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 120μV_{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.

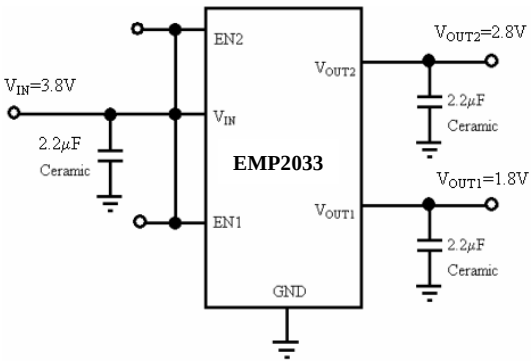
Features

- Miniature SOT-23-6 and TDFN-2x2-6 packages
- 300mA guaranteed output current
- 72dB typical PSRR at 1kHz (60dB typical at 10KHz)
- 120μV_{RMS} output voltage noise (10Hz to 100kHz)
- 150mV 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
- 30μs 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

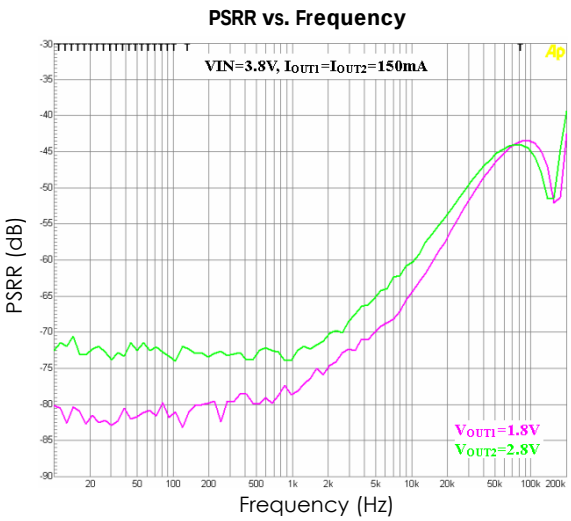
Applications

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

Typical Application Diagram

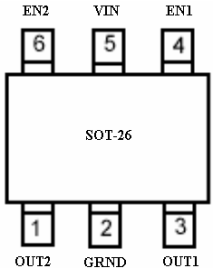


Typical Performance Characteristics



Connection Diagrams

SOT-23-6

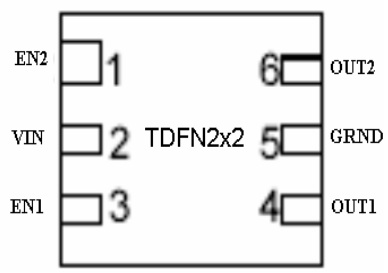


Order information

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



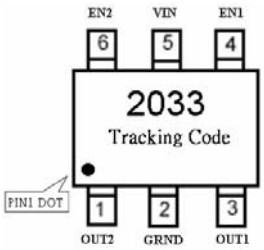
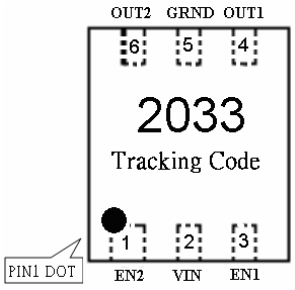
EMP2033-XXFE06NRR

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)

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})	
TDFN-2X2-6	(Note 3)
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	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 VIN=4.0V, V_{OUT}=3.0V I_{OUT}=150mA	f = 1kHz		72		dB
		f = 10kHz		60		
		f = 100kHz		43		
	Power-supply rejection ratio VIN=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) ≤ V_{IN} ≤ 5.5V, (Note 6)	-0.1	0.01	0.1	%/V
	Load Regulation	1mA ≤ I_{OUT} ≤ 100mA		6		mV
		1mA ≤ I_{OUT} ≤ 300mA		20		
e_n	Output Voltage Noise	V_{OUT}=2.8V, I_{OUT} = 30mA, 10Hz ≤ f ≤ 100kHz (Note 8)		120		μV_{RMS}
V_{EN}	Enable Input Threshold	V_{IH}, (V_{OUT} + 0.5V) ≤ V_{IN} ≤ 5.5V (Note 6)	**1.2**			V
		V_{IL}, (V_{OUT} + 0.5V) ≤ V_{IN} ≤ 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		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 similarity 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.

