High-PSRR, Low-Noise, Low-Dropout, 300mA CMOS Linear Regulator

General Description

The EMP2133 series is a family of dual-channel CMOS linear regulators featuring ultra-high power supply rejection ratio (PSRR), low output voltage noise, low dropout voltage, low quiescent current and fast transient response. It guarantees delivery of 300mA output current per regulator, and supports preset output voltages ranging from 1.2V to 3.3V with 0.1V increment (except for 1.85V and 2.85V).

The EMP2133 is well suited for portable battery-powered application which requires high efficiency, low noise and small board space. With 130mV low dropout voltage at 300mA output current, EMP2133 sustains high PSRR at very low input voltage which is common in battery-powered application. The EMP2133 also features 110μV_{RMS} low output voltage noise without the presence of a noise bypass capacitor, which fits the application where noise and board space are both concerned.

Each regulator in the EMP2133 can be turned off independently, further prolonging the battery life. Internally build-in thermal protection and over-current protection provide additional safety for the end use. The EMP2133 is available in miniature SOT-23-6 and TSOP-6 package.

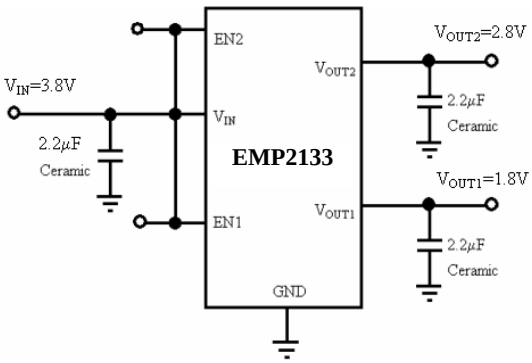
Features

- Miniature SOT-23-6 package
- 300mA guaranteed output current
- 70dB typical PSRR at 1kHz (55dB typical at 10KHz)
- 110μV_{RMS} output voltage noise (10Hz to 100kHz)
- 130mV typical dropout at 300mA
- 150µA typical quiescent current
- Less than 1µA typical shutdown mode
- Auto-discharge during chip disable
- Fast line and load transient response
- 35µs typical turn-on time
- 2.5V to 5.5V input range
- Stable with small ceramic output capacitors
- Over temperature and over current protection
- ±2% output voltage tolerance

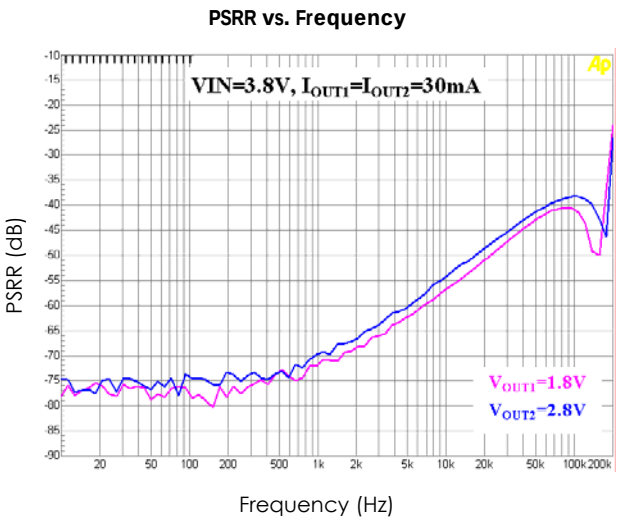
Applications

- Wireless handsets
- PCMCIA cards
- DSP core power
- Hand-held instruments
- Battery-powered systems
- Portable information appliances

Typical Application Diagram

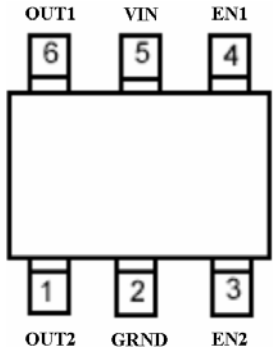


Typical Performance Characteristics



Pin Configuration

SOT-23-6



Order information

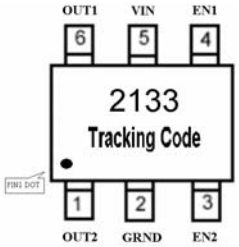
EMP2133-XXVC06GRR/NRR

XX	Voltage Code
VC06	SOT-23-6 Package
GRR	RoHS (Pb Free)
	Rating: -40 to 85°C
	Package in Tape & Reel
NRR	RoHS & Halogen free (By Request)
	Rating: -40 to 85°C
	Package in Tape & Reel

