

### General Description

The FS8854 is a low-dropout linear regulator that operations in the input voltage range from +2.5V to +6.5V and delivers 350mA 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 1.3V to 5.0V with 100mV increment, except FS8854-29Cx which has 2.85V output voltage.

The FS8854 consist 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 FS8854 devices are available in TO-92, SOT-89 and SOT-23 packages.

### Features

- Low dropout voltage 500mV at 350mA (Typ.)
- Up to  $\pm 35\text{mV}$  output voltage accuracy  
Preset at 2.5V, 3.3V  
Mask option from 1.3V to 5.0V
- Small output capacitor
- Output current limit
- Thermal overload shutdown protection
- TO-92, SOT-89 and SOT-23 Package

### Applications

- Battery Powered Equipment
- Palmtops
- Portable Cameras and Video Recorders
- Reference Voltage Sources
- Post Regulator for Switching Power

### Ordering Information

FS8854-xx xx

Package

Pin Out

A : SOT-23	1.IN	2.GND	3.OUT
B : SOT-23	1.GND	2.IN	3.OUT
C : SOT-23	1.GND	2.OUT	3.IN
V : SOT-23	1.OUT	2.GND	3.IN
D : TO-92	1.IN	2.GND	3.OUT
E : TO-92	1.GND	2.IN	3.OUT
F : TO-92	1.OUT	2.GND	3.IN
W : TO-92	1.GND	2.OUT	3.IN
K : SOT-89	1.IN	2.GND	3.OUT
L : SOT-89	1.GND	2.IN	3.OUT
I : SOT-89	1.OUT	2.GND	3.IN
Y : SOT-89	1.GND	2.OUT	3.IN

Temperature Range

C : Commercial Standard

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

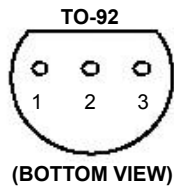
Output Voltage

13 : 1.3V	26 : 2.6V	39 : 3.9V
14 : 1.4V	27 : 2.7V	40 : 4.0V
15 : 1.5V	28 : 2.8V	41 : 4.1V
16 : 1.6V	29 : 2.85V	42 : 4.2V
17 : 1.7V	30 : 3.0V	43 : 4.3V
18 : 1.8V	31 : 3.1V	44 : 4.4V
19 : 1.9V	32 : 3.2V	45 : 4.5V
20 : 2.0V	<b>33 : 3.3V</b>	46 : 4.6V
21 : 2.1V	34 : 3.4V	47 : 4.7V
22 : 2.2V	35 : 3.5V	48 : 4.8V
23 : 2.3V	36 : 3.6V	49 : 4.9V
24 : 2.4V	37 : 3.7V	50 : 5.0V
<b>25 : 2.5V</b>	38 : 3.8V	

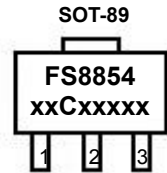
Note : Mask option output types are available by order only.

## Pin Configurations

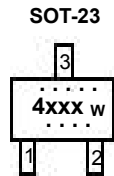
Part No.	Pin 1	Pin 2	Pin 3
FS8854-xxxD	IN	GND	OUT
FS8854-xxxE	GND	IN	OUT
FS8854-xxxF	OUT	GND	IN
FS8854-xxxW	GND	OUT	IN




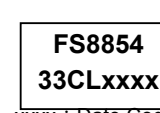
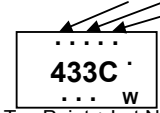
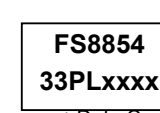
Part No.	Pin 1	Pin 2	Pin 3
FS8854-xxxK	IN	GND	OUT
FS8854-xxxL	GND	IN	OUT
FS8854-xxxI	OUT	GND	IN
FS8854-xxxY	GND	OUT	IN



Part No.	Pin 1	Pin 2	Pin 3
FS8854-xxxA	IN	GND	OUT
FS8854-xxxB	GND	IN	OUT
FS8854-xxxC	GND	OUT	IN
FS8854-xxxV	OUT	GND	IN



## Package Marking Information

SOT-23	TO-92 & SOT-89
<p>EX : FS8854-<u>33CC</u></p>  <p>Top Point : Lot No. Bottom Point : Year w : week, A~Z &amp; A~Z</p>	<p>EX : FS8854-33CL</p>  <p>xxxx : Date Code</p>
<p>EX : FS8854-<u>33PC</u></p>  <p>Top Point : Lot No. Bottom Point : Year w : week, A~Z &amp; A~Z A dot after marking : Pb/P Free</p>	<p>EX : FS8854-33PL</p>  <p>xxxx : Date Code</p>

