

300mA LDO Linear Regulator

Features

- I Operating Voltages Range : +2.5V to +9.0V
- I Output Voltages Range : +1.5V to +5.0V with 100mV Increment
- I Maximum Output Current : 300 mA
- I Low Dropout: 120mV @ 100mA ($V_{OUT} \geq 2.0V$)
- I $\pm 2\%$ Output Voltage Accuracy
- I High Ripple Rejection : 70 dB
- I Output Current Limit Protection (600mA)
- I Short Circuit Protection (300mA)
- I Thermal Overload Shutdown Protection
- I Low ESR Capacitor Compatible
- I SOT-23, SOT-89 Packages
- I RoHS Compliant and 100% Lead (Pb)-Free

General Description

The AP8853 is a low-dropout linear regulator that operations in the input voltage range from +2.5V to +9.0V 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-optioned from 1.5V to 5.0V with 100mV increment.

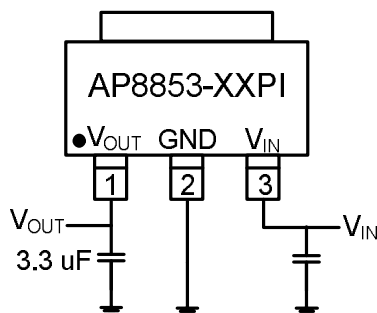
The AP8853 consists of a 1.25V bandgap reference, an error amplifier, and a P-channel pass transistor. Other features include short-circuit protection and thermal shutdown protection. The AP8853 devices are available in SOT-23 and SOT-89 packages.

Applications

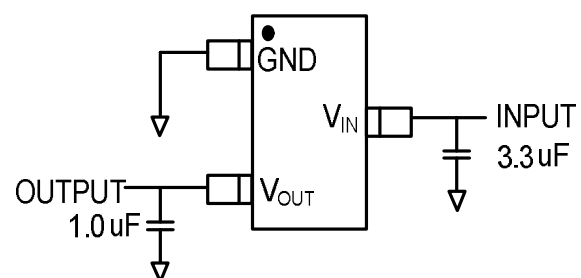
- I Battery powered Equipments
- I Palmtops
- I Portable Cameras and Video Recorders
- I Reference Voltage Sources
- I Post Regulator for Switching Power

Simplified Application Circuit

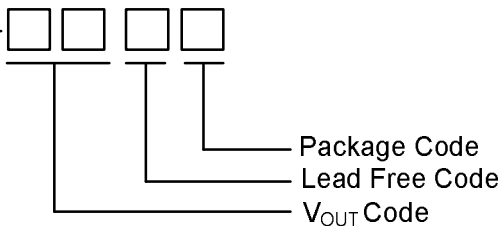
SOT-89



SOT-23



Ordering Information

<p>AP8853 – </p>  <p style="margin-left: 100px;"> Package Code Lead Free Code V_{OUT} Code </p>	<p><u>Vout Code</u> :</p> <p>Exam. 18=1.8V 、 25=2.5V 、 33=3.3V</p> <p><u>Lead Free Code</u> :</p> <p>P : Commercial Standard, Lead (Pb) Free and Phosphorous (P) Free Package</p> <p><u>Package Code</u> :</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">A : SOT-23</td> <td style="width: 50%;">B : SOT-23</td> </tr> <tr> <td>C : SOT-23</td> <td>L : SOT-89</td> </tr> <tr> <td>I : SOT-89</td> <td></td> </tr> </table>	A : SOT-23	B : SOT-23	C : SOT-23	L : SOT-89	I : SOT-89	
A : SOT-23	B : SOT-23						
C : SOT-23	L : SOT-89						
I : SOT-89							

Note :

* The difference between “A” , “B” & “C” type, and “L” & “I” type please refer “Pin Description”.

Absolute Maximum Ratings

Parameter	Symbol	Ratings	Units	
Input Voltage V _{IN} to GND	V _{IN}	10	V	
Output Current Limit, I _(LIMIT)	I _{OUT}	600	mA	
Junction Temperature	T _J	+155	°C	
Power Dissipation	P _D	SOT-23	300	°C/W
		SOT-89	550	°C/W
Thermal Resistance	θ _{JA}	SOT-23	320	°C/W
		SOT-89	180	°C/W
Operating Ambient Temperature Range	T _{OPR}	-40 ~ +125	°C	
Storage Temperature Range	T _{STG}	-55 ~ +150	°C	
Lead Temperature (soldering, 10sec)		+260	°C	

Note:

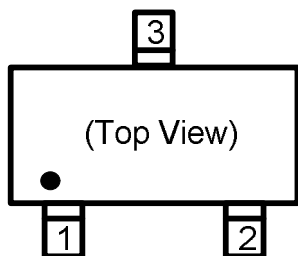
*Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and function operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated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

Electrical Characteristics

(T_A=25°C, unless otherwise noted.)

