Dual, High-PSRR, Low-Noise, Low-Dropout, 150mA CMOS Linear Regulator

General Description

The EMP2011 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 150mA 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 EMP2011 is well suited for portable battery-powered application which requires high efficiency, low noise and small board space. With 75mV low dropout voltage at 150mA output current, EMP2011 sustains high PSRR at very low input voltage which is common in battery-powered application. The EMP2011 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 EMP2011 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 EMP2011 is available in miniature 6-pin SOT-23-6, 6-pin FBP and DFN (2x2) packages.

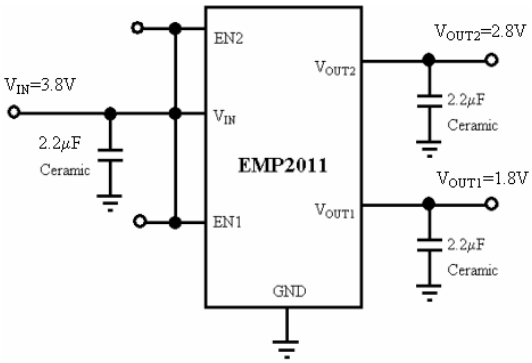
Features

- Miniature SOT-26, FBP-6 and DFN-6(2x2) packages
- 150mA guaranteed output current
- 72dB typical PSRR at 1kHz (60dB typical at 10KHz)
- 120μV_{RMS} output voltage noise (10Hz to 100kHz)
- 75mV typical dropout at 150mA
- 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

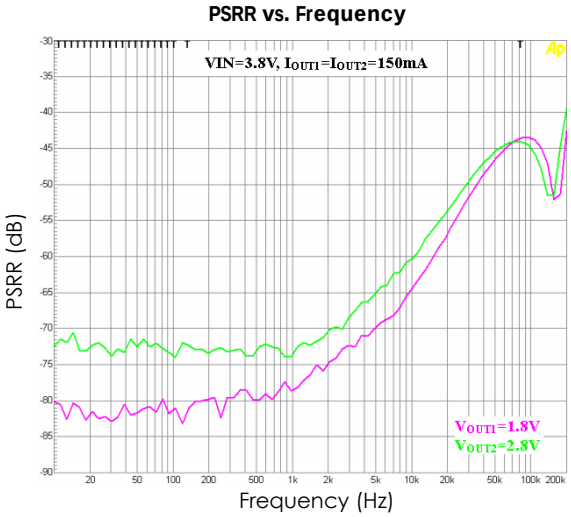
Applications

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

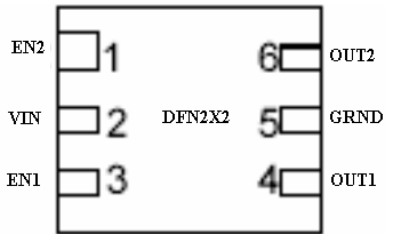
Typical Application Diagram

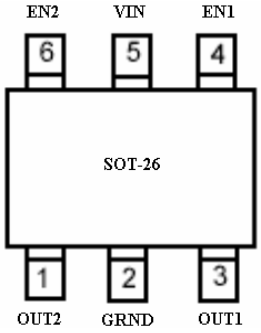


Typical Performance Characteristics



Pin Configuration





Pin Functions

Name	SOT-26	DFN2x2 FBP-6	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.