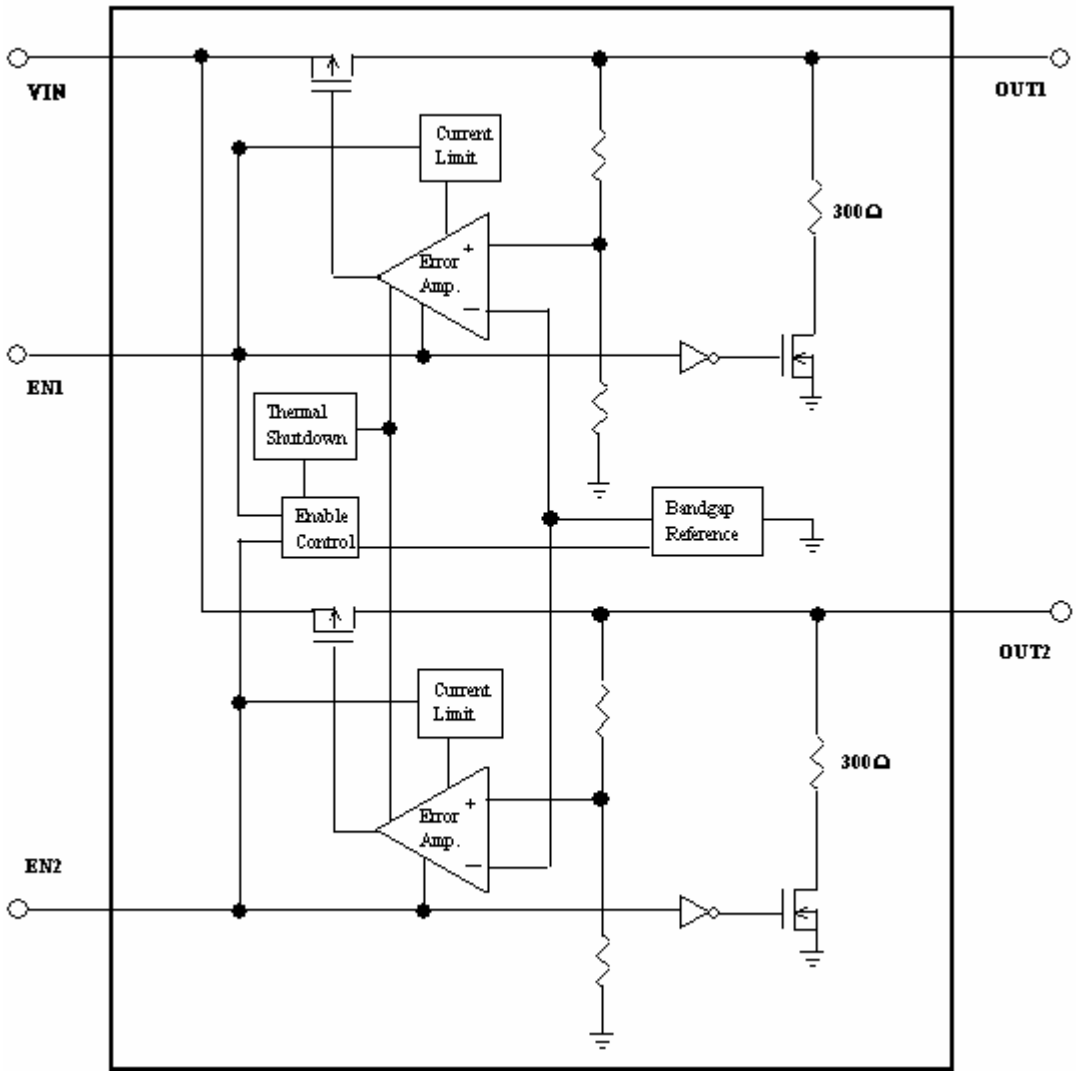
Note 7: Typical Values represent the most likely parametric norm.

