

600mA Adjustable Voltage LDO with Fast Enable Function and Fast Discharge
600mA Fixed Voltage LDO with Fast Enable Function and Fast Discharge

Features

- Operating Voltage Range : +2.4V to +7.0V
- Output Voltages : +1.0V to +5.0V (0.1V Step) (Fixed), +1.2V to +5.0V (ADJ Type)
- Dropout Voltage : 500mV @ 600mA (Fixed)
- Fast Response in Turn-on Transient : 35 μ S (Typ.)
- Low Current Consumption : 60 μ A (Typ.)
- Shutdown Current : 0.7 μ A (Typ.)
- $\pm 2\%$ Output Voltage Accuracy (special $\pm 1\%$ highly accurate), $V_{OUT} \geq 1.8V$
- Low ESR Capacitor Compatible
- High Ripple Rejection : 65 dB (Typ.)
- Output Current Limit Protection : 1.0A (Typ.)
- Short Circuit Protection : 200mA (Typ.)
- Thermal Overload Shutdown Protection
- Control Output ON/OFF Function
- SOT-25, SOT-89-5, SOP-8, SOT-223-5 & SC-70-5 Packages
- RoHS Compliant and 100% Lead (Pb)-Free and Green (Halogen Free with Commercial Standard)

General Description

The AP6256A series is a low-dropout linear regulator with ON/OFF control that operates in the input voltage range from +2.4V to +7.0V and delivers 600mA output current.

The AP6256A is available in two types, fixed output voltage type and adjustable output voltage type. The fixed output voltage type is preset at an internally trimmed voltage 1.8V, 2.5V, or 3.3V. Other options 1.2V, 1.5V, 2.85V, 3.0V and 3.6V are available by special order only. The output voltage range of the adjustable type is from 1.2V to 5V.

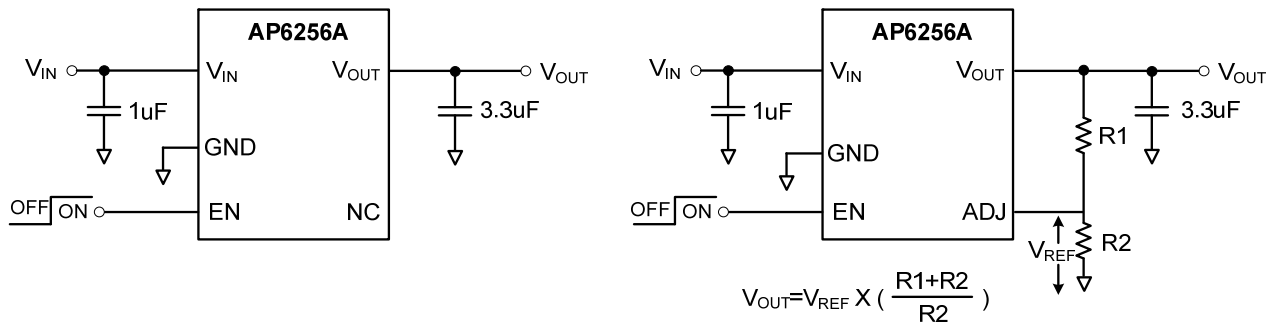
The AP6256A (ADJ type) consists of a 1.175V bandgap reference, an error amplifier, and a P-channel pass transistor. Other features include short-circuit protection and thermal shutdown protection.

The AP6256A (Fixed type) consists of a 0.95V bandgap reference, an error amplifier, and a P-channel pass transistor. Other features include short-circuit protection and thermal shutdown protection, the fixed type version has fast respond and discharge features. The AP6256A series devices are available in SOT-25, TSOT-25, SOT-89-5, SOP-8, SOT-223-5, and SC-70-5 packages.

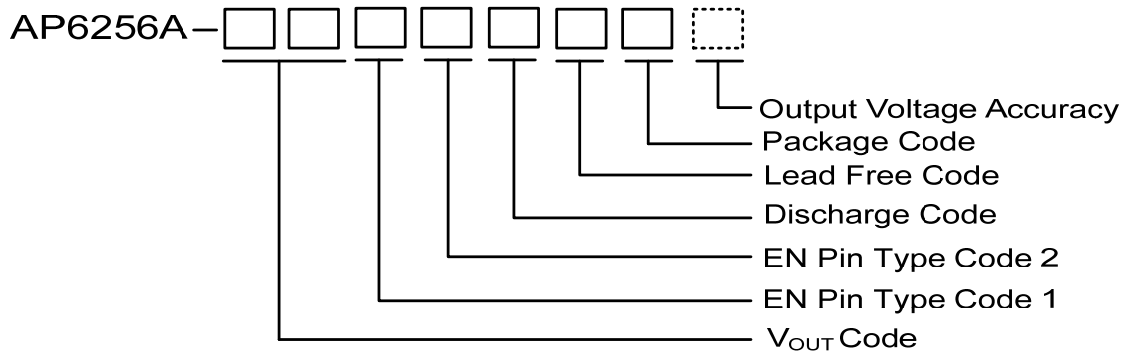
Applications

- Battery-Powered Equipments
- Graphic Card
- Peripheral Card
- PCMCIA & New Card
- Mini PCI & PCI-Express Cards
- Digital Still Camera
- CDMA/GSM Cellular Handsets
- Laptop, Palmtops, Notebook Computers
- Portable Information Application

Simplified Application Circuit



Ordering Information



Vout Code :

Exam. 18=1.8V, 25=2.5V, 33=3.3V

Default : Adjustable Output

EN Pin Type Code 1 :

N : None Function

U : Pull High Function

D : Pull Low Function

EN Pin Type Code 2 :

H : High Active Option Function

L : Low Active Option Function

Discharge Code :

F : Fast Discharge

Lead Free Code :

P : Commercial Standard, Lead (Pb) Free and Phosphorous (P) Free Package

G : Green (Halogen Free with Commercial Standard)

Package Code :

A : SOT-25*

P : SC-70-5

F : SOT-89-5

S : SOP-8

M : SOT-223-5

V : SOT-25*

B : TSOT-25

Output Voltage Accuracy :

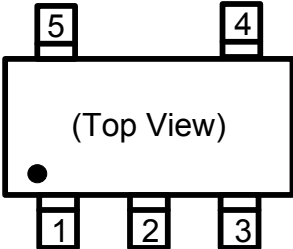
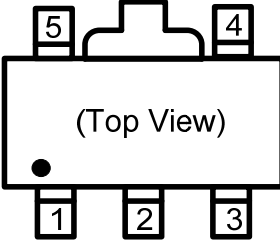
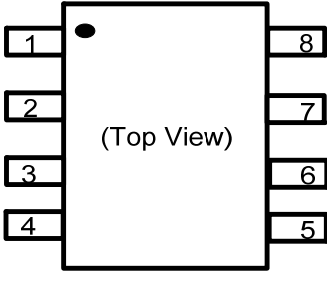
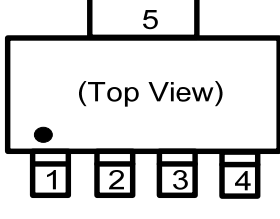
1 : ±1%

Default : ±2%

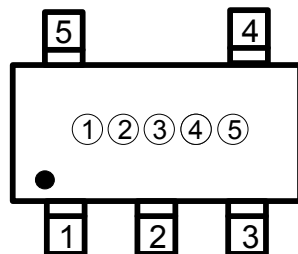
Note :

* The difference between "A" & "V" type, please refer "Pin Description".