Pin Functions

Name	SOT-23-6 TSOP-6	Function
OUT2	**1**	**Output Voltage Feedback of Regulator 2**
GRND	**2**	**Ground Pin**.
EN2	**3**	**Enable Input of Regulator 2.** Set regulator 2 into the disable mode by pulling the EN2 pin low. To keep regulator 2 on during normal operation, connect the EN2 pin to VIN. The EN2 pin must not exceed VIN under all operating conditions.
EN1	**4**	**Enable Input of Regulator 1.** Set regulator 1 into the disable mode by pulling the EN1 pin low. To keep regulator 1 on during normal operation, connect the EN1 pin to VIN. The EN1 pin must not exceed VIN under all operating conditions.
VIN	**5**	**Supply Voltage Input**. Require a minimum input capacitor of close to 1μF to ensure stability and sufficient decoupling from the ground pin.
OUT1	**6**	**Output Voltage Feedback of Regulator 1**

Order, Mark & Packing Information

No. of PIN	EN1	EN2	Vout1	Vout2	Marking	Product ID	Package
6	Y	Y	3.0	3.0		EMP2133-00VC06GRR	3K units Tape & Reel
			1.8	3.0		EMP2133-01VC06GRR	3K units Tape & Reel
			1.8	2.8		EMP2133-02VC06GRR	3K units Tape & Reel
			2.5	3.3		EMP2133-03VC06GRR	3K units Tape & Reel
			2.8	3.3		EMP2133-04VC06GRR	3K units Tape & Reel
			1.8	3.3		EMP2133-05VC06GRR	3K units Tape & Reel
			2.85	2.85		EMP2133-06VC06GRR	3K units Tape & Reel
			2.8	1.8		EMP2133-07VC06GRR	3K units Tape & Reel
			3.3	2.8		EMP2133-08VC06GRR	3K units Tape & Reel
			2.5	1.8		EMP2133-10VC06GRR	3K units Tape & Reel
			1.2	2.8		EMP2133-11VC06GRR	3K units Tape & Reel

Absolute Maximum Ratings (Notes 1, 2)

VIN, V_{OUT1}, V_{OUT2}, V_{EN1}, V_{EN2}	-0.3V to 6.5V
Power Dissipation	(Note 3)
Storage Temperature Range	-65°C to160°C
Junction Temperature (TJ)	150°C
Lead Temperature (10 sec.)	260°C
ESD Rating	
HBM (Note 5)	2kV
MM	200V

Thermal Resistance (θ_{JA})	
SOT-23-6	250°C/W

Operating Ratings (Note 1, 2)

Temperature Range	-40°C to 85°C
Supply Voltage	2.5V to 5.5V

Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $V_{IN} = V_{OUT}$ +1V (Note 6), $V_{EN1} = V_{EN2} = VIN$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = 25°C$. **Boldface** limits apply for the operating temperature extremes: -40°C and 85°C.