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.

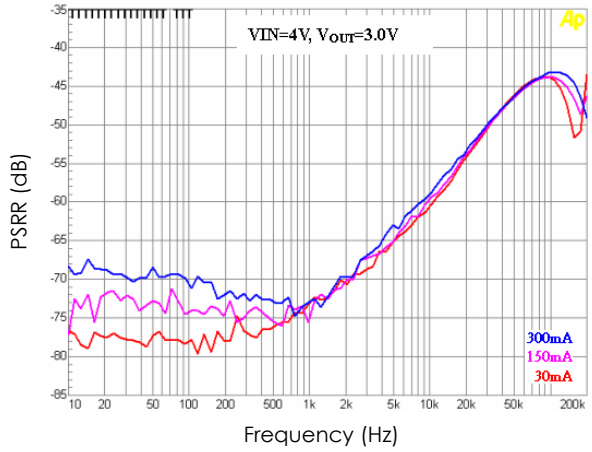
Functional Block Diagram



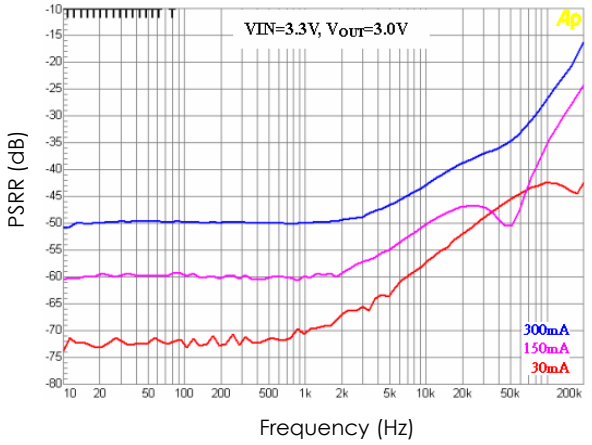
Typical Performance Characteristics

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

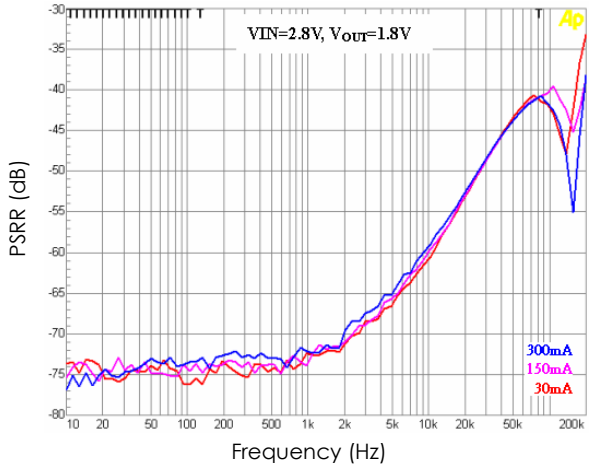
PSRR vs. Frequency



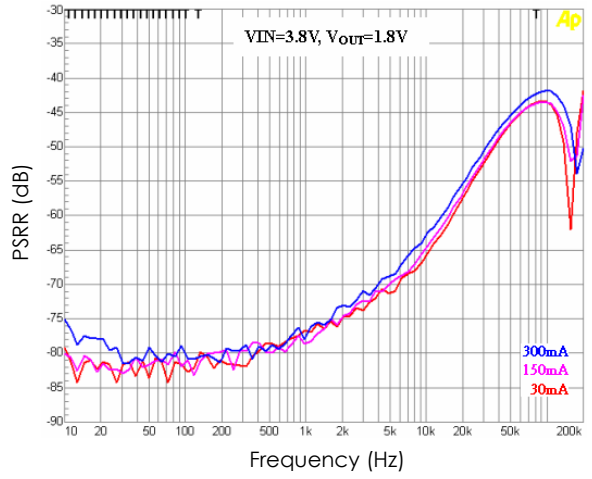
