

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

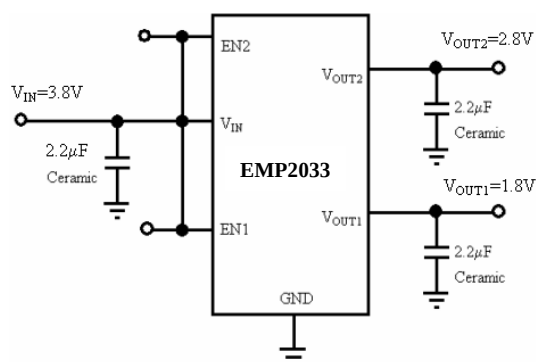
General Description

The EMP2033 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 EMP2033 is well suited for portable battery-powered application which requires high efficiency, low noise and small board space. With 150mV low dropout voltage at 300mA output current, EMP2033 sustains high PSRR at very low input voltage which is common in battery-powered application. The EMP2033 also features 120 μ V_{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 EMP2033 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 EMP2033 is available in miniature 6-pin SOT-23-6, 6-pin FBP and TDFN (2x2) packages.

■ Typical Application Diagram



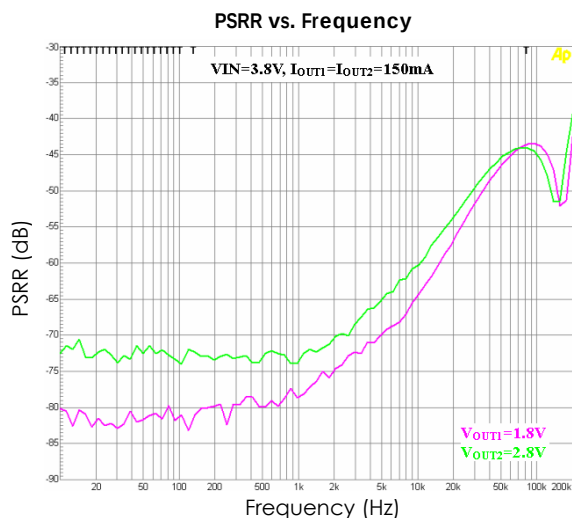
Features

- Miniature SOT-23-6 and TDFN-2x2-6 packages
- 300mA guaranteed output current
- 72dB typical PSRR at 1kHz (60dB typical at 10kHz)
- 120 μ V_{RMS} output voltage noise (10Hz to 100kHz)
- 150mV typical dropout at 300mA
- 150 μ A typical quiescent current
- Less than 1 μ A typical shutdown mode
- Auto-discharge during chip disable
- Fast line and load transient response
- 30 μ s typical turn-on time
- 2.5V to 5.5V input range
- Stable with small ceramic output capacitors
- Over temperature and over current protection
- $\pm 2\%$ output voltage tolerance

Applications

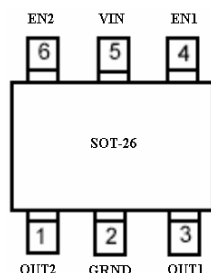
- Wireless handsets
- PCMCIA cards
- DSP core power
- Hand-held instruments
- Battery-powered systems
- Portable information appliances

■ Typical Performance Characteristics



Connection Diagrams

SOT-23-6

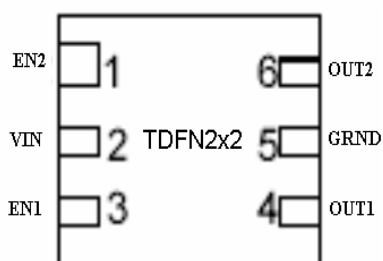


Order information

EMP2033-XXVC06GRR/NRR

XX	Output Operation
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

TDFN-6



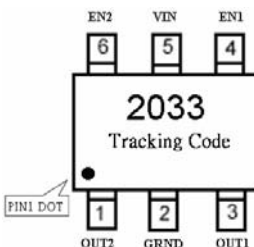
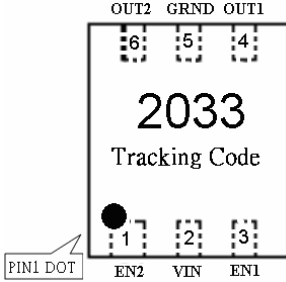
EMP2033-XXFE06NRR

XX	Output Operation
FE06	TDFN-6 Package
NRR	RoHS & Halogen free
	Rating: -40 to 85°C
	Package in Tape & Reel

Name	SOT-23-6	TDFN2x2	Function
OUT2	1	6	Output Voltage Feedback of Regulator 2
GRND	2	5	Ground Pin.
OUT1	3	4	Output Voltage Feedback of Regulator 1
EN1	4	3	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	2	Supply Voltage Input. Require a minimum input capacitor of close to 1μF to ensure stability and sufficient decoupling from the ground pin.
EN2	6	1	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.

