

## 4- Low 300mA Linear Regulator

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### Description

The EC8803 is a 4-Low (Low-dropout, Low-noise, Low-quiescent current, Low-cost) linear regulator that operations in the input voltage range from +2.2V to +7.0V and delivers 300mA output current.

The high-accuracy output voltage is preset at an internally trimmed voltage 2.5V or 3.3V. Other output voltages can be mask-optional from 1.2V to 5.0V with 100mV increment, except EC8803 which has 2.85V output voltage.

The EC8803 consists of a 1.25V band-gap reference, an error amplifier, and a P-channel pass transistor. Other features include short-circuit protection and thermal shutdown protection. The EC8803 devices are available in SOT-23, TSOT-23, SOT-89 and TO-92 packages.

### Features

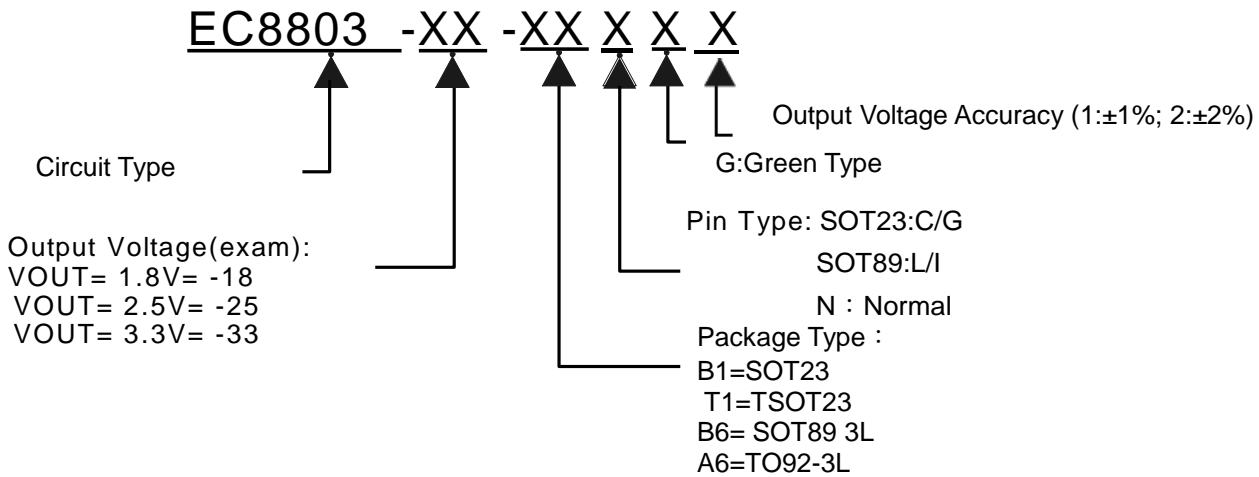
- Operating Voltages Range : +2.2V to +7.0V
- Output Voltages Range : +1.2V to +5.0V with 100mV Increment
- Maximum Output Current : 300 mA
- Low Dropout: 125mV @ 100mA ( $V_{OUT} \geq 2.0$  V)
- $\pm 2\%$  Output Voltage Accuracy (special  $\pm 1\%$  highly accurate)
- Output Current Limit Protection (500mA)
- Short Circuit Protection (150mA)
- Thermal Overload Shutdown Protection
- Low ESR Capacitor Compatible
- SOT-23, TSOT-23, SOT-89, TO-92 Packages
- RoHS Compliant and 100% Lead (Pb)-Free and Green (Halogen Free with Commercial Standard)

### Applications

- Battery powered equipments
- Palmtops
- Reference voltage sources
- Portable Cameras and video recorders
- Post Regulator for switching power

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## Ordering Information



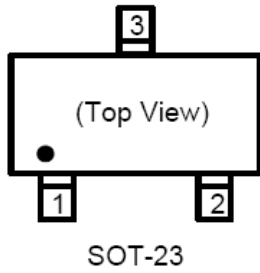
Package	Part Number	Marking	Marking Information
SOT-23	EC8803XXB1CG1	<u>3</u> VXX1	The 1st character represents the Product part . Example: EC8803=3 V is the output voltage of production. Example: 5=1.2V; 8=1.5V;A=1.8V, D=2.0V;G=2.5V, J=2.7V;K=2.8V;M=3.0V;Q=3.3V.V=3.6V XX represents the Production Date Code.
	EC8803XXB1CG2	<u>3</u> VXX2	
	EC8803XXB1GG1	3 <u>V</u> XX1	
	EC8803XXB1GG2	3 <u>V</u> XX2	
TSOT23	EC8803XXT1NG1	3V <u>X</u> X1	
	EC8803XXT1NG2	3V <u>X</u> X2	
SOT89	EC8803XXB6LG1	3V <u>X</u> X1	
	EC8803XXB6LG2	3V <u>X</u> X2	
	EC8803XXB6IG1	3V <u>X</u> X1	
	EC8803XXB6IG2	3V <u>X</u> X2	
TO92	EC8803XXA6NG1	3VXX <u>1</u>	
	EC8803XXA6NG2	3VXX <u>2</u>	

**Note:**

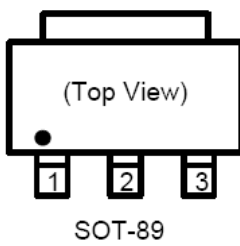
- There is an under-line on 1st character represents the pin out type of C type package.
- There is an under-line on 2nd character represents the pin out type of G type package.
- There is an under-line on 3rd character represents the pin out type of L type package
- There is an under-line on 4th character represents the pin out type of I type package

## 4- Low 300mA Linear Regulator

### Pin Assignment & Pin Description



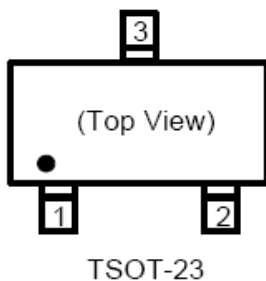
Pin Number		Pin Name	Functions
SOT-23(C)	SOT-23(G)		
1	3	GND	Ground
2	1	V <sub>OUT</sub>	Output
3	2	V <sub>IN</sub>	Power Input