Order, Mark & Packing Information

Product ID	No. of PIN	EN1	EN2	Package	Vout1 Volt	Vout2 Volt	Marking	Order Information
EMP2011	6	Y	Y	SOT-26	3.0	3.0	1100	EMP2011-00VC06GRR
					1.8	3.0	1101	EMP2011-01VC06GRR
					1.8	2.8	1102	EMP2011-02VC06GRR
					2.5	3.3	1103	EMP2011-03VC06GRR
					2.8	3.3	1104	EMP2011-04VC06GRR
					1.8	3.3	1105	EMP2011-05VC06GRR
					2.85	2.85	1106	EMP2011-06VC06GRR
EMP2011	6	Y	Y	DFN-6	3.0	3.0	1100	EMP2011-00FA06GRR
					1.8	3.0	1101	EMP2011-01FA06GRR
					1.8	2.8	1102	EMP2011-02FA06GRR
					2.5	3.3	1103	EMP2011-03FA06GRR
					2.8	3.3	1104	EMP2011-04FA06GRR
					1.8	3.3	1105	EMP2011-05FA06GRR
					2.85	2.85	1106	EMP2011-06FA06GRR
EMP2011	6	Y	Y	FBP-6	3.0	3.0	1100	EMP2011-00BB06GRR
					1.8	3.0	1101	EMP2011-01BB06GRR
					1.8	2.8	1102	EMP2011-02BB06GRR
					2.5	3.3	1103	EMP2011-03BB06GRR
					2.8	3.3	1104	EMP2011-04BB06GRR
					1.8	3.3	1105	EMP2011-05BB06GRR
					2.85	2.85	1106	EMP2011-06BB06GRR