## Pin Description

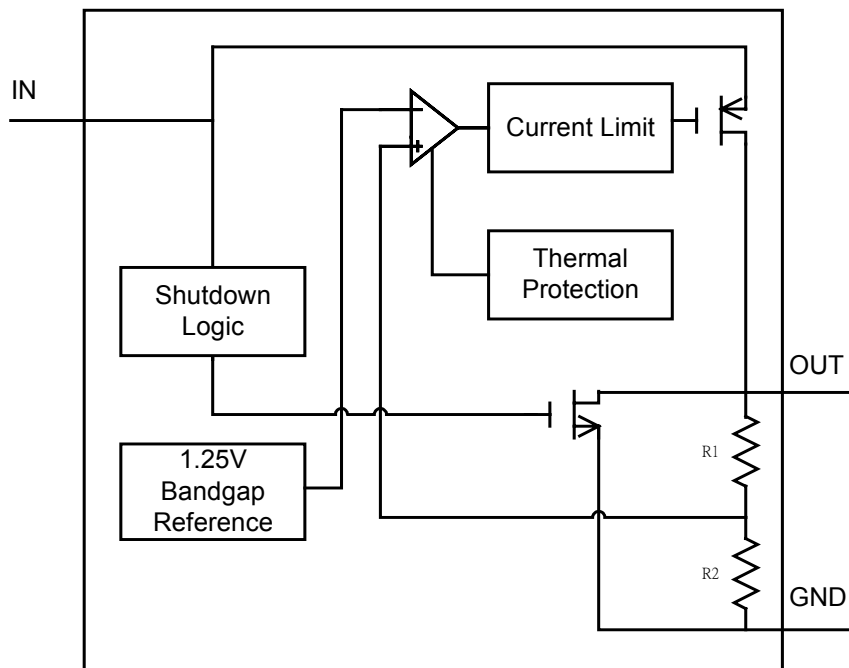
Part NO.	Symbol	Description
FS8854-xxCA FS8854-xxCB FS8854-xxCC FS8854-xxCV FS8854-xxCD FS8854-xxCE FS8854-xxCF FS8854-xxCW FS8854-xxCK FS8854-xxCL FS8854-xxCI FS8854-xxCY	GND	Ground pin.
	IN	Regulator input pin.
	OUT	Regulator output pin.

**IN** is the regulator input pin. Supply voltage can range from 2.5V to 6.5V. Bypass with a 1 $\mu$ F capacitor to GND.

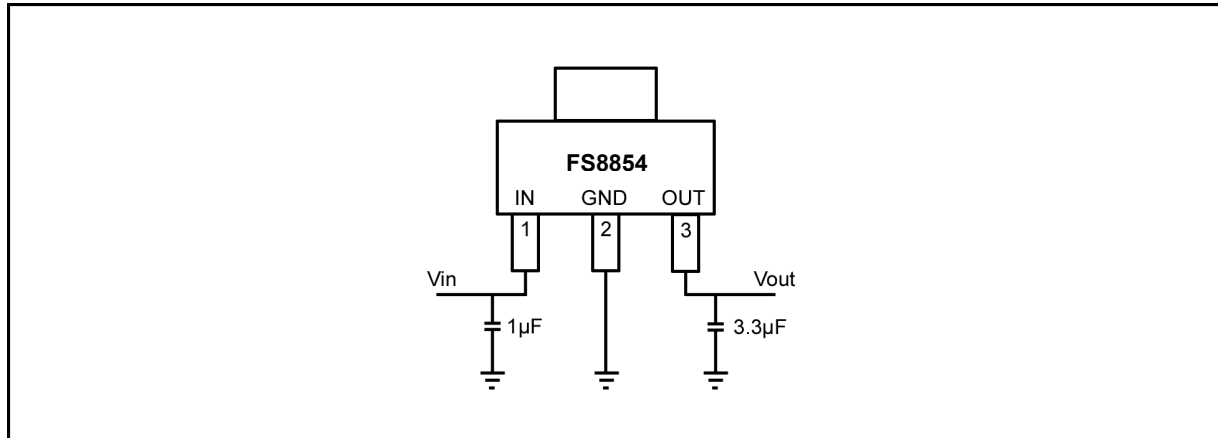
**OUT** is the output voltage pin. Sources up to 350mA. Bypass with a 3.3 $\mu$ F capacitor to GND.