Pin Number		Pin Name	Functions
SOT-89(L)	SOT-89(I)		
1	2	GND	Ground
2	3	V <sub>IN</sub>	Power Input
3	1	V <sub>OUT</sub>	Output



Pin Number		Pin Name	Functions
TO-92			
1		GND	Ground
2		V <sub>IN</sub>	Power Input
3		V <sub>OUT</sub>	Output



Pin Number		Pin Name	Functions
TSOT-23			
1		GND	Ground
2		V <sub>OUT</sub>	Output
3		V <sub>IN</sub>	Power Input

## 4- Low 300mA Linear Regulator

### Absolute Maximum Rating

Parameter		Symbol	Value	Units
Input Voltage $V_{IN}$ to GND		$V_{IN}$	7.0	V
Output Current Limit, $I_{LIMIT}$		$I_{OUT}$	500	mA
Junction Temperature		$T_J$	+155	°C
Thermal Resistance	SOT23	$\theta_{JA}$	280	°C/ W
	TSOT23		280	°C/ W
	SOT89		180	°C/ W
	TO-92		160	°C/ W
Power Dissipation	SOT23	$P_D$	350	mW
	TSOT23		350	mW
	SOT-89		550	mW
	TO-92		550	mW
Storage Temperature		$T_{STG}$	-55 to+150	°C
Operating Ambient Temperature		$T_{OPR}$	-40 to+125	°C
Lead Temperature (Soldering, 10sec)		—	+260	°C
Moisture Sensitivity Level		MSL	3	--

Note :

\*Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device.

These are stress ratings only, and function operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

\* The power dissipation of UFN-6 would be 500 mW normally with the 0.5X0.5 square inches cooper area connected to the bottom pad. However, it could be up to 1000mW with larger cooper area.

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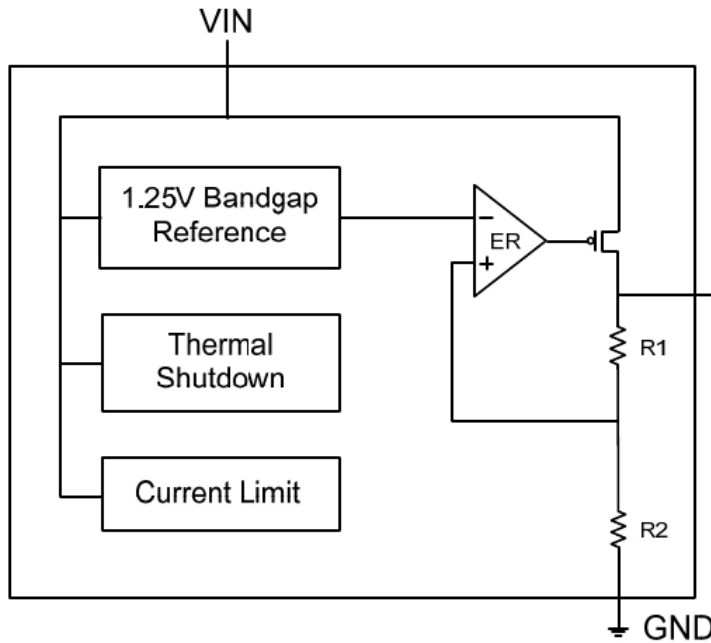
### Electrical Characteristics

(T<sub>A</sub>=25°C, unless otherwise noted.)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V <sub>IN</sub>	Input Voltage		2.2		7.0	V
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> =V <sub>OUT</sub> +0.8V, I <sub>OUT</sub> =1mA, V <sub>IN</sub> ≥2.5V	-2%	V <sub>OUT</sub>	+2%	V
		V <sub>IN</sub> =V <sub>OUT</sub> +0.8V, I <sub>OUT</sub> =1mA, V <sub>IN</sub> ≥2.5V	-1%		+1%	
I <sub>MAX</sub>	Maximum Load Current	V <sub>OUT</sub> +0.8V ≤ V <sub>IN</sub> ≤ 7.0V	300			mA
I <sub>LIMIT</sub>	Current Limit				0.5	A
I <sub>SC</sub>	Short Circuit Current	V <sub>OUT</sub> =0V, V <sub>IN</sub> > V <sub>OUT</sub> +0.8V		150		mA
I <sub>Q</sub>	Ground Pin Current	I <sub>LOAD</sub> =0mA to 300mA, V <sub>IN</sub> =V <sub>OUT</sub> +0.8V		15	30	μA
V <sub>DROP</sub>	Dropout Voltage	I <sub>OUT</sub> =100mA, V <sub>IN</sub> ≥ 2.5V		125	140	mV
		I <sub>OUT</sub> =200mA, V <sub>IN</sub> ≥ 2.5V		250	280	
		I <sub>OUT</sub> =300mA, V <sub>IN</sub> ≥ 2.5V		550	650	
ΔV <sub>LINE</sub>	Line Regulation	V <sub>OUT</sub> +0.8V < V <sub>IN</sub> < 7.0V, I <sub>LOAD</sub> =1mA		0.2	0.3	%/V
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>OUT</sub> =0mA to 300mA,		0.01	0.02	%/mA
PSRR	Ripple Rejection	f=1KHz, C <sub>OUT</sub> =1uF, I <sub>OUT</sub> =30mA		50		dB
TSD	Thermal Shutdown Temperature			150		°C
THYS	Thermal Shutdown Hysteresis			20		°C

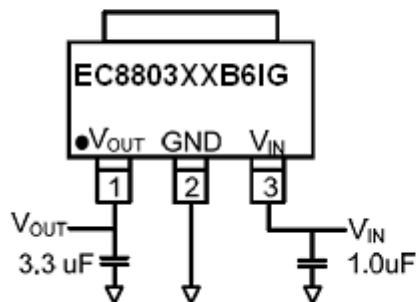
## 4- Low 300mA Linear Regulator

### Block Diagram

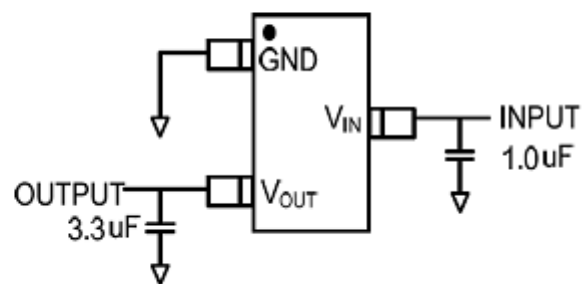


### Simplified Application Circuit

#### SOT-89



#### SOT-23



## Detail Description

The EC8803 is a low-dropout linear regulator. The device provides preset 2.5V and 3.3V output voltages for output current up to 300mA. Other mask options for special output voltages from 1.2V to 5.0V with 100mV increment are also available (but only 1.28V instead of 1.3V). As illustrated in function block diagram, it consists of a 1.25V reference, error amplifier, a P-channel pass transistor, and an internal feedback voltage divider.