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})	
6-Pin DFN	(Note 3)
6-pin 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, $C_{IN} = C_{OUT}$ = 2.2µF, 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	**150**			mA
I_{LIMIT}	Output Current Limit			300		mA
I_Q	Supply Current	$I_{OUT1} = I_{OUT2}$ = 0mA		150		µA
		$I_{OUT1} = I_{OUT2}$ = 150mA		200		
	Shutdown Supply Current	EN1 = EN2 = GND		0.001		
V_{DO}	Dropout Voltage (Note 4), (Note 6)	I_{OUT} = 30mA		15		mV
		I_{OUT} = 150mA		75		
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
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		℃

Elite MicroPower Inc. reserves the right to make changes to improve reliability or manufacturability without notice, and customers are advised to obtain the latest version of relevant information prior to placing orders.

	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:

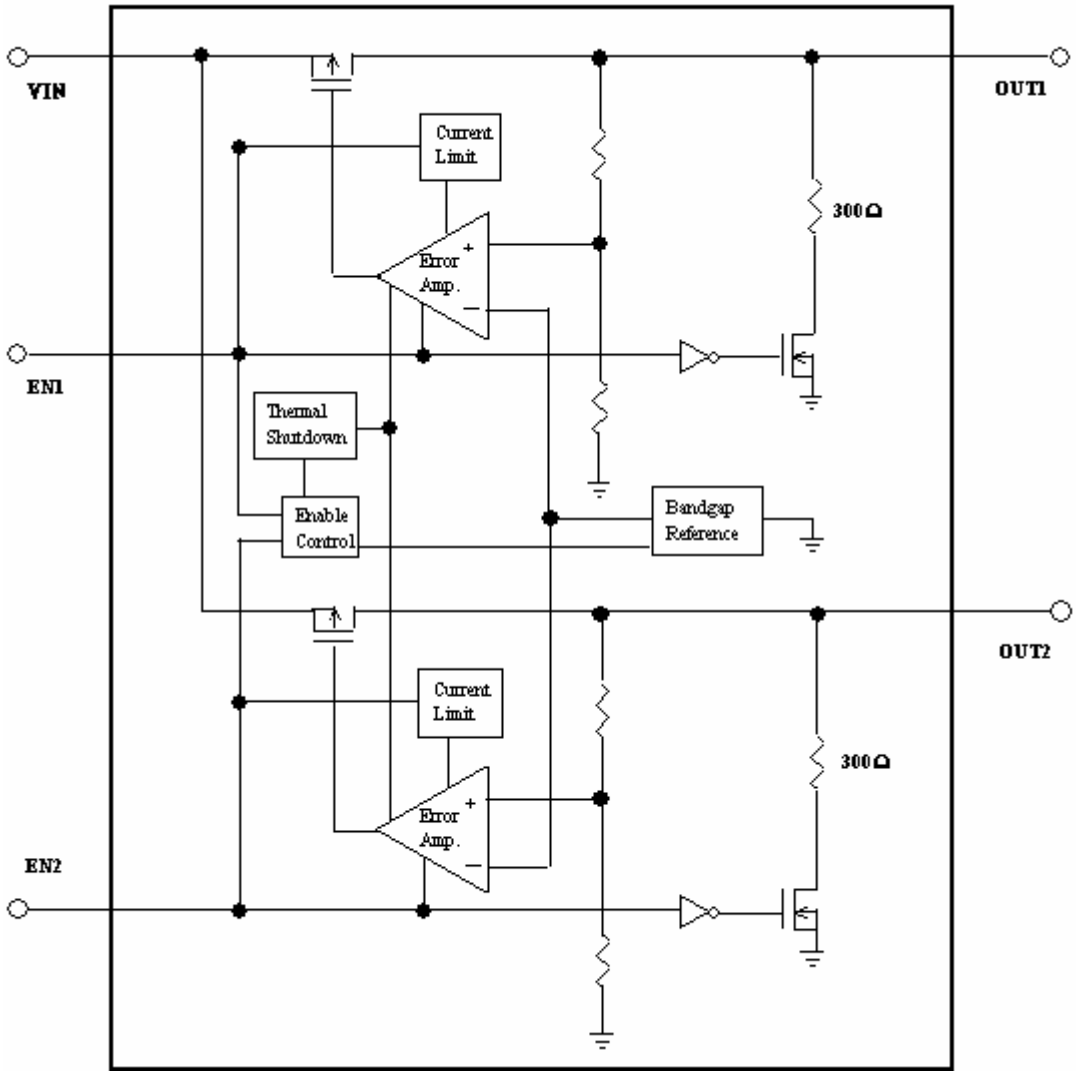
$$P_D = \frac{T_{J(MAX)} - T_A}{\theta_{JA}}$$