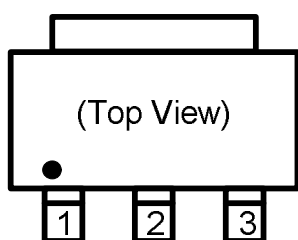
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V _{IN}	Input Voltage		2.5		9.0	V
V _{OUT}	Output Voltage	V _{IN} =V _{OUT} +0.48V, I _{OUT} =1mA, V _{IN} ≤7.0V	-2%	V _{OUT}	+2%	V
		V _{IN} =V _{OUT} +0.48V, I _{OUT} =1mA, 7.0V<V _{IN} ≤9.0V				
ΔV _{OUT}	Output Voltage Accuracy	V _{IN} >V _{OUT} +0.48V, V _{IN} ≤7.0V	-2%	V _{OUT}	+2%	V
		V _{IN} >V _{OUT} +0.48V, 7.0V<V _{IN} ≤9.0V				
I _{MAX}	Maximum Load Current		300			mA
I _{LIMIT}	Current Limit				0.6	A
I _{SC}	Short Circuit Current	V _{OUT} =0V, V _{IN} =5.0V		300	350	mA
I _Q	Ground Pin Current	I _{LOAD} =0mA to 300mA, V _{IN} =5.0V		30	50	μA
V _{DROP}	Dropout Voltage	I _{OUT} =1mA		1.1	1.3	mV
		I _{OUT} =100mA		120	145	
		I _{OUT} =300mA,		400	480	
ΔV _{LINE}	Line Regulation	V _{OUT} +0.48V<V _{IN} <9.0V, I _{LOAD} =1mA		0.2	0.3	%/V
ΔV _{LOAD}	Load Regulation	I _{OUT} =0mA to 300mA,		0.01	0.02	%/mA
e _N	Output Noise	F=1Hz to 10KHz, C _{OUT} =3.3μF		70		μV _{RMS}
PSRR	Ripple Rejection	F=1KHz, C _{OUT} =3.3μF		70		dB
T _{SD}	Thermal Shutdown Temperature			155		°C
T _{HYS}	Thermal Shutdown Hysteresis			10		°C

Pin Assignment & Pin Description



SOT-23

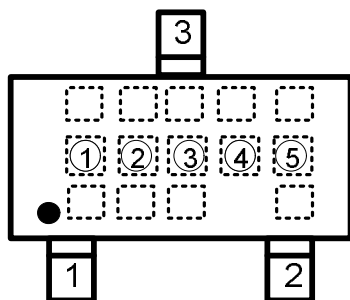
Pin Number			Pin Name	Functions
SOT-23(A)	SOT-23(B)	SOT-23(C)		
2	1	1	GND	Ground
3	3	2	V _{OUT}	Output
1	2	3	V _{IN}	Power Input



SOT-89

Pin Number		Pin Name	Functions
SOT-89(L)	SOT-89(I)		
1	2	GND	Ground
2	3	V _{IN}	Power Input
3	1	V _{OUT}	Output

Package Marking Information



SOT-23
(Top View)

Top Point Represents Products Series

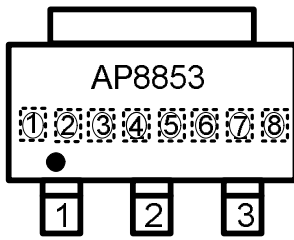
Mark	Products Series
Top Point Dot	Dot above Product Code : Lot Code (see note*1)

Middle Represents Products Series

	Mark	Description
①	A	AP8853
②③	Voltage	Voltage Code : 15、18、33...
④	A, B & C	Package Code
⑤	Dot	Dot for Pb-free package

Bottom Point Represents Production Date Code

Mark	Products Series
Bottom Dot	Dot under Product Code : Year Code (see note*2)
The last Dot	Week Code : i.1-26 week : A~Z ii.27-52 week : <u>A</u> ~ <u>Z</u> (add underscore)



SOT-89-3
(Top View)

Top Point Represents Products Series

Mark	Products Series
Top Point	Part No. : AP8853

①、②、③、④ Represents Products Series

Mark	Description
①、②	Voltage Voltage Code : 18、25、33...
③	Pb-Free Code
④	Package Code

⑤、⑥、⑦、⑧ Represents Production Date Code

Note :

Lot Code :

Lot	Code				
1					•
2				•	
3				•	•
4			•		
5			•		•
6			•	•	
7			•	•	•
8		•			
9		•			•
10		•		•	
11		•		•	•
12		•	•		
13		•	•		•
14		•	•	•	
15		•	•	•	•

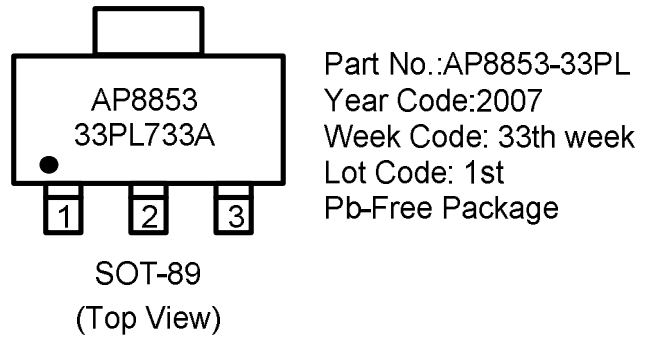
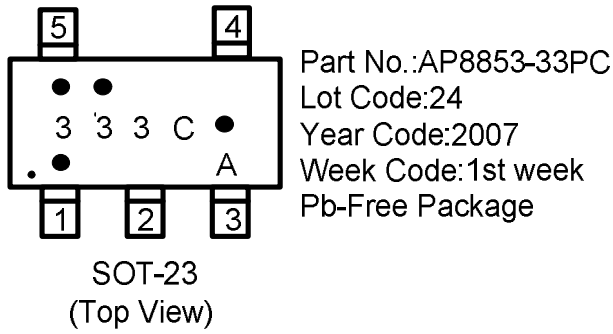
16	•				
17	•				•
18	•			•	
19	•			•	•
20	•		•		
21	•		•		•
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23	•		•	•	•
24	•	•			
25	•	•			•
26	•	•		•	
27	•	•		•	•
28	•	•	•		
29	•	•	•		•
30	•	•	•	•	
31	•	•	•	•	•