The 1.25V bandgap reference is connected to the error amplifier, which compares this reference with the feedback voltage and amplifies the voltage difference. If the feedback voltage is lower than the reference voltage, the pass-transistor gate is pulled lower, which allows more current to pass to the output pin and increases the output voltage. If the feedback voltage is too high, the pass-transistor gate is pulled up to decrease the output voltage.

The output voltage is feedback through an internal resistive divider connected to  $V_{OUT}$  pin. Additional blocks include with output current limiter and shutdown logic.

### Internal P-channel Pass Transistor

The EC8803 features a P-channel MOSFET pass transistor. Unlike similar designs using PNP pass transistors, P-channel MOSFETs require no base drive, which reduces quiescent current. PNP-based regulators also waste considerable current in dropout conditions when the pass transistor saturates, and use high base-drive currents under large loads. The EC8803 does not suffer from these problems and consumes only 15 $\mu$ A (Typical) of current consumption under light loads.

### Output Voltage Selection

The EC8803 output voltage is preset at an internally trimmed voltage 1.8V, 2.5V or 3.3V. The output voltage also can be mask-optional from 1.2V to 5.0V with 100mV increment. The first two digits of part number suffix identify the output voltage (see **Ordering Information**). For example, EC8803-33 has a preset 3.3V output voltage.

## Current Limit

The EC8803 also includes a fold back current limiter. It monitors and controls the pass-transistor's gate voltage, estimates the output current, and limits the output current within 500mA.

## Thermal Overload Protection

Thermal overload protection limits total power dissipation in the EC8803. When the junction temperature exceeds  $T_J = +150^{\circ}\text{C}$ , a thermal sensor turns off the pass transistor, allowing the IC to cool down. The thermal sensor turns the pass transistor active again after the junction temperature cools down by  $20^{\circ}\text{C}$  resulting in a pulsed output during continuous thermal overload conditions.

Thermal overload protection is designed to protect the EC8803 in the event of fault conditions. For continuous operation, the maximum operating junction temperature rating of  $T_J = +125^{\circ}\text{C}$  should not be exceeded.

## Operating Region and Power Dissipation

Maximum power dissipation of the EC8803 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 devices is  $P = I_{OUT} \times (V_{IN} - V_{OUT})$ . The resulting maximum power dissipation is:

$$P_{MAX} = \frac{(T_J - T_A)}{\theta_{JC} + \theta_{CA}} = \frac{(T_J - T_A)}{\theta_{JA}}$$

Where  $(T_J - T_A)$  is the temperature difference between the EC8803 die junction and the surrounding air,  $\theta_{JC}$  is the thermal resistance of the package chosen, and  $\theta_{CA}$  is the thermal resistance through the printed circuit board, copper traces and other materials to the surrounding air. For better heat-sinking, the copper area should be equally shared between the  $V_{IN}$ ,  $V_{OUT}$ , and GND pins.

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If the EC8803 uses a SOT-89 package and this package is mounted on a double sided printed circuit board with two square inches of copper allocated for “heat spreading”, the resulting  $\theta_{JA}$  is 180 °C/W.

Based on a maximum operating junction temperature 125 °C with an ambient of 25°C, the maximum power dissipation will be:

$$P_{MAX} = \frac{(T_J - T_A)}{\theta_{JC} + \theta_{CA}} = \frac{(125 - 25)}{180} = 0.555W$$

Thermal characteristics were measured using a double-side board with 1” x 2” square inches of copper area connected to the GND pin for “heat spreading”.

### Inout-Output 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. The EC8803 uses a P-channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on-resistance ( $R_{DS(ON)}$ ) multiplied by the load current.

$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

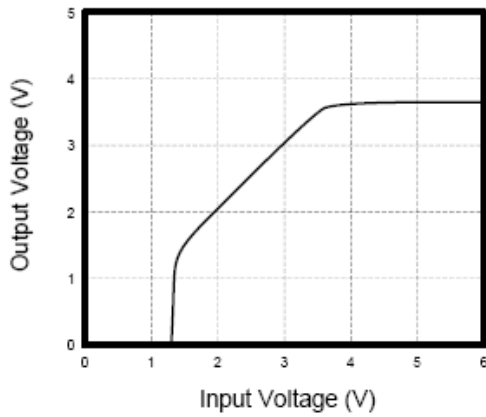


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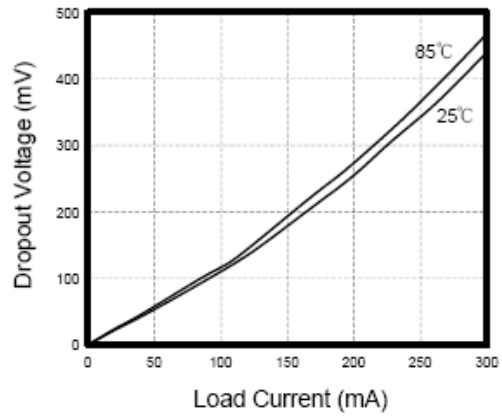
### Typical Operating Characteristics

( $C_{IN}=1\mu F$ ,  $C_{OUT}=3.3\mu F$ ,  $T_A=+25^\circ C$ , unless otherwise noted.)