Symbol	Parameter	Conditions	Min	Typ (Note 7)	Max	Units
V_{IN}	Input Voltage		**2.5**		**5.5**	V
ΔV_{OTL}	Output Voltage Tolerance	I_{OUT} = 30mA	-2		+2	% of
		$V_{IN} = V_{OUT\ (NOM)}$ +1V, (Note 6)	**-3**		**+3**	$V_{OUT\ (NOM)}$
I_{OUT}	Maximum Output Current	Average DC Current Rating	**300**			mA
I_{LIMIT}	Output Current Limit			600		mA
I_Q	Supply Current	$I_{OUT1} = I_{OUT2}$ = 0mA		150		µA
		$I_{OUT1} = I_{OUT2}$ = 300mA		250		
	Shutdown Supply Current	EN1 = EN2 = GND		0.001		
V_{DO}	Dropout Voltage (Note 4), (Note 6)	I_{OUT} = 30mA		13		mV
		I_{OUT} = 300mA		130		
PSRR	Power-supply rejection ratio VIN=3.8V, V_{OUT}=2.8V I_{OUT}=10mA	f = 100Hz		75		dB
		f = 1kHz		70		
		f = 10kHz		55		
	Power-supply rejection ratio VIN=3.8V, V_{OUT}=2.8V I_{OUT}=150mA	f = 100Hz		68		
		f = 1kHz		68		
		f = 10kHz		55		
ΔV_{OUT}	Line Regulation	I_{OUT} = 30mA, $(V_{OUT} + 1V) \le V_{IN} \le$ 5.5V, (Note 6)	-0.1	0.01	0.1	%/V
	Load Regulation	$1mA \le I_{OUT} \le 300mA$		0.0003		%/mA
e_n	Output Voltage Noise	V_{OUT}=2.8V, I_{OUT} = 30mA, 10Hz ≤ f ≤ 100kHz (Note 8)		110		μV_{RMS}
V_{EN}	Enable Input Threshold	V_{IH}, $(V_{OUT} + 0.5V) \le V_{IN} \le 5.5V$ (Note 6)	**1.2**			V
		V_{IL}, $(V_{OUT} + 0.5V) \le V_{IN} \le 5.5V$ (Note 6)			**0.4**	
T_{SD}	Thermal Shutdown Temperature			170		℃
	Thermal Shutdown Hysteresis			30		

T_{ON}	Turn-On Time	V_{OUT} at 95% of Final Value		35		μs
T_{OFF}	Turn-Off Time	I_{OUT}=0mA (Note 9)		2.4		ms

Note 1: Absolute Maximum ratings indicate limits beyond which damage may occur. Electrical specifications are not applicable when the device is operated outside of its rated operating conditions.
Note 2: All voltages are defined and measured with respect to the potential at the ground pin.
Note 3: Maximum Power dissipation for the device is calculated using the following equations:

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

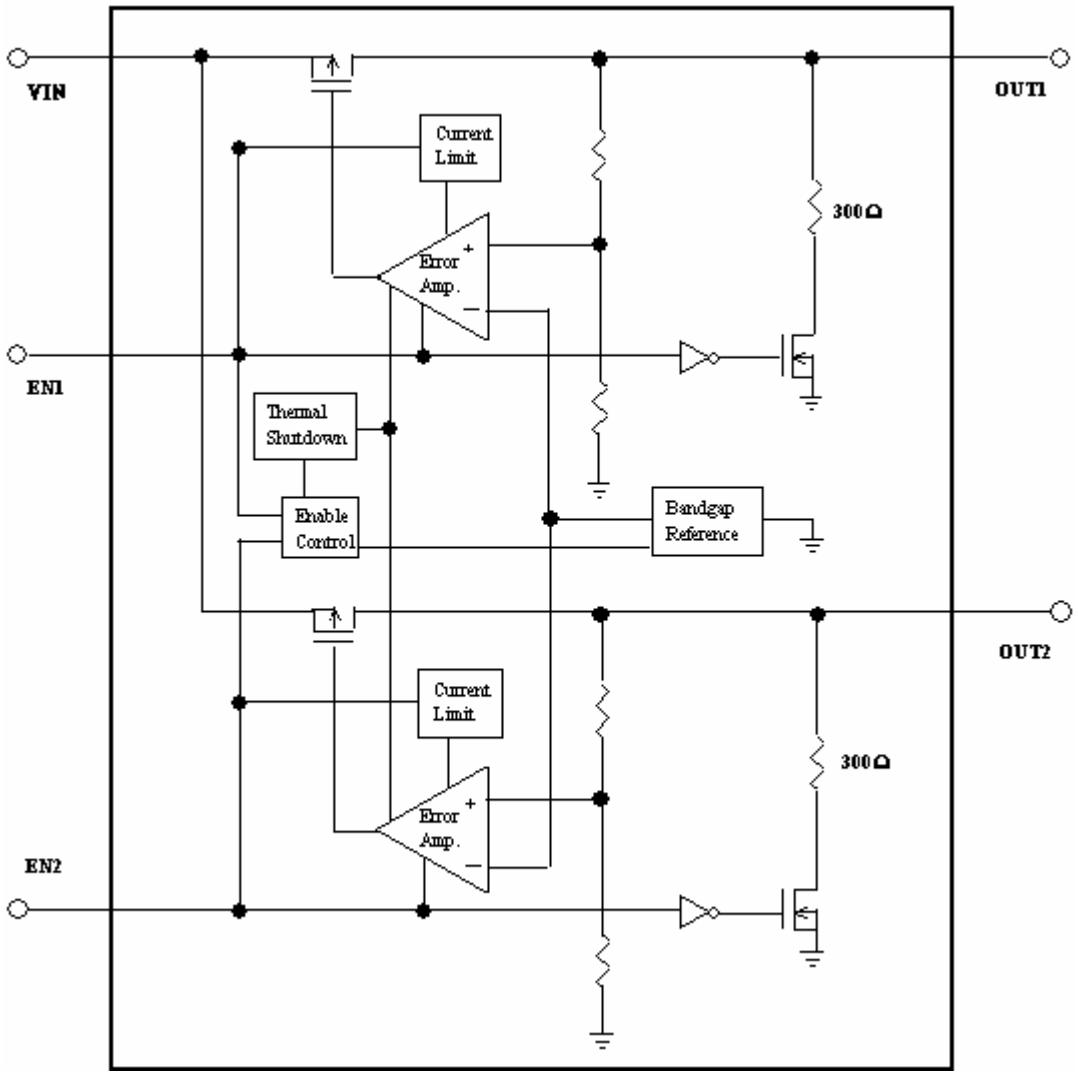
where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction-to-ambient thermal resistance. E.g. for the SOT-23-6 package θ_{JA} = 250°C/W, $T_{J(MAX)}$ = 150°C and using T_A = 25°C, the maximum power dissipation is found to be 500mW. The derating factor (-1/θ_{JA}) = -4mW/°C, thus below 25°C the power dissipation figure can be increased by 4mW per degree, and similarity decreased by this factor for temperatures above 25°C.

Note 4: 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 2.5V.
Note 5: Human body model: 1.5kΩ in series with 100pF.
Note 6: Condition does not apply to input voltages below 2.5V since this is the minimum input operating voltage.
Note 7: Typical Values represent the most likely parametric norm.
Note 8: For different output voltage, the noise can be approximately calculated using the following formula:

$$Noise = V_{OUT} \times 38\,(\mu V_{RMS})$$

Note 9: 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.

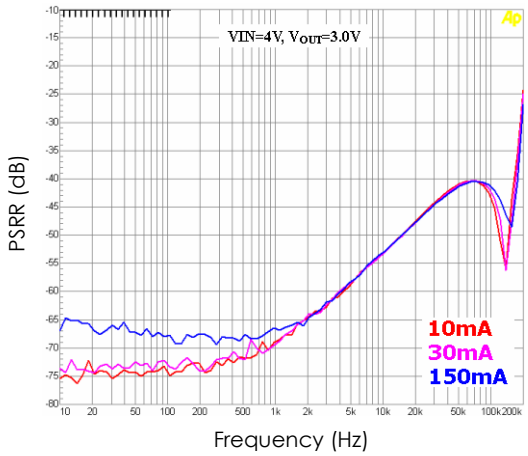
Functional Block Diagram



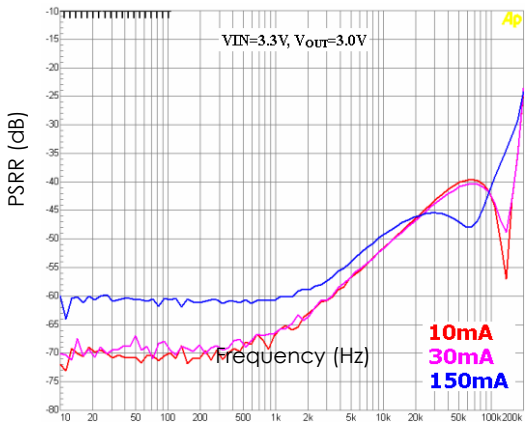
Typical Performance Characteristics

Unless otherwise specified, VIN = $V_{OUT\ (NOM)}$ + 1V, C_{IN} = C_{OUT} = 2.2µF, T_A = 25°C, V_{EN1} = V_{EN2} = VIN.