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.

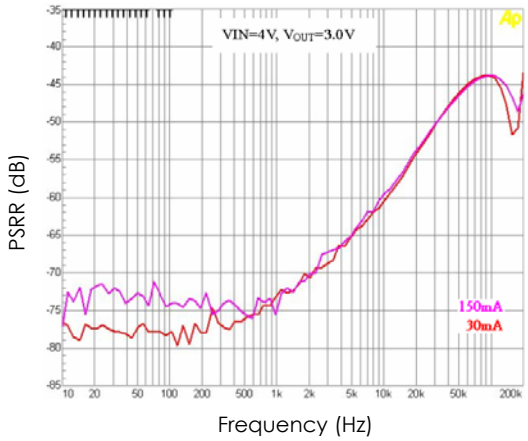
Functional Block Diagram



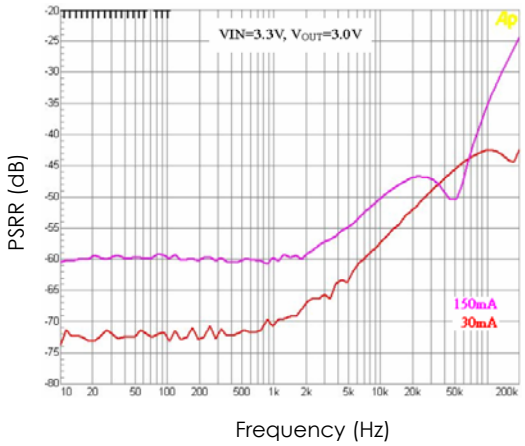
Typical Performance Characteristics

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

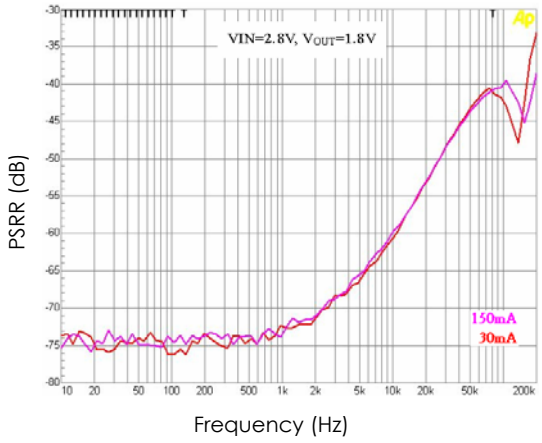
PSRR vs. Frequency



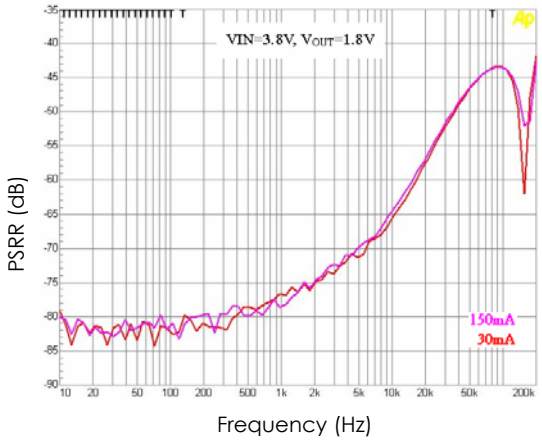
PSRR vs. Frequency



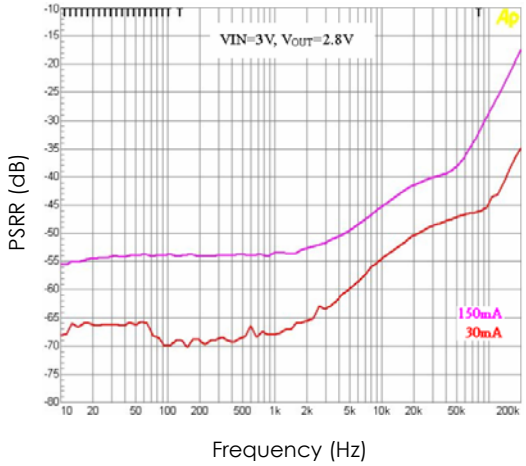
PSRR vs. Frequency



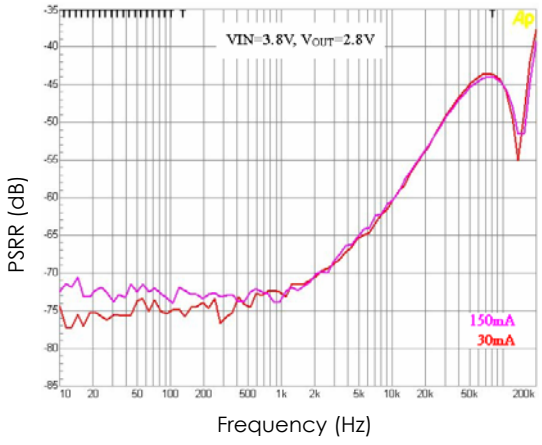