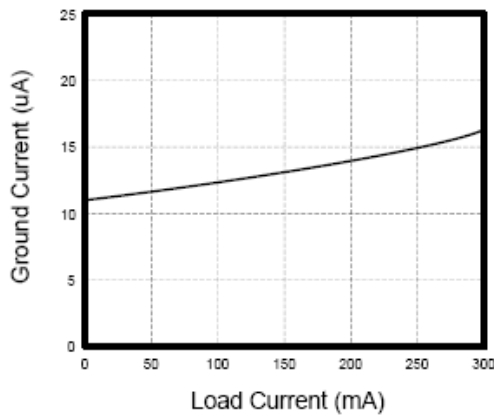
Input Voltage vs. Output Voltage



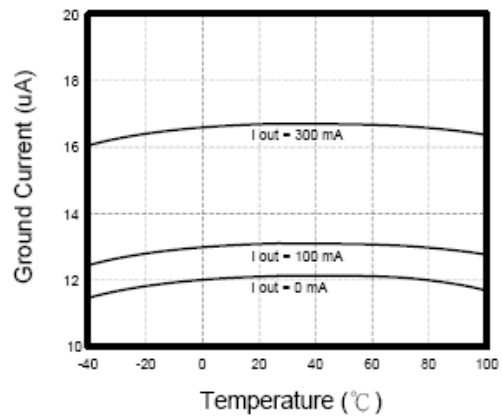
Dropout Voltage vs. Load Current



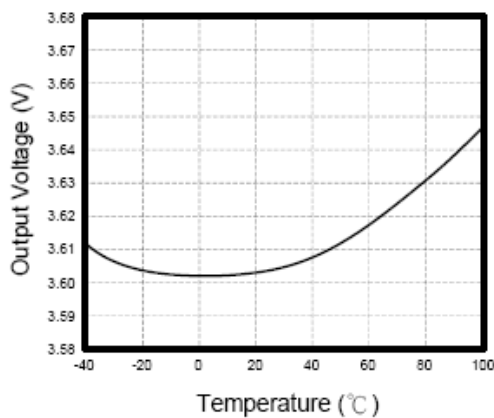
Ground Current vs. Load Current



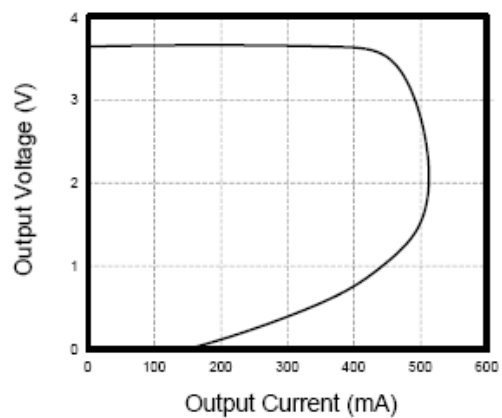
Ground Current vs. Temperature



Output Voltage vs. Temperature

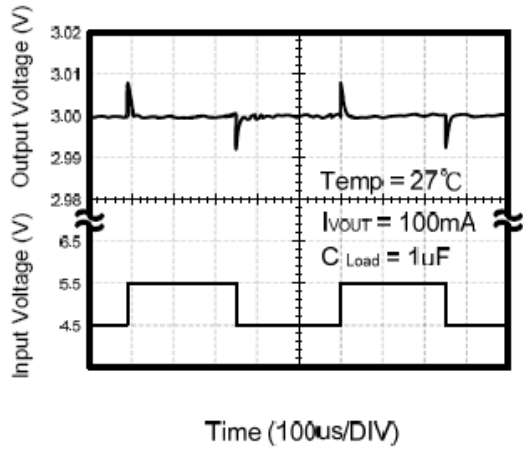


Output Voltage vs. Current Limit

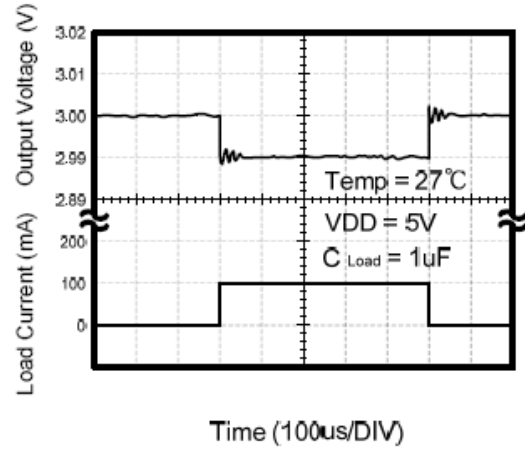


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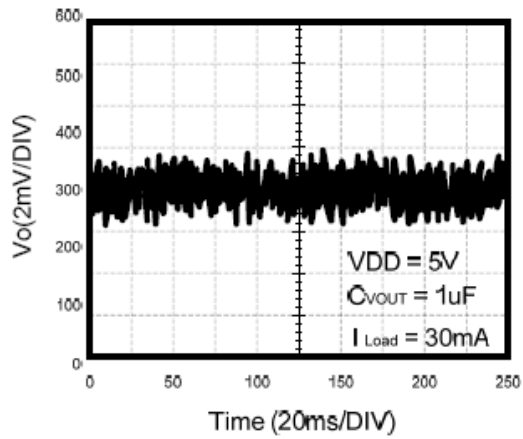
Line Transient Response