Pin Description

Part NO.	Pin			Symbol	Pin Description
	Fixed	ADJ			
 (Top View) SOT-25/TSOT-25/ SC-70-5	A/B	P	V		
	1	1	5	V _{IN}	Regulator Input Pin.
	2	2	2	GND	Ground Pin.
	3	3	1	EN	Enable Pin
	4	4	3	NC/ADJ	No Connect for Fixed Voltage or ADJ Terminal Pin for Adjustable
	5	5	4	V _{OUT}	Regulator Output Pin.
 (Top View) SOT-89-5	1	1	NC/ADJ	No Connect for Fixed Voltage or ADJ Terminal Pin for Adjustable	
	2	2	GND	Ground Pin.	
	3	3	EN	Enable Pin	
	4	4	V _{IN}	Regulator Input Pin.	
	5	5	V _{OUT}	Regulator Output Pin.	
 (Top View) SOP-8	---	1	EN	Enable Pin	
	---	2	V _{IN}	Regulator Input Pin.	
	---	3	V _{OUT}	Regulator Output Pin.	
	---	4	ADJ	ADJ Terminal Pin for Adjustable Voltage.	
	---	5, 6, 7, 8	GND	Ground Pin or ADJ Terminal Pin.	
 (Top View) SOT-223-5	1	1	V _{IN}	Regulator Input Pin.	
	2	2	V _{OUT}	Regulator Output Pin.	
	3	3	NC/ADJ	No Connect for Fixed Voltage or ADJ Terminal Pin for Adjustable	
	4	4	EN	Enable Pin	
	5	5	GND	Ground Pin or ADJ Terminal Pin.	

Package Marking Information



SOT-25/TSOT-25
(Top View)

① Represents Products Series

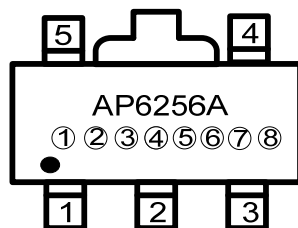
Mark	Products Series
6	Part No. : AP6256A

②、③ Represents Products Series

Mark	Description
②	Voltage
③	Function
	See Note 1
	See Note 2

④、⑤ Represents Production Date Code

- * There is a under-line on 1st digit for A type package.
- * There is a under-lines on 5th digit for Pb-Free package.
- * There are two under-lines on 4th & 5th digit for Green package.
- * There is a top-line on 1st digit for $\pm 1\%$ Output voltage accuracy.



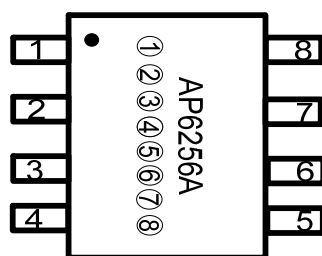
SOT-89-5
(Top View)

Top Point Represents Products Series

Mark	Products Series
Top Point	Part No. : AP6256A

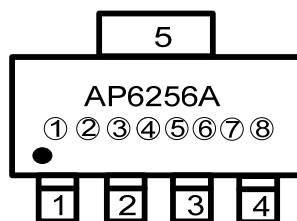
①、②、③、④、⑤ Represents Products Series

Mark	Description
①、②	Voltage
③	Function
④	P, G
⑤	F, S, M
⑥	Accuracy
	Voltage Code or Default (Adjustable)
	See Note 2
	Pb-Free Code or Green
	Package Code
	1($\pm 1\%$) or Default



SOP-8
(Top View)

⑦、⑧ Represents Production Date Code



SOT-223-5
(Top View)

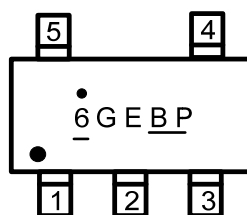
Note1 :

Mark	Voltage	Mark	Voltage
4	1.0V	M	3.0V
5	1.2V	N	3.1V
8	1.5V	Q	3.3V
A	1.8V	V	3.6V
G	2.5V	Z	5.0V
L	2.85V	O	Adjustable Type

Note 2 :

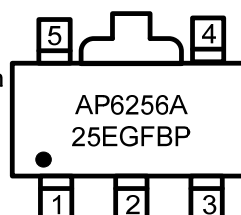
Mark	Code	EN Type		Discharge	Mark	Code	EN Type		Discharge
		Type Code 1	Type Code 2				Type Code 1	Type Code 2	
A	NHF	None	High	Fast	G	UHN	Pull High	High Active	Normal
B	NLF	None	Low	Fast	H	ULN	Pull High	Low Active	Normal
C	NHN	None	High	Normal	J	DHF	Pull Low	High Active	Fast
D	NLN	None	Low	Normal	K	DLF	Pull Low	Low Active	Fast
E	UHF	Pull	High	Fast	L	DHN	Pull Low	High Active	Normal
F	ULF	Pull	Low	Fast	M	DLN	Pull Low	Low Active	Normal

Example :



SOT-25
(Top View)

Part No.: AP6256A-25UHFGA
 Type: High Active with Pull high
 & Fast Discharge
 Date Code: BP
 2007/49th week
 Green Package



SOT-89-5
(Top View)

Part No.: AP6256A-25UHFGF
 Type: High Active with Pull high
 & Fast Discharge
 Date Code: BP
 2007/49th week
 Green Package

Absolute Maximum Ratings

Parameter		Symbol	Ratings	Units
Input Voltage V_{IN} to GND		V_{IN}	9.0	V
Output Current Limit, $I_{(LIMIT)}$		I_{OUT}	1.0	A
Junction Temperature		T_J	+155	°C
Thermal Resistance	SOT-25	θ_{JA}	155	°C/W
	TSOT-25		155	
	SOT-89-5		90	
	SC-70-5		333	
	SOP-8		60	
Power Dissipation	SOT-25	P_D	350	mW
	TSOT-25		350	
	SOT-89-5		1200	
	SC-70-5		250	
	SOP-8		1670	
Operating Ambient Temperature		T_{OPR}	-40 ~ +85	°C
Storage Temperature		T_{STG}	-55 ~ +150	°C
Lead Temperature (soldering, 10sec)			+260	°C

Note :

* The power dissipation values are based on the condition that junction temperature T_J and ambient temperature T_A difference is 100°C.