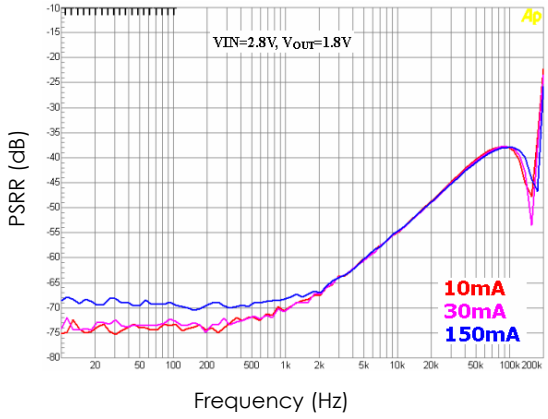
PSRR vs. Frequency



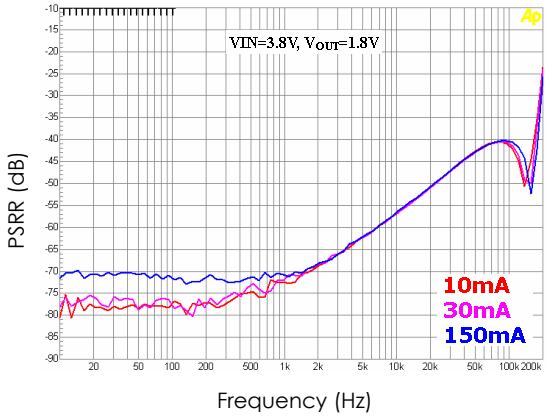
PSRR vs. Frequency



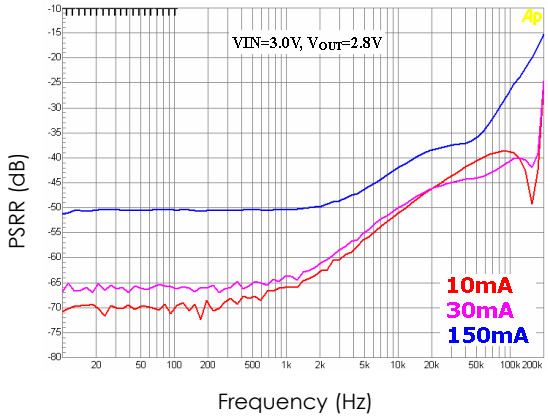
PSRR vs. Frequency



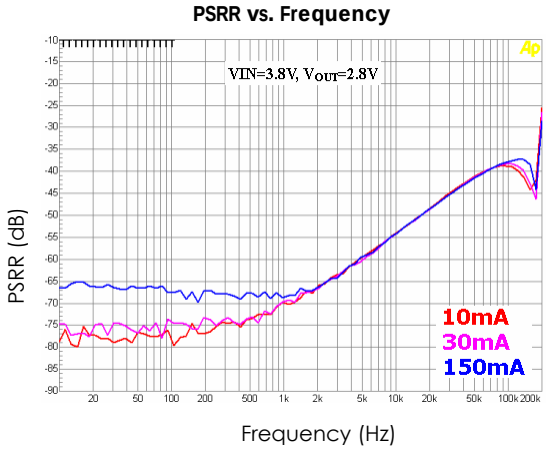
PSRR vs. Frequency



PSRR vs. Frequency



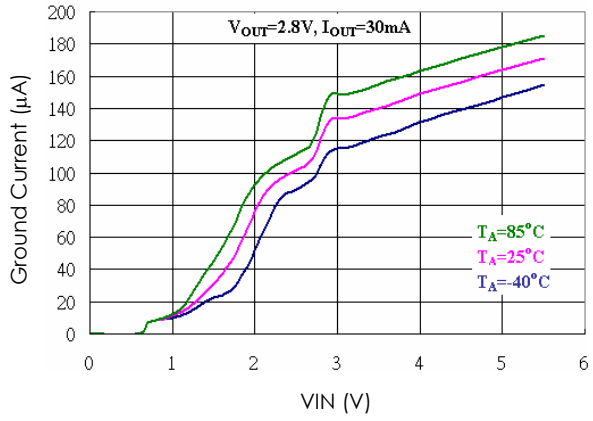
PSRR vs. Frequency



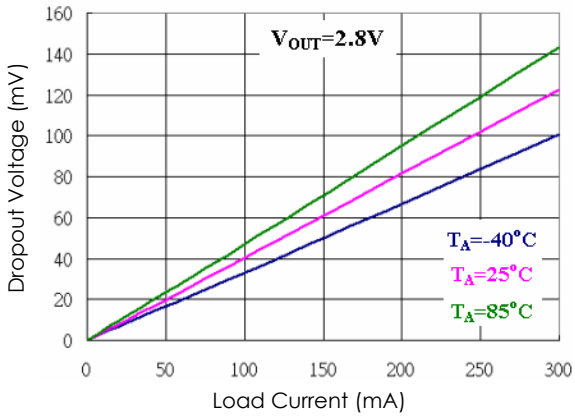