Year Code :

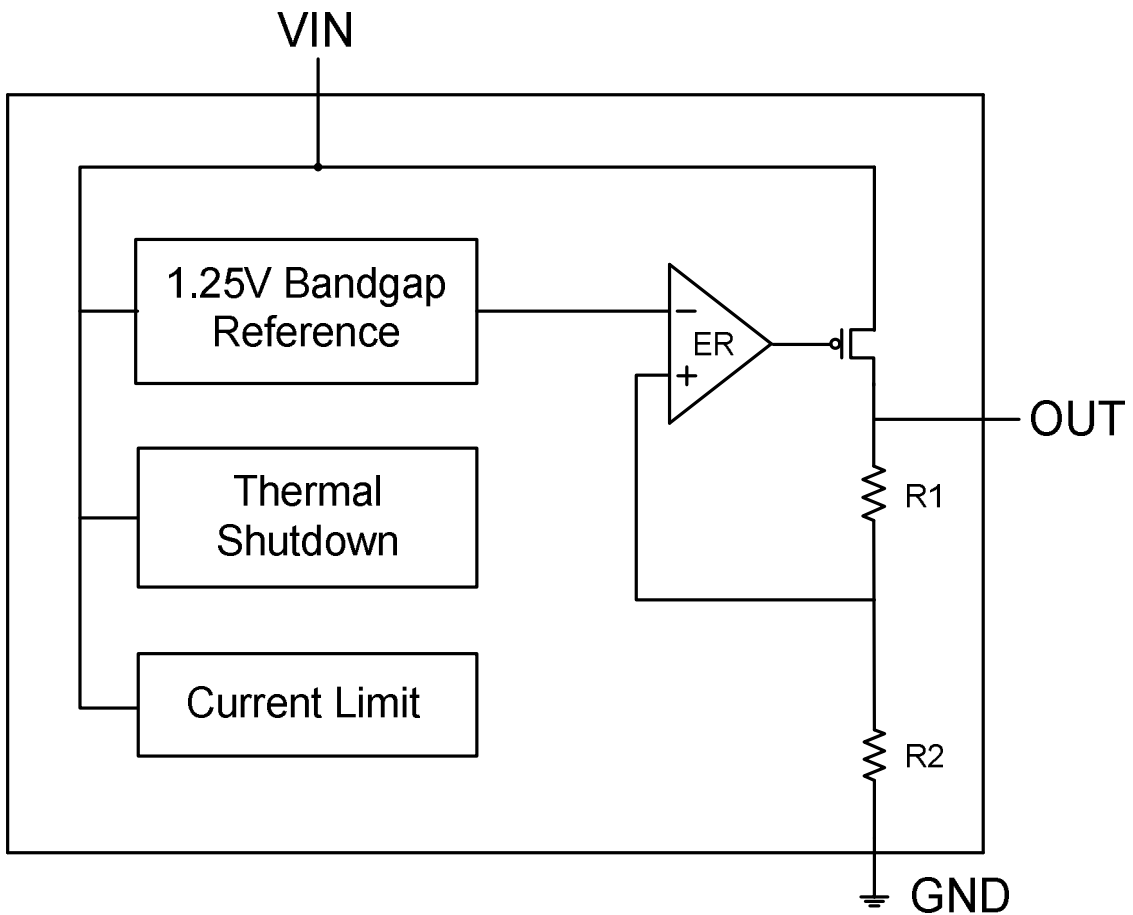
Year	Code		
2003			
2004			•
2005	•	•	
2006		•	•

Year	Code		
2007	•		
2008	•		•
2009	•	•	
2010	•	•	•

Example :



Function Block Diagram



Detail Description

The AP8853 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 1.5V to 5.0V with 100mV increment are also available. 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 AP8853 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 AP8853 does not suffer from these problems and consumes only 65 μ A (Typical) of ground pin current under heavy loads as well as in dropout conditions.

Output Voltage Selection

The AP8853 output voltage is preset at an internally trimmed voltage 2.5V or 3.3V or can be mask-optioned from 1.5V to 5.0V with 100mV increment. The first two digits of part number suffix identify the output voltage (see [Ordering Information](#)). For example, AP8853-33PL has a preset 3.3V output voltage.

Current Limit

The AP8853 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 600mA.

Thermal Overload Protection

Thermal overload protection limits total power dissipation in the AP8853. When the junction temperature exceeds $T_J=+155^{\circ}\text{C}$, 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°C resulting in a pulsed output during continuous thermal overload conditions.

Thermal overload protection is designed to protect the AP8853 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 AP8853 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:

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

Where (T_J-T_A) is the temperature difference between the AP8853 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 V_{IN} , V_{OUT} , and GND pins.

AP8853 Series

If the AP8853 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 θ_{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:

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

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”.