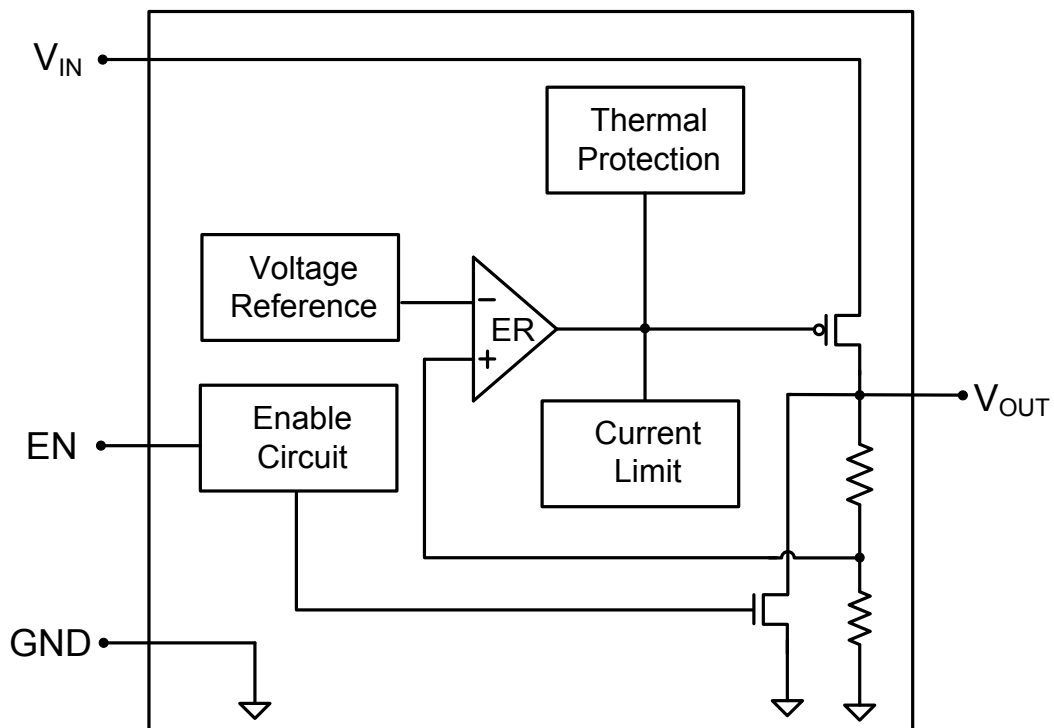
* Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and function operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated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

Electrical Characteristics (V_{IN}=5V, T_A=25°C, unless otherwise noted.)

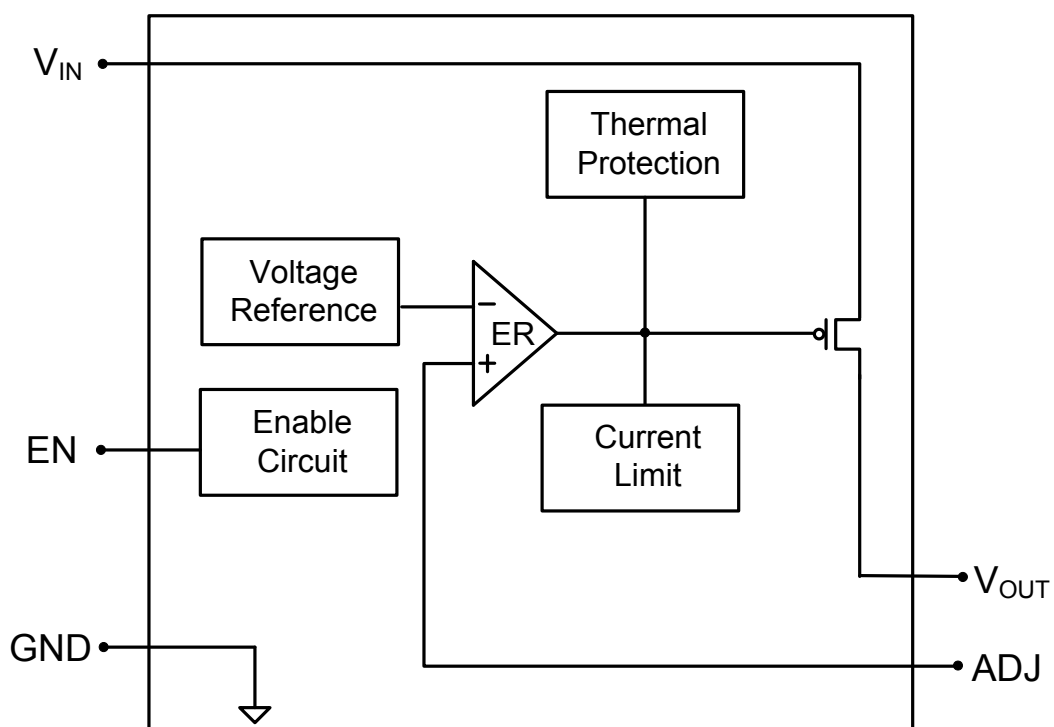
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V _{IN}	Input Voltage		2.4		7.0	V
V _{OUT}	Output Voltage	Fixed Voltage Type	V _{IN} = V _{OUT} +1.0V, I _{OUT} =1mA, V _{OUT} ≥ 1.8V	-1% -2%	+1% +2%	V
			V _{IN} = V _{OUT} +1.0V, I _{OUT} =1mA, V _{OUT} < 1.8V, V _{IN} > 2.4V	-35	+35	mV
		ADJ Voltage Type	V _{IN} = V _{OUT} +1.2V, I _{OUT} =1mA, V _{OUT} ≥ 1.8V	-1% -2%	+1% +2%	V
			V _{IN} = V _{OUT} +1.2V, I _{OUT} =1mA, V _{OUT} < 1.8V, V _{IN} > 2.4V	-50	+50	mV
I _{MAX}	Output Current (see note *1)	V _{OUT} +1.0V ≤ V _{IN} ≤ 7.0V, V _{IN} ≥ 2.4V	0.6			A
I _{LIMIT}	Current Limit			1.0		A
V _{REF}	ADJ Pin Reference Voltage	For Adjustable Voltage Type		1.175		V
V _{DROP}	Dropout Voltage (For Fixed Voltage Type)	I _{OUT} =100mA, V _{OUT} > 3.0V		50		mV
		I _{OUT} =600mA, V _{OUT} > 3.0V		500		
	Dropout Voltage (For ADJ Voltage Type)	I _{OUT} =600mA, V _{OUT} > 3.0V		800		
ΔV _{LINE}	Line Regulation	V _{OUT} +1.0V ≤ V _{IN} ≤ 7.0V, I _{OUT} =1mA For Fixed Voltage Type		0.2	0.3	%/V
		V _{OUT} +1.2V ≤ V _{IN} ≤ 7.0V, I _{OUT} =1mA, V _{IN} ≥ 2.8V, For ADJ Voltage Type			0.2	%/V
ΔV _{LOAD}	Load Regulation	V _{IN} =V _{OUT} +1V, 1mA ≤ I _{OUT} ≤ 100mA		0.01	0.02	%/mA
I _Q	Ground Pin Current	I _{LOAD} =0mA to 1A, V _{IN} = V _{OUT} +1.0V		60		μA
I _{SD}	Shutdown Current	V _{IN} = V _{OUT} +1V, EN=0V, No Load		0.7		μA
I _{ADJ}	ADJ Pin Current	I _{LOAD} =0 to 600mA, V _{IN} = V _{OUT} +1.0V		0.1		μA
I _{SC}	Short Circuit Current			200		mA
PSRR	Ripple Rejection	I _{OUT} =30mA, F=1KHz, C _{OUT} =3.3uF		65		dB
e _N	Output Noise	I _{OUT} =100mA, F=1KHz, C _{OUT} =3.3uF		40		μV _(rms)
V _{IH}	EN Pin Input Voltage "H"	V _{IN} ≤ 5.0V	1.6			V
V _{IL}	EN Pin Input Voltage "L"	V _{IN} ≤ 5.0V			0.3	V
R _{DIS}	Discharge Resistor	V _{EN} =0V, For Fixed Voltage Type		30	100	Ω
T _{DIS}	Discharge Time	V _{OUT} =3.3V to 0V, C _{OUT} =1uF For Fixed Voltage Type		70	100	μs
T _{SD}	Thermal Shutdown Temperature			155		°C
T _{HYS}	Thermal Shutdown Hysteresis			20		°C

Note : *1) Measured using a double sided board with 1" x 2" square inches of copper area connected to the GND pins for "heat spreading".

