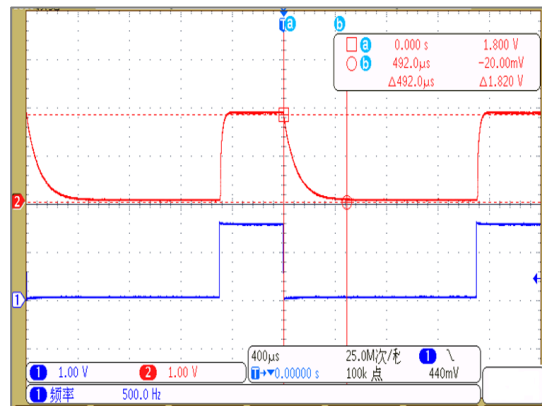
Power-Supply Ripple Rejection vs Frequency (Vout=2.8V)



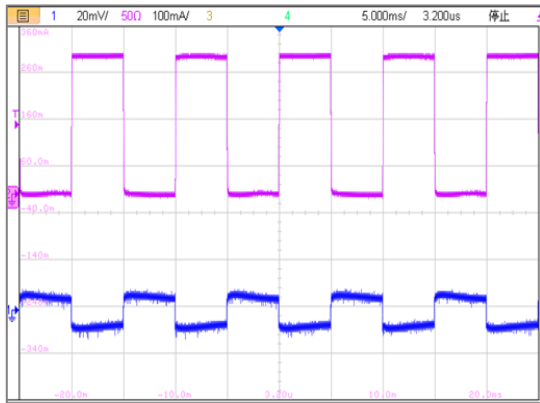
Power-Supply Ripple Rejection vs Frequency (Vout=1.8V)



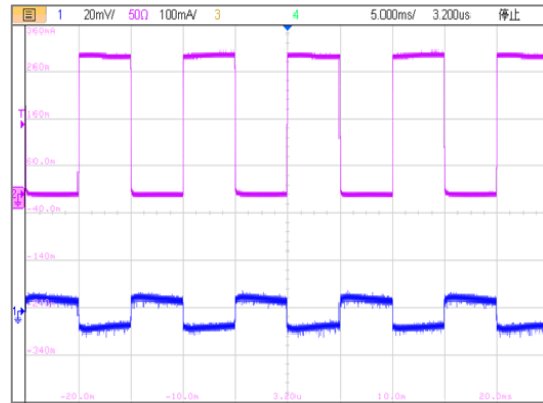
EN Start (Vout=1.8V)



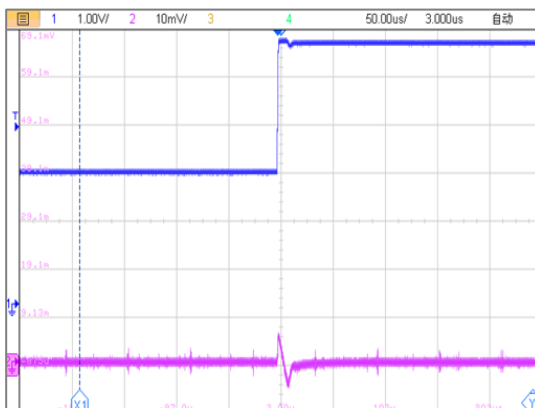
EN Shutdown (Vout=1.8V)



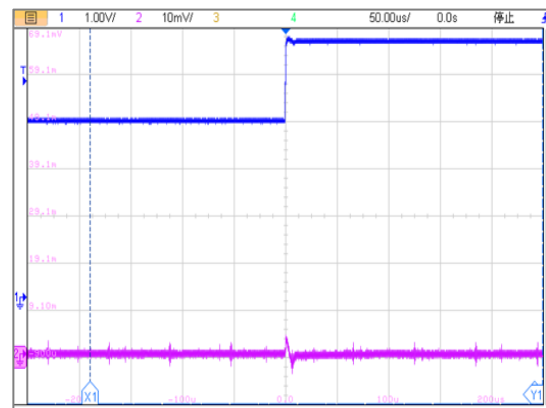
Load Trans 1mA - 300mA (Vout= 1.8V)



