1.5A Fixed Voltage LDO Linear Regulator

General Description

The EMP8110 is a CMOS low-dropout linear regulator that operates in the input voltage range from +2.5V to +6.5V and delivers 1.5A output current.

The EMP8110 features include short-circuit protection and thermal shutdown protection. The EMP8110 series devices are available in both of SOT-223 and TO-252 packages.

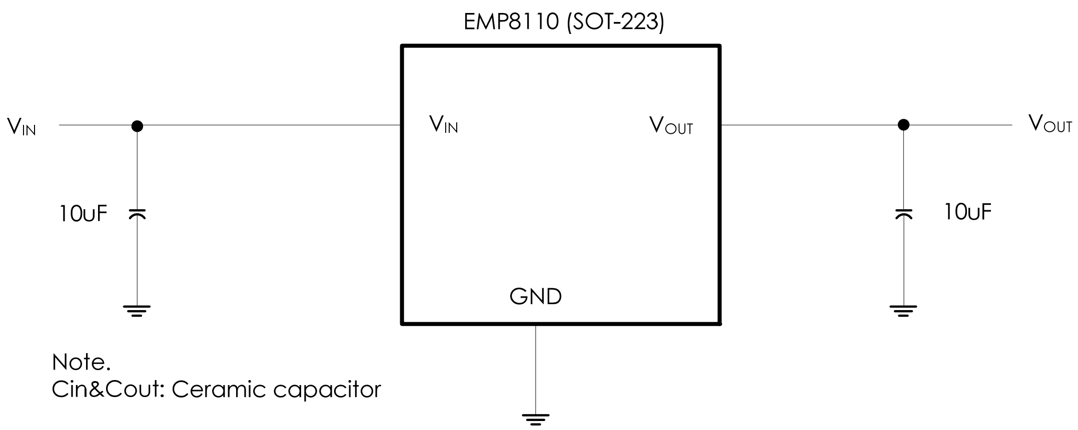
Applications

- Active SCSI Terminators
- High Efficiency Linear Regulators
- Monitor Microprocessors
- Low Voltage Micro-Controllers
- Post Regulator for Switching Power

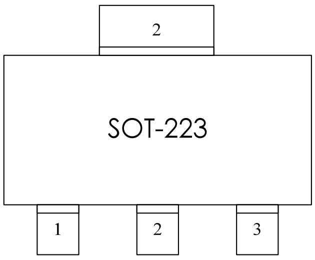
Features

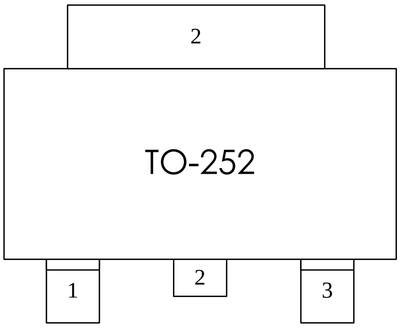
- Operating Voltage Range：+2.5V to +6.5V
- Output Voltages：+1.2V to +4.5V (0.1V Step)
- Maximum Output Current：1.5A
- Dropout Voltage：570mV @ 1.5A(Vout=1.8V)
- Low Current Consumption：65μA (Typ.)
- ±2% Output Voltage Accuracy
- Low ESR Capacitor Compatible
- High Ripple Rejection：60 dB (Vout=1.8V)
- Fold back short circuit protection
- Thermal Overload Shutdown Protection
- SOT-223 and TO-252 Packages
- RoHS Compliant and 100% Lead (Pb)-Free and Green (Halogen Free with Commercial Standard)

Typical Application



Connection Diagrams





Order Information

EMP8110-XXVE#3NRR

XX Output voltage

VE#3 SOT-223 Package (Package Code)

#：Pin fuction type

NRR RoHS & Halogen free package

Commercial Grade Temperature

Rating: -40 to 85°C

Package in Tape & Reel

EMP8110-XXTB#3NRR

XX Output voltage

TB#3 TO-252 Package (Package Code)

#：Pin fuction type

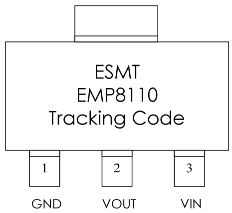
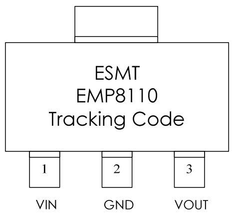
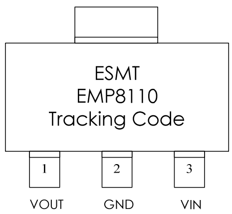
NRR RoHS & Halogen free package