PSRR vs. Frequency



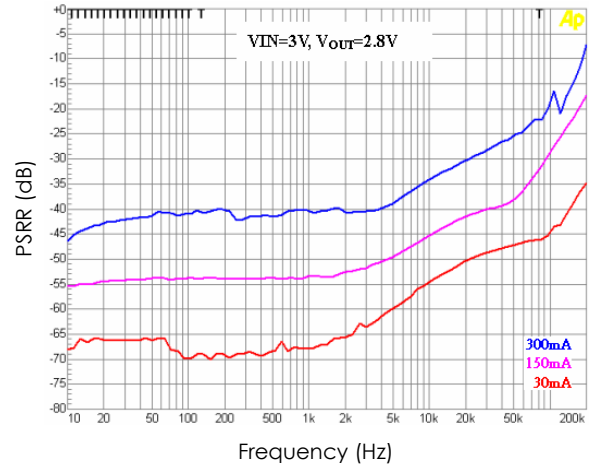
PSRR vs. Frequency



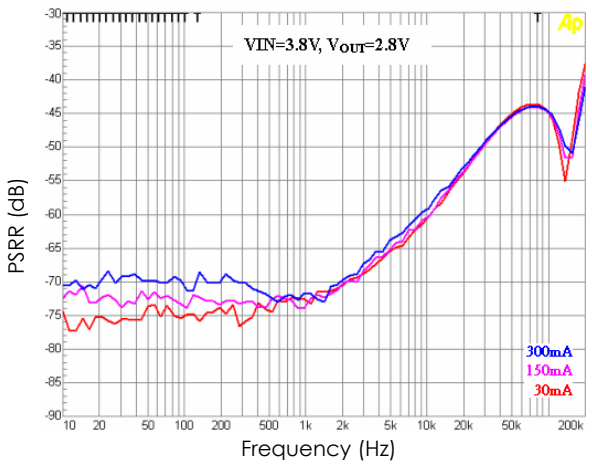
PSRR vs. Frequency



PSRR vs. Frequency



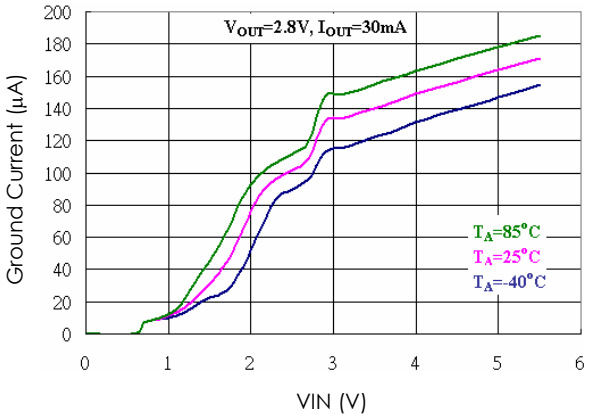
PSRR vs. Frequency



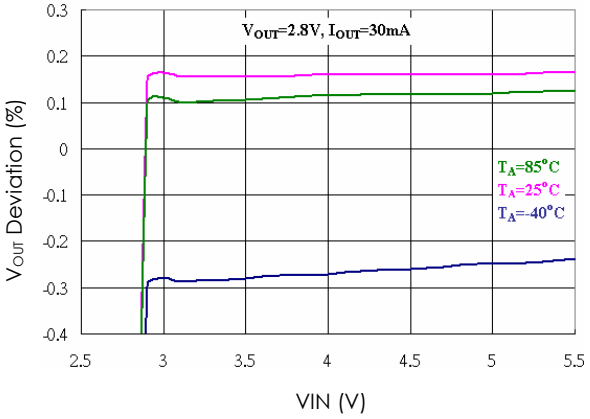
Typical Performance Characteristics