PSRR vs. Frequency



PSRR vs. Frequency



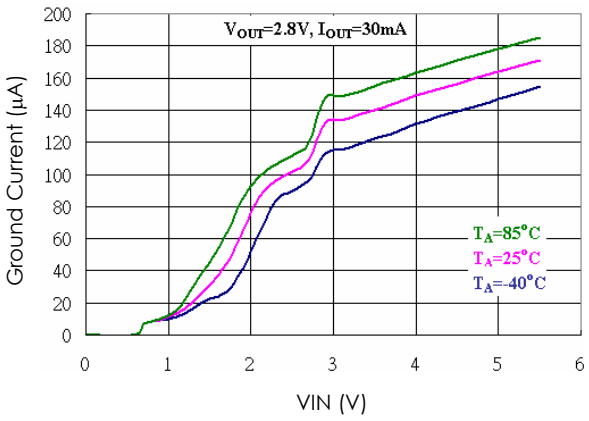
PSRR vs. Frequency



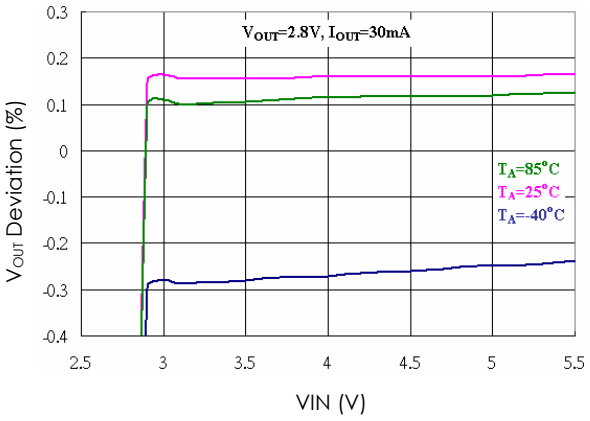
Typical Performance Characteristics

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

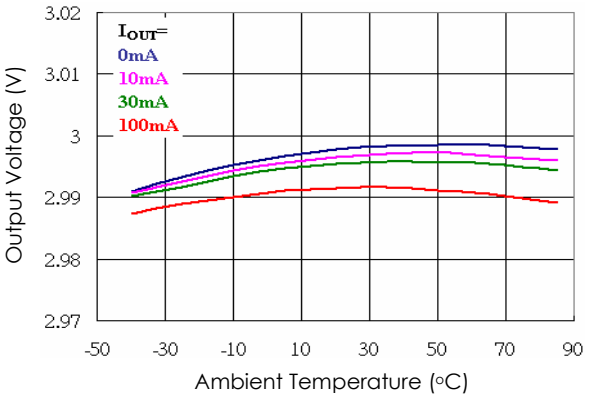
Ground Current vs. VIN



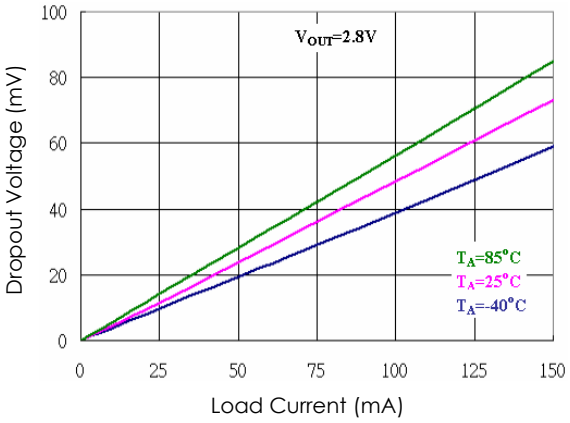
Line Regulation



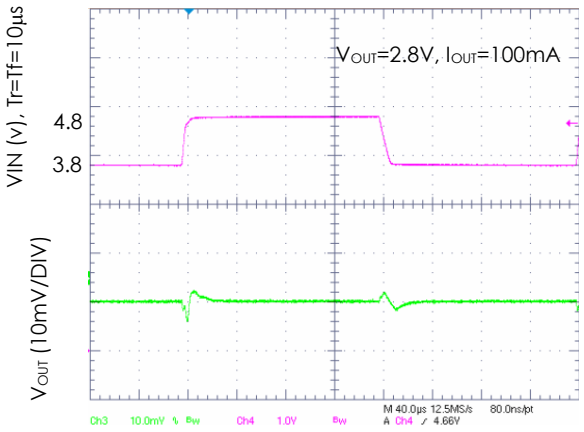
Temperature Stability



Dropout Voltage vs. Load Current (For Different Temperature)