Typical Performance Characteristics

Unless otherwise specified, VIN = $V_{OUT\ (NOM)}$ + 1V, C_{IN} = C_{OUT} = 2.2µF, T_A = 25°C, V_{EN1} = V_{EN2} = VIN. (Continued)

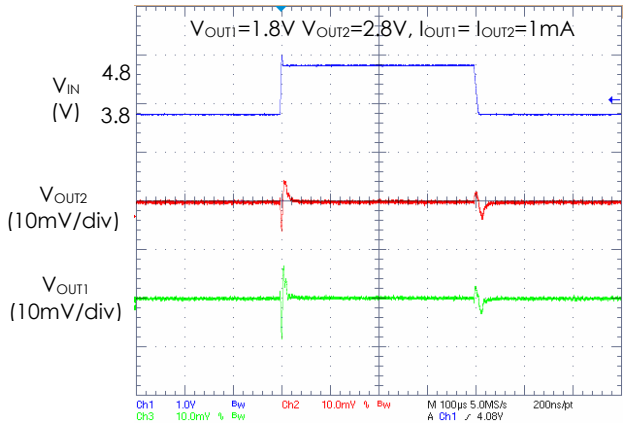
Ground Current vs. VIN



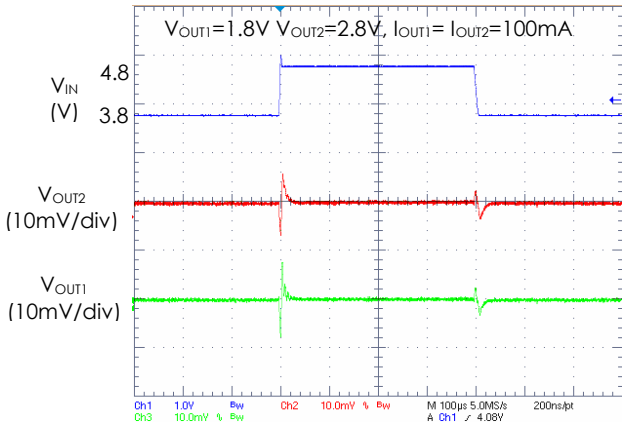
Dropout Voltage vs. Load Current (For Different Temperature)