Note: EN1 and EN2-pin can't be floating

Order, Mark & Packing Information

No. of PIN	EN1	EN2	Package	Marking	Vout1	Vout2	Product ID
6	Y	Y	SOT-23-6		3.0	3.0	EMP2033-00VC06GRR
					1.8	3.0	EMP2033-01VC06GRR
					1.8	2.8	EMP2033-02VC06GRR
					2.5	3.3	EMP2033-03VC06GRR
					2.8	3.3	EMP2033-04VC06GRR
					1.8	3.3	EMP2033-05VC06GRR
					2.85	2.85	EMP2033-06VC06GRR
					1.5	2.8	EMP2033-07VC06GRR
					1.2	2.8	EMP2033-11VC06GRR
					1.5	2.5	EMP2033-12VC06GRR
6	Y	Y	TDFN-6		3.0	3.0	By Request
					1.8	3.0	By Request
					1.8	2.8	By Request
					2.5	3.3	By Request
					2.8	3.3	By Request
					1.8	3.3	By Request
					2.85	2.85	By Request
					1.5	2.8	By Request
					1.2	2.8	EMP2033-11FE06NRR
					1.5	2.5	By Request

Packing : SOT-23-6 Tape & Reel 3Kpcs

TDFN-6 Tape & Reel 3Kpcs

Absolute Maximum Ratings (Notes 1, 2)

V_{IN} , V_{OUT1} , V_{OUT2} , V_{EN1} , V_{EN2}	-0.3V to 6.5V	Thermal Resistance (θ_{JA})	
Power Dissipation	(Note 3)	TDFN-2X2-6	(Note 3)
Storage Temperature Range	-65°C to 160°C	SOT-23-6	250°C/W
Junction Temperature (T_J)	150°C		
Lead Temperature (10 sec.)	260°C	Operating Ratings (Note 1, 2)	
ESD Rating		Temperature Range	-40°C to 85°C
HBM (Note 5)	2kV	Supply Voltage	2.5V to 5.5V
MM	200V		

Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $V_{IN} = V_{OUT} + 1V$ (Note 6), $V_{EN1} = V_{EN2} = V_{IN}$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = 25^\circ C$.

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	$I_{OUT} = 30mA$ $V_{IN} = V_{OUT(NOM)} + 1V$, (Note 6)	-2 -3		+2 +3	% of $V_{OUT(NOM)}$
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	225	μA
		$I_{OUT1} = I_{OUT2} = 300mA$		250		
	Shutdown Supply Current	$EN1 = EN2 = GND$		0.001	1	
V_{DO}	Dropout Voltage (Note 4), (Note 6)	$I_{OUT} = 30mA$		15	31	mV
		$I_{OUT} = 100mA$		50		
		$I_{OUT} = 300mA$		150	316	
PSRR	Power-supply rejection ratio $V_{IN}=4.0V$, $V_{OUT}=3.0V$ $I_{OUT}=150mA$	$f = 1kHz$		72		dB
		$f = 10kHz$		60		
		$f = 100kHz$		43		
	Power-supply rejection ratio $V_{IN}=3.3V$, $V_{OUT}=3.0V$ $I_{OUT}=30mA$	$f = 1kHz$		70		
		$f = 10kHz$		57		
		$f = 100kHz$		42		
ΔV_{OUT}	Line Regulation	$I_{OUT} = 30mA$, $(V_{OUT} + 1V) \leq V_{IN} \leq 5.5V$, (Note 6)	-0.1	0.01	0.1	%/V
	Load Regulation	$1mA \leq I_{OUT} \leq 100mA$		6		mV
		$1mA \leq I_{OUT} \leq 300mA$		20		
e_n	Output Voltage Noise	$V_{OUT}=2.8V$, $I_{OUT} = 30mA$, $10Hz \leq f \leq 100kHz$ (Note 8)		120		μV_{RMS}
V_{EN}	Enable Input Threshold	V_{IH} , $(V_{OUT} + 0.5V) \leq V_{IN} \leq 5.5V$ (Note 6)	1.2			V
		V_{IL} , $(V_{OUT} + 0.5V) \leq V_{IN} \leq 5.5V$ (Note 6)			0.4	

T _{SD}	Thermal Shutdown Temperature			170		°C
	Thermal Shutdown Hysteresis			30		
T _{ON}	Turn-On Time	V _{OUT} at 95% of Final Value		30		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 similarly decreased by this factor for temperatures above 25°C. The value of the θ_{JA} for the DFN package is specifically dependent on the PCB trace area, trace material, and the number of layers and thermal vias.

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.