AP6256A Function Block Diagram



Fixed Voltage Type



Adjustable Voltage Type

Detail Description

The AP6256A is a low-dropout linear regulator. The device provides preset 1.8V, 2.5V and 3.3V output voltages for output current up to 600mA. Adjustable output voltage and other mask options for special output voltages are also available. As illustrated in function block diagram, it consists of a 1.175V bandgap (Fixed voltage type is 0.95V) reference, an error amplifier, a P-channel pass transistor and an internal feedback voltage divider.

The bandgap reference for fixed voltage types 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 feed back through an internal resistive divider (or external resistive divider for adjustable output voltage type) connected to OUT pin. Additional blocks include an output current limiter, thermal sensor, and shutdown logic.

Internal P-channel Pass Transistor

The AP6256A 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 when the pass transistor saturates, and use high base-drive currents under large loads. The AP6256A does not suffer from these problems and consumes only 60μA (Typ.) of current consumption under heavy loads as well as in dropout conditions.

Enable Function

EN pin starts and stops the regulator. When the EN pin is switched to the power off level, the operation of all internal circuit stops, the build-in P-channel MOSFET output transistor between pins V_{IN} and V_{OUT} is switched off, allowing current consumption to be drastically reduced. The V_{OUT} pin enters the GND level through the internal discharge path between V_{OUT} and GND pins.

Fast Discharge Function

The AP6256A fixed type has fast discharge Function on EN pin disable. When user turns off the device, its internal pull-low resistor will discharge output capacitor charge. It'll avoid other device to arise wrong motions.

Output Voltage Selection

For fixed voltage type of AP6256A, the output voltage is preset at an internally trimmed voltage. The first two digits of part number suffix identify the output voltage (see Ordering Information). For example, the AP6256A-33 has a preset 3.3V output voltage.

For adjustable voltage type of AP6256A, the output voltage is set by comparing the feedback voltage at adjust terminal to the internal bandgap reference voltage. The reference voltage V_{REF} is 1.175V. The output voltage is given by the equation:

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

(See Typical Application Schematic.)

Current Limit

The AP6256A 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 1.0A.

Thermal Overload Protection

Thermal overload protection limits total power dissipation in the AP6256A. 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 on again after the junction temperature cools down by 20°C , resulting in a pulsed output during continuous thermal overload conditions.

Thermal overload protection is designed to protect the AP6256A in the event of fault conditions. For continuous operation, the absolute 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 AP6256A 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 AP6256A die junction and the surrounding air, θ_{JC} is the thermal resistance of the package chosen, and θ_{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 IN, OUT, and GND pins.

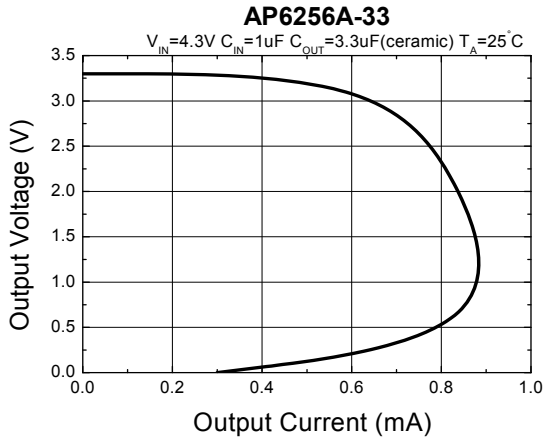
Dropout Voltage

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. The AP6256A use 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.

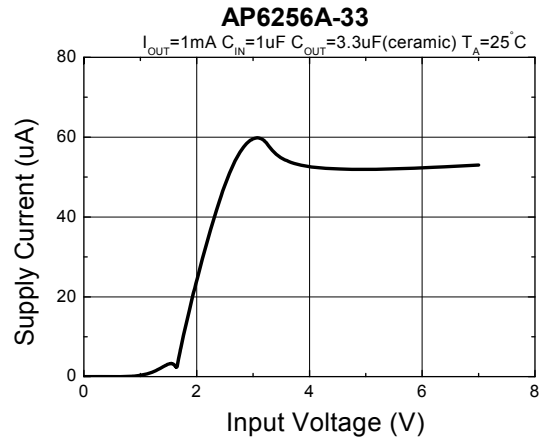
$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

Typical Operating Characteristics

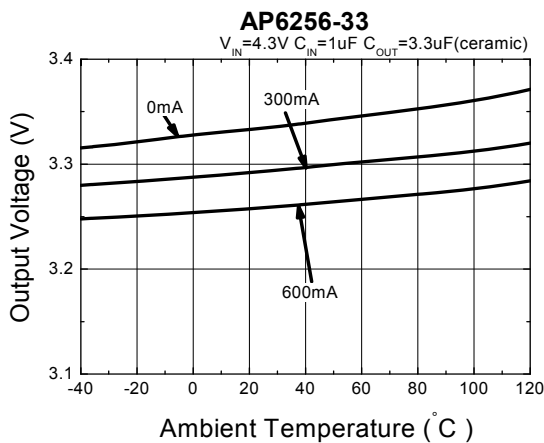
(1) Output Voltage vs. Output Current



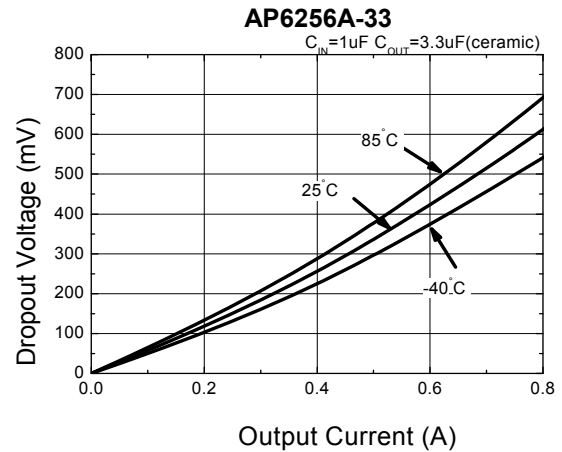
(2) Supply Current vs. Input Voltage



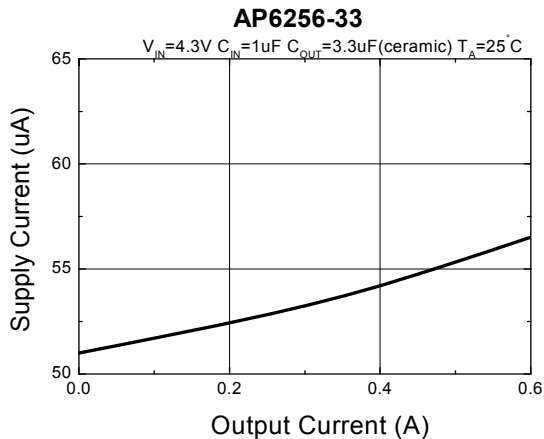
(3) Output Voltage vs. Ambient Temperature