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

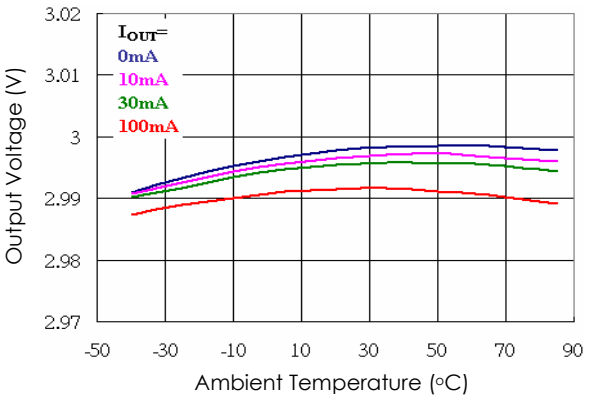
Ground Current vs. VIN



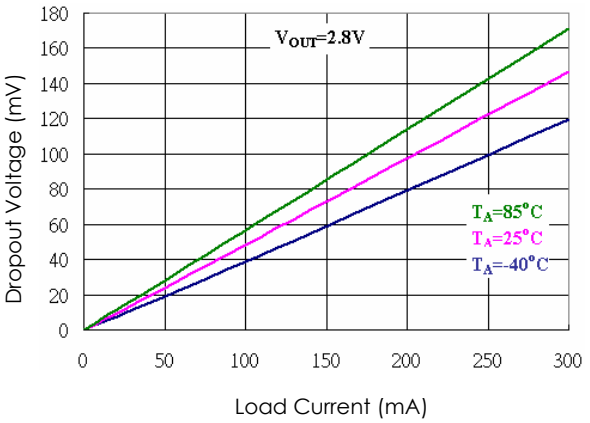
Line Regulation



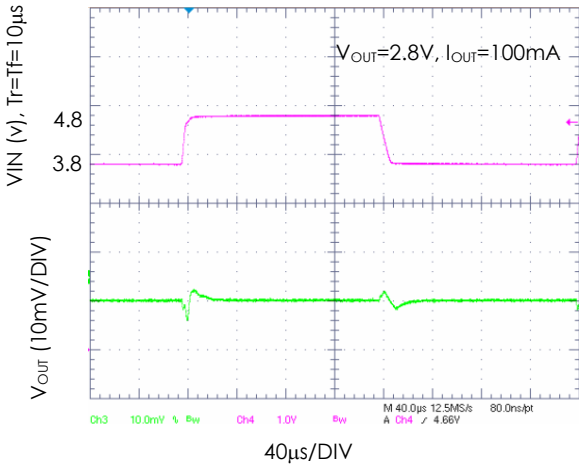
Temperature Stability



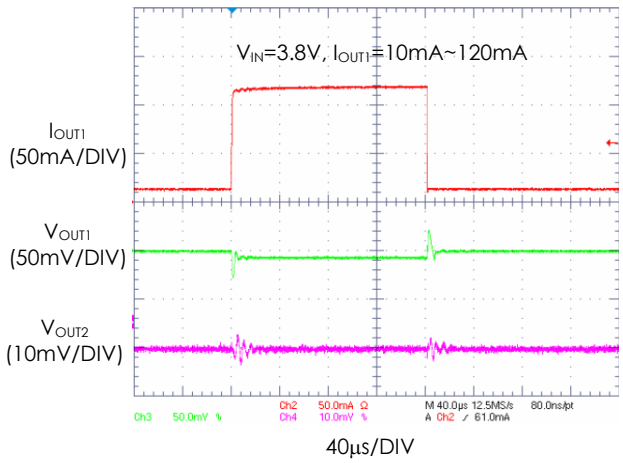
Dropout Voltage vs. Load Current (For Different Temperature)