Commercial Grade Temperature

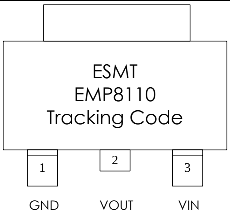
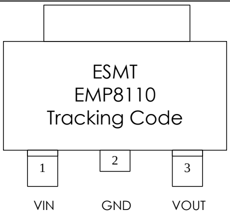
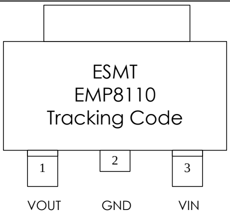
Rating: -40 to 85°C

Package in Tape & Reel

Order, Marking & Packing Information

Package	Vout	Product ID.	Marking	Packing
SOT-223	1.2-4.5V	EMP8110-XXVEJ3NRR		Tape & Reel 2.5kpcs
SOT-223	1.2-4.5V	EMP8110-XXVEG3NRR		Tape & Reel 2.5kpcs
SOT-223	1.2-4.5V	EMP8110-XXVEX3NRR		Tape & Reel 2.5kpcs

Order, Marking & Packing Information (cont.)

Package	Vout	Product ID.	Marking	Packing
TO-252	1.2-4.5V	EMP8110-XXTBJ3NRR		Tape & Reel 3kpcs
TO-252	1.2-4.5V	EMP8110-XXTBG3NRR		Tape & Reel 3kpcs
TO-252	1.2-4.5V	EMP8110-XXTBX3NRR		Tape & Reel 3kpcs

Note.

XX: Output voltage, example

12: 1.2V output

1C: 1.25V output

25: 2.5V output

Pin Functions

Name	SOT-223/TO-252			Function
	J	G	X	
IN	3	1	3	**Supply Voltage Input.** Require a minimum input capacitor of close to 10μF to ensure stability and sufficient decupling from the ground pin.
GND	1	2	2	**Ground Pin.**
OUT	2	3	1	**Output Voltage.**

Functional Block Diagram

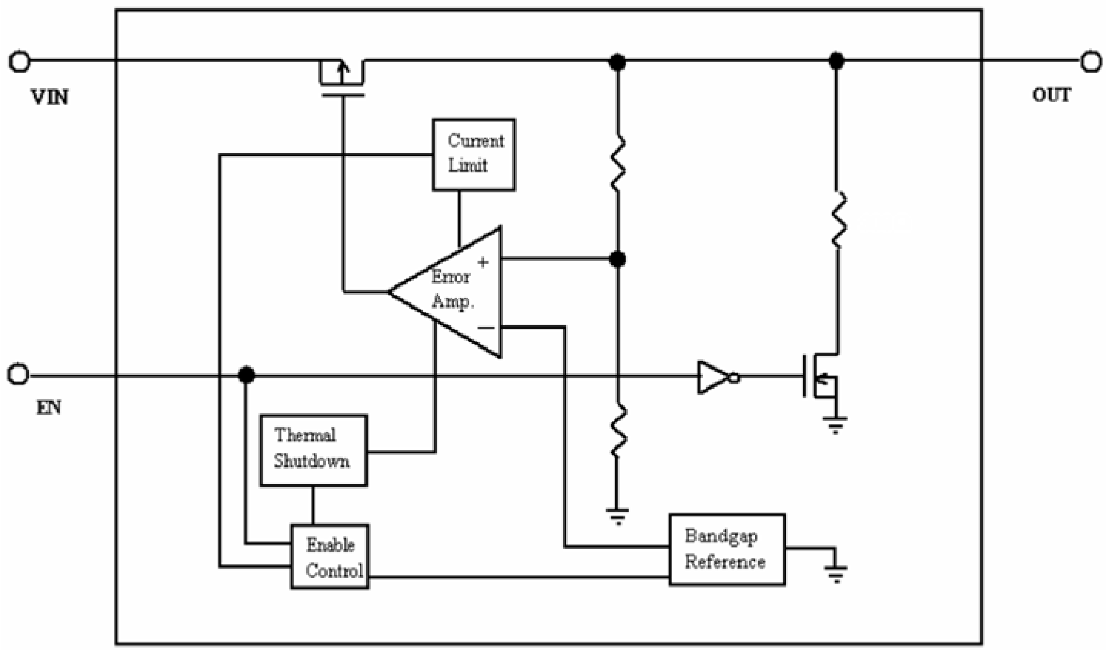


FIG.1. Functional Block Diagram of EMP8110

Absolute Maximum Ratings (Notes 1, 2)

IN	-0.3V to 7V
OUT	-0.3V to 5.0V
Power Dissipation	(Note 8)
Storage Temperature Range	-55°C to 150°C
Junction Temperature (T_J)	155°C
Lead Temperature (Soldering, 10 sec.)	260°C
ESD Rating	
Human Body Model	2KV