Load Trans 1mA - 300mA (Vout= 2.8V)



Line Trans 2.8V~5.5V (Vout=1.8V, Iout=1mA)



Line Trans 3.8V~5.5V (Vout=2.8V, Iout=1mA)

Applications Information

Like any low-dropout regulator, the external capacitors used with the BL9165 must be carefully selected for regulator stability and performance. Using a capacitor whose value is $> 1\mu\text{F}$ on the BL9165 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 LDOs application. Generally, $1.0\text{-}\mu\text{F}$ X7R-type ceramic capacitors are recommended because these capacitors have minimal variation in value and equivalent series resistance (ESR) over temperature. Output capacitor of larger capacitance can reduce noise and improve load transient response, stability, and PSRR. The output capacitor should be located not more than 0.5 inch from the VOUT pin of the BL9165 and returned to a clean analog ground.

Enable Function

The BL9165 features an LDO regulator enable/disable function. To assure the LDO regulator will switch on; the EN turn on control level must be greater than 1.2 volts. The LDO regulator will go into the shutdown mode when the voltage on the EN pin falls below 0.4 volts. For to protect the system, the BL9165 have a quick discharge function. If the enable function is not needed in a specific application, it may be tied to VIN to keep the LDO regulator in a continuously on state.

Thermal Considerations

Thermal protection limits power dissipation in BL9165. When the operation junction temperature exceeds 170°C , the OTP circuit starts the thermal shutdown function turn the pass element off. The pass element turns on again after the junction temperature cools by 25°C .

For continue operation, do not exceed absolute maximum operation junction temperature 125°C . The power dissipation definition in device is:

$$PD(\text{MAX}) = (T_{\text{J}}(\text{MAX}) - T_{\text{A}}) / \theta_{\text{JA}}$$

Where $T_{\text{J}}(\text{MAX})$ is the maximum operation junction temperature 125°C , T_{A} is the ambient temperature and the θ_{JA} is the junction to ambient thermal resistance. For recommended operating conditions specification of BL9165, where $T_{\text{J}}(\text{MAX})$ is the maximum junction temperature of the die (125°C) and T_{A} is the maximum ambient temperature. The junction to ambient thermal resistance (θ_{JA} is layout dependent) for SOT-23-5 package is $250^{\circ}\text{C}/\text{W}$, on standard JEDEC 51-3 thermal test board. The maximum power dissipation at $T_{\text{A}} = 25^{\circ}\text{C}$ can be calculated by following formula:

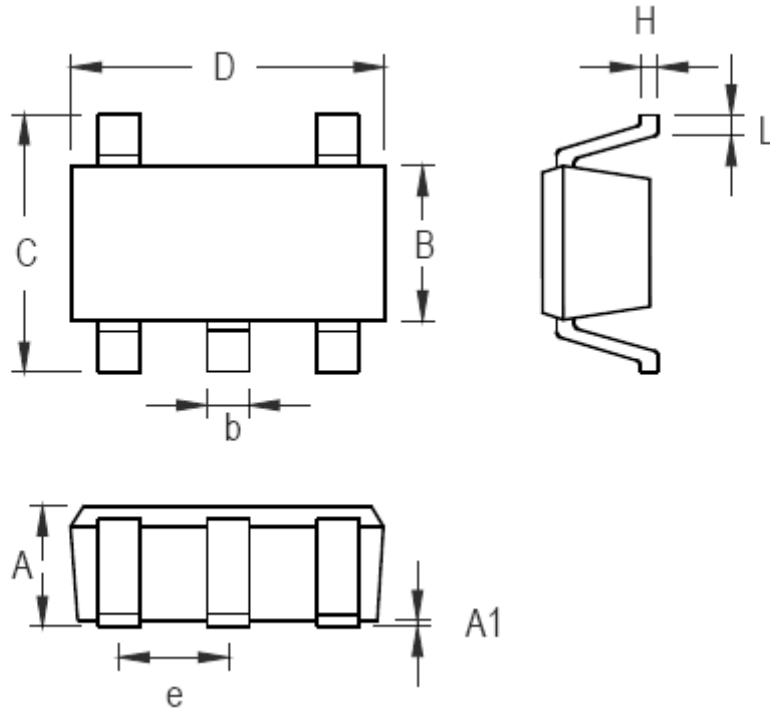
$$PD(\text{MAX}) = (125^{\circ}\text{C} - 25^{\circ}\text{C}) / 250 = 400\text{mW (SOT-23-5)}$$