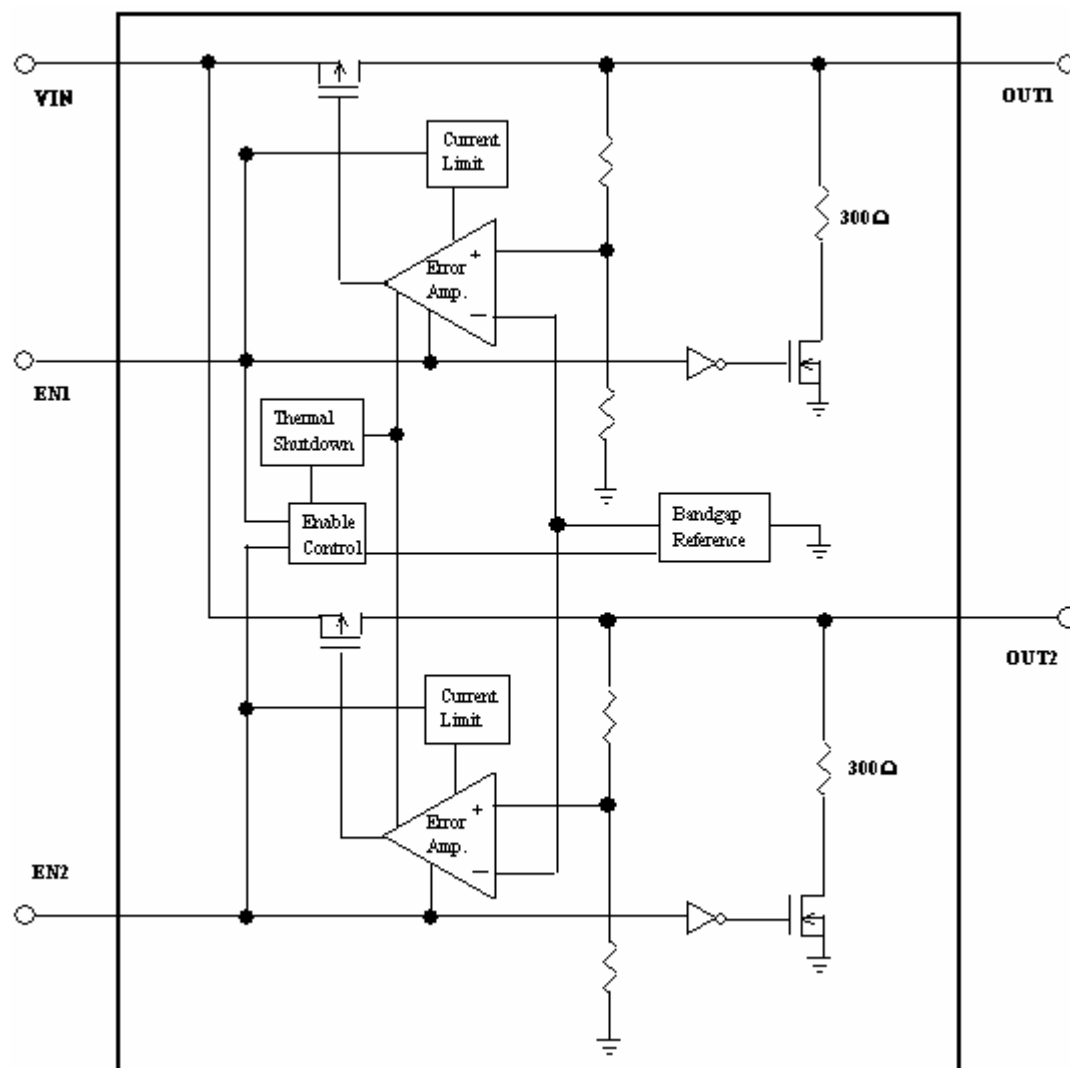
Note 7: Typical Values represent the most likely parametric norm.

Note 8: For different output voltage, the noise can be approximately calculated using the following formula:

$$Noise = V_{OUT} \times 42 (\mu V_{RMS})$$

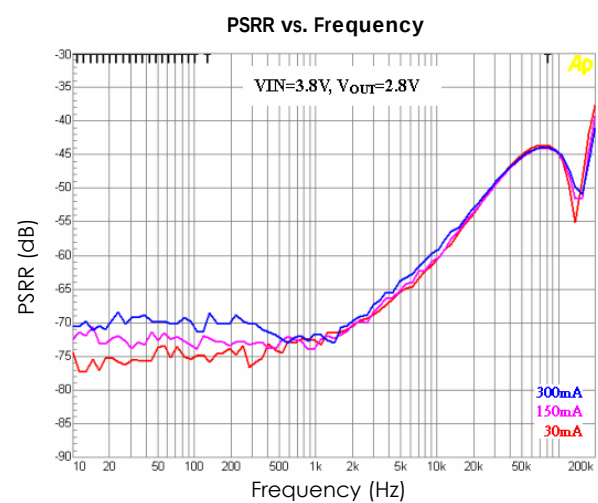
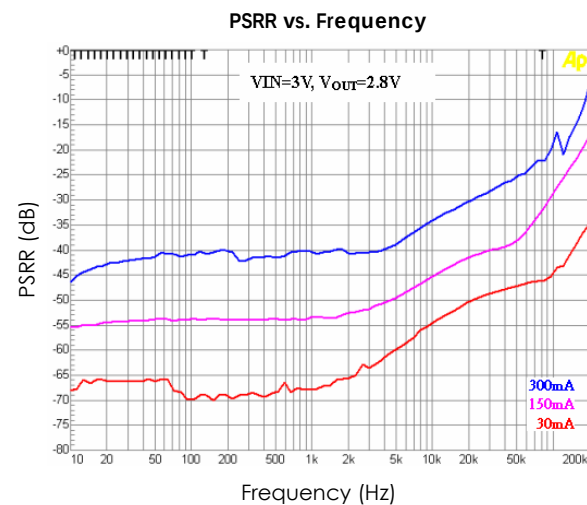
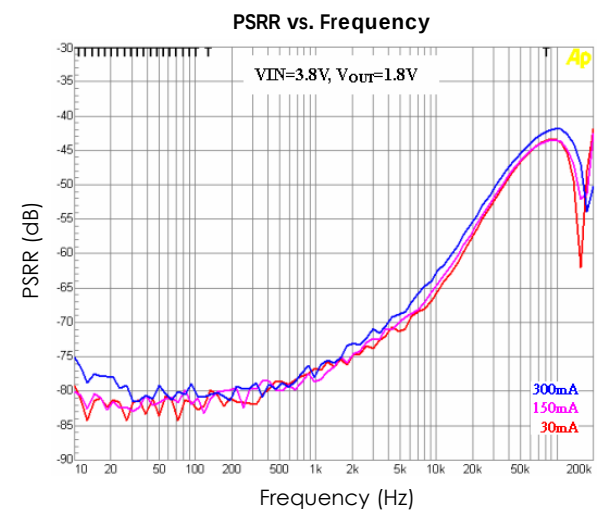
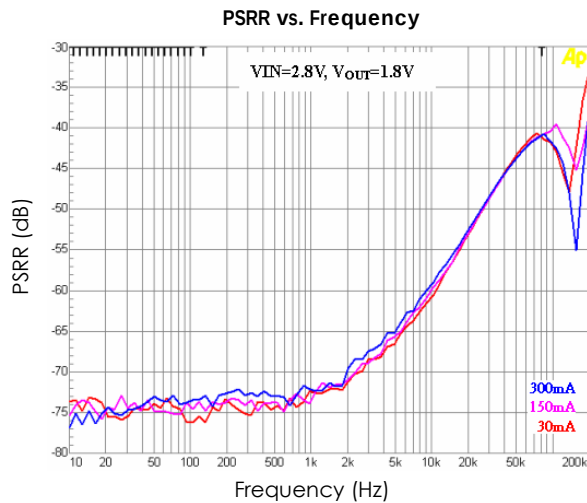
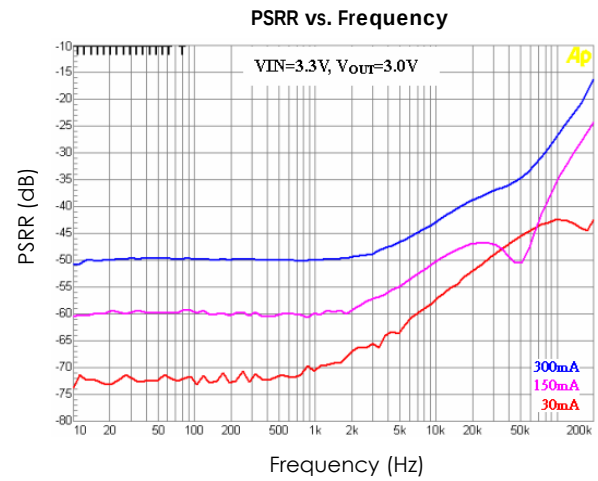
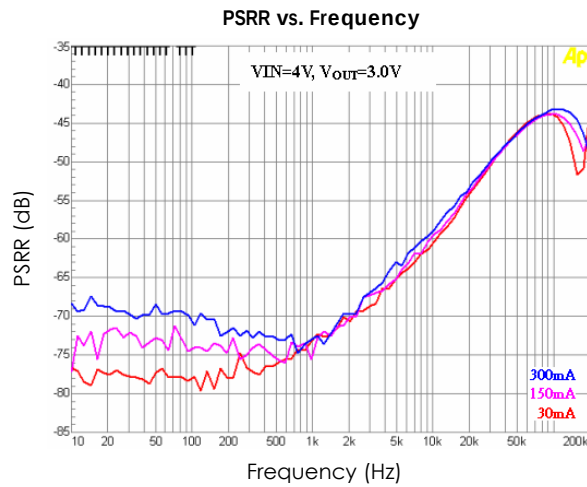
Note 9: Turn-off time is time measured between the enable input just decreasing below V_{IL} and the output voltage just decreasing to 10% of its nominal value.