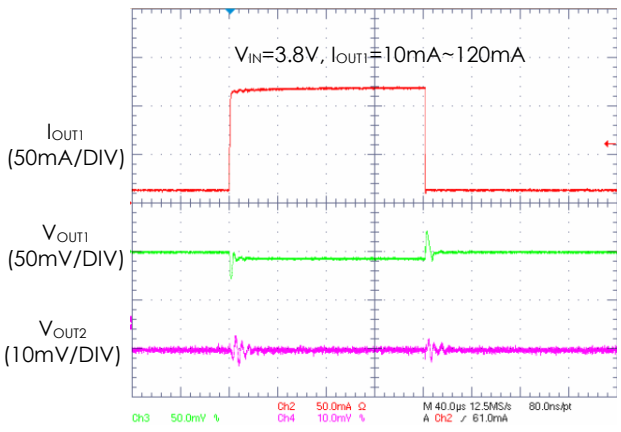


Line Transient



40µs/DIV

Load Transient

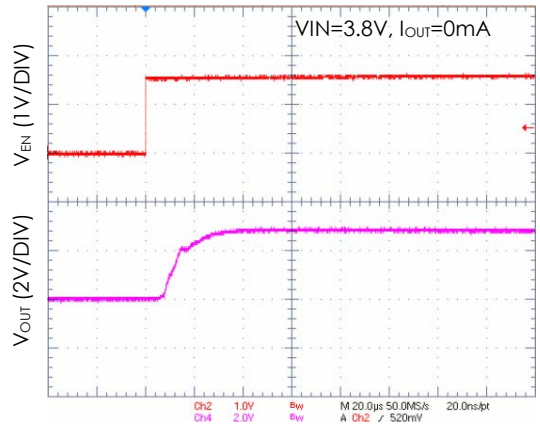


40µs/DIV

Typical Performance Characteristics

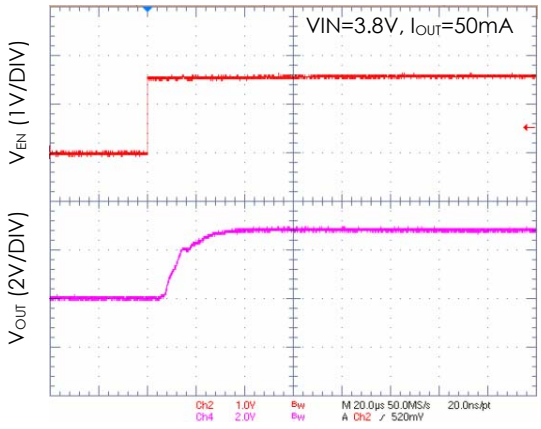
Unless otherwise specified, VIN = $V_{OUT\ (NOM)}$ + 1V, C_{IN} = C_{OUT} = 2.2µF, T_A = 25°C, V_{EN1} = V_{EN2} = VIN. (Continued)