**GND** provides the reference for all voltages.

## Functional Block Diagram



## Typical Application Circuit



## Absolute Maximum Ratings

Input voltage $V_{IN}$ to GND	-----	7V
Output current limit, $I_{LIMIT}$	-----	0.6A
Continuous power dissipation, $P_D$ ( $\Delta T = T_J - T_A = 100^\circ\text{C}$ )		
SOT-23	-----	0.31W
SOT-89	-----	0.55W
TO-92	-----	0.55W
* The power dissipation values are based on the condition that junction temperature $T_J$ and ambient temperature $T_A$ difference is $100^\circ\text{C}$ .		
Junction Temperature, $T_J$	-----	$+155^\circ\text{C}$
Storage temperature range, $T_{STG}$	-----	$-55^\circ\text{C}$ to $+150^\circ\text{C}$
Operating junction temperature range	-----	$-40^\circ\text{C}$ to $+125^\circ\text{C}$
Lead temperature (soldering, 10sec)	-----	$260^\circ\text{C}$

\* 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.

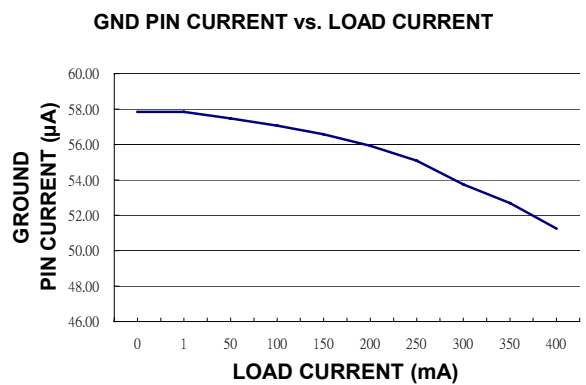
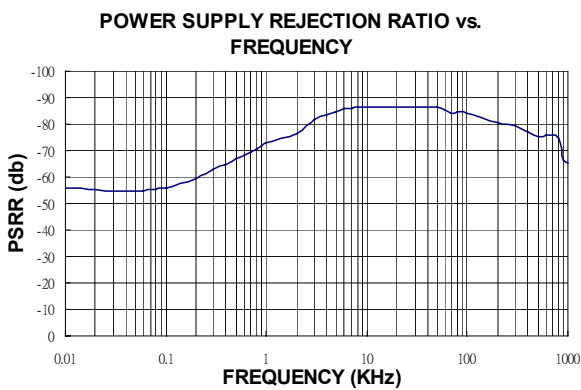
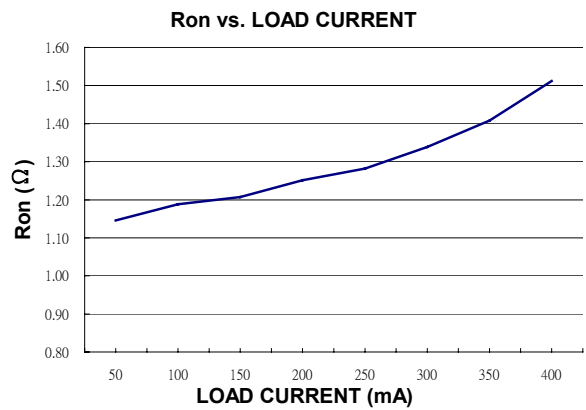
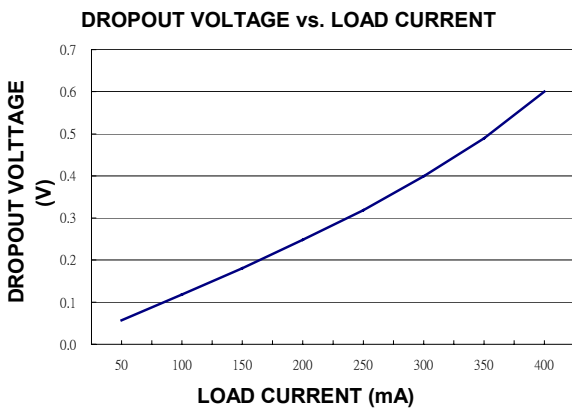
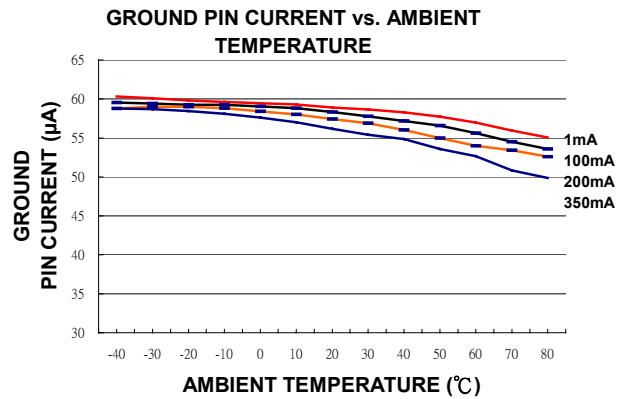
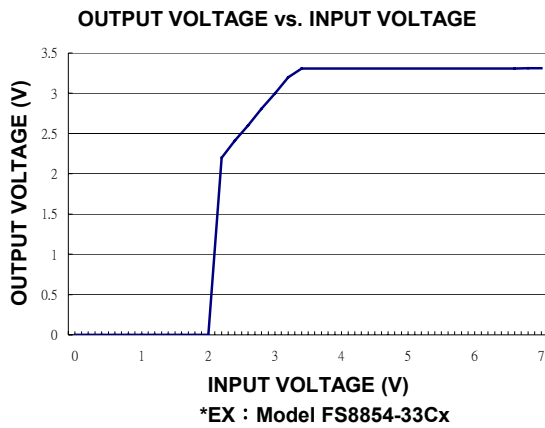
## Electrical Characteristics