Operating Ratings (Note 1, 2)

Supply Voltage	2.5V to 6.5V
Operating Temperature Range	-40°C to 85°C
Thermal Resistance (θ_{JA} , Note 3))	
SOT-223 (package code VEG3 and VEX3)	110°C/W
SOT-223 (package code VEJ3)	290°C/W
TO-252 (package code TBG3 and TBX3)	80°C/W
TO-252 (package code TBJ3)	170°C/W

Electrical Characteristics

Unless otherwise specified, all limits guaranteed for V_{IN} = V_{OUT}+1V, C_{IN} = C_{OUT} = 10μF, T_A = 25°C.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage		2.5		6.5	V
V_{OUT}	Output Accuracy	V_{IN}=V_{OUT}+1V, I_{OUT}=10mA	-2%	V_{OUT}	+2%	V
I_{MAX}	Output Current		1.5			A
I_{LIMIT}	Current Limit			1.8		A
V_{DROP}	Dropout Voltage	I_{OUT}= 1000mA, 2.5V<V_{OUT}≦4.5V		270		mV
		I_{OUT}= 1000mA, 1.5<V_{OUT}≦2.5V		330	600	mV
		I_{OUT}= 1000mA, 1.4<V_{OUT}≦1.5V		380	800	mV
		I_{OUT}= 1000mA, 1.3<V_{OUT}≦1.4V		450	900	mV
		I_{OUT}= 1000mA, 1.2<V_{OUT}≦1.3V		500	1000	mV
ΔV_{LINE}	Line Regulation	V_{OUT}≦2V, 2.5V≦V_{in}≦3 V, I_{OUT}=30mA	-0.15	0.1	0.15	%/V
		V_{OUT} +1V≦V_{in}≦V_{out} +2, I_{OUT}=30mA	-0.1	0.02	0.1	%/V
ΔV_{LOAD}	Load Regulation	V_{IN}=V_{OUT}+1V, 1mA≦I_{OUT}≦1500mA		0.02	0.05	%/mA
I_Q	Ground Pin Current	I_{LOAD}=0mA, V_{IN} = V_{OUT}+1.0V		65		μA
		I_{LOAD}=1000mA, V_{IN} = V_{OUT}+1.0V		90		μA
		I_{LOAD}=1500mA, V_{IN} = V_{OUT}+1.0V		115		μA
I_{SC}	Fold back Short Circuit Current			250		mA
PSRR	Ripple Rejection	I_{OUT}=100mA @1kHz, V_{OUT}=1.8V		60		dB
T_{SD}	Thermal Shutdown Temperature			160		°C
T_{HYS}	Thermal Shutdown Hysteresis			30		°C

Note 1: Absolute Maximum ratings indicate limits beyond which damage may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions.

Note 2: All voltages are with respect to the potential at the ground pin.

Note 3: θ_{JA} is measured in the natural convection at T_A=25℃ on a high effective thermal conductivity test board (2 layers, 2S0P).

Note 4: Condition does not apply to input voltages below 2.2V since this is the minimum input operating voltage.

Note 5: Dropout voltage is measured by reducing V_{IN} until V_{OUT} drops 100mV from its nominal value at V_{IN} -V_{OUT} = 1V. Dropout voltage does not apply to the regulator versions with V_{OUT} less than 2.2V.

Note 6: Turn-off time is time measured between the enable input just decreasing below V_{IL} and the output voltage just decreasing to 10% of its nominal value.

Note 7: Maximum Power dissipation for the device is calculated using the following equations:

$$P_D = \frac{T_{J(MAX)} - T_A}{\theta_{JA}}$$

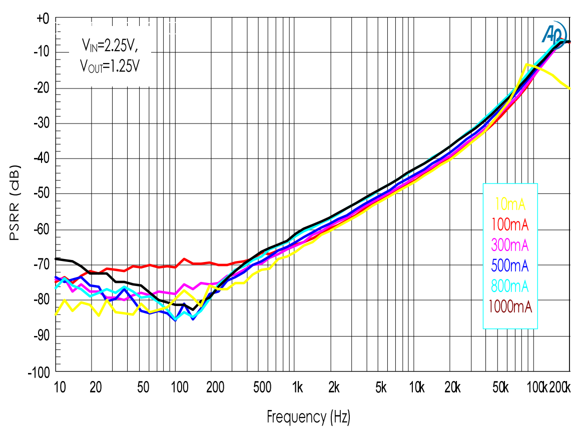
Where T_J(MAX) is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction-to-ambient thermal resistance. E.g. for the SOT-223 package θ_{JA} = 110°C/W, T_J (MAX) = 150°C and using T_A = 25°C, the maximum power dissipation is found to be 1.136W. The derating factor (-1/θ_{JA}) = -9.09mW/°C, thus below 25°C the power dissipation figure can be increased by 9.09mW per degree, and similarity decreased by this factor for temperatures above 25°C.