Enable Response



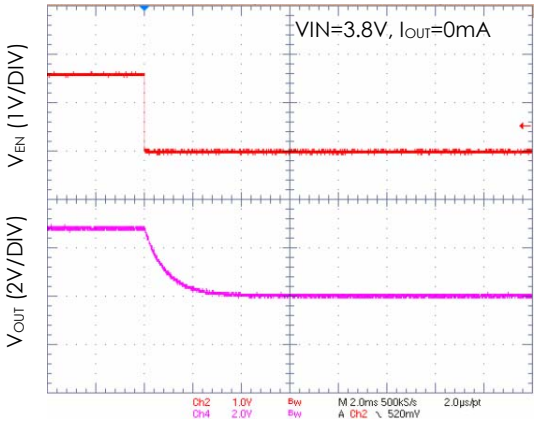
20µs/DIV

Enable Response



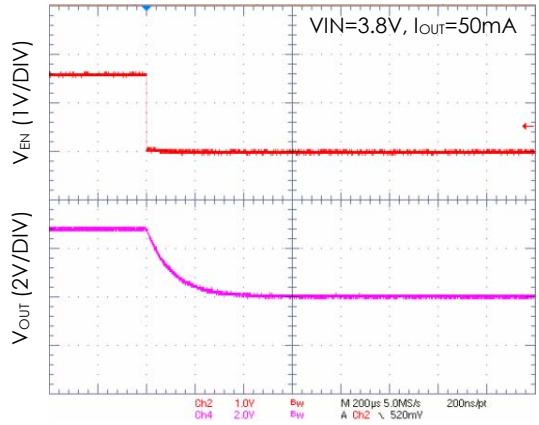
20µs/DIV

Disable Response



2ms/DIV

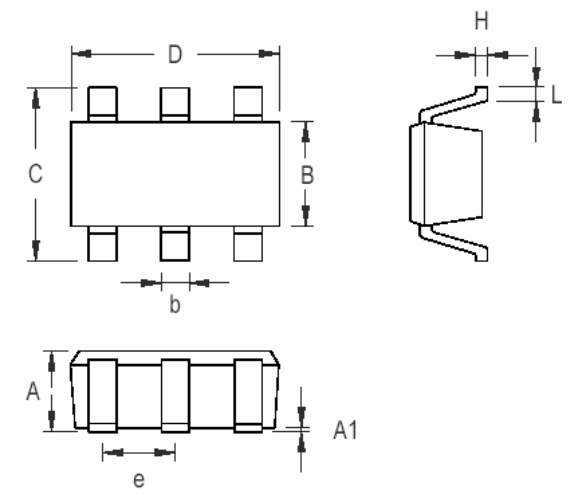
Disable Response



200µs/DIV

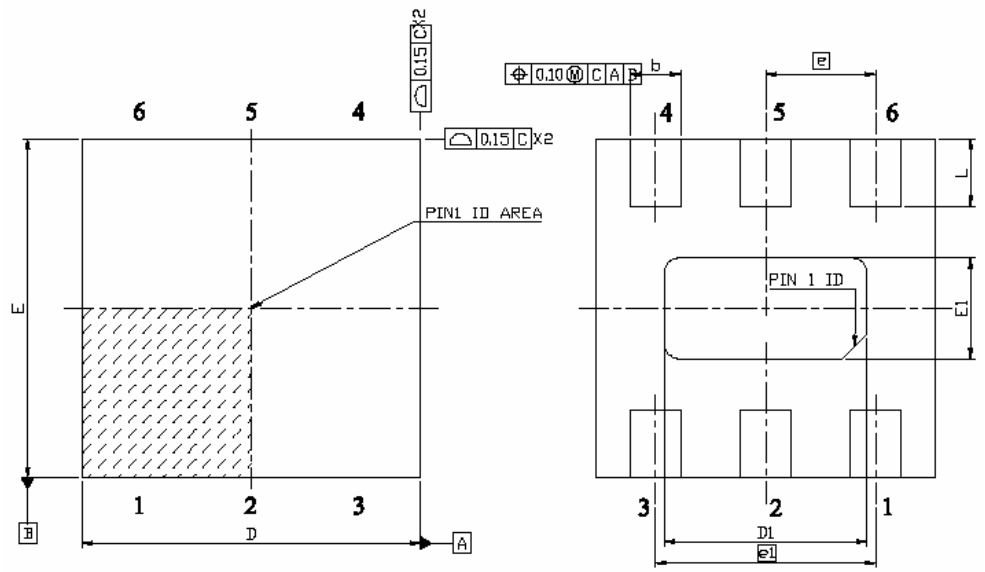
Physical Dimensions

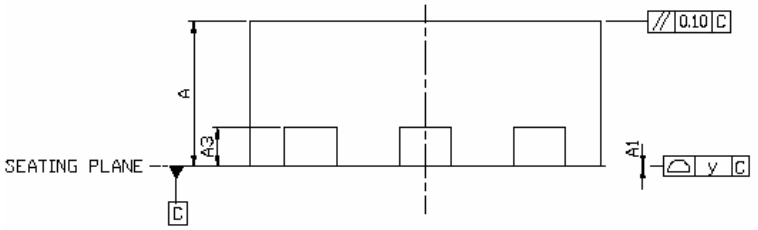
SOT-23-6



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.031	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.250	0.560	0.010	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