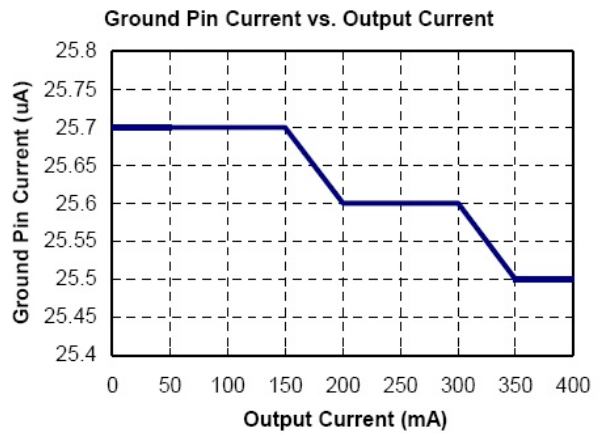
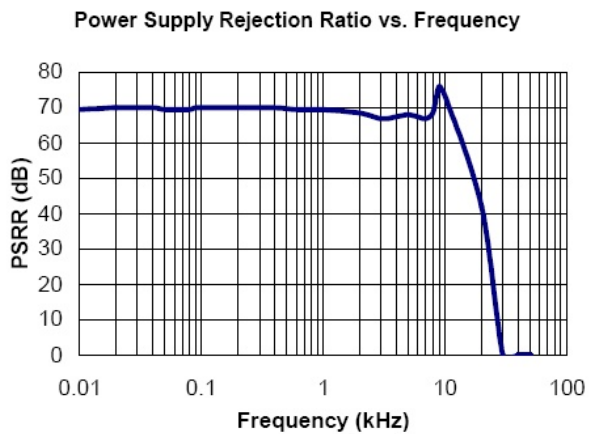
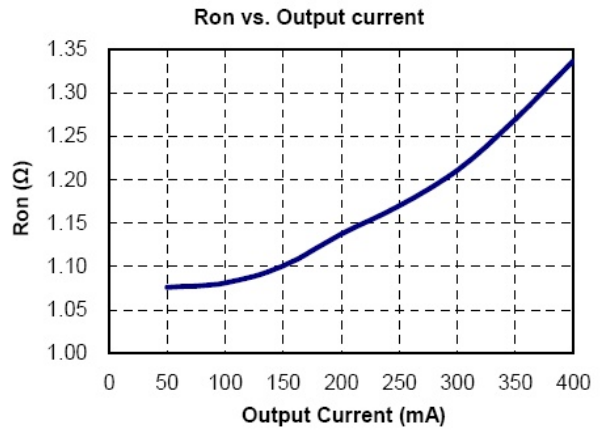
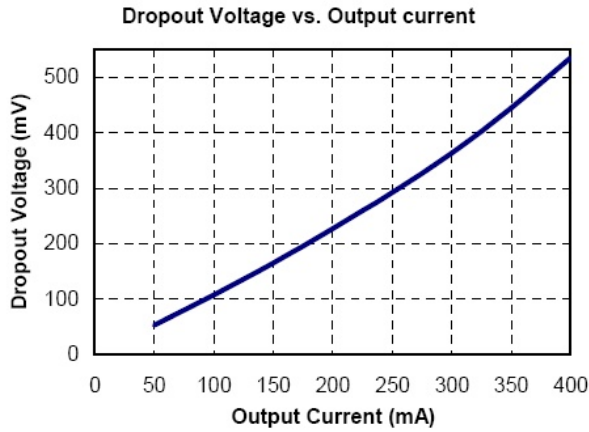
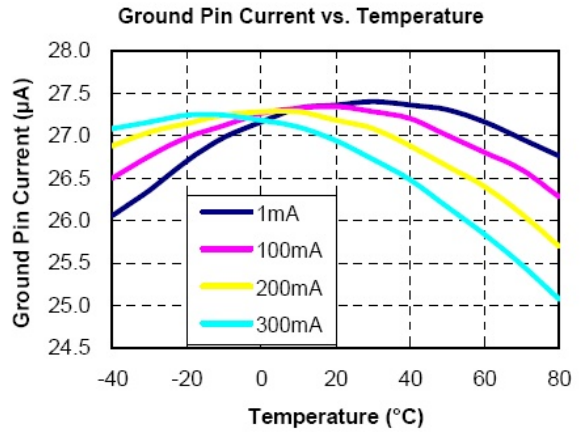
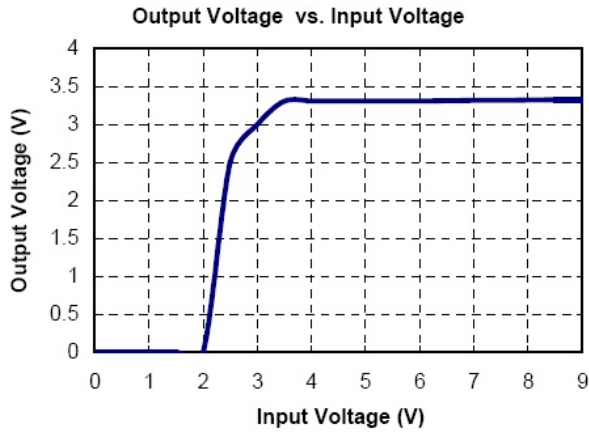
Inout-Output Voltage

