



# BQ8211

## Low Dropout 300mA Voltage Regulator with Enable

Product Specification	Revision 1.3	September 13, 2006
-----------------------	--------------	--------------------

### General Description

The BQ8211 is a low dropout voltage regulator capable of delivering **300 mA** to the load. It is adjustable and can set a precise voltage from 1.175V to 15V with two external resistors. The BQ8211 meets all specifications down to 1.175V output, unlike CMOS LDO's which loose performance with outputs below 2.25V.

The **enable** pin provides a remote turn-off for low power consumption. It draws virtually zero current while in shutdown mode.

To assure accuracy within **2% over temperature**, the heart of the BQ8211 is a self-correcting AcuRef™ bandgap reference.

On-chip current limit and thermal shutdown with hysteresis protects against any combination of overload and ambient temperature that might cause the junction temperature to exceed safe limits.

### Applications

- Graphic cards and PC motherboards
- Cell Phones
- DVD video player

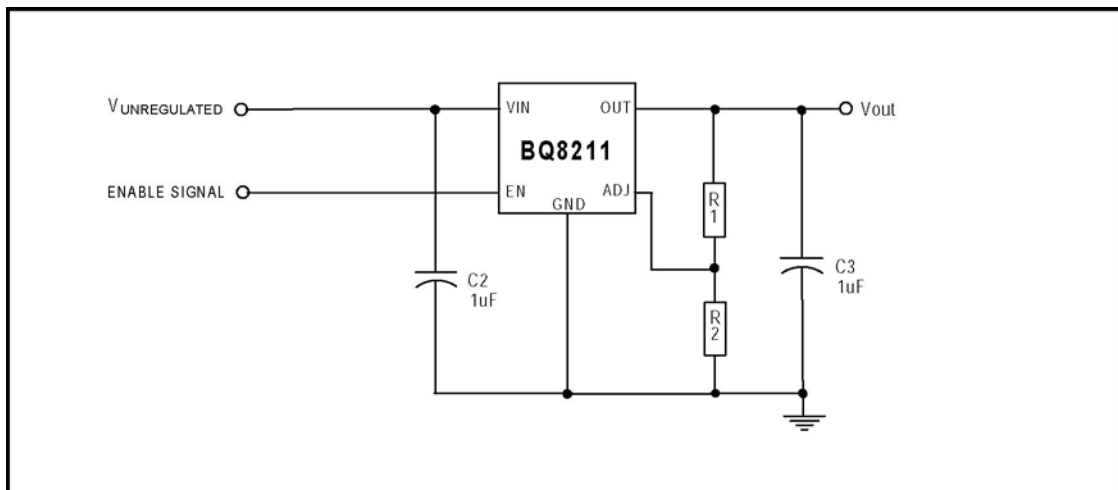
### Replacement for:

- LX8211

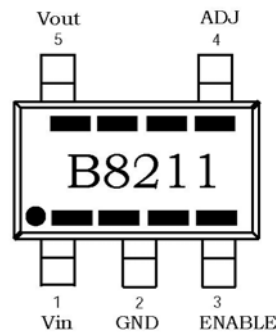
### Features

- Low dropout voltage (980mV at **300 mA**)
- Enable pin implements sequencing
- Vout tolerance less than **2 %** over temperature
- Featured in the very small **SOT-23** package
- Stable with low cost 1μF capacitor
- Low ground current
- Thermal protection with hysteresis
- Short circuit protection
- **RoHS compliant** available