Line Transient



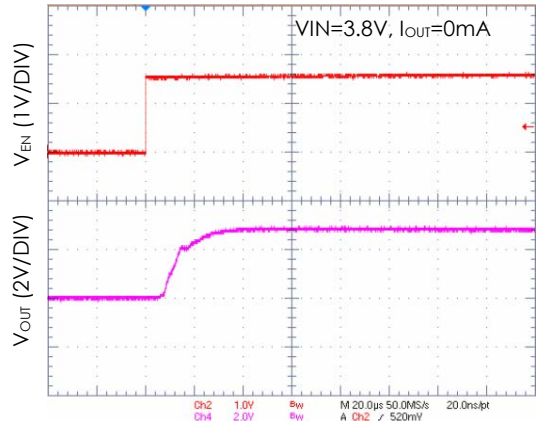
Load Transient



Typical Performance Characteristics

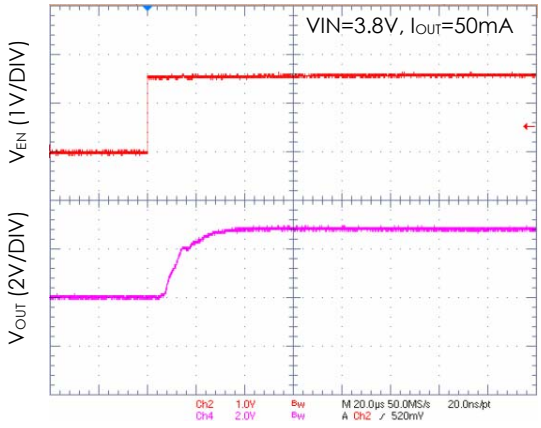
Unless otherwise specified, VIN = $V_{OUT\ (NOM)}$ + 1V, C_{IN} = C_{OUT} = 2.2µF, T_A = 25°C, V_{EN1} = V_{EN2} = VIN. (Continued)