Note 8: Typical Values represent the most likely parametric norm

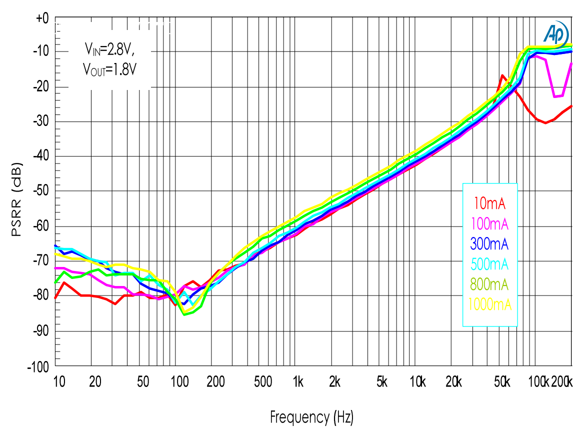
Typical Performance Characteristics

Unless otherwise specified, $V_{IN} = V_{OUT\ (NOM)} + 1V$, $V_{EN}=V_{IN}$, $C_{IN} = C_{OUT} = 10\mu F$, $T_A = 25°C$

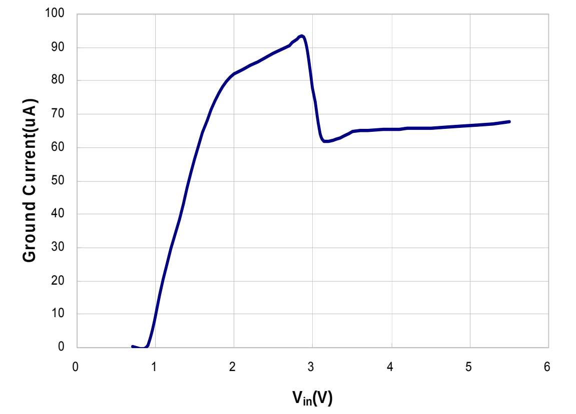
PSRR vs. Frequency (V_{OUT}=1.25V)



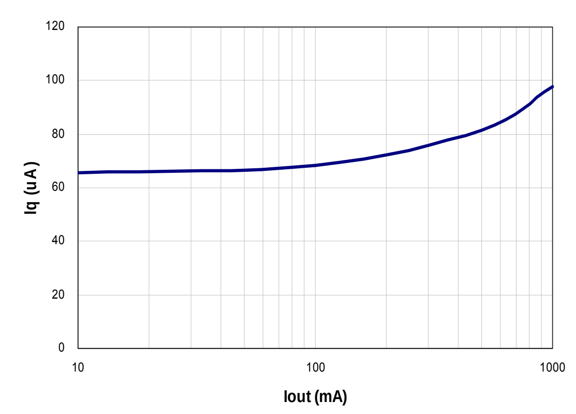
PSRR vs. Frequency (V_{OUT}=1.8V)



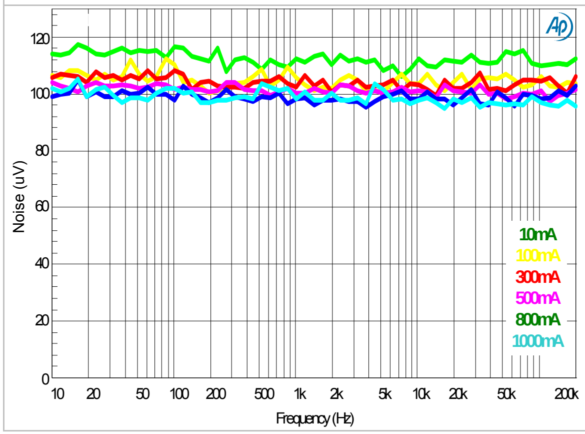
Ground Current vs. V_{IN} (V_{OUT}=3.3V)



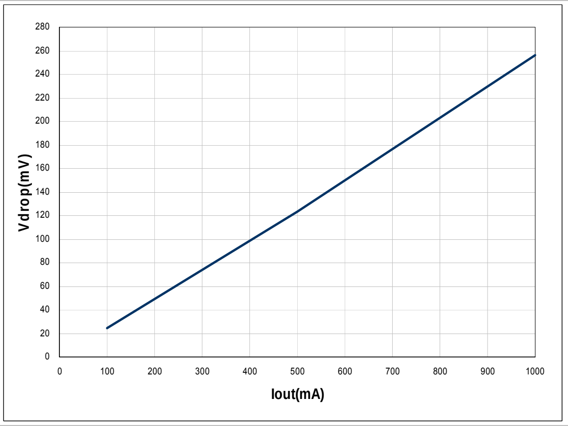
Ground Current vs. I_{OUT} (V_{OUT}=3.3V)