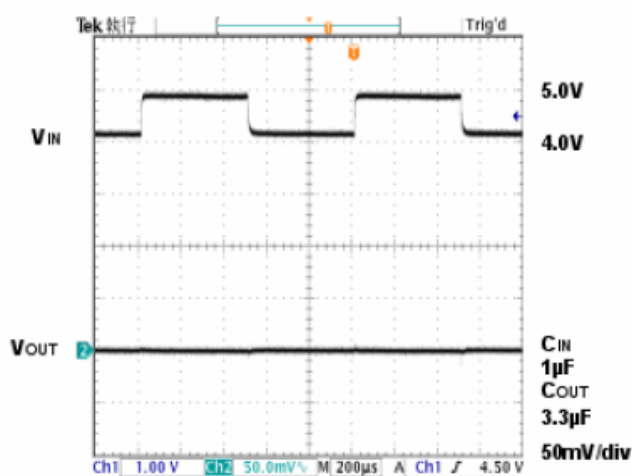
Load Transient Response



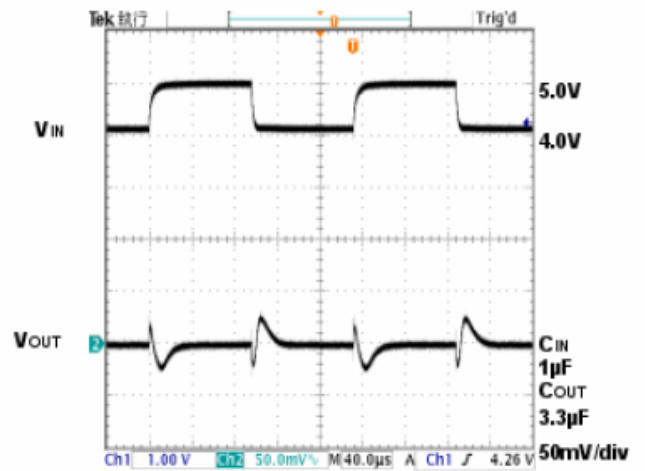
Noise Measurement



LINE TRANSIENT (I<sub>OUT</sub>=0mA)

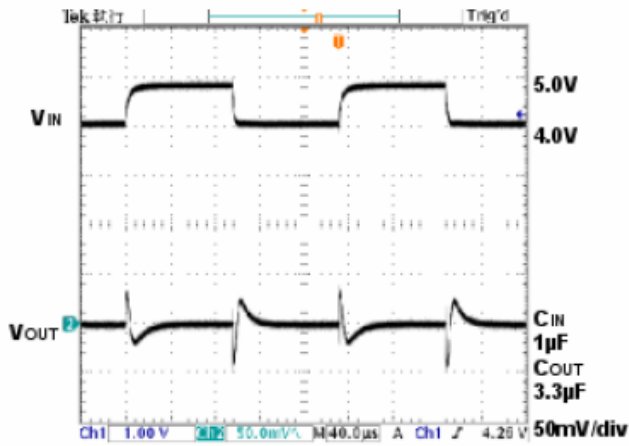


LINE TRANSIENT (I<sub>OUT</sub>=10mA)

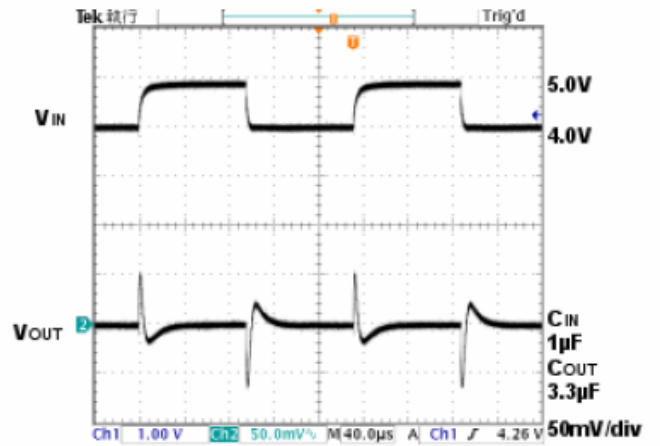


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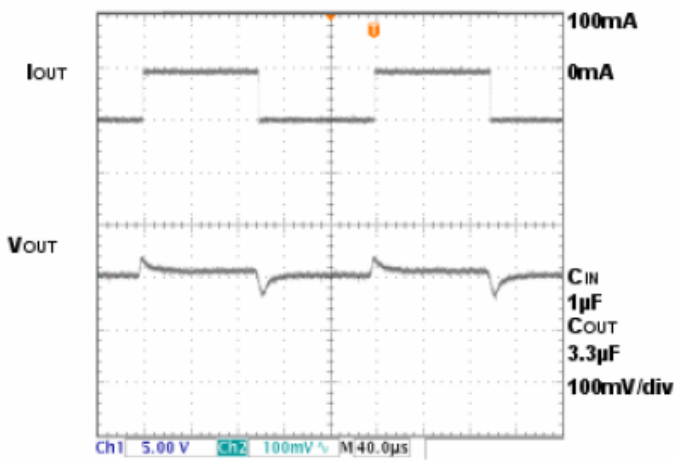
LINE TRANSIENT (I<sub>OUT</sub>=100mA)



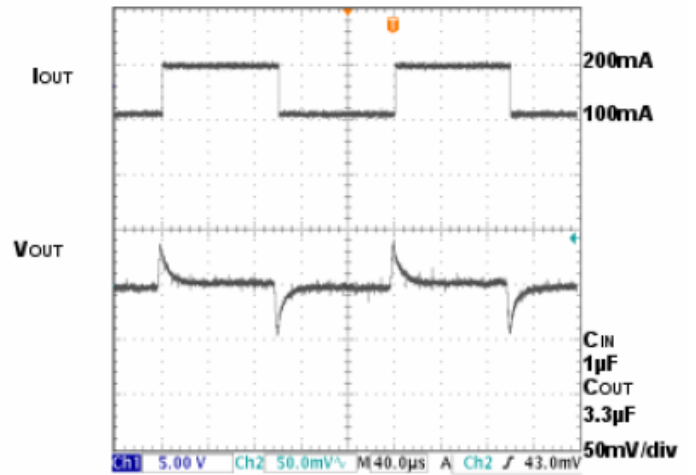
LINE TRANSIENT (I<sub>OUT</sub>=200mA)