### Typical Application



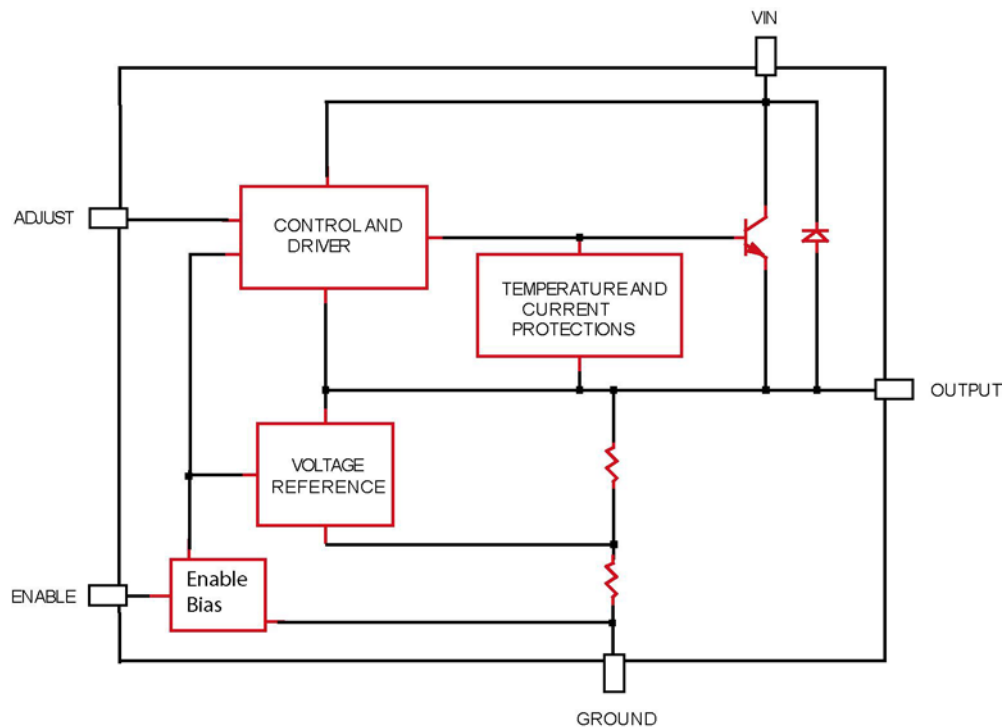
## Pin Configuration



## Pin Descriptions

Pin Name	Function
VIN	+ Unregulated Input Voltage, Collector of Pass Transistor
Ground	- Ground
ENABLE	Active high, ENABLE > 1 V OFF low, ENABLE < 0.25V
Adjust	Adjust input. Connect to resistive feed back divider.
VOUT	Regulated Output

## Functional Block Diagram



## Ordering Information

Device	Operating Tj	%Tol	PKG Type	VOUT	Wrap	Ordering Number
BQ8211	0C° ≤ 125C°	1.0	SOT-23-5	1.8V	T&R	BQ8211CY-M5-18-TR
BQ8211	0C° ≤ 125C°	1.0	SOT-23-5	1.8V	T&R	BQ8211CY-M5-18-TRL
BQ8211	0C° ≤ 125C°	1.0	SOT-23-5	2.5V	T&R	BQ8211CY-M5-25-TR
BQ8211	0C° ≤ 125C°	1.0	SOT-23-5	2.5V	T&R	BQ8211CY-M5-25-TRL
BQ8211	0C° ≤ 125C°	1.0	SOT-23-5	3.3V	T&R	BQ8211CY-M5-33-TR
BQ8211	0C° ≤ 125C°	1.0	SOT-23-5	3.3V	T&R	BQ8211CY-M5-33-TRL
BQ8211	0C° ≤ 125C°	1.0	SOT-23-5	ADJ	T&R	BQ8211CY-M5-AJ-TR
BQ8211	0C° ≤ 125C°	1.0	SOT-23-5	ADJ	T&R	BQ8211CY-M5-AJ-TRL

Note: The TRL parts are Lead Free and RoHS compliant.

## Absolute Maximum Ratings

Stress greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These stress ratings only, and functional operation of the device at these or any conditions beyond those indicated under recommended Operating Conditions is not implied. Exposure to “Absolute Maximum Rating” for extended periods may affect device reliability. Use of standard ESD handling precautions is required.