Functional Block Diagram



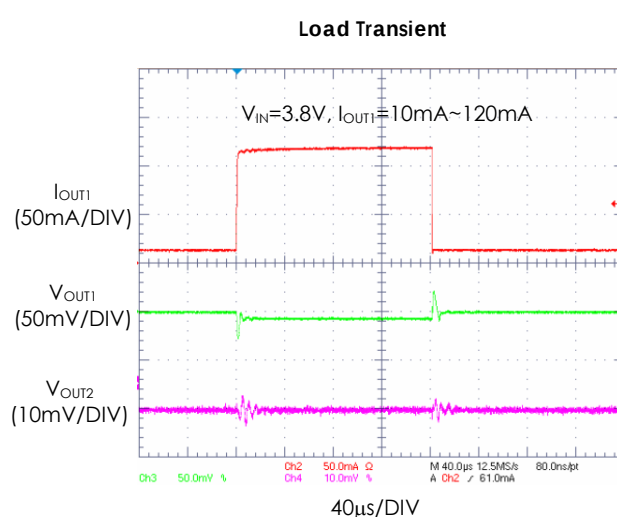
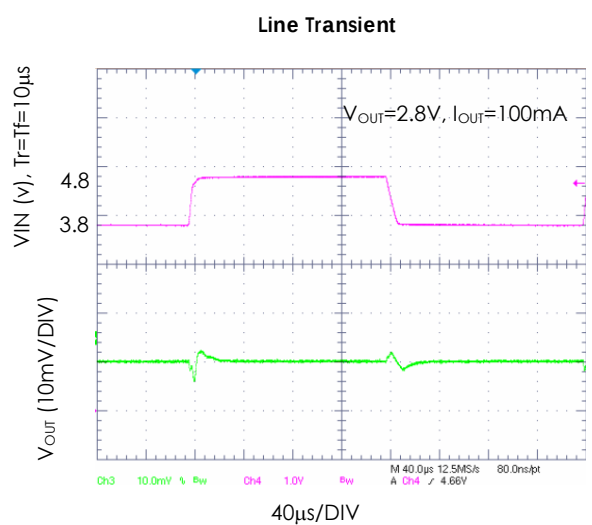
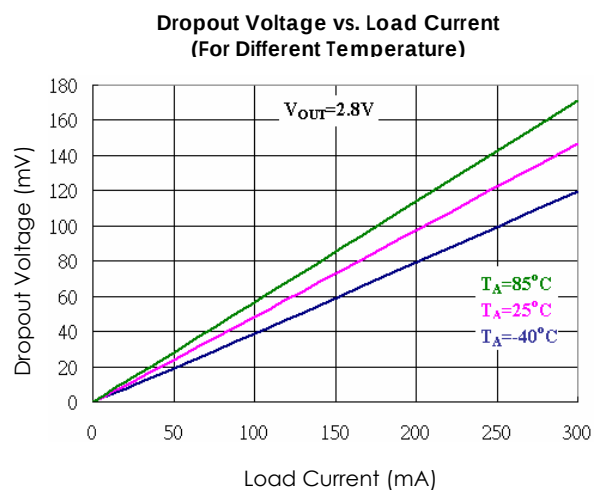
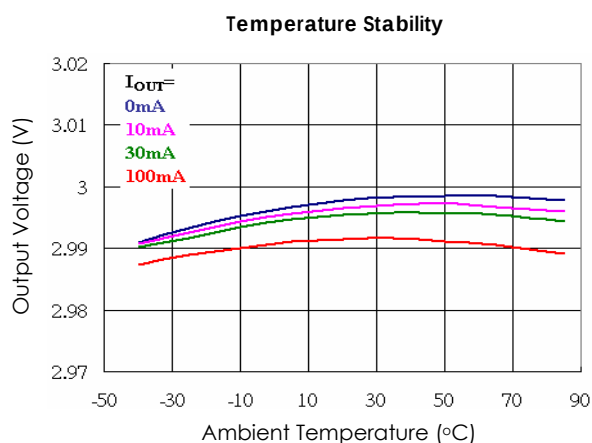
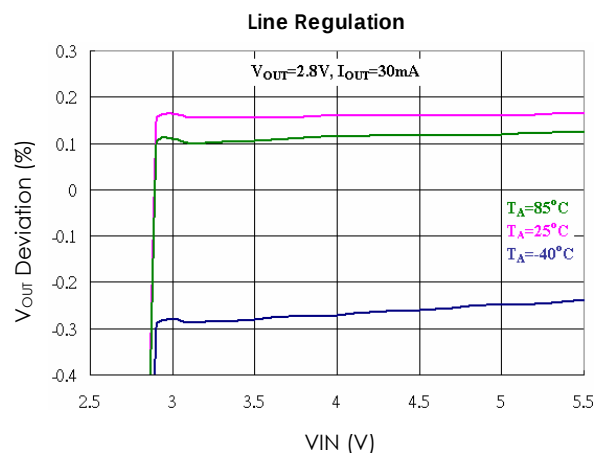
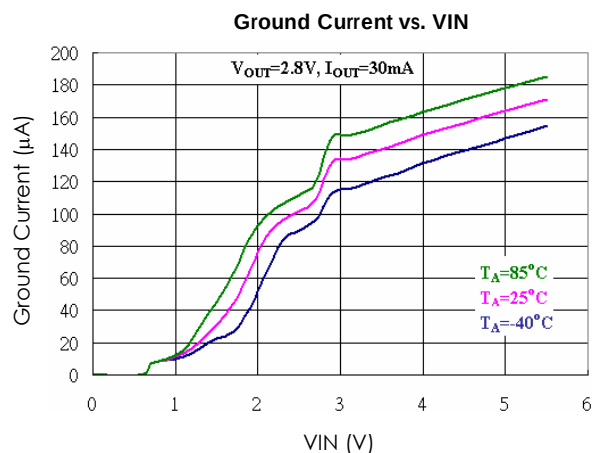
Typical Performance Characteristics