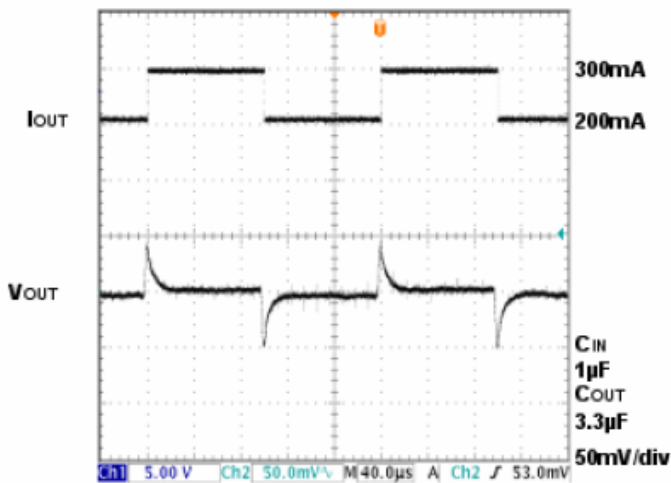
LOAD TRANSIENT



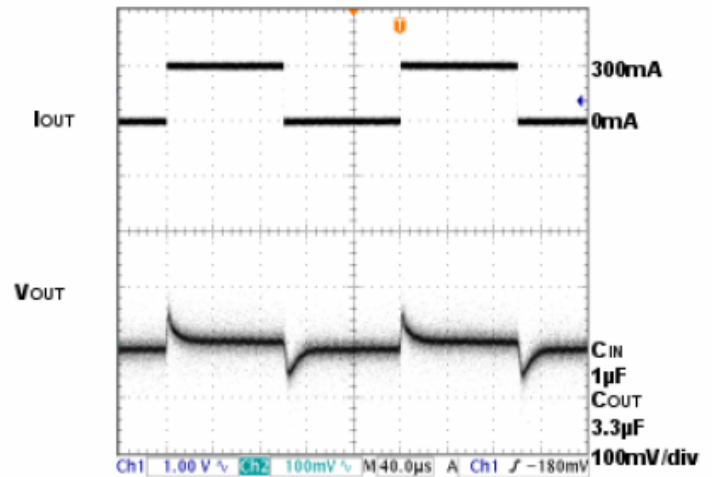
LOAD TRANSIENT



LOAD TRANSIENT

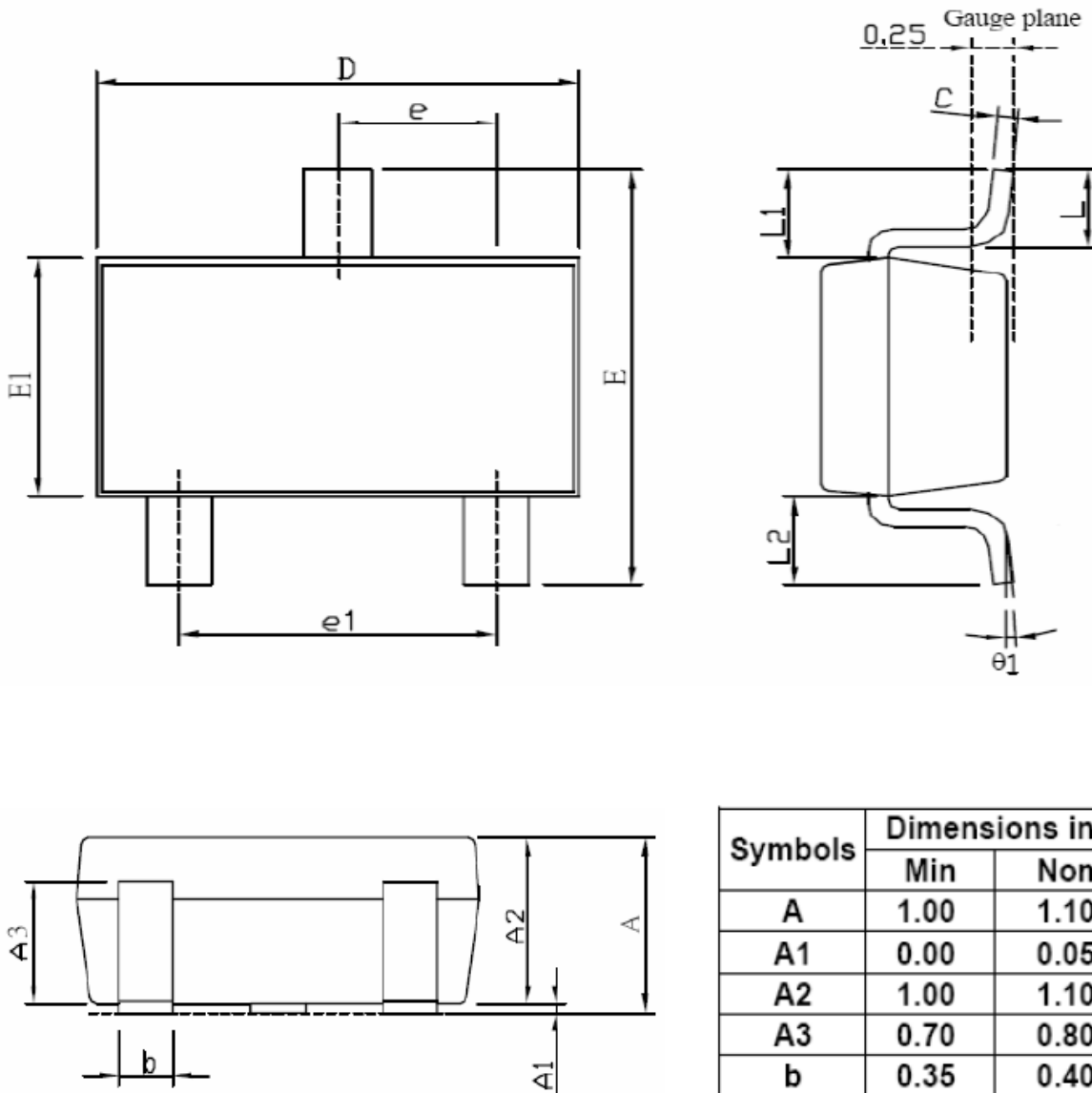


LOAD TRANSIENT



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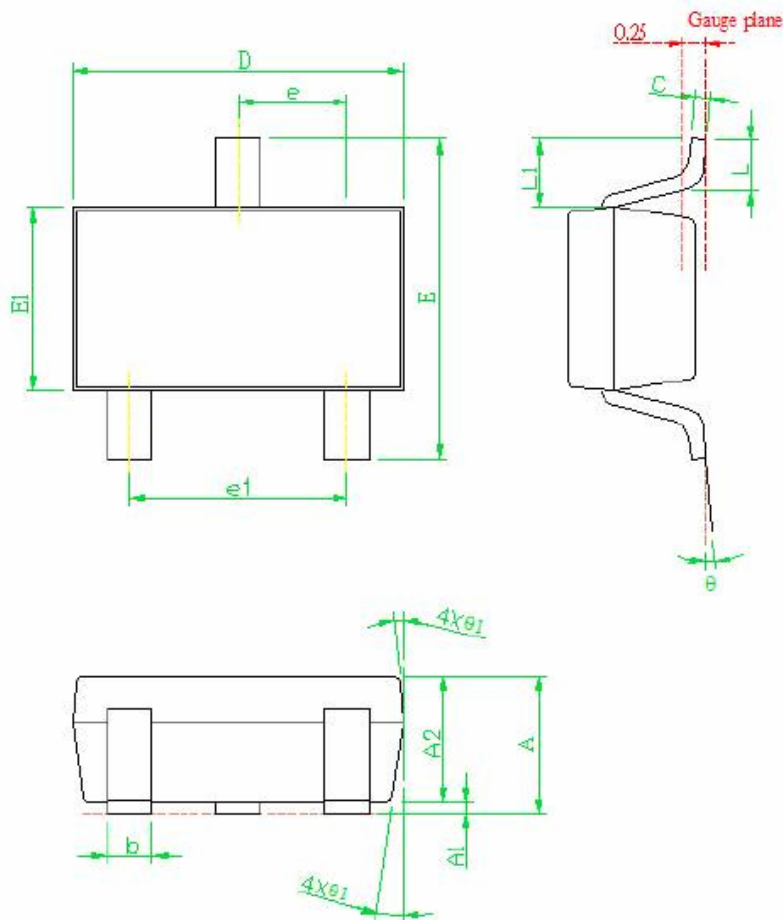
### Mechanical Dimensions OUTLINE DRAWING SOT-23



Symbols	Dimensions in Millimeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	0.05	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	---	0.95(Typ)	---