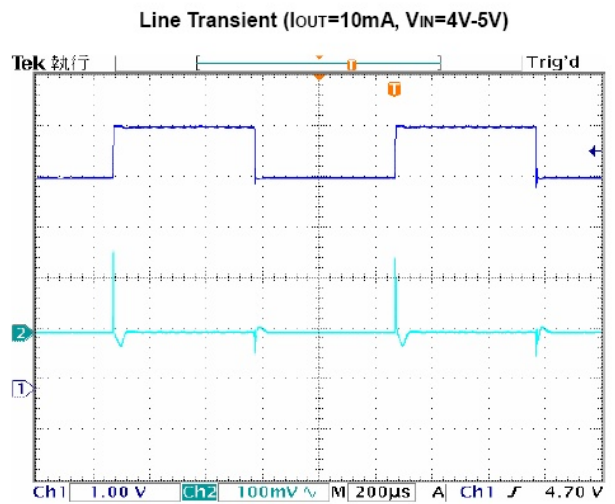
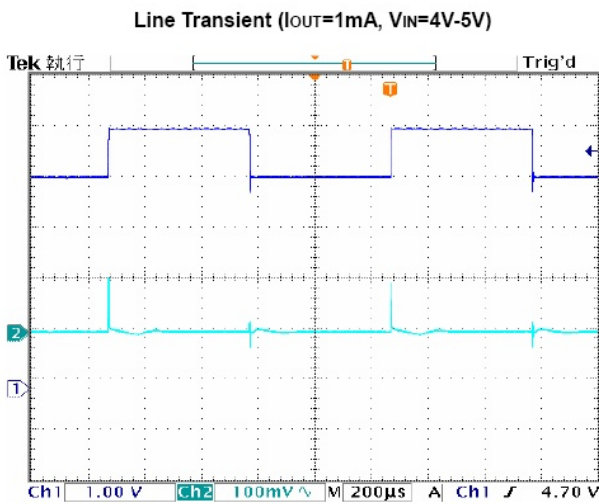
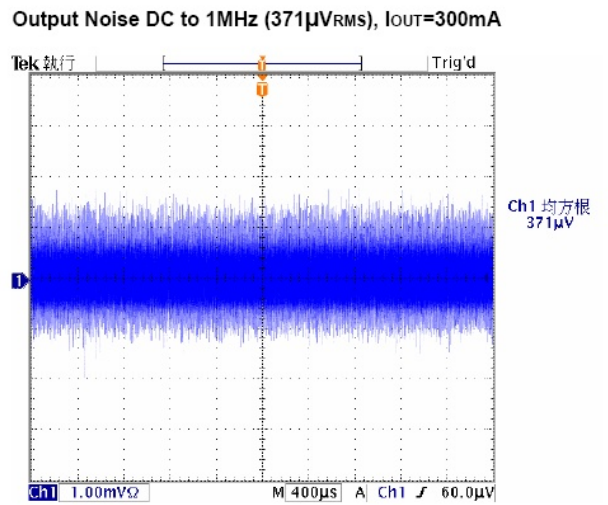
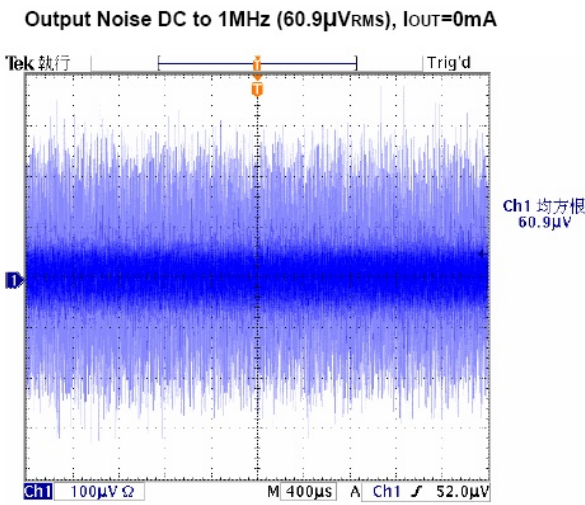
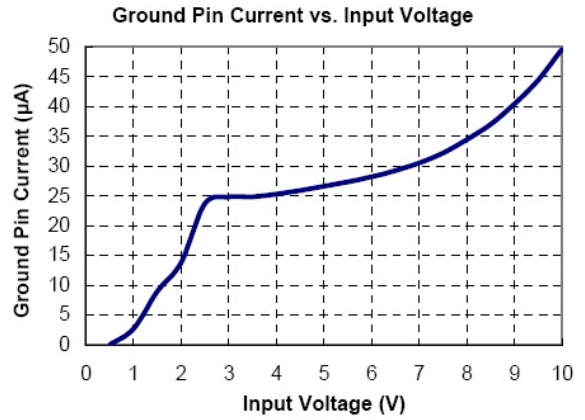
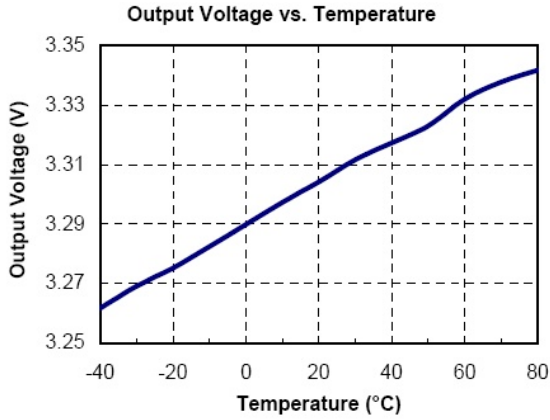
A regulator’s minimum input-output voltage differential, or dropout voltage, determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. The AP8853 uses a P-channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on-resistance ($R_{DS(ON)}$) multiplied by the load current.