Unless otherwise specified, $V_{IN} = V_{OUT(NOM)} + 1V$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_A = 25^\circ C$, $V_{EN1} = V_{EN2} = V_{IN}$.



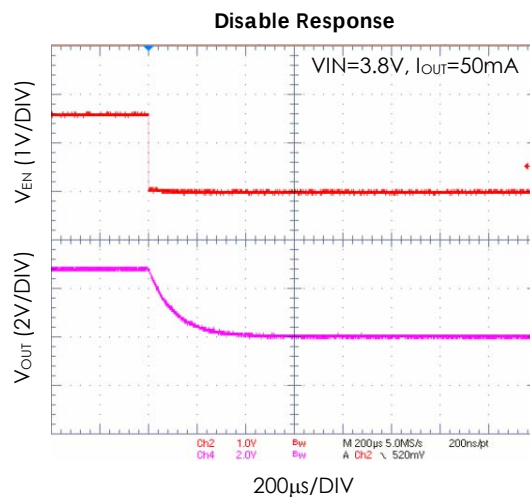
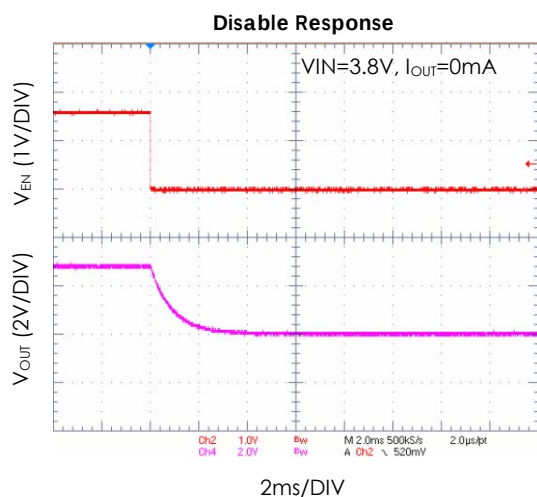
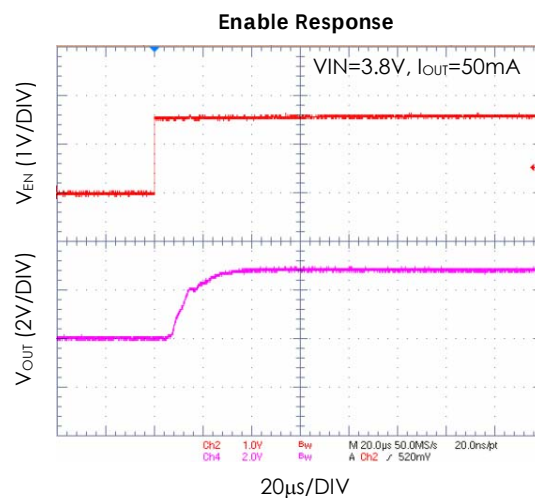
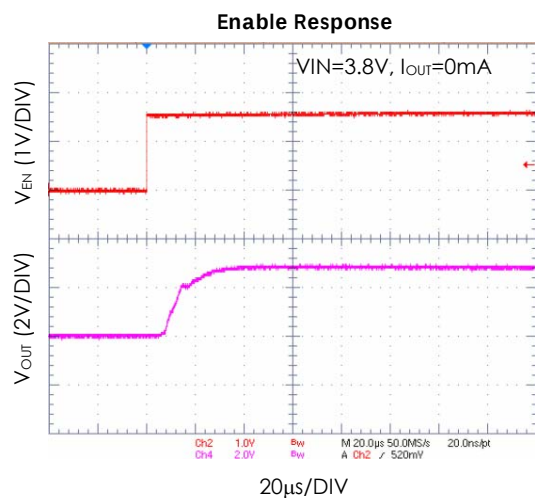
Typical Performance Characteristics