e1	---	1.90(Typ)	---
$\theta_1$	1°	5°	9°
L	0.37	---	---
L1	---	0.6REF	---
L1-L2	---	---	0.12

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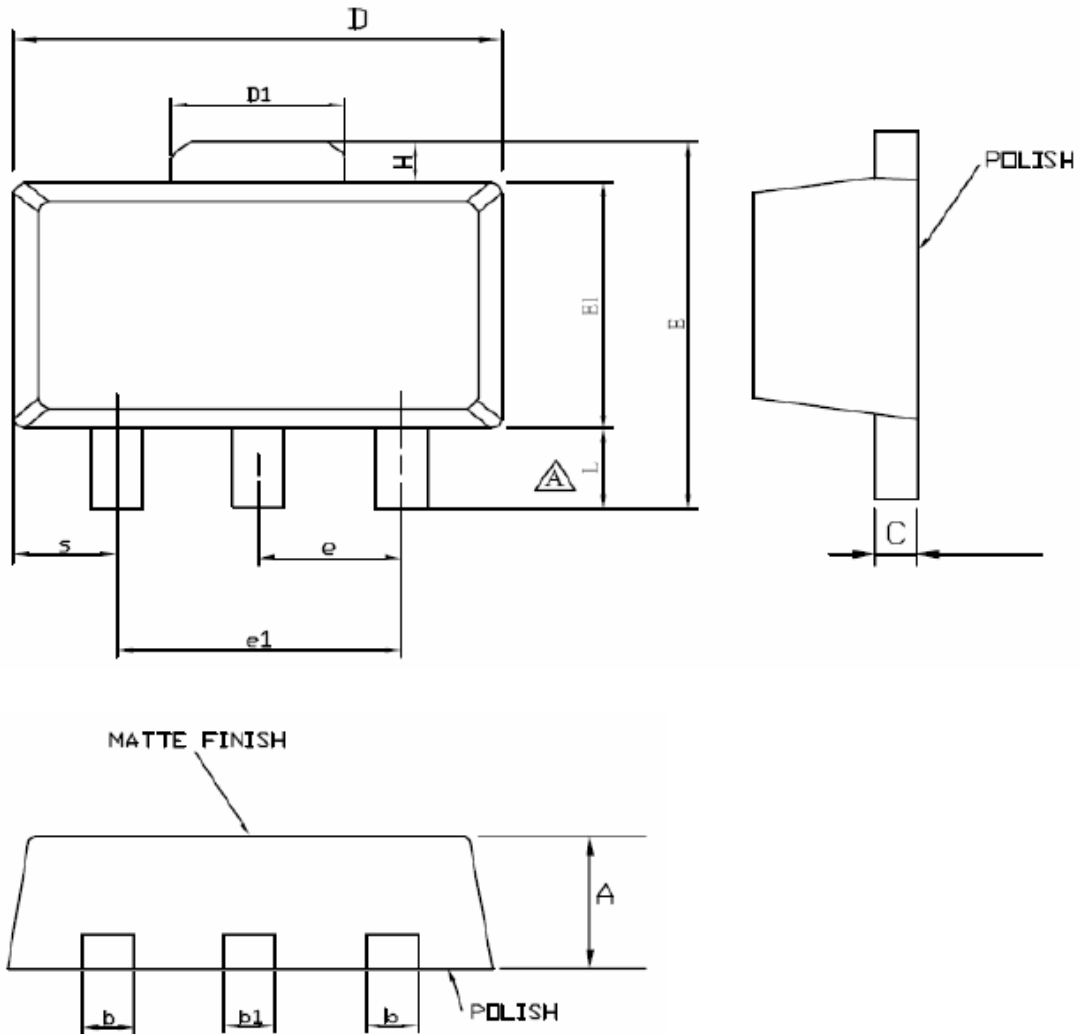
## Mechanical Dimensions OUTLINE DRAWING TSOT-23



Symbols	Dimensions in Millimeters		
	MIN	NOM	MAX
A			1.14
A1	0	0.05	0.1
A2	0.84	0.94	1.04
b	0.35	0.4	0.5
C	0.1	0.125	0.15
D	2.7	2.9	3.1
E1	1.4	1.6	1.8
e1		1.9(TYP.)	
E	2.6	2.8	3
L	0.3	0.4	0.6
θ	0°	4°	8°
θ1	4°	8°	12°
e		0.95(TYP.)	