Parameter	Value	Units
Maximum VIN	18	Volts
Maximum VENABLE	Vin + 0.3V	Volts
Power Dissipation (Internally limited)		
Maximum Junction Temperature	150	°C
Operating Junction Temperature Range	-40 to 125	°C
Storage Temperature Range	-65 to 150	°C
Lead Temperature (Soldering, 4 sec.) SOT- 23-5 package	300	°C

## Thermal Management

Thermal Resistance (Junction to Ambient)	Typical Value	Units
SOT-23-5 (minimum foot print)	220	°C/W

Thermal Resistance (Junction to Ambient)	Typical Value	Units
SOT-23-5 (Soldered to 1 in <sup>2</sup> 1 oz. copper PCB)	170	°C/W

## Electrical Specifications

Electrical characteristics are guaranteed over the full temperature range  $40^{\circ}\text{C} < T_j < 125^{\circ}\text{C}$ . Ambient temperature must be de-rated based upon power dissipation and package thermal characteristics. Unless otherwise specified:  $V_{\text{ENABLE}} = 1\text{V}$ ,  $V_{\text{IN}} = (V_{\text{OUT}} + 1.5\text{V})$ ,  $I_{\text{OUT}} = 10\text{ mA}$ ,  $T_j = 25^{\circ}\text{C}$ . Values in **bold** are over the full temperature range.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V <sub>OUT</sub>	Output Voltage (1)		-1	V <sub>OUT</sub>	+1	%
		$40^{\circ}\text{C} \leq T_j \leq 125^{\circ}\text{C}$	<b>-2.0</b>	V <sub>OUT</sub>	<b>+2.0</b>	%
LNREG	Line Regulation (1)	$\Delta V_{\text{EN}} = V_{\text{OUT}} + (1.5\text{V to } 10\text{V})$		0.035	<b>0.2</b>	%
LDREG	Load Regulation (1)	$\Delta I_{\text{OUT}} = (10\text{mA to } 300\text{ mA})$		0.2	<b>0.4</b>	%
V <sub>D</sub>	Dropout Voltage (1, 2)	$I_{\text{OUT}} = 100\text{ mA}$		0.93	<b>1.0</b>	V
		$I_{\text{OUT}} = 150\text{ mA}$		0.94	<b>1.0</b>	V
		$I_{\text{OUT}} = 300\text{ mA}$		0.98	<b>1.1</b>	V
ISC	Current Limit (1)	$V_{\text{EN}} - V_{\text{OUT}} = 2\text{V}$	500	800		mA
I <sub>GND</sub>	Ground Current ON			100	<b>150</b>	μA
I <sub>GND</sub>	Ground Current ON (5)	Adjustable version		65	<b>100</b>	μA
V <sub>IH</sub>	Enable Pin Voltage (ON)	With respect to GND		0.92	<b>1.0</b>	V
V <sub>IL</sub>	Enable Pin Voltage (OFF)	With respect to GND	<b>0.25</b>	0.45		V
I <sub>ENON</sub>	Enable Current ON	$V_{\text{ENABLE}} = V_{\text{IN}} = 5\text{V}$		60	<b>100</b>	μA
V <sub>ADJ</sub>	Reference Voltage	Adjustable version only	1.163	1.175	1.187	V
		$0^{\circ}\text{C} \leq T_j \leq 125^{\circ}\text{C}$	<b>1.151</b>		<b>1.199</b>	V
I <sub>QMIN</sub>	Minimum Load Current (5)	To maintain regulation		0.5	<b>2.0</b>	mA
TC	Temperature Coefficient			<b>0.005</b>		%/°C
TS	Temperature Stability			<b>0.5</b>		%/°C
V <sub>N</sub>	RMS Output Noise (3)			0.003		% V <sub>OUT</sub>
PSRR	Ripple Rejection Ratio (4)	$V_{\text{in}} = 5\text{V}$	<b>60</b>	72		dB
TSD	Thermal Shutdown	Junction Temperature		<b>150</b>		°C
TSDHYST	TSD Hysteresis			<b>25</b>		°C