Unless otherwise specified, $V_{IN} = V_{OUT(NOM)} + 1V$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_A = 25^\circ C$, $V_{EN1} = V_{EN2} = V_{IN}$. (Continued)

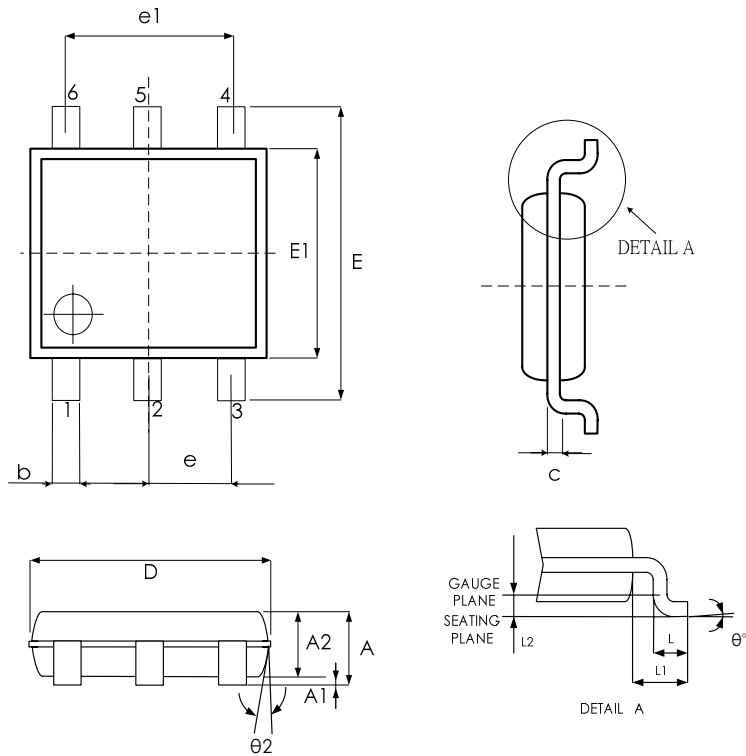


Typical Performance Characteristics

Unless otherwise specified, $V_{IN} = V_{OUT(NOM)} + 1V$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_A = 25^\circ C$, $V_{EN1} = V_{EN2} = V_{IN}$. (Continued)