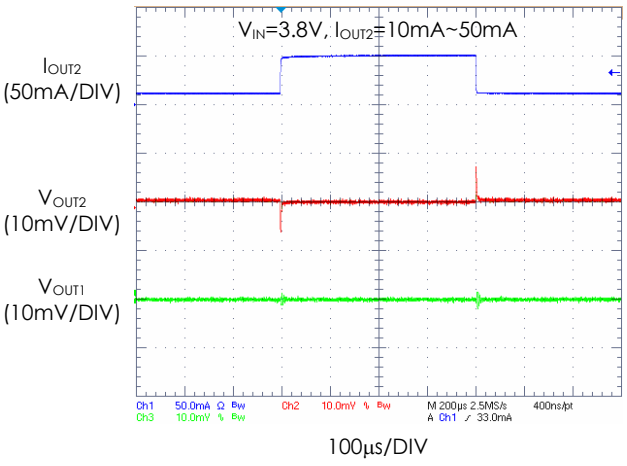
Line Transient



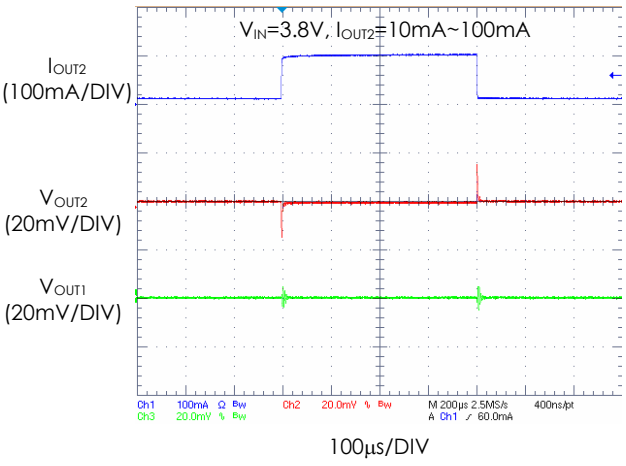
Line Transient



Load Transient



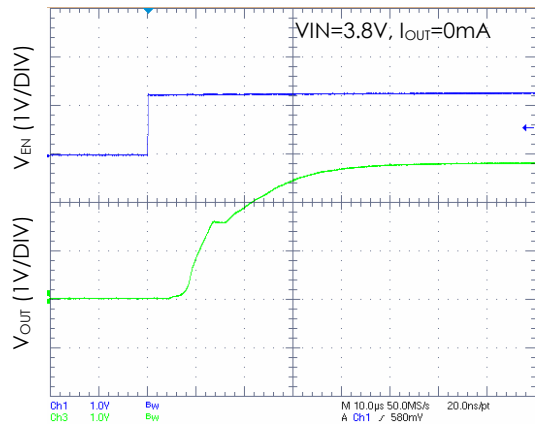
Load Transient



Typical Performance Characteristics

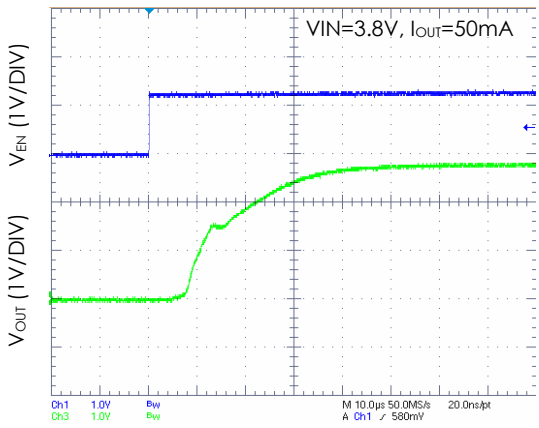
Unless otherwise specified, VIN = $V_{OUT\ (NOM)}$ + 1V, C_{IN} = C_{OUT} = 2.2µF, T_A = 25°C, V_{EN1} = V_{EN2} = VIN. (Continued)