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

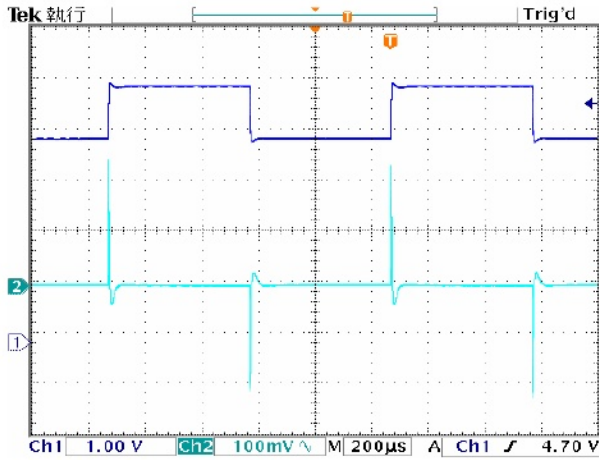
Typical Operating Characteristics

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

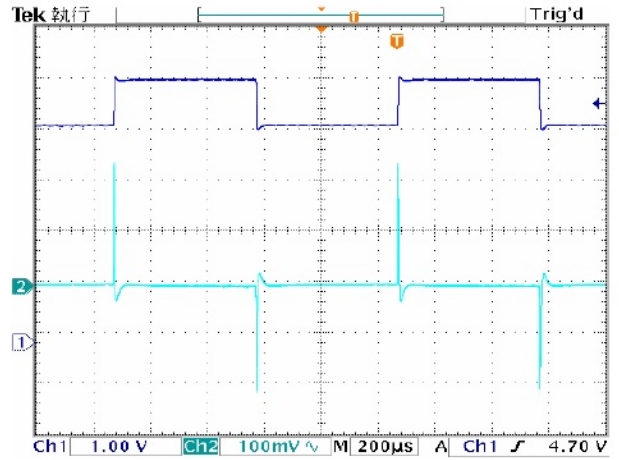




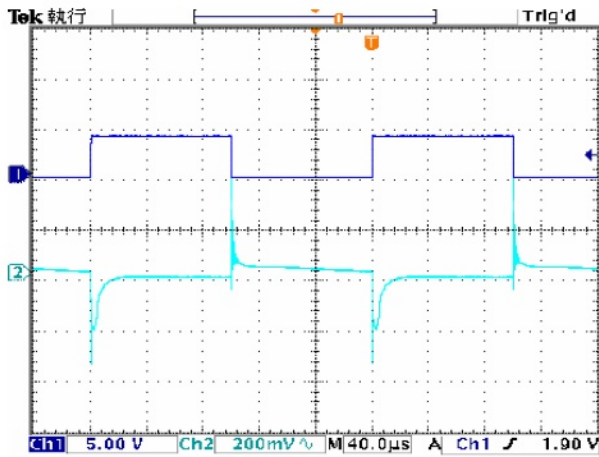
Line Transient ($I_{OUT}=100mA$, $V_{IN}=4V-5V$)



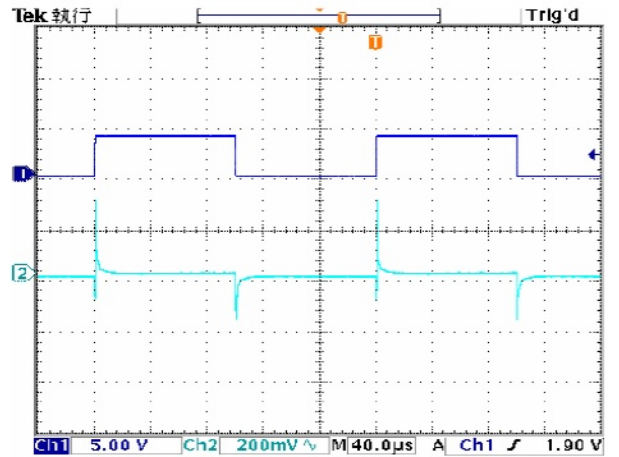
Line Transient ($I_{OUT}=200mA$, $V_{IN}=4V-5V$)



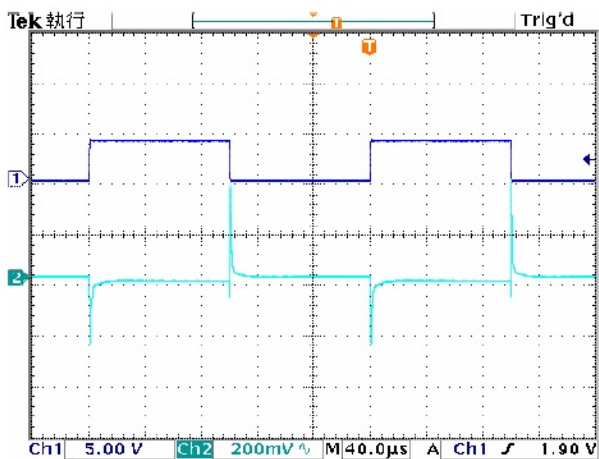
Load Transient ($I_{OUT}=1mA-100mA$)



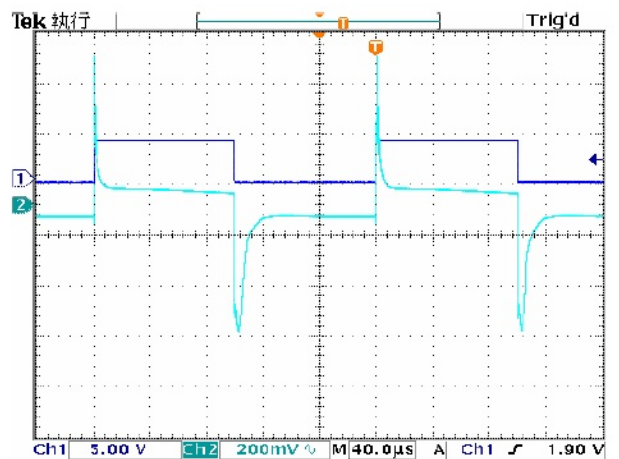
Load Transient ($I_{OUT}=100mA-200mA$)



Load Transient ($I_{OUT}=200mA-300mA$)