Output Voltage Noise (V_{OUT}=3.3V)



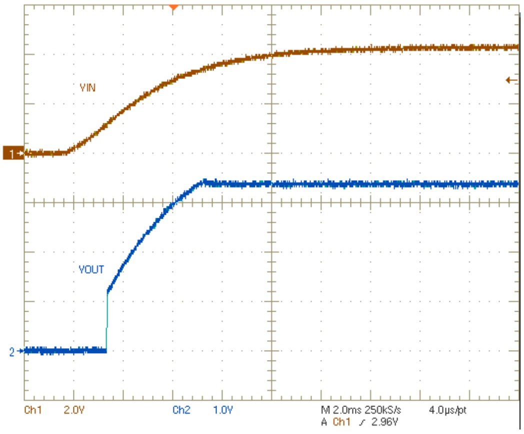
Dropout Voltage (V_{OUT}=3.3V)



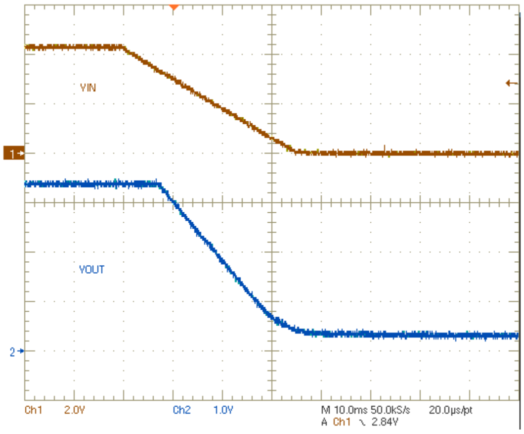
Typical Performance Characteristics (cont.)

Unless otherwise specified, $V_{IN} = V_{OUT\ (NOM)} + 1V$, $V_{EN}=V_{IN}$, $C_{IN} = C_{OUT} = 10\mu F$, $T_A = 25°C$

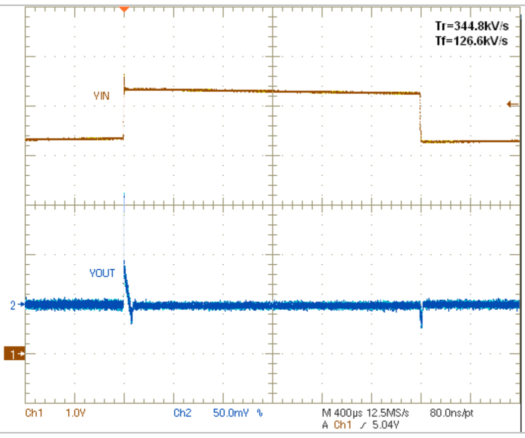
Enable Response (V_{OUT}=3.3V)



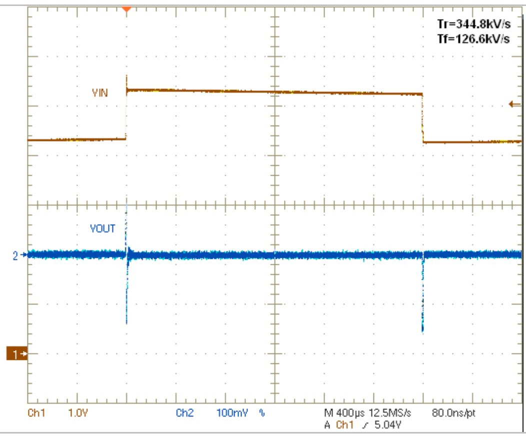
Disable Response (V_{OUT}=3.3V)



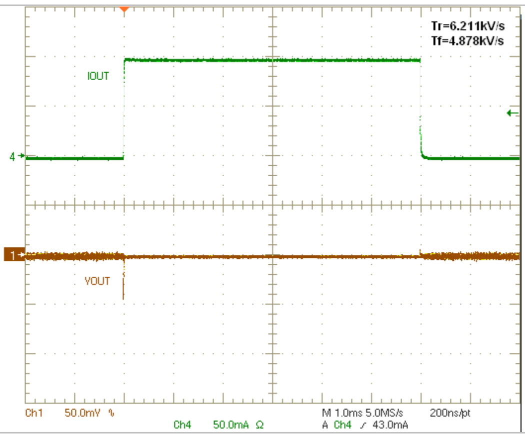
Line transient (Vin=4.3V~5.3V, Iout=1mA)