**Notes:** (1) Low duty cycle pulse testing with Kelvin connections required.

(2) Measure  $(V_{\text{IN}} - V_{\text{OUT}})$  when  $\Delta V_{\text{OUT}}$ , OR  $\Delta V_{\text{REF}} = 1\%$

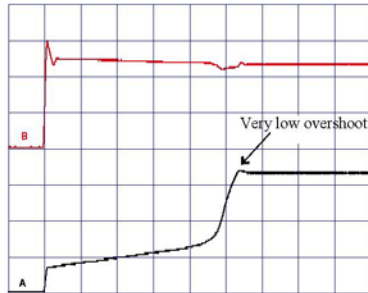
(3) Bandwidth of 10Hz to 10kHz

(4) 120Hz input ripple

(5) Adjustable version only

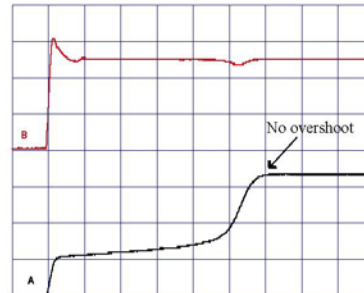
# Application Notes

Output Overshoot With Line, 500mA Load



Input Step (B) 0-5V  
Output Response (A) 0-3.3V with 500mA load  
Horizontal: 100us/div

Output Overshoot With Line, No Load



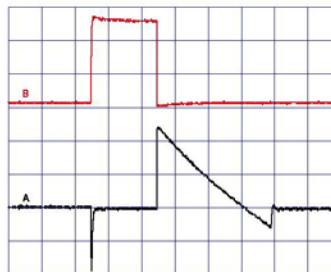
Input Step (B) 0-5V  
Output Response (A) 0-3.3V Zero Load  
Horizontal: 20us/div

Active Load Short Circuit Cycling



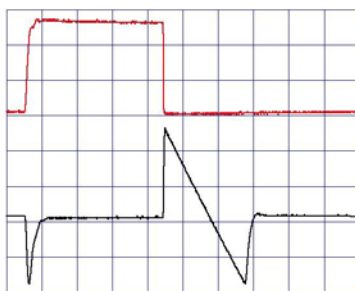
Output Response (A)  
Low duty cycle, repetitive, no thermal limit intervention  
Horizontal: 10us/div Vertical: 500mV/div

Load Step 0mA to 500mA



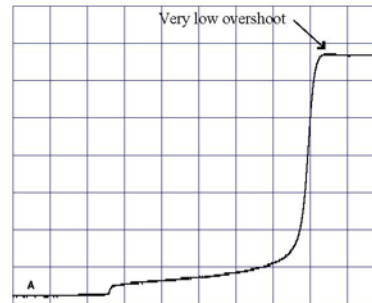
Load Step (B) 0mA to 500mA to 0mA  
Output Response (A) 50mV/div (AC coupled)  
Horizontal: 500us/div

Load Step 10mA to 500mA



Load Step (B) 10mA to 500mA to 10mA  
Output Response (A) 50mV/div (AC coupled)  
Horizontal: 100us/div