(TA=25°C, unless otherwise noted.)

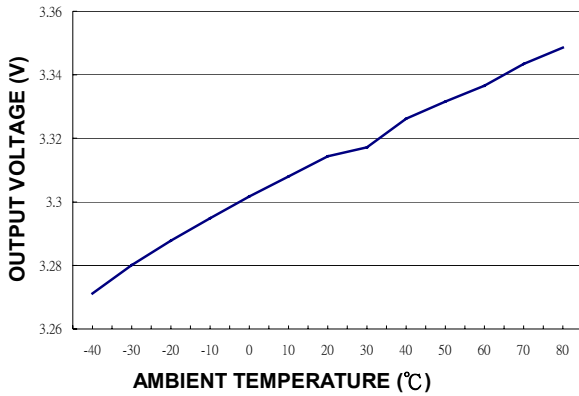
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V <sub>IN</sub>	Input Voltage		2.5		6.5	V
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> =V <sub>OUT</sub> +0.6V, I <sub>OUT</sub> =1mA	V <sub>OUT</sub> -0.035	V <sub>OUT</sub>	V <sub>OUT</sub> +0.035	V
Δ V <sub>OUT</sub>	Output Voltage Accuracy	V <sub>IN</sub> >V <sub>OUT</sub> +0.6V, V <sub>IN</sub> ≤6.5V	-35		+35	mV
I <sub>MAX</sub>	Maximum Load Current		350			mA
I <sub>LIMIT</sub>	Current Limit				0.6	A
I <sub>SC</sub>	Short-Circuit Current	V <sub>OUT</sub> =0V, V <sub>IN</sub> >V <sub>OUT</sub> +0.6V		140	160	mA
I <sub>Q</sub>	Ground Pin Current	I <sub>LOAD</sub> =0mA to 350mA, V <sub>IN</sub> =V <sub>OUT</sub> +0.6V		65	90	μA
V <sub>DROP</sub>	Dropout Voltage	I <sub>OUT</sub> =100mA		120	145	mV
		I <sub>OUT</sub> =300mA		400	480	mV
		I <sub>OUT</sub> =350mA		500	600	mV
ΔV <sub>LINE</sub>	Line Regulation	V <sub>OUT</sub> +0.6V<V <sub>IN</sub> <6.5V, I <sub>LOAD</sub> =1mA		0.2	0.3	%/V
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>OUT</sub> =0mA to 350mA		0.02	0.03	%/mA
e <sub>N</sub>	Output Noise	F=1Hz to 10KHz, C <sub>OUT</sub> =3.3μF		70		μVRMS
PSRR	Ripple Rejection	F=10KHz, C <sub>OUT</sub> =3.3μF		75		dB
T <sub>SD</sub>	Thermal Shutdown Temperature			155		°C
T <sub>HYS</sub>	Thermal Shutdown Hysteresis			20		°C
θ <sub>JA</sub>	Thermal Resistance	SOT-23			320	°C/W
		SOT-89			180	°C/W
		TO-92			180	°C/W