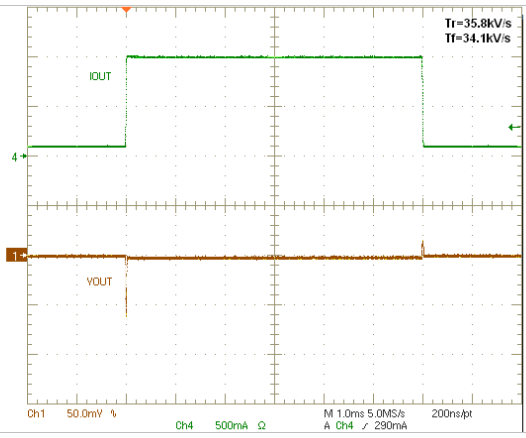
Line transient (Vin=4.3V~5.3V, Iout=100mA)



Load transient (V_{OUT}=3.3V, I_{OUT}=1mA to 100mA)



Load transient (V_{OUT}=3.3V, I_{OUT}=100mA to 1A)



Application Information

Detail Description

The EMP8110 is a CMOS low-dropout linear regulator. The device provides fixed output voltages for output current up to 1.5A.

The band-gap reference voltage 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 fed back 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 EMP8110 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 EMP8110 does not suffer from these problems and consumes only 65μA (Typ.) of current consumption under heavy loads as well as in dropout conditions.

Output Voltage Selection

For voltage type of EMP8110, 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 EMP8110-33 has a preset 3.3V output voltage.

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 EMP8110 use a P-channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on-resistance RDS(ON) multiplied by the load current.

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

Current Limit

The EMP8110 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 1.8A (Typ.).

Thermal Overload Protection

Thermal overload protection limits total power dissipation in the EMP8110. When the junction temperature exceeds T_J = +160°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 30°C, resulting in a pulsed output during continuous thermal overload conditions.

Thermal overload protection is designed to protect the EMP8110 in the event of fault conditions. For continuous operation, the absolute maximum operating junction temperature rating of T_J = +125°C should not be exceeded.

Operating Region and Power Dissipation

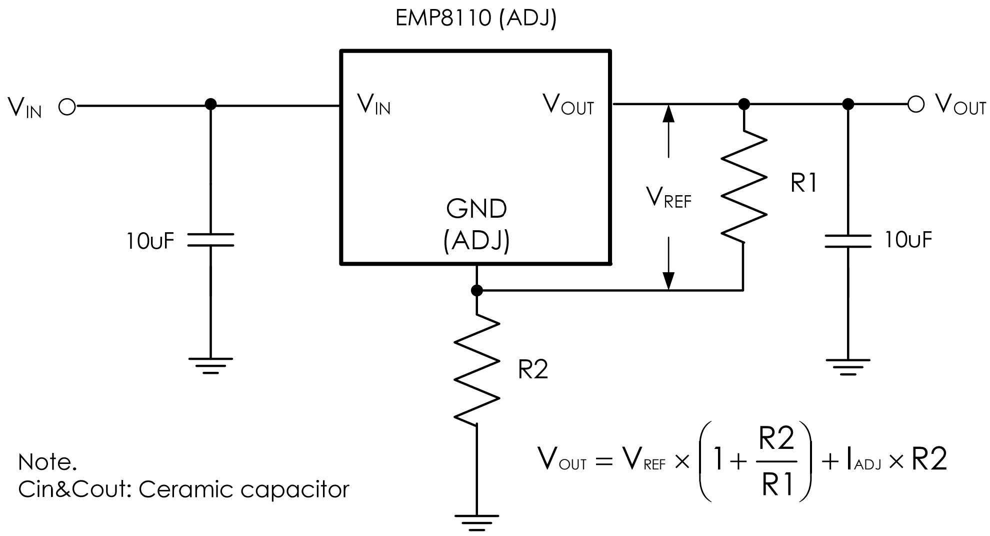
Maximum power dissipation of the EMP8110 depends on the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The power dissipation across the devices is P = I_{OUT} x (V_{IN}-V_{OUT}). The resulting maximum power 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 EMP8110 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.

Application Circuit

a) Application circuit for adjustment V_{OUT}



Output Voltage Setting

The output voltage V_{OUT} is set using a resistive divider from the output to GND (ADJ) pin. The regulated voltage is V_{REF} between V_{OUT} and GND (ADJ) pin. Thus the output voltage is:

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

R2 recommended value is 1kΩ, Table 1 lists recommended values of R1 and R2 for most used output voltage.