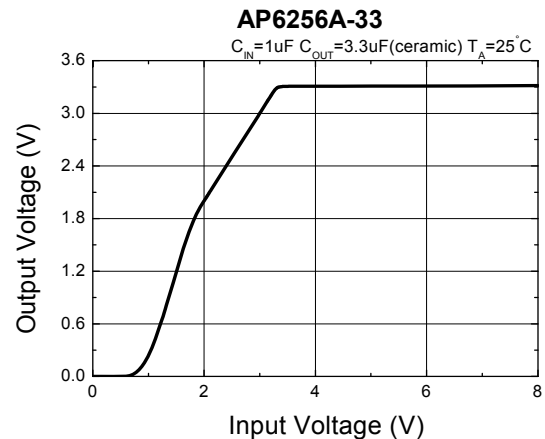
(4) Dropout Voltage vs. Output Current



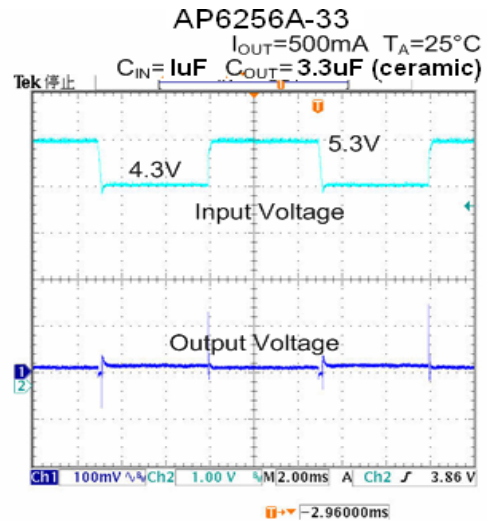
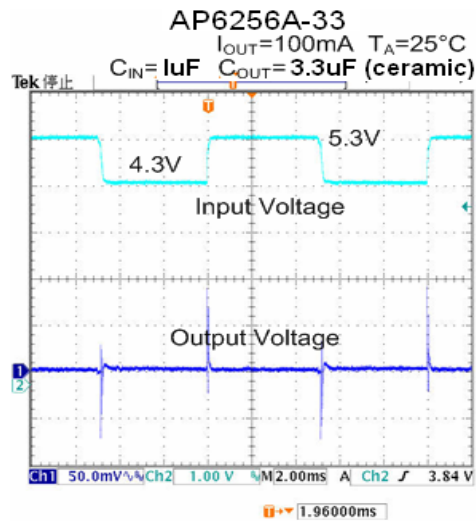
(5) Supply Current vs. Output Current



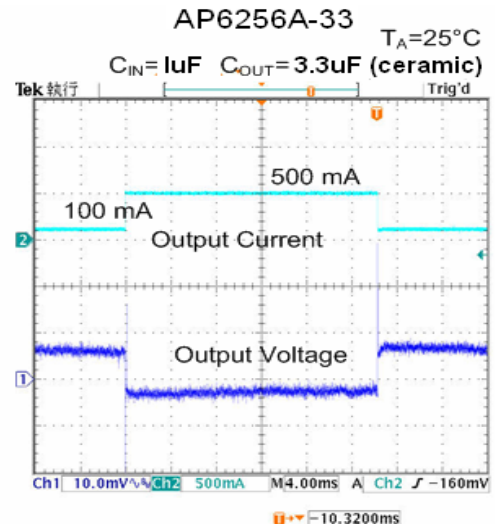
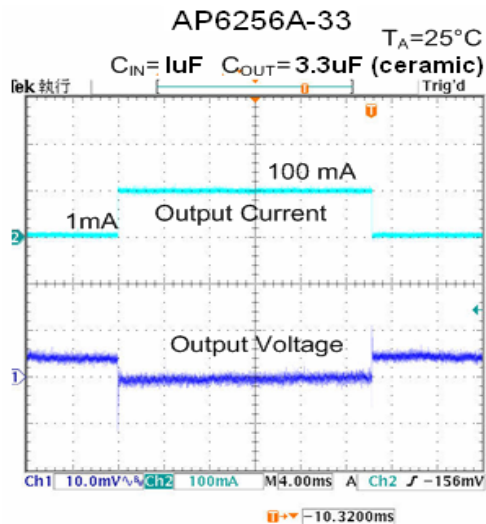
(6) Output Voltage vs. Input Voltage