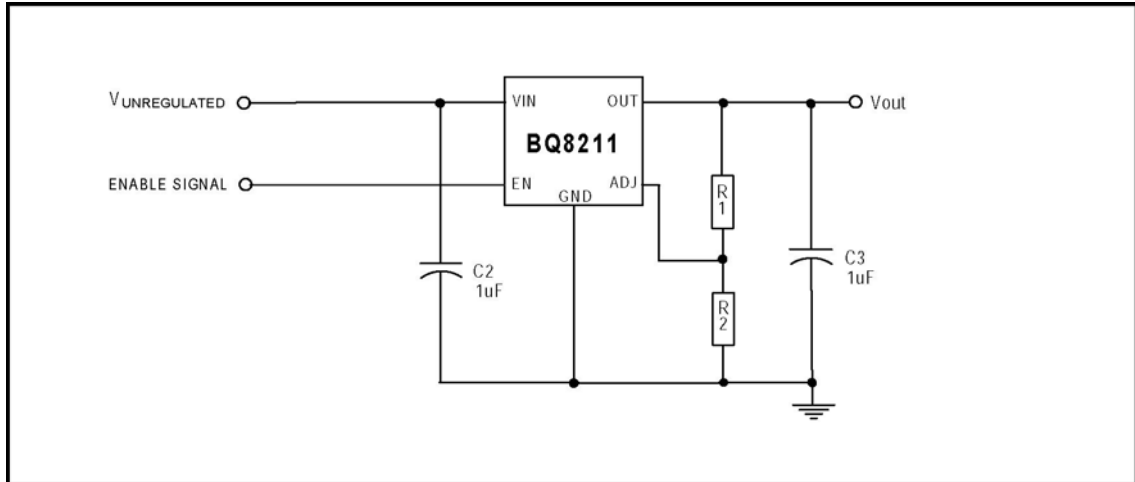
Short Circuit Removal (to no load)



Output Response (A) 0-3.3V  
Output grounded to open circuit, single shot  
Horizontal: 200us/div Vertical: 500mV/div

## Application Notes

### 1. Typical Application



Notes:

1. Output voltage is  $1.175V * (R1 + R2)/R2$
2. Input and output capacitors should be located close to the device.
3. The BQ8211 will remain stable with C2 and C3 as low as 1.0  $\mu F$ . Overall transient performance is improved with increased capacitance.
4. The output is fully enabled when Enable is above 1V. EN may be driven by either a digital or analog signal to control turn-on time.

### 2. Stability

A **Vin** Capacitor is also recommended. A 1 $\mu F$  capacitor is a bypassing for almost all applications. A larger capacitor is also suitable depending on the cleanliness of the VIN source.

The **Output** capacitor is critical in maintaining regular stability. The BQ8211 is stable with an output capacitor greater than 1 $\mu F$ . Any increase of the output capacitor will merely improve the loop stability and the load transient response.

Tantalum Capacitors exhibit the best stability over a wide range of loads and are recommended.

### 3. Output Voltage

The BQ8211 meets all specifications down to 1.175V output. It does not suffer from performance degradation issues such as experienced with CMOS LDO's.

The BQ8211 develops a 1.175V reference voltage between the adjust pin terminal and ground. This voltage is applied across the resistor R2 to generate a constant current ( $I_2$ ). The current from the adjust terminal could introduce error to the output, but since it is very small ( $<0.5\mu\text{A}$ ) compared with the current  $I_2$  and very constant with line and load changes, the error can be ignored. The constant current  $I_2$  then flows through resistor R1 and sets the output voltage to the desired level.

The BQ8211 regulates the voltage that appears between its output and ground pins or between its adjust and ground pins. In some cases, line resistances can introduce errors to the voltage across the load. To obtain the best load regulation a few precautions are needed. For example, it is important to minimize the line resistances to the load. So, the load itself should be tied directly to the output terminal on the positive side and directly to the ground terminal on the negative side.

The best performance is obtained with the positive side of the resistor R1 tied near the load and with the ground side of the resistor R2 tied near the ground of the regulator. This will provide remote output sensing which will optimize regulation at the load.

### 4. Enable/Sequencing

The BQ8211 provides an enable function. The EN pin has to be at least 1V for the device to be fully turned on. When the voltage of the EN pin is low the device is in shutdown mode and it will not draw any current from the VIN terminal.

### 5. Protection Diodes

Unlike older regulators, the BQ8211 requires no protection diodes between the ADJ pin and VOUT or from the VOUT to the VIN to prevent over-stressing the die. Internal resistors are limiting the internal current paths on the ADJ pin. Therefore, even with capacitors on the ADJ pin, no protection diode is needed to ensure device safety under short circuit conditions. External diodes between the VIN and VOUT are not usually needed. Only if high value output capacitors are used ( $> 1000\mu\text{F}$ ) and the input is instantaneously shorted to ground, can damage occur.