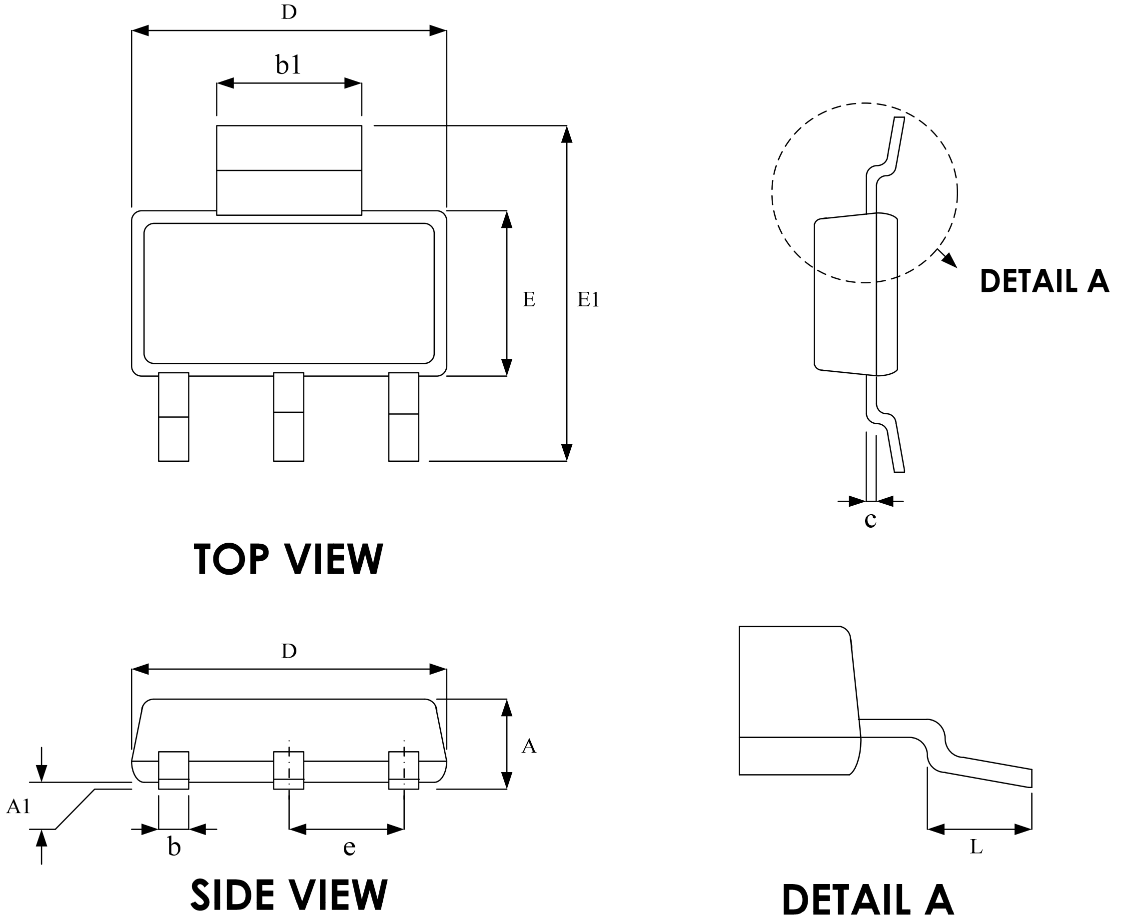
Table 1. Recommended Resistance Values

V_{OUT}	Output Version	V_{REF}	I_{ADJ}	R1	R2
3.3V	1.25V	1.25V	65uA	0.63 kΩ	1 kΩ
2.8V	1.25V	1.25V	65uA	0.84 kΩ	1 kΩ
2.5V	1.25V	1.25V	65uA	1.05 kΩ	1 kΩ
1.8V	1.25V	1.25V	65uA	2.58 kΩ	1 kΩ
1.5V	1.25V	1.25V	65uA	6.76 kΩ	1 kΩ
3.3V	1.8V	1.8V	65uA	1.25 kΩ	1 kΩ
2.5V	1.8V	1.8V	65uA	2.83 kΩ	1 kΩ

Note.