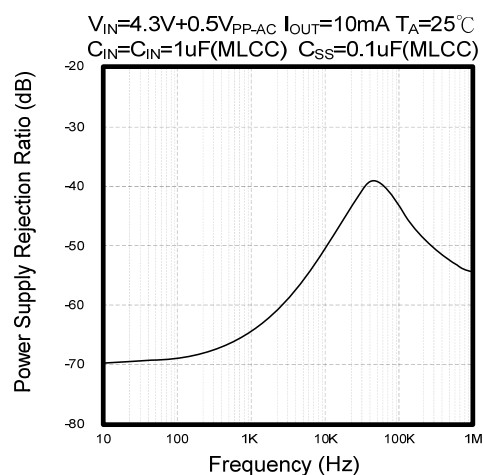
(7) Input Transient Response



(8) Load Transient Response

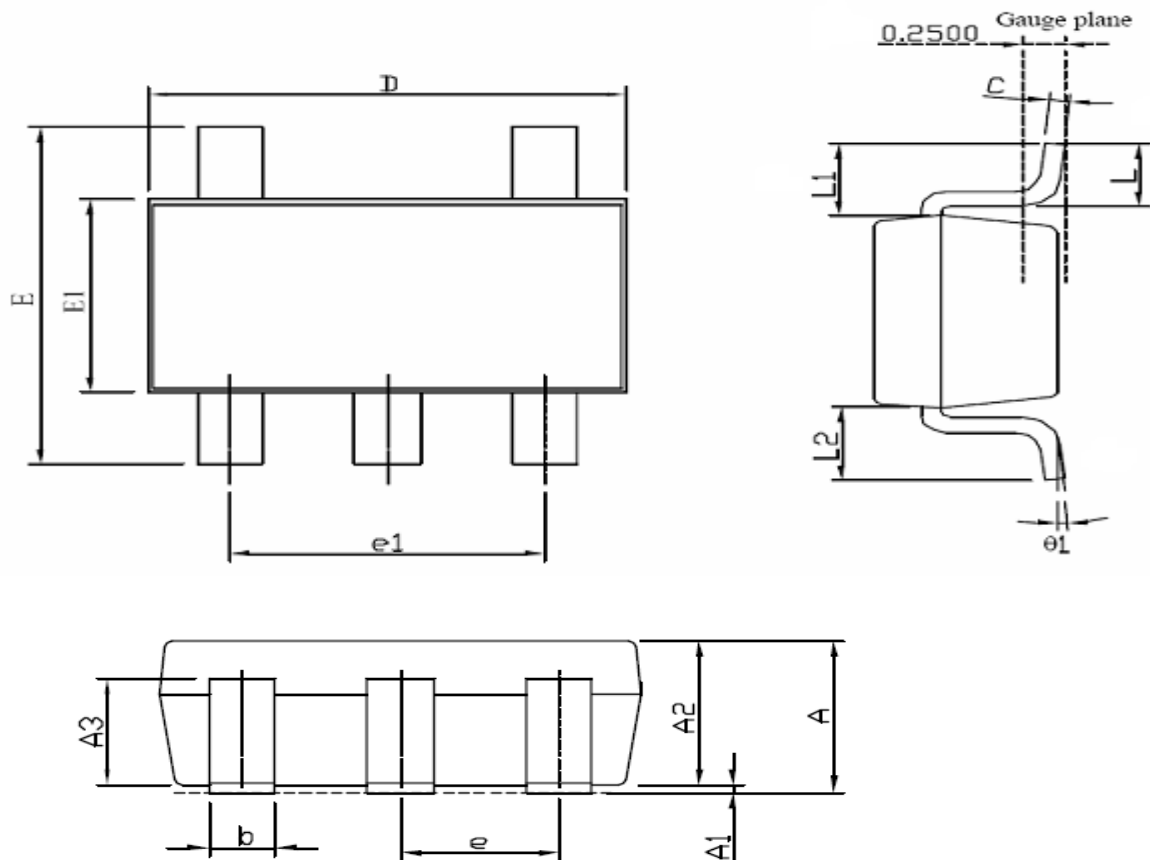


(9) Power Supply Rejection Ratio



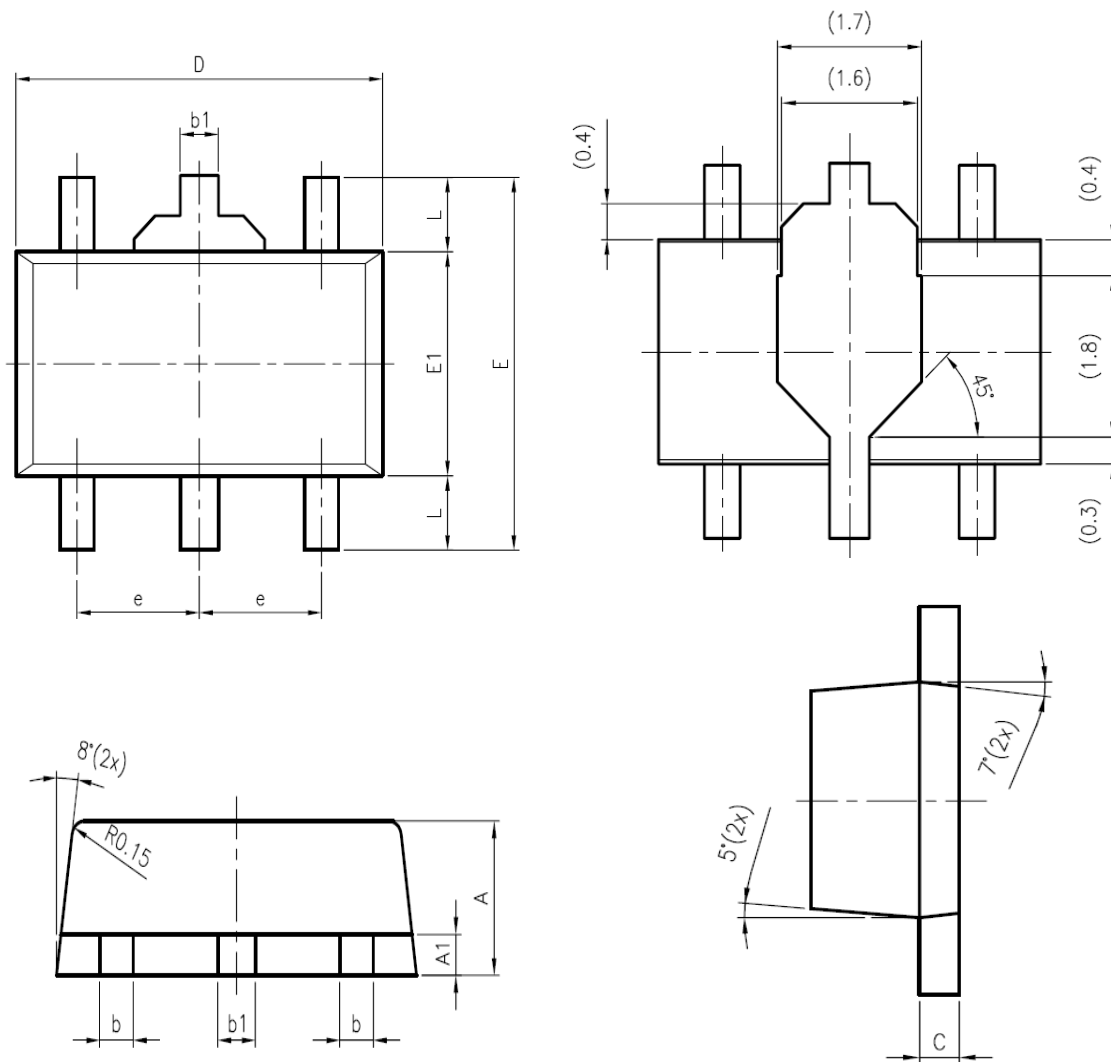
Package Outline

A) SOT-25



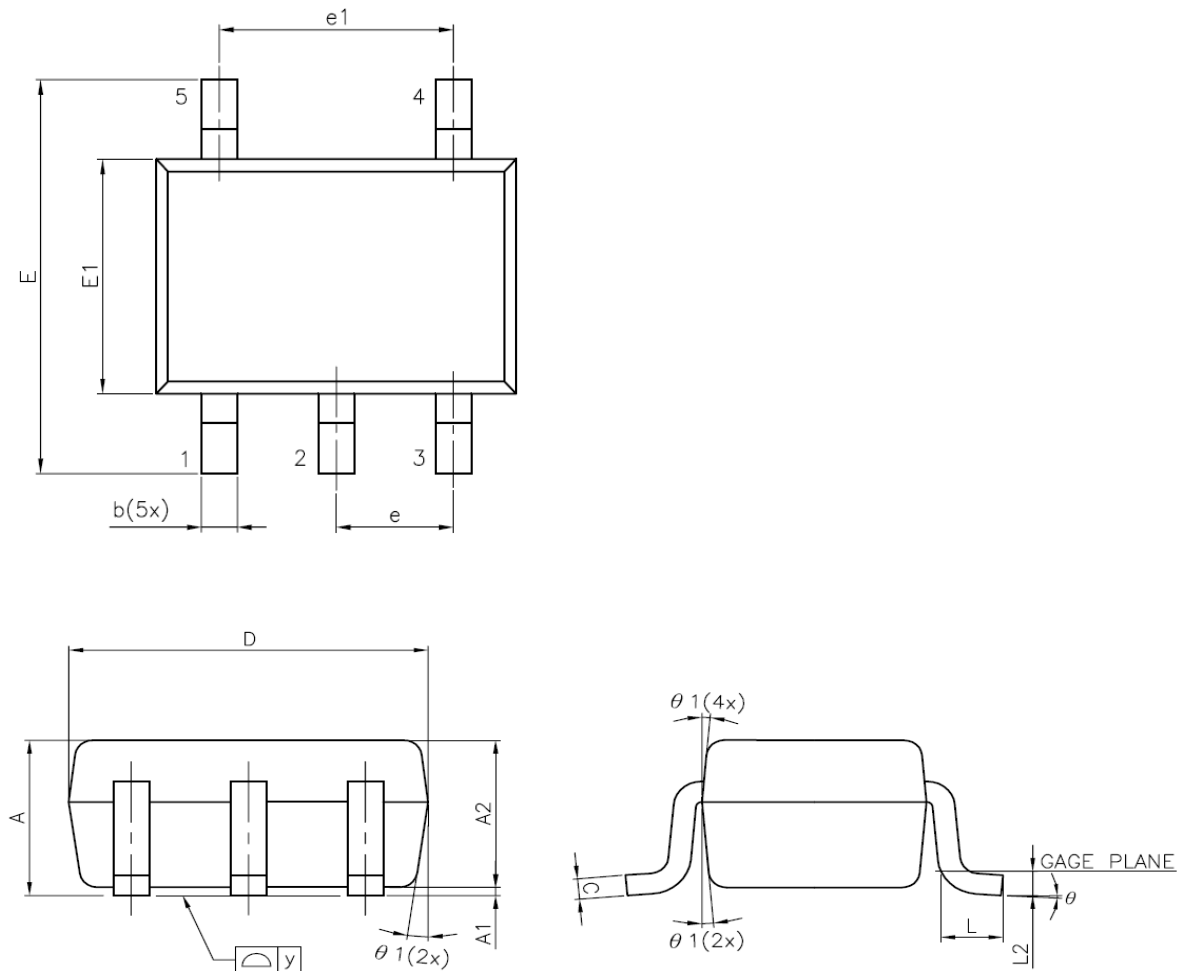
Symbols	Dimensions in Millimeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	---	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E1	1.40	1.60	1.80
e1	---	1.90(TYP)	---
E	2.60	2.80	3.00
L	0.37	---	---
θ1	1°	5°	9°
e	---	0.95(TYP)	---
L1	---	0.6(REF)	---
LI-L2	---	---	0.12