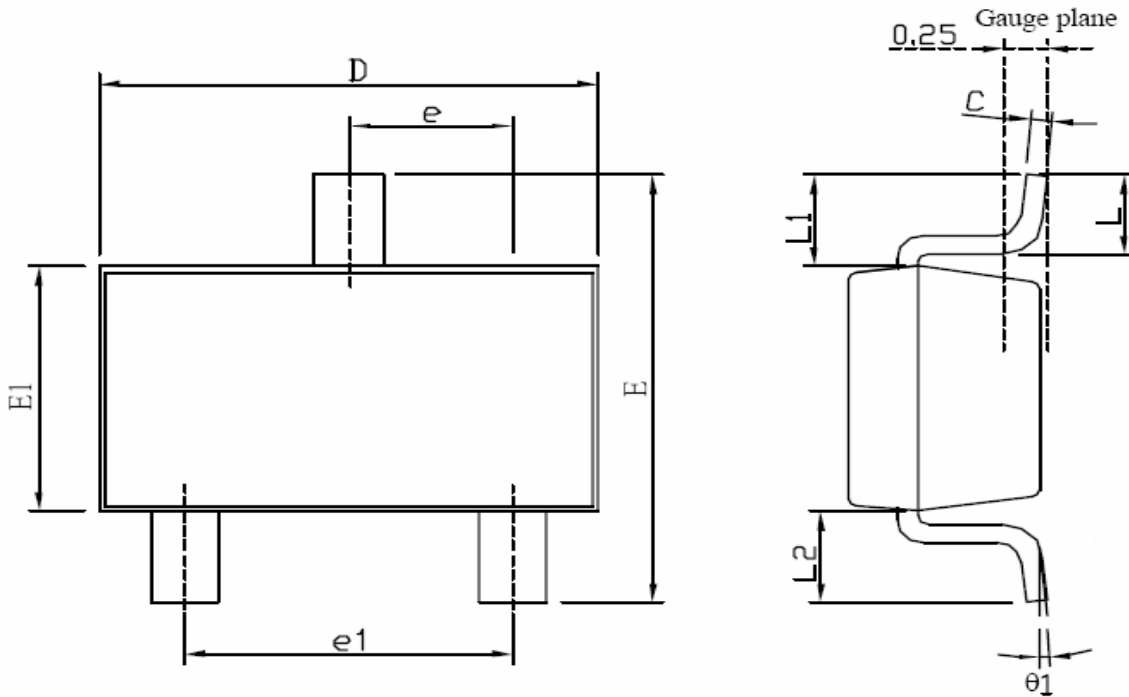


Load Transient ($I_{OUT}=1mA-300mA$)