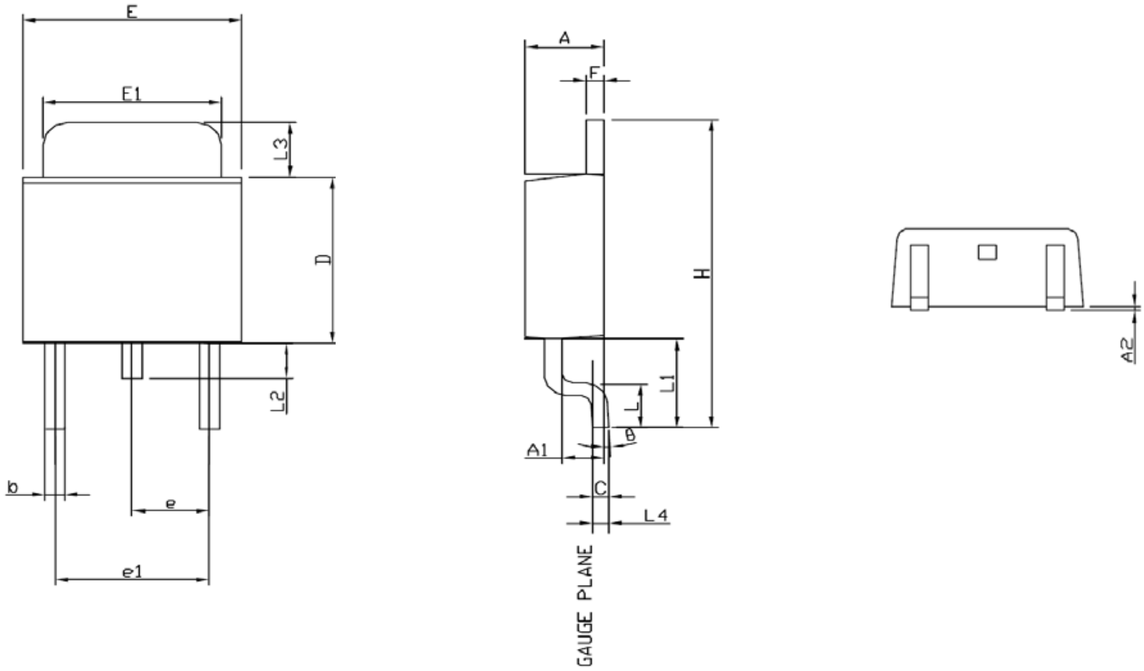
The load regulation performance degradation can be expected during ADJ application if R2 value too large adopted.

Package Outline Drawing
SOT-223



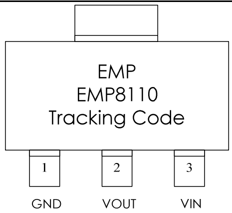
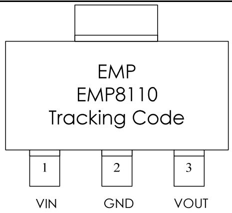
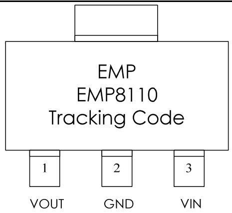
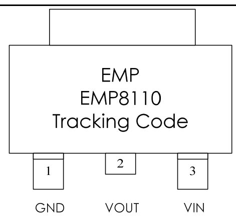
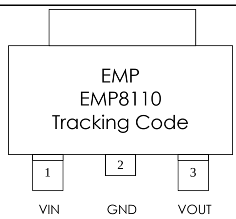
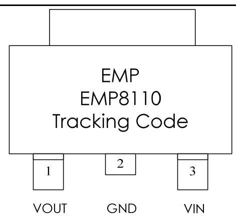
Symbol	Dimension in mm	
	Min.	Max.
A	--	1.80
A1	0.02	0.10
b	0.60	0.80
b1	2.90	3.10
c	0.23	0.35
D	6.30	6.80
E	3.30	3.70
E1	6.70	7.30
e	2.30 BSC	
L	0.90	--

Package Outline Drawing
TO-252



Symbols	Millimeters	Inches
	Min	Max
A	2.19	2.38
A1	0.89	1.27
A2	0	0.13
b	0.51	0.89
C	0.46	0.58
D	5.97	6.22
E	6.35	6.73
E1	5.21	5.46
e	2.28 BSC	0.090 BSC
e1	3.96	5.18
F	0.46	0.58
L	1.4	1.78
L1	2.67 (REF.)	0.105 (REF.)
L2	0.64	1.02
L3	1.52	2.03
L4	0.51 BSC	0.020 BSC
H	9.4	10.4
θ	0°	8°

Old order, Marking & Packing Information

Package	Vout	Product ID.	Marking	Packing
SOT-223	1.2-4.5V	EMP8110-XXVEJ3NRR		Tape & Reel 2.5kpcs
SOT-223	1.2-4.5V	EMP8110-XXVEG3NRR		Tape & Reel 2.5kpcs
SOT-223	1.2-4.5V	EMP8110-XXVEX3NRR		Tape & Reel 2.5kpcs
TO-252	1.2-4.5V	EMP8110-XXTBJ3NRR		Tape & Reel 3kpcs
TO-252	1.2-4.5V	EMP8110-XXTBG3NRR		Tape & Reel 3kpcs
TO-252	1.2-4.5V	EMP8110-XXTBX3NRR		Tape & Reel 3kpcs

Revision History

Revision	Date	Description
0.1	2013.07.01	Initial version.
0.2	2013.11.13	1) Added ADJ application circuit. 2) Removed EMP logo and update marking information.

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