## Typical Operating Characteristics

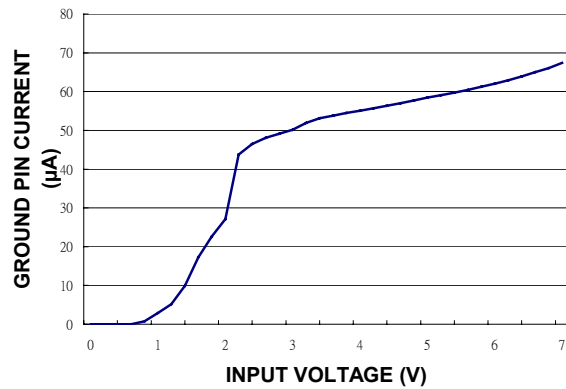
(C<sub>IN</sub>=1μF, C<sub>OUT</sub>=3.3μF, T<sub>A</sub>=+25°C, unless otherwise noted.)



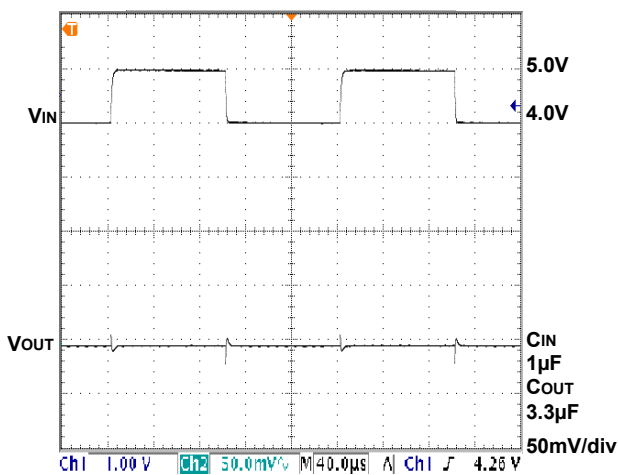
OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



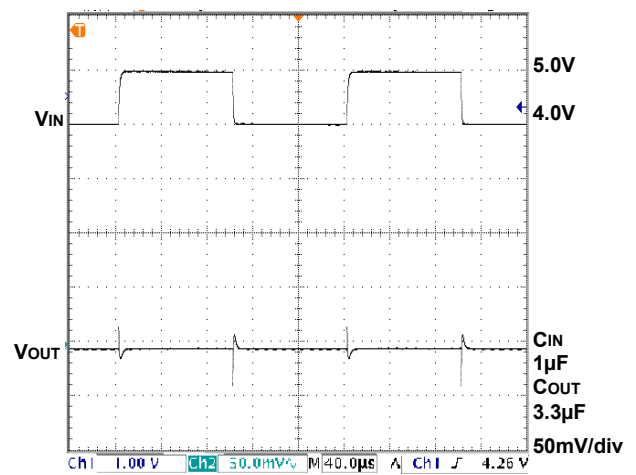
GROUND PIN CURRENT vs. INPUT VOLTAGE



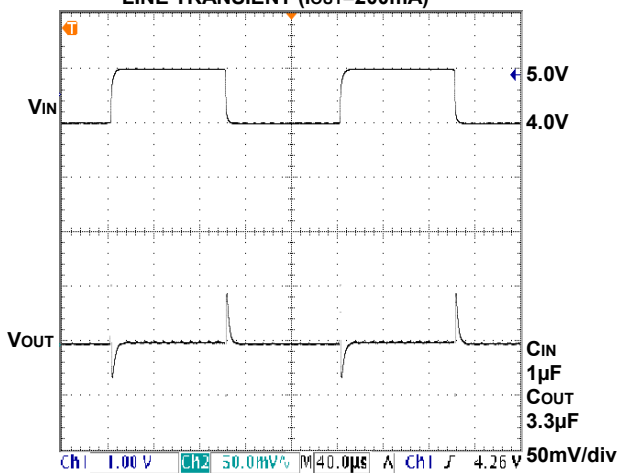
LINE TRANSIENT (I<sub>OUT</sub>=0mA)