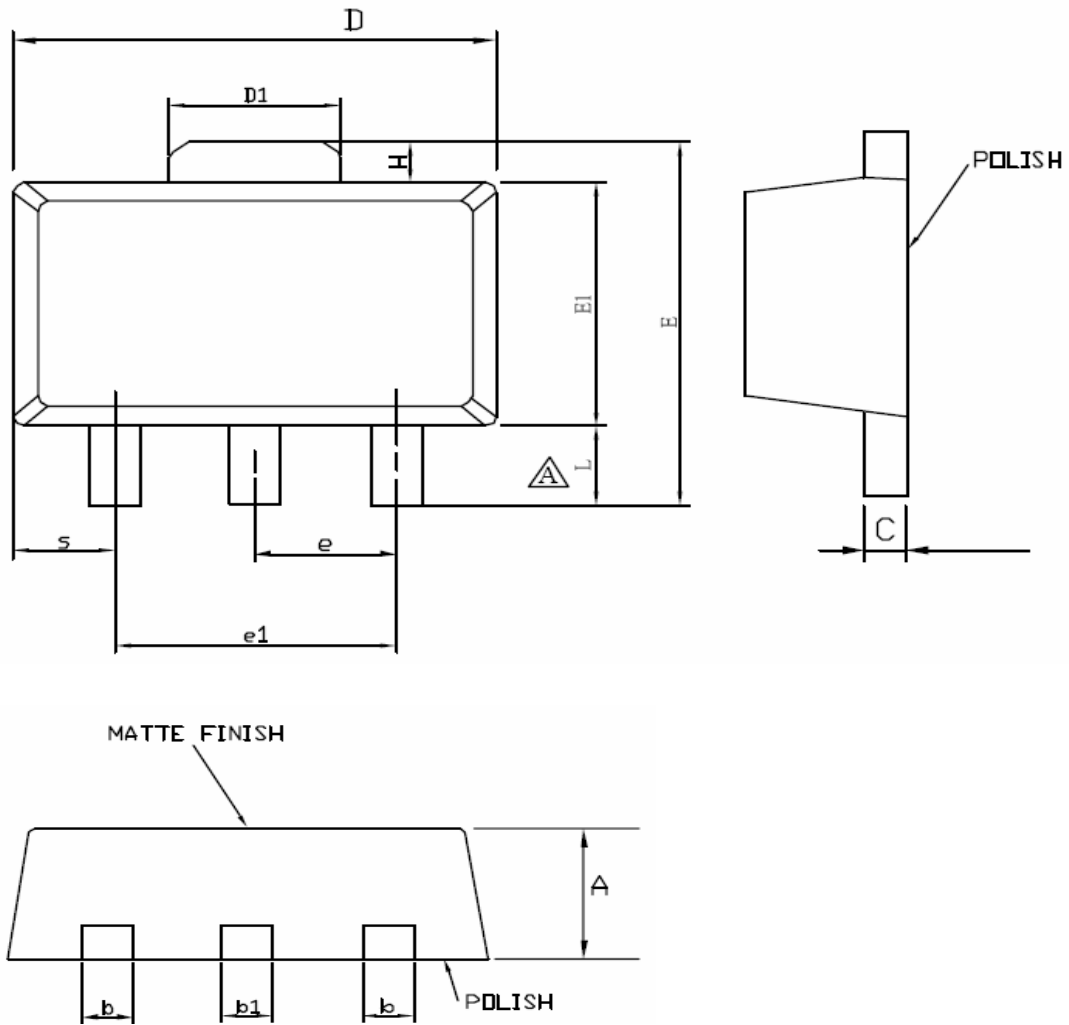
Package Outline

A) SOT-23



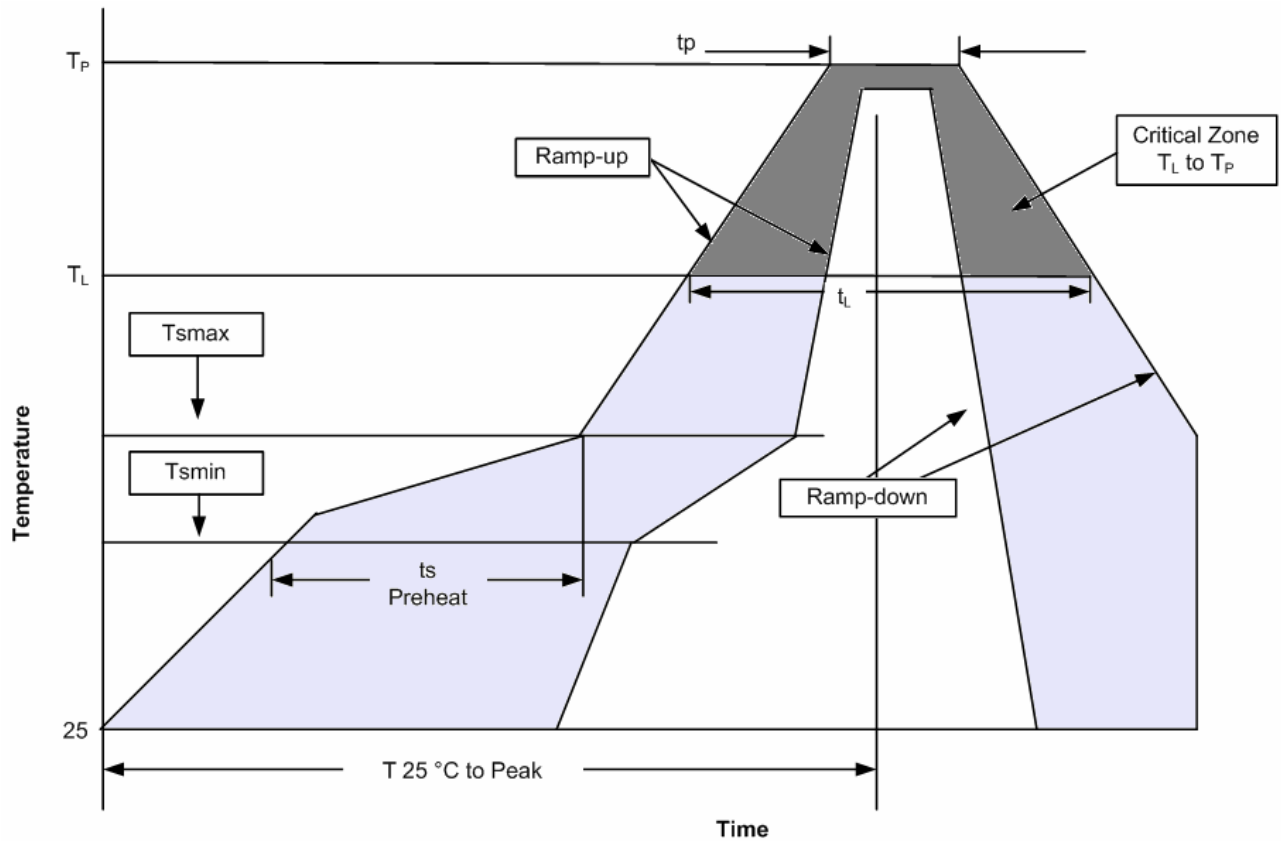
Symbols	Dimensions in Millimeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	0.05	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	---	0.95(Typ)	---
e1	---	1.90(Typ)	---
θ_1	1°	5°	9°
L	0.37	---	---
L1	---	0.6REF	---
L1-L2	---	---	0.12

B) 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

Reflow Condition (IR/Convection or VPR Reflow)



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (T _L to T _P)	3°C/second max	3°C/second max
Preheat - Temperature Min (T _{min}) - Temperature Max (T _{max}) - Time (min to max) (t _s)	100°C 150°C 60-120 seconds	150°C 200°C 60-180 seconds
Time maintained above: - Temperature (T _L) - Time (t _L)	183°C 60-150 seconds	217°C 60-150 seconds
Peak/Classification Temperature (T _P)	See table 1	See table 2
Time within 5°C of actual Peak Temperature (t _p)	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max	6°C/second max
Time 25°C to Peak Temperature	6 minutes max	8 minutes max

Notes :

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

Table 1. Sn-Pb Eutectic Process – Package Peak Reflow Temperatures

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥ 350
<2.5 mm	240 +0/-5°C	225 +0/-5°C
≥2.5 mm	225 +0/-5°C	225 +0/-5°C

Table 2. Pb-free 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.