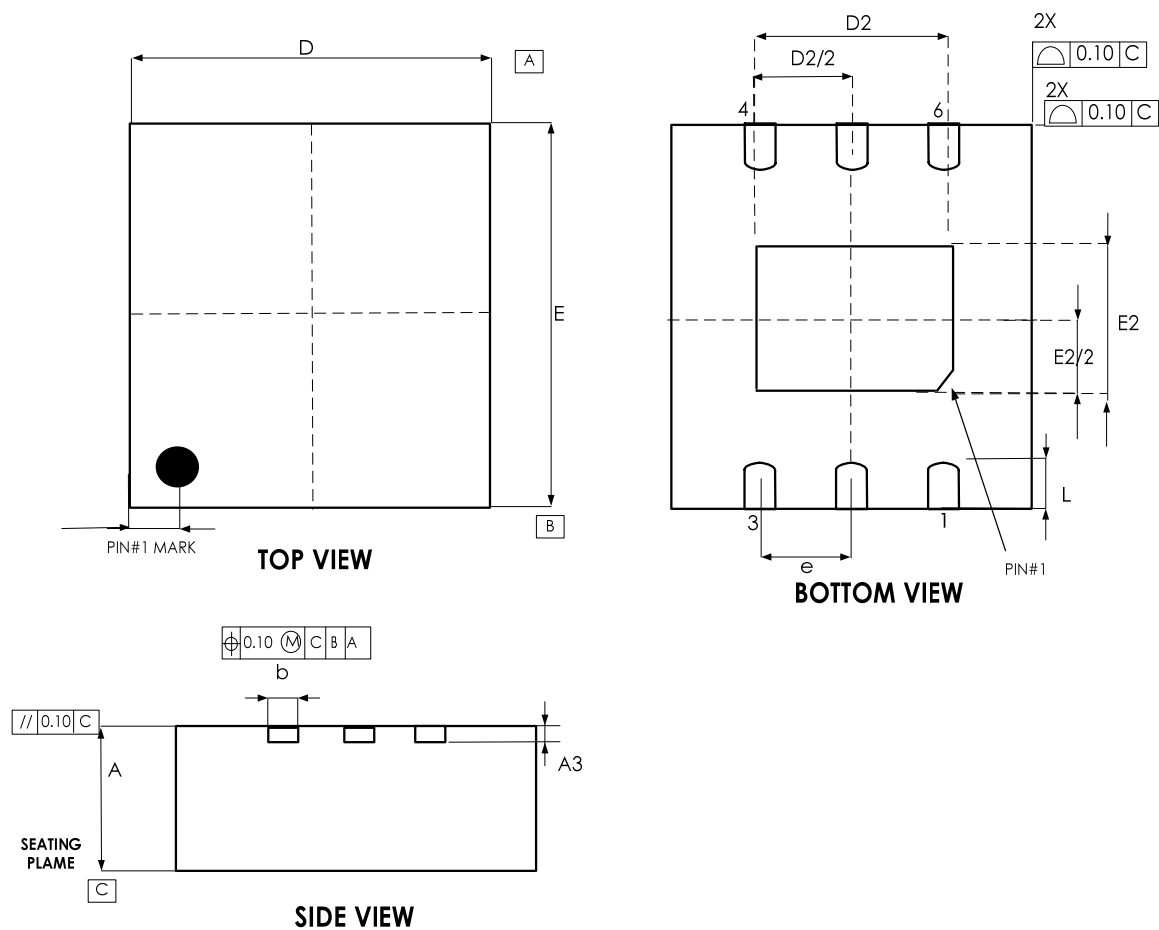
Physical Dimensions SOT-23-6



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
$\theta2^\circ$	5	10	15

UNIT: MM

TDFN-6



SYMBOL	COMMON					
	DIMENSIONS MILLIMETER			DIMENSIONS INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.027	0.029	0.031
A3	0.200 REF			0.008 REF		
b	0.25	0.30	0.35	0.010	0.012	0.014
D	2.00 BSC			0.079 BSC		
D2	1.20	1.30	1.40	0.046	0.050	0.054
E	2.00 BSC			0.079 BSC		
E2	0.50	0.60	0.70	0.022	0.024	0.026
e	0.650 BSC			0.026 BSC		
L	0.25	0.30	0.35	0.009	0.011	0.013

Old Order, Mark & Packing Information

No. of PIN	EN1	EN2	Package	Marking	Vout1	Vout2	Product ID
6	Y	Y	SOT-23-6	3300 Date Code	3.0	3.0	EMP2033-00VC06GRR
				3301 Date Code	1.8	3.0	EMP2033-01VC06GRR
				3302 Date Code	1.8	2.8	EMP2033-02VC06GRR
				3303 Date Code	2.5	3.3	EMP2033-03VC06GRR
				3304 Date Code	2.8	3.3	EMP2033-04VC06GRR
				3305 Date Code	1.8	3.3	EMP2033-05VC06GRR
				3306 Date Code	2.85	2.85	EMP2033-06VC06GRR

Revision History

Revision	Date	Description
7.0	2009.04.03	1.Title 2.Ending 3.Order information 4.Add Revision History Form 5. Important Notice.
7.1	2009.10.30	1. Update mark & packing information 2. Add NRR 3. Modify TDFN from 3x3 to 2x2
7.2	2010.03.18	Update P11 Bottom View Drawing

Important Notice

All rights reserved.

No part of this document may be reproduced or duplicated in any form or by any means without the prior permission of ESMT.

The contents contained in this document are believed to be accurate at the time of publication. ESMT assumes no responsibility for any error in this document, and reserves the right to change the products or specification in this document without notice.

The information contained herein is presented only as a guide or examples for the application of our products. No responsibility is assumed by ESMT for any infringement of patents, copyrights, or other intellectual property rights of third parties which may result from its use. No license, either express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of ESMT or others.

Any semiconductor devices may have inherently a certain rate of failure. To minimize risks associated with customer's application, adequate design and operating safeguards against injury, damage, or loss from such failure, should be provided by the customer when making application designs.

ESMT's products are not authorized for use in critical applications such as, but not limited to, life support devices or system, where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. If products described here are to be used for such kinds of application, purchaser must do its own quality assurance testing appropriate to such applications.