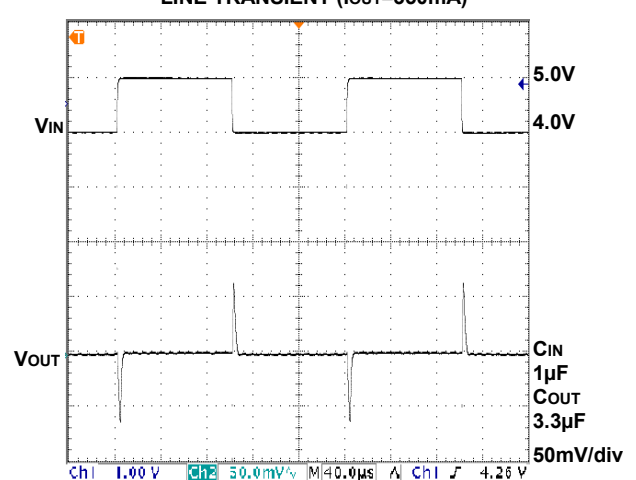
LINE TRANSIENT (I<sub>OUT</sub>=10mA)



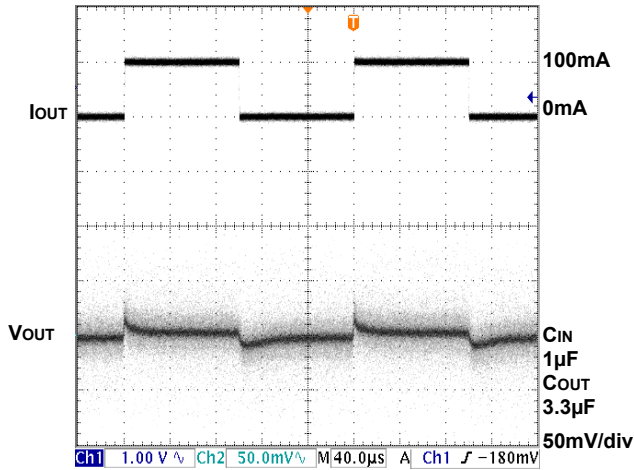
LINE TRANSIENT (I<sub>OUT</sub>=200mA)



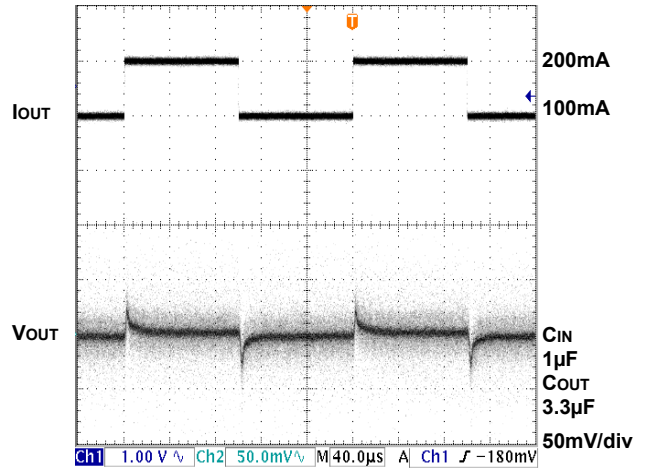
LINE TRANSIENT (I<sub>OUT</sub>=350mA)