Enable Response



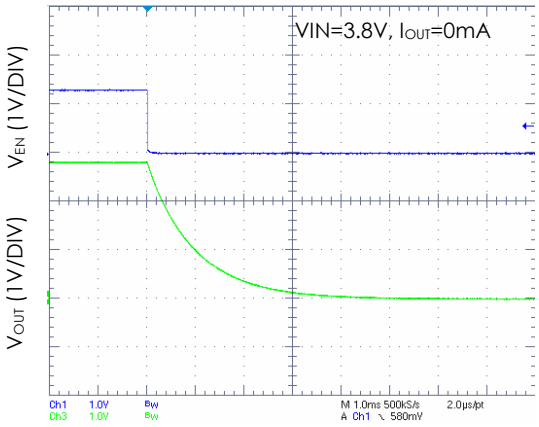
10µs/DIV

Enable Response



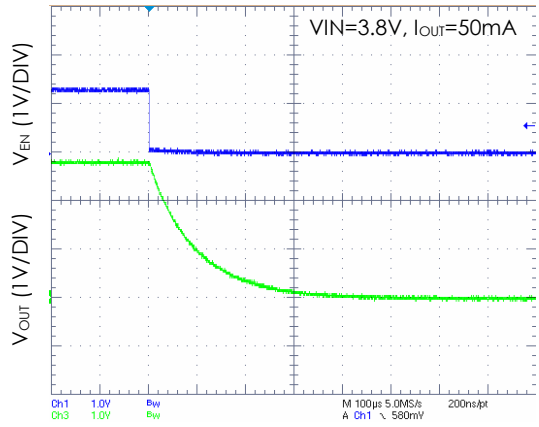
10µs/DIV

Disable Response



1ms/DIV

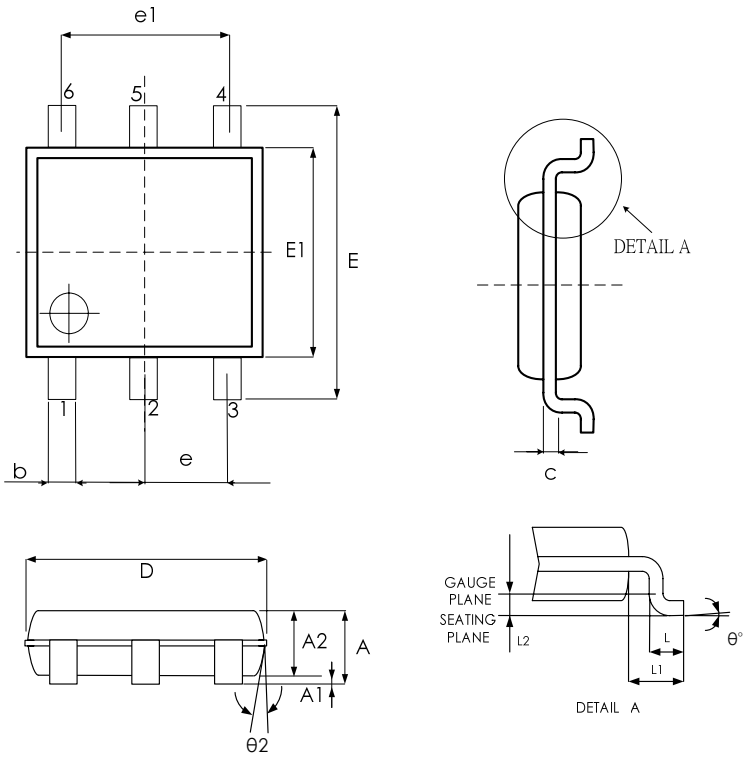
Disable Response



100µs/DIV

Physical Dimensions

SOT-23-6



SYMBPLS	MIN.	NOM.	MAX.
A	—	—	1.45
A1	—	—	0.15
A2	0.9	1.15	1.3
b	0.3	—	0.5
c	0.08	—	0.22
D	2.90 BSC.		
E	2.80 BSC.		
E1	1.60 BSC.		
e	0.95 BSC		
e1	1.90 BSC		
L	0.3	0.45	0.6
L1	0.60 REF		
L2	0.25 REF		
θ°	0	4	8
θ2°	5	10	15

UNIT: MM

Old Order, Mark & Packing Information

No. of PIN	EN1	EN2	Vout1	Vout2	Option	Old Marking	Package
6	Y	Y	3.0	3.0	00	1300 Date code	3K units Tape & Reel
			1.8	3.0	01	1301 Date code	3K units Tape & Reel
			1.8	2.8	02	1302 Date code	3K units Tape & Reel
			2.5	3.3	03	1303 Date code	3K units Tape & Reel
			2.8	3.3	04	1304 Date code	3K units Tape & Reel
			1.8	3.3	05	1305 Date code	3K units Tape & Reel
			2.85	2.85	06	1306 Date code	3K units Tape & Reel

Revision History

Revision	Date	Description
3.0	2009.06.08	EMP transferred from version 2.3

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