## 4- Low 300mA Linear Regulator

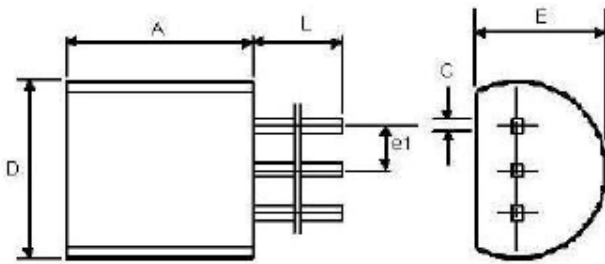
### Mechanical Dimensions OUTLINE DRAWING SOT-89



Symbol	Dimensions in millimeters			Dimensions in inches		
	Min	Nom	Max	Min	Nom	Max
A	1.40	1.50	1.60	0.055	0.059	0.063
L	0.89	1.04	1.20	0.0350	0.041	0.047
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.018	0.020
C	0.38	0.40	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	1.60	1.75	0.055	0.062	0.069
E	3.64	---	4.25	0.143	---	0.167
E1	2.40	2.50	2.60	0.094	0.098	0.102
e1	2.90	3.00	3.10	0.114	0.118	0.122
H	0.35	0.40	0.45	0.014	0.0169	0.018
S	0.65	0.75	0.85	0.026	0.030	0.034
e	1.40	1.50	1.60	0.054	0.059	0.063

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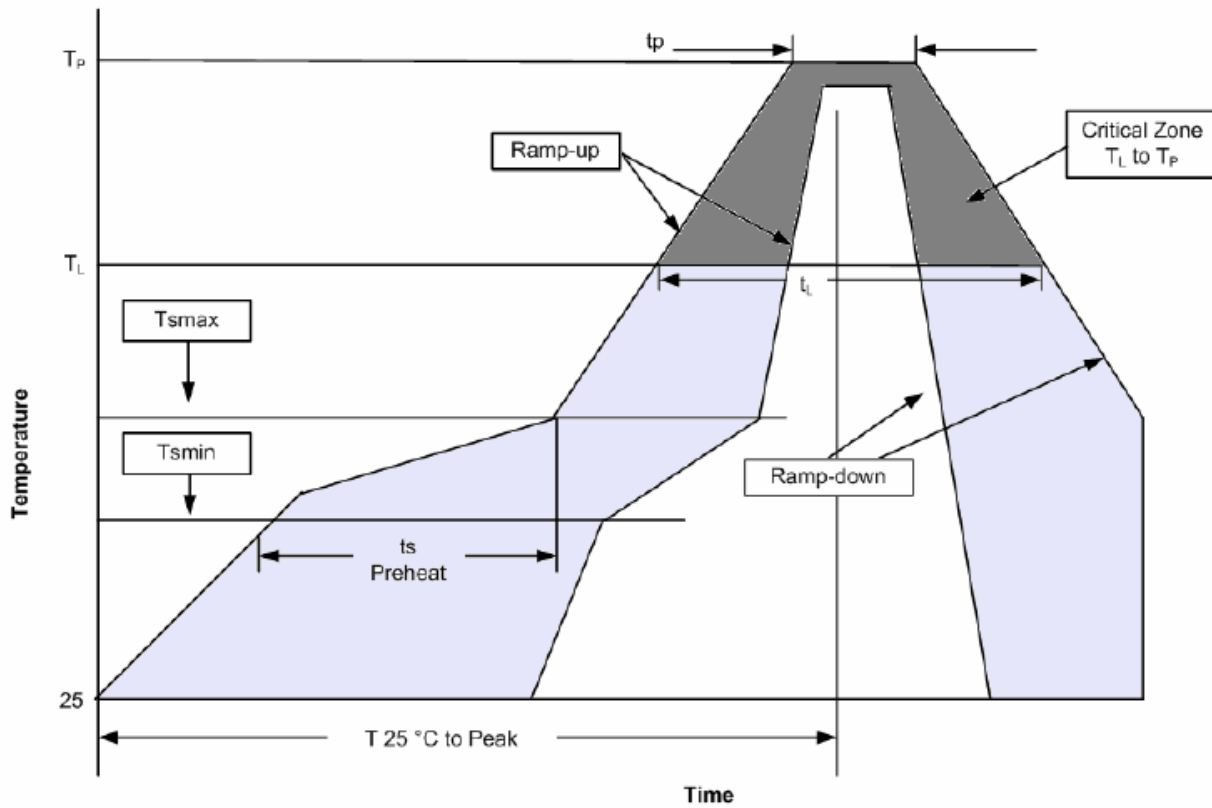
### Mechanical Dimensions OUTLINE DRAWING TO-92



SYMBOL	MIN	MAX
A	4.32	5.33
C	0.38 (TYP.)	
D	4.40	5.20
E	3.17	4.20
e1	1.27 (TYP.)	
L	12.7	-

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### Reflow Condition (IR/Convection or VPR Reflow)



### Classification Reflow Profiles

Profile Feature	Pb-Free / Green Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	3°C/second max
Preheat - Temperature Min ( $T_{smin}$ ) - Temperature Max ( $T_{smax}$ ) - Time (min to max) ( $t_s$ )	150°C 200°C 60-180 seconds
Time maintained above: - Temperature ( $T_L$ ) - Time ( $t_L$ )	217°C 60-150 seconds
Peak/Classification Temperature ( $T_p$ )	See table 1
Time within 5°C of actual Peak Temperature ( $t_p$ )	20-40 seconds
Ramp-down Rate	6°C/second max
Time 25°C to Peak Temperature	8 minutes max

Notes :

- 1) All temperatures refer to topside of the package.
- 2) Measured on the body surface.