### 6. Thermal Considerations

When an integrated circuit operates with an appreciable current, its junction temperature is elevated. It is important to quantify its thermal limits in order to achieve acceptable performance and reliability. This limit is determined by summing the individual parts consisting of a series of temperature rises from the semiconductor junction to the operating environment. The heat generated at the device junction flows through the die to the die attach pad, through the lead frame to the surrounding case material, to the printed circuit board, and eventually to the ambient environment.

The BQ8211 regulators have internal thermal shutdown to protect the device from over-heating. Under all possible operating conditions, the junction temperature of the BQ8211 must be lower than 125°C. A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application.

To determine if a heatsink is needed, the power dissipated by the regulator,  $P_D$ , must be calculated:

$$P_D = (V_c - V_{OUT}) I_L$$

where the  $I_L$  is the load current.

The next parameter, which must be calculated, is the max. allowable temperature rise,  $T(\max)$ :

$$T(\max) = T_J(\max) - T_A(\max)$$

where  $T_J(\max)$  is the maximum allowable junction temperature (125°C), and  $T_A(\max)$  is the maximum ambient temperature, which will be encountered in the application.

Using the calculated values for  $T(\max)$  and  $P_D$ , the maximum allowable value for the junction to ambient thermal resistance ( $\theta_{JA}$ ) can be calculated:

$$\theta_{JA} = T(\max) / P_D$$

If the maximum allowable value for  $\theta_{JA}$  is found to be greater than the junction to ambient thermal resistance for the package used, no heatsink is needed since the package alone will dissipate enough heat to satisfy these requirements.

---

## Contact Information

**Acutechnology Semiconductor Inc.**  
**3487 McKee Rd. Suite 52**  
**San Jose CA , USA 95127**

**TEL: (408) 259-2300**  
**FAX: (408) 259-9160**  
**website: www.acutechnology.com**

---

### Disclaimer

The information furnished by Acutechnology in this data sheet is believed to be accurate and reliable. However, Acutechnology assumes no responsibility for its use. Acutechnology reserves the right to change circuitry and specifications at any time without notification to the customer.