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 VIN and VOUT, with each ground plane connected only at the GND pin of the device.

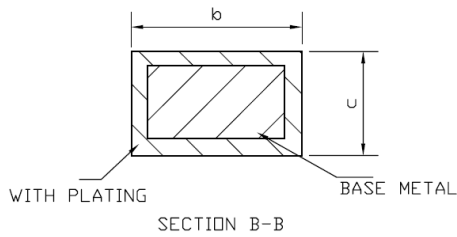
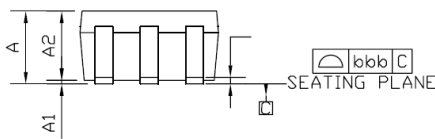
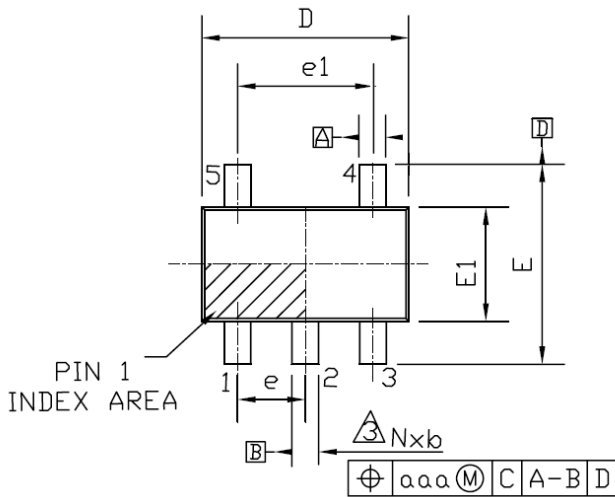
Package Description

SOT23-5

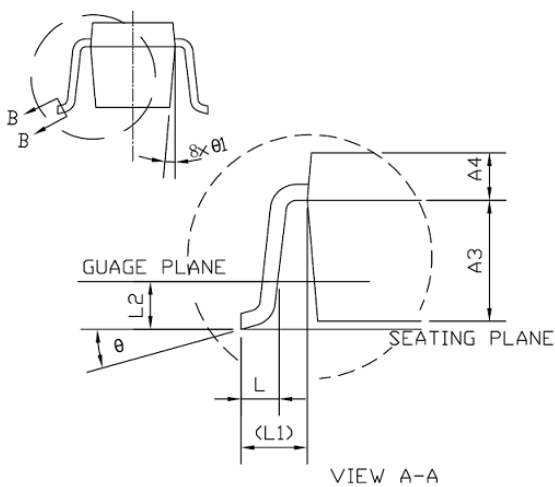


| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 0.889 | 1.295 | 0.035 | 0.051 |
| A1 | 0.000 | 0.152 | 0.000 | 0.006 |
| B | 1.397 | 1.803 | 0.055 | 0.071 |
| b | 0.356 | 0.559 | 0.014 | 0.022 |
| C | 2.591 | 2.997 | 0.102 | 0.118 |
| D | 2.692 | 3.099 | 0.106 | 0.122 |
| e | 0.838 | 1.041 | 0.033 | 0.041 |
| H | 0.080 | 0.254 | 0.003 | 0.010 |
| L | 0.300 | 0.610 | 0.012 | 0.024 |