Enable Response



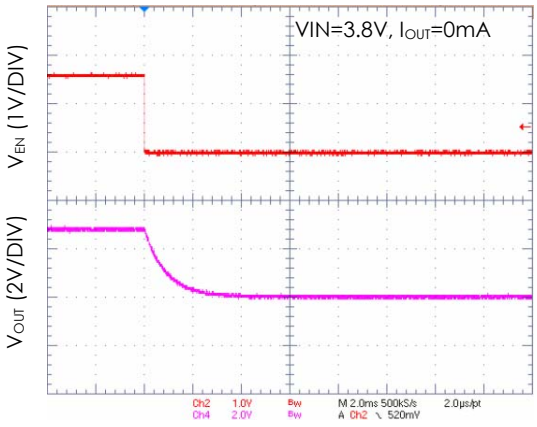
20µs/DIV

Enable Response



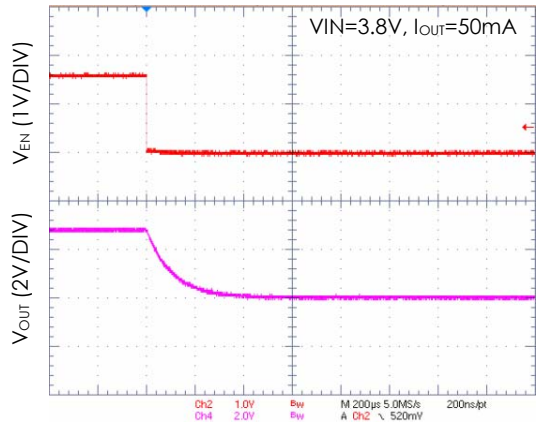
20µs/DIV

Disable Response



2ms/DIV

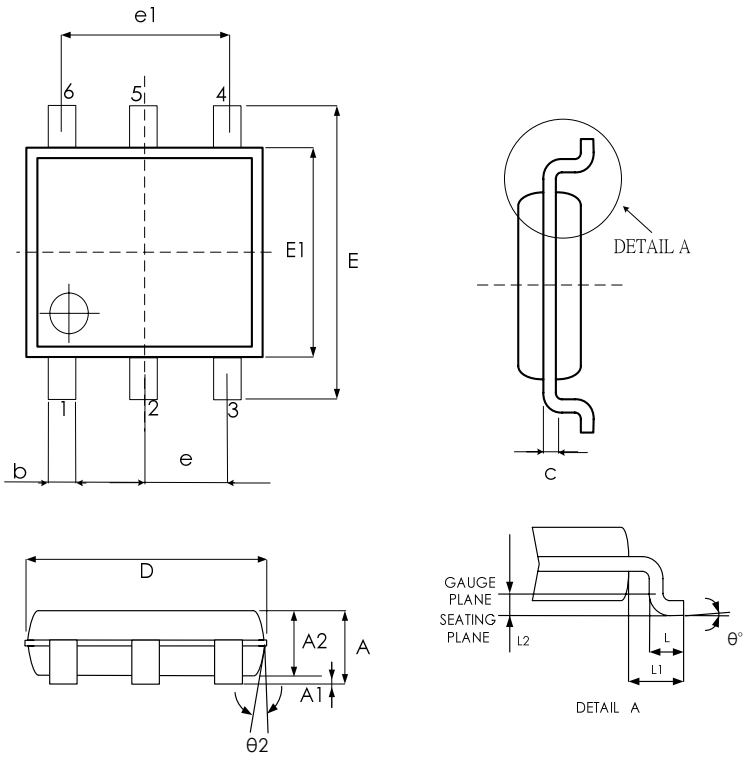
Disable Response



200µs/DIV

Physical Dimensions

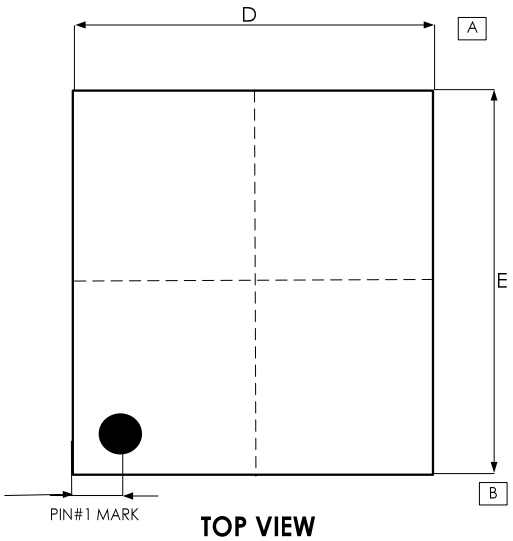
SOT-23-6



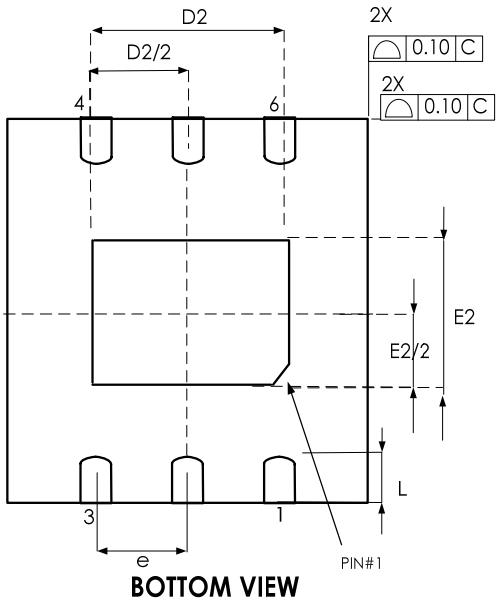
SYMBPLS	MIN.	NOM.	MAX.
A	—	—	1.45
A1	—	—	0.15
A2	0.9	1.15	1.3
b	0.3	—	0.5
c	0.08	—	0.22
D	2.90 BSC.		
E	2.80 BSC.		
E1	1.60 BSC.		
e	0.95 BSC		
e1	1.90 BSC		
L	0.3	0.45	0.6
L1	0.60 REF		
L2	0.25 REF		
θ°	0	4	8
θ2°	5	10	15

UNIT: MM

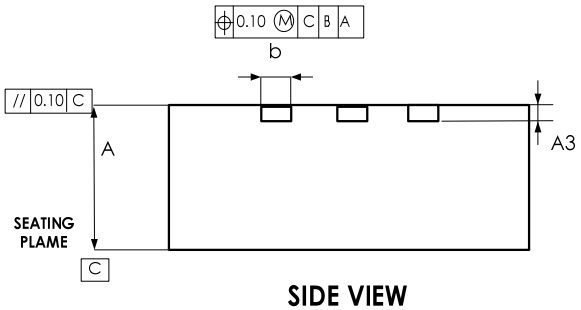
TDFN-6



TOP VIEW



BOTTOM VIEW



SIDE VIEW

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

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