B) SOT-89-5



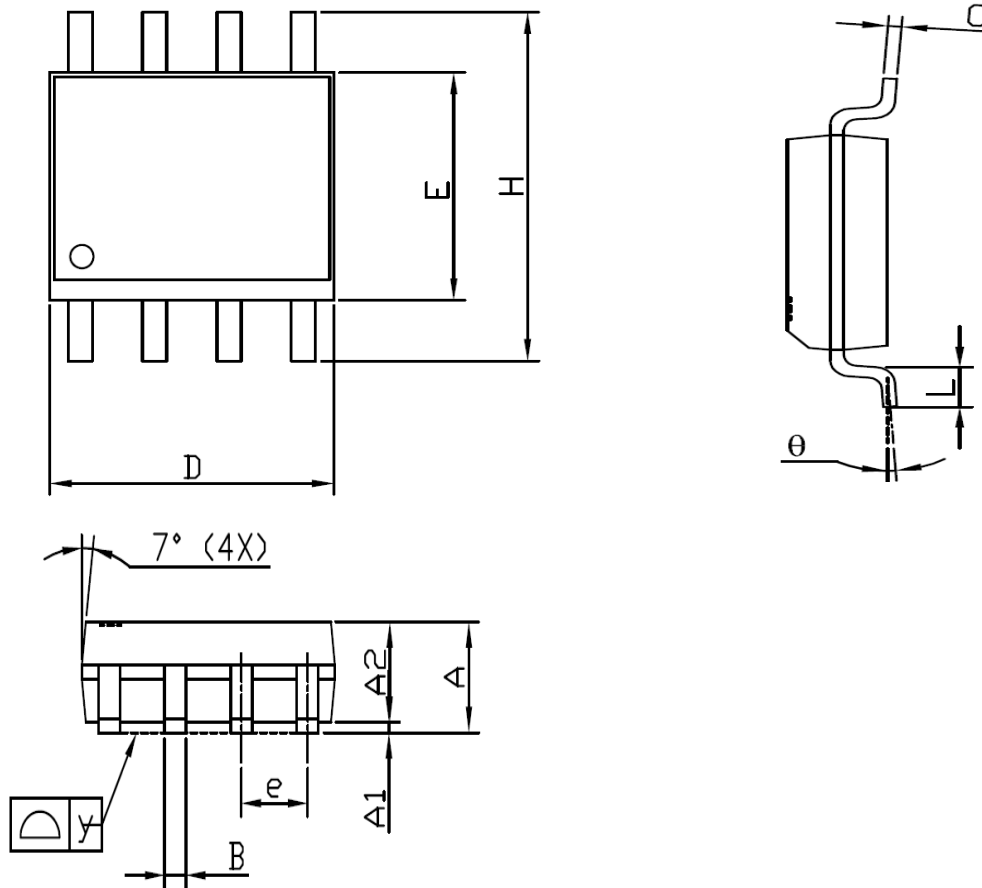
Symbols	Millimeters			Inches		
	Min	Nom	Max	Min	Nom	Max
A	1.40	1.50	1.60	0.055	0.059	0.063
A1	0.30	0.40	0.50	0.011	0.015	0.019
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.018	0.020
C	0.38	0.40	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
E	---	---	4.25	---	---	0.167
E1	2.40	2.50	2.60	0.094	0.098	0.102
e	1.40	1.50	1.60	0.055	0.059	0.063
L	0.80	---	---	0.031	---	---

C) SC-70-5



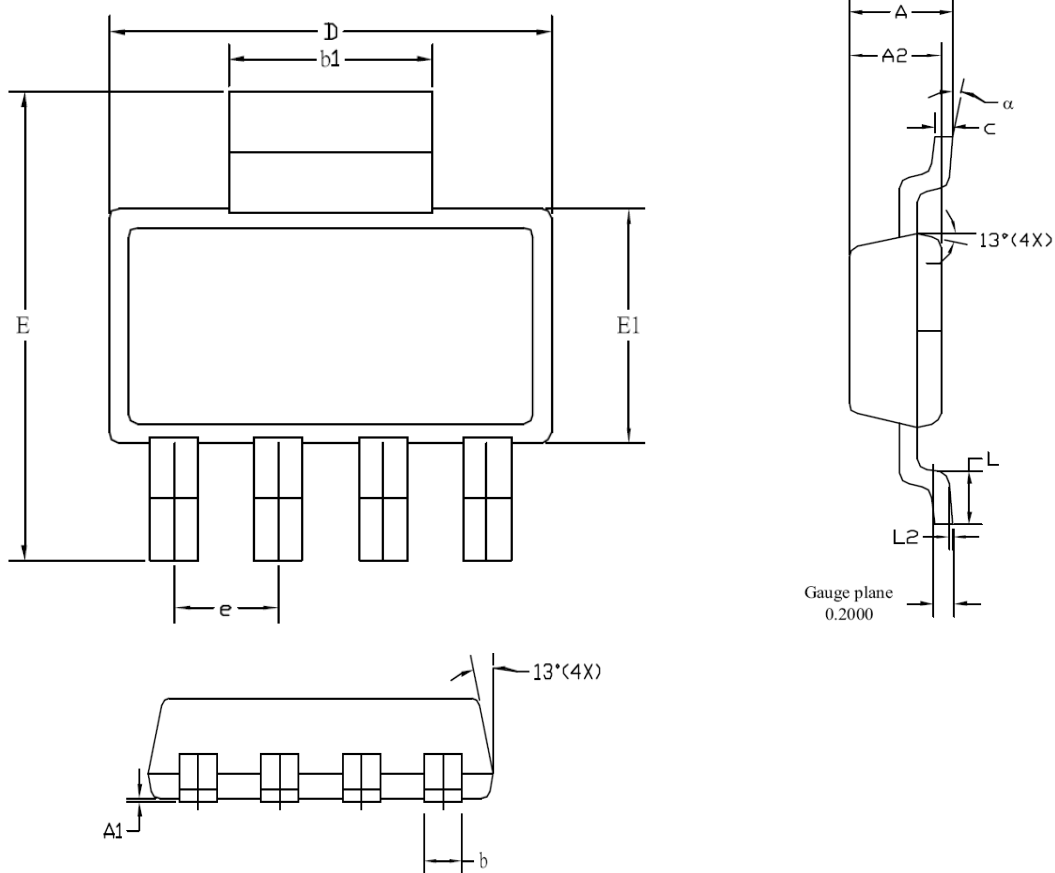
Symbols	Millimeters			Inches		
	Min	Nom	Max	Min	Nom	Max
A	0.80	---	1.10	0.031	---	0.043
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.90	1.00	0.028	0.035	0.039
b	0.15	---	0.30	0.006	---	0.012
C	0.08	---	0.22	0.003	---	0.009
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E1	1.15	1.25	1.35	0.045	0.049	0.053
e	---	0.65	---	---	0.026	---
e1	---	1.30	---	---	0.051	---
L	0.26	0.36	0.46	0.010	0.014	0.018
L2	---	0.15	---	---	0.006	---
y	---	---	0.10	---	---	0.004
θ	0°	4°	8°	0°	4°	8°
θ1	4°	---	12°	4°	---	12°