SC70-5

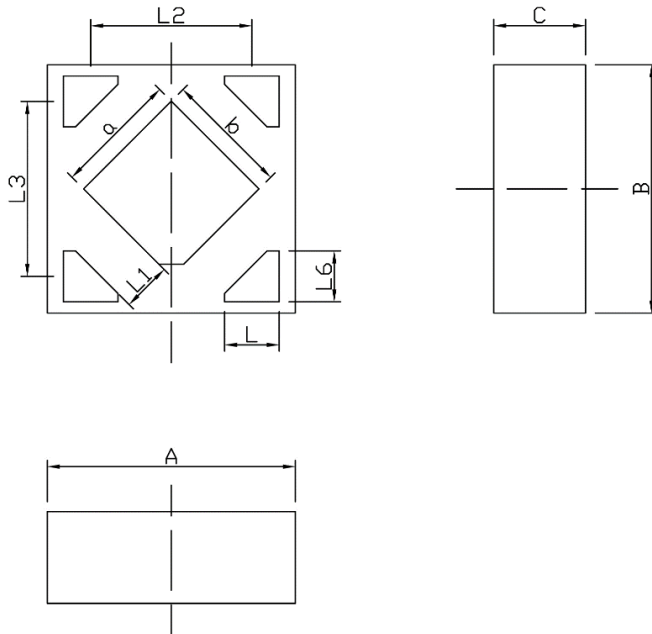


SEE VIEW A-A



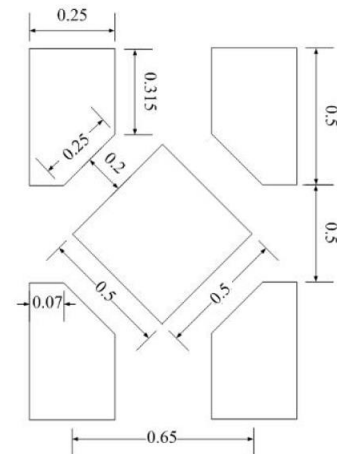
| COMMON DIMENSION | | | |
|----------------------|----------------|-------|------|
| SYMBOL | IN MILLIMETERS | | |
| | MIN | NOMAL | MAX |
| A | 0.80 | - | 1.10 |
| A1 | 0 | - | 0.10 |
| A2 | 0.80 | 0.90 | 1.00 |
| A3 | 0.47 | 0.52 | 0.57 |
| A4 | 0.33 | 0.38 | 0.43 |
| b | 0.15 | - | 0.30 |
| c | 0.10 | - | 0.25 |
| D | 1.85 | 2.00 | 2.20 |
| e | 0.65 BSC | | |
| e1 | 1.30 BSC | | |
| E | 1.80 | 2.10 | 2.40 |
| E1 | 1.15 | 1.25 | 1.35 |
| L | 0.10 | - | 0.45 |
| L1 | 0.42 REF. | | |
| L2 | 0.20 BSC | | |
| θ | 0° | 4° | 30° |
| θ_1 | 4° | - | 12° |
| $\alpha\alpha\alpha$ | 0.10 | | |
| bbb | 0.10 | | |

DFN1×1-4L



| Dimensions In Millimeterer | | | |
|----------------------------|-------|-------|-------|
| Symbol | MIN | TYP | MAX |
| A | 0.950 | 1.000 | 1.050 |
| B | 0.950 | 1.000 | 1.050 |
| C | 0.320 | 0.370 | 0.420 |
| L | 0.170 | 0.220 | 0.270 |
| L1 | 0.140 | 0.190 | 0.240 |
| L2 | 0.600 | 0.650 | 0.700 |
| L3 | 0.625 | 0.675 | 0.725 |
| L6 | 0.175 | 0.225 | 0.275 |
| a | 0.440 | 0.490 | 0.540 |
| b | 0.440 | 0.490 | 0.540 |

There may be slight differences in shape



RECOMMENDED LAND PATTERN (Unit: mm)

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