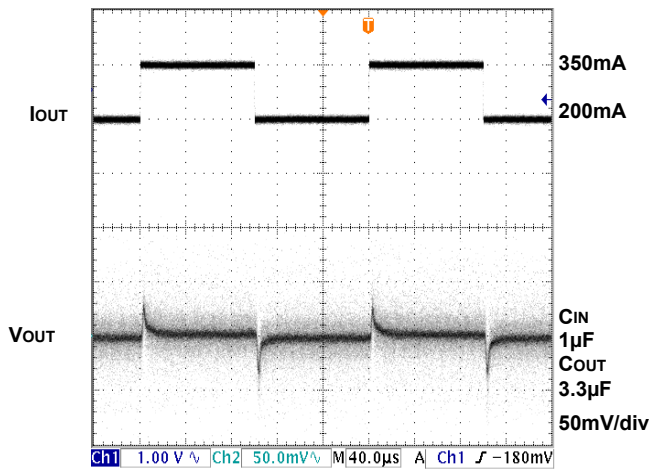
LOAD TRANSIENT



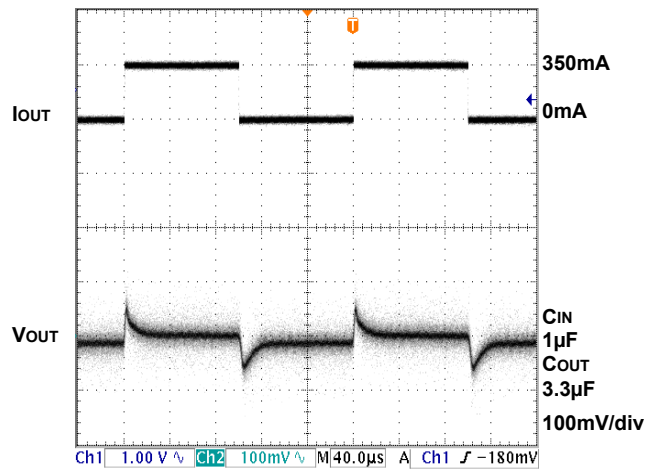
LOAD TRANSIENT



LOAD TRANSIENT



LOAD TRANSIENT





## Detail Description

The FS8854 is a low-dropout linear regulator. The device provides preset 2.5V and 3.3V output voltages for output current up to 350mA. Other mask options for special output voltages from 1.3V to 5.0V with 100mV increment are also available. As illustrated in function block diagram, it consists of a 1.25V reference, error amplifier, 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 OUT pin. Additional blocks include an output current limiter, thermal sensor, and shutdown logic.

### Internal P-channel Pass Transistor

The FS8854 features a P-channel MOSFET pass transistor. Unlike similar designs using PNP pass transistors, P-channel MOSFETs require no base drive, which reduces ground pin 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 FS8854 does not suffer from these problems and consumes only 65µA (Typ.) of ground pin current under heavy loads as well as in dropout conditions.

### Output Voltage Selection

The FS8854 output voltage is preset at an internally trimmed voltage 2.5V, 3.3V or can be mask-optional from 1.3V to 4.5V with 100mV increment. The first two digits of part number suffix identify the output voltage (see [Ordering Information](#)). For example, the FS8854-33CL has a preset 3.3V output voltage.

### Current Limit

The FS8854 also include 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 0.6A.

### Thermal Overload Protection

Thermal overload protection limits total power dissipation in the FS8854. 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 on 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 FS8854 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 FS8854 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 FS8854 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 IN, OUT, and GND pins.

If the FS8854 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 sided board with 1" x 2" square inches of copper area connected to the GND pin for "heat

spreading".

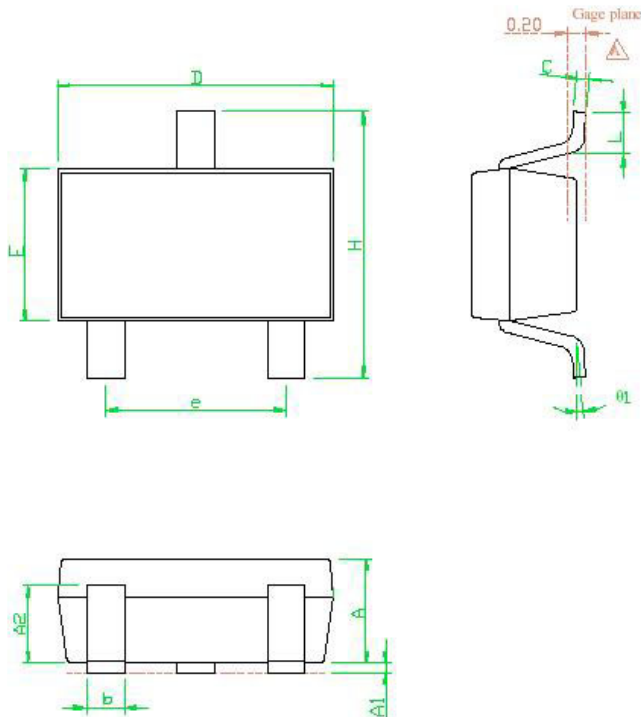
#### **Input-Output Voltage**

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 FS8854 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.