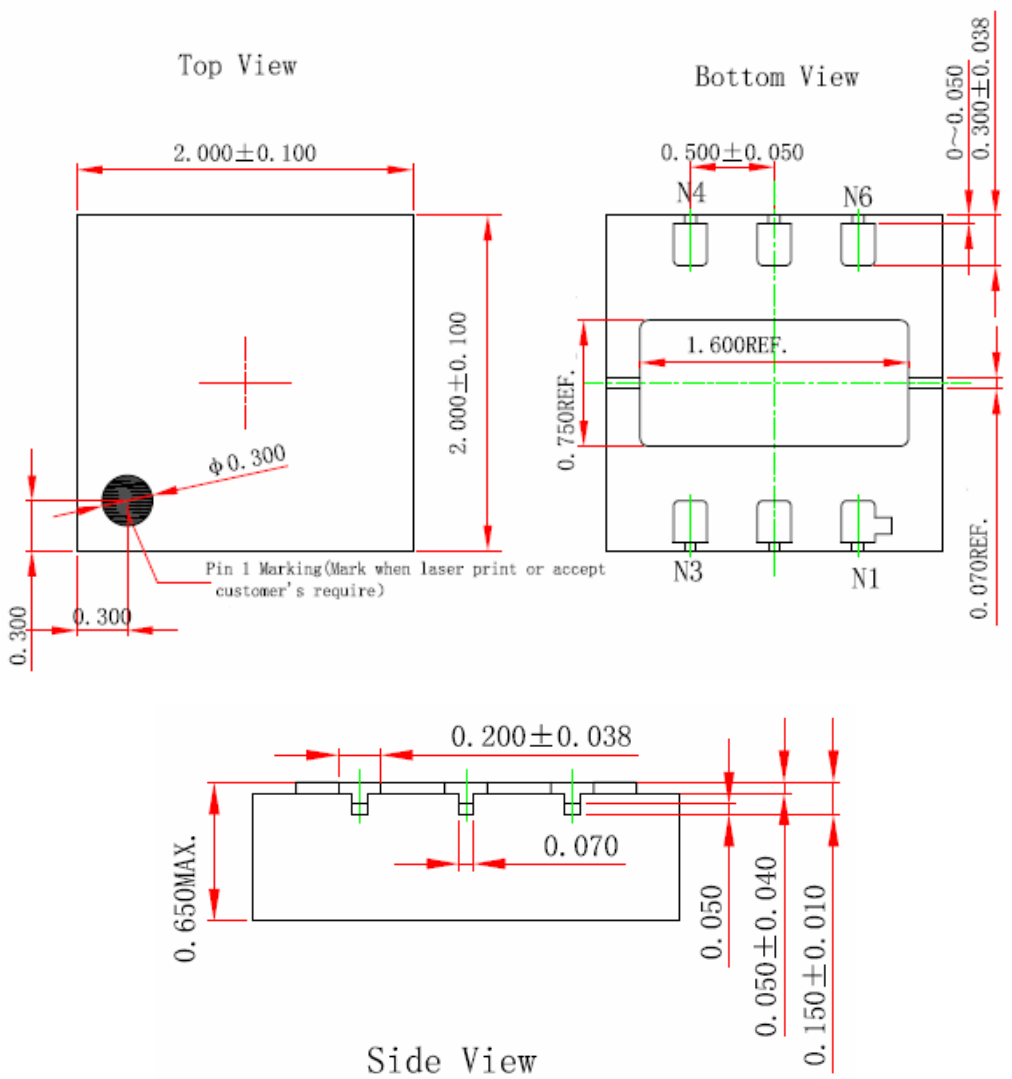
DFN-6





SYMBOL	DIMENSION (MM)			DIMENSION (MIL)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	27.6	29.5	31.5
A1	0.00	0.02	0.05	0	0.8	2
A3	0.20 REF			8 REF		
b	0.20	0.30	0.40	8	12	16
D	1.9	2.00	2.10	75	79	83
D1	0.00	1.20	1.25	0	47.2	49.2
E	1.9	2.00	2.10	75	79	83
E1	0.00	0.60	0.65	0	23.6	25.6
e	0.65 BSC			25.6 BSC		
e1	1.30 BSC			51.2 BSC		
L	0.40 REF			15.7 REF		
y			0.08			3

FBP-6



TECHNOLOGY SPECIFICATION

1. MOLDED BODY SHALL NOT HAVE CRACK, DAMAGE, ETC.