D) SOP-8



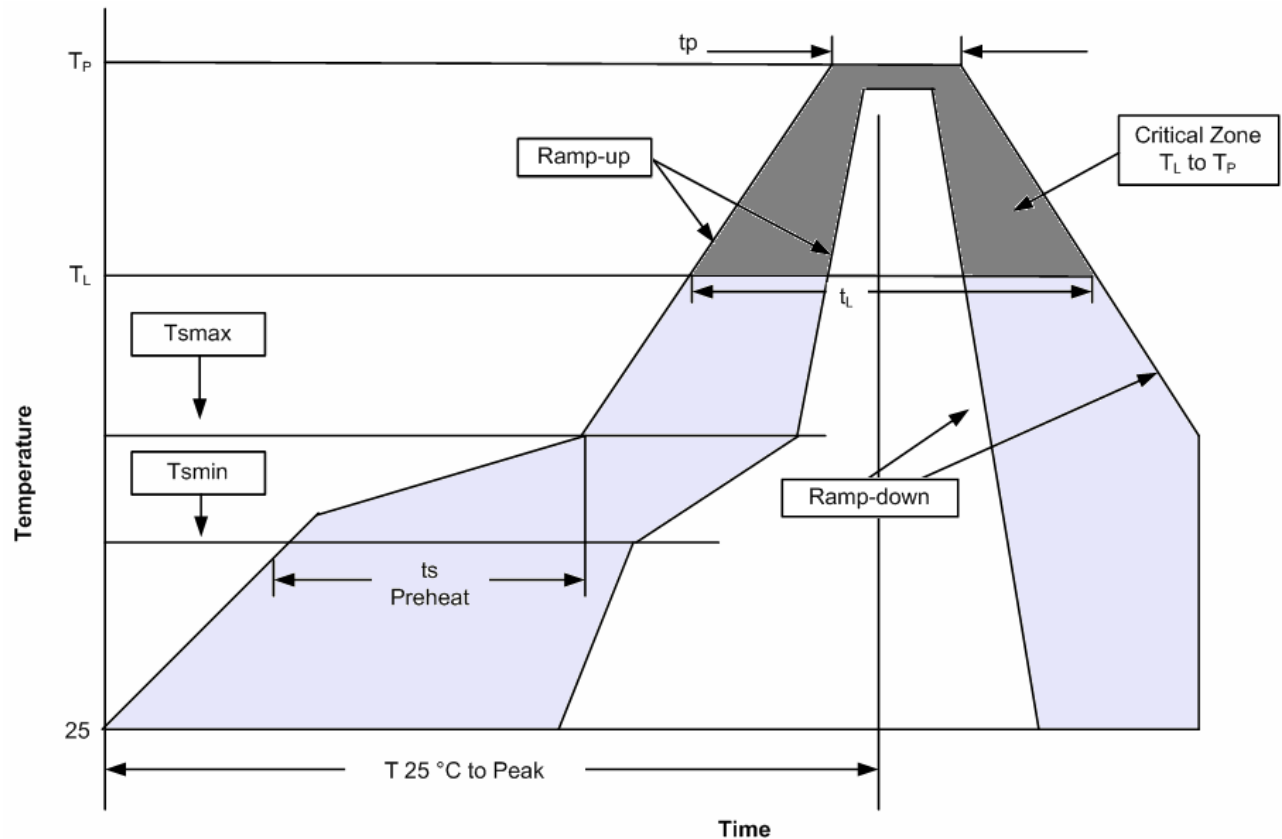
Symbols	Millimeters			Inches		
	Min	Nom	Max	Min	Nom	Max
A	1.45	1.50	1.55	0.057	0.059	0.061
A1	0.10	---	0.25	0.004	---	0.010
A2	---	1.45	---	---	0.057	---
B	0.33	---	0.51	0.013	---	0.020
C	0.19	---	0.25	0.007	---	0.010
D	4.80	---	5.00	0.189	---	0.197
E	3.80	---	4.00	0.150	---	0.157
e	---	1.27	---	---	0.050	---
H	5.80	---	6.20	0.228	---	0.244
L	0.40	---	1.27	0.016	---	0.050
y	---	---	0.10	---	---	0.004
θ	0°	---	8°	0°	---	8°

E) SOT-223-5



Symbols	Millimeters			Inches		
	Min	Nom	Max	Min	Nom	Max
A	1.52	1.66	1.80	0.061	0.066	0.071
A1	0.02	0.66	0.10	0.0008	0.0024	0.0040
A2	1.50	1.60	1.70	0.059	0.063	0.067
b	0.60	0.70	0.80	0.024	0.0275	0.031
b1	2.90	3.00	3.10	0.114	0.118	0.122
C	0.24	0.28	0.32	0.009	0.011	0.013
D	6.30	6.55	6.80	0.248	0.258	0.268
E1	3.30	3.50	3.70	0.130	0.138	0.146
e	1.50 BSC			0.059 BSC		
E	6.70	7.00	7.30	0.264	0.2755	0.287
L	0.90 Min			0.036 Min		
L2	0.06 BSC			0.0024 BSC		
α	0°	5°	10°	0°	5°	10°

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.

Classification Reflow Profiles (Continued)

Table 1. Pb-free / Green Process – Package Classification Reflow Temperatures

Package Thickness	Volume mm ³ <350	Volume mm ³ 350~2000	Volume mm ³ ≥2000
<2.5 mm	260 +0°C*	260 +0°C*	260 +0°C*
1.6-2.5 mm	260 +0°C*	250 +0°C*	245 +0°C*
≥2.5 mm	250 +0°C*	245 +0°C*	245 +0°C*

Notes :

* Tolerance: The device manufacturer/supplier shall assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0°C. For example 260°C+0°C) at the rated MSL level.