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

## Package Outline

### SOT-23

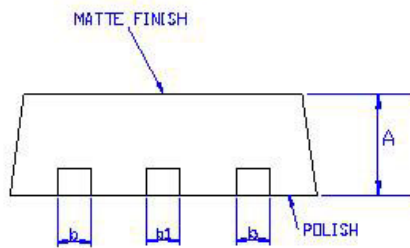
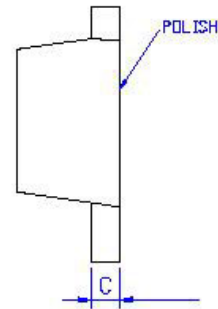
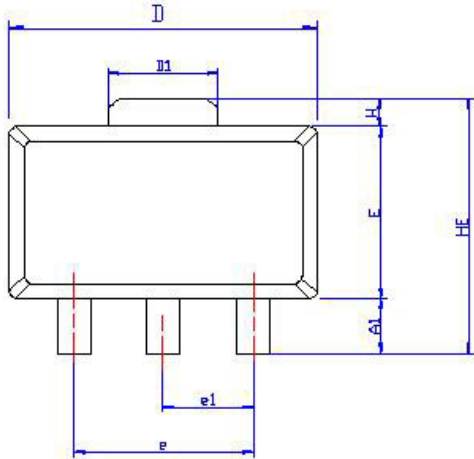


**NOTE**

1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH PROTRUSIONS OR GATE BURRS
2. TOLERANCE  $\pm 0.1000$  mm (4 mil) UNLESS OTHERWISE SPECIFIED
3. COPLANARITY : 0.1000 mm
4. DIMENSION L IS MEASURED IN GAGE PLANE

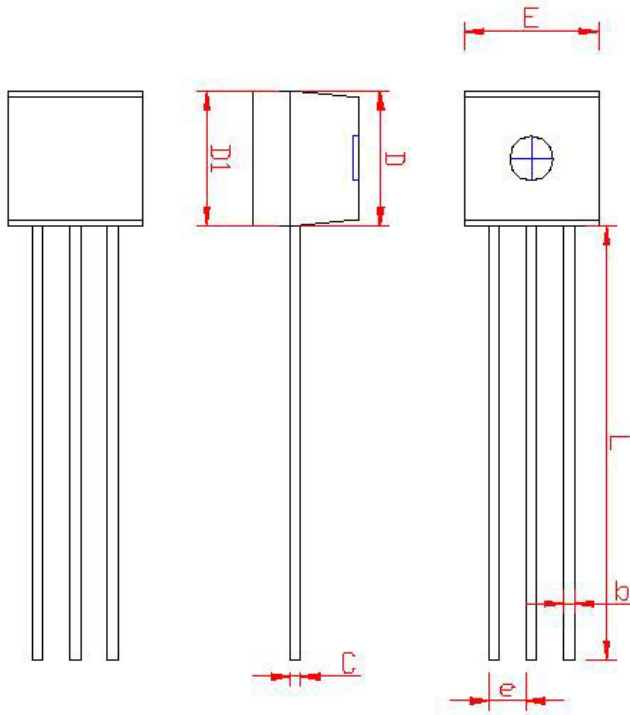
SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	1.00	1.10	1.30
A1	0.00	---	0.10
A2	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E	1.40	1.60	1.80
e	---	1.90(TYP)	---
H	2.60	2.80	3.00
L	0.37	---	---
$\theta 1$	1°	5°	9°

**SOT-89**



SYMBOLS	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
A1	0.80	1.04	—	0.031	0.041	—
b	0.35	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
HE	—	—	4.25	—	—	0.167
E	2.40	2.50	2.60	0.094	0.098	0.102
e	2.90	3.00	3.10	0.114	0.118	0.122
H	0.35	0.40	0.45	0.014	0.016	0.018
S	0.65	0.75	0.85	0.026	0.030	0.034
e1	1.40	1.50	1.60	0.054	0.059	0.063

**TO-92**



SYMBOL	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	3.35	3.86	0.132	0.152
A1	1.0414	1.55	0.041	0.061
b	0.254	0.508	0.010	0.020
E	4.34	4.85	0.171	0.191
C	0.254	0.508	0.010	0.020
L	14.53	15.04	0.572	0.592
e	1.143	1.397	0.045	0.055
G	3.683	4.191	0.145	0.165
D	4.29	4.80	0.169	0.189
D1	4.34	4.85	0.171	0.191