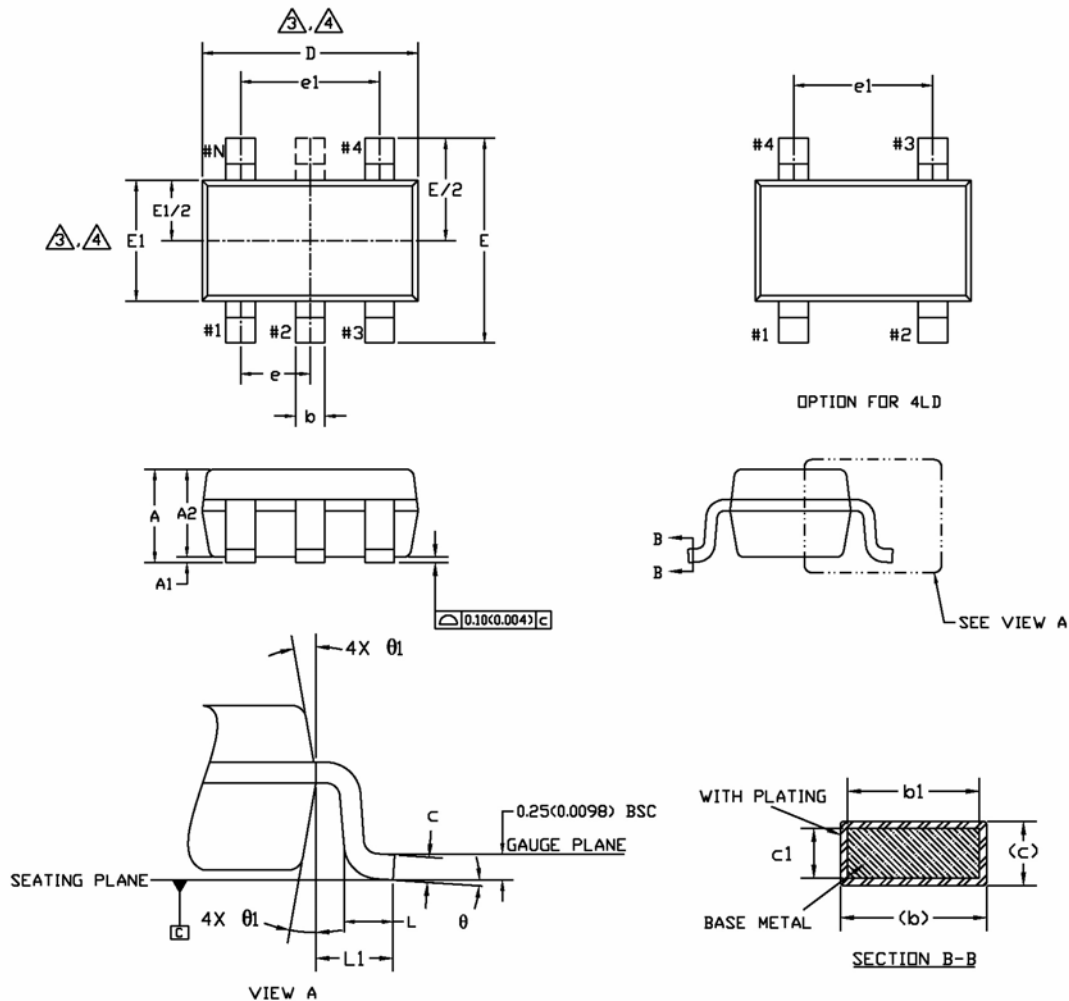
### Life Support Policy

Acutechnology Products are not designed or authorized for use as components in life support devices or systems where malfunction of a product can reasonably be expected to result in personal injury. Life support devices or systems are devices or systems that (a) are intended for surgical implant into the body or (b) support or sustain life, and whose failure to perform can be reasonably expected to result in a significant injury to the user.

**AcuRef™** is a trademark of Acutechnology Semiconductor Inc



PACKAGE DIMENSIONS SOT23-3 SOT23-5, SOT23-4, SOT23-6



SYMBOL	COMMON					
	DIMENSIONS MILLIMETER			DIMENSIONS INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.20	1.30	1.40	0.047	0.051	0.055
A1	0.05	-	0.15	0.002	-	0.006
A2	0.90	1.15	1.30	0.035	0.045	0.051
b	0.35	-	0.50	0.013	-	0.020
b1	0.35	0.40	0.45	0.013	0.015	0.017
c	0.08	-	0.22	0.003	-	0.008
c1	0.08	0.13	0.20	0.003	0.005	0.007
D	2.90 BSC			0.114 BSC		
E	2.80 BSC			0.110 BSC		
E1	1.60 BSC			0.062 BSC		
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.074 BSC		
L	0.35	0.45	0.55	0.013	0.017	0.021
L1	0.60 REF.			0.023 REF.		
θ	0°	4°	8°	0°	4°	8°
θ1	10° TYP			10° TYP		

NOTE :

1. Dimensioning and tolerancing per ASME Y 14.5 M - 1994.
2. Dimensions are in millimeters. Converted inch dimension are not necessarily exact.
3. Dimension D does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 0.15 mm per side.
4. Dimension E1 does not include interlead flash or protrusion. Interlead flash or protrusion shall not exceed 0.15 mm per side.
5. Top package may be smaller than the bottom package. Dimension D and E1 are determine at the outermost extremes of the plastic body exclusive of mold flash gate burrs and interlead flash.
5. Terminal numbers are shown for reference only. Die is facing up for molding. Die is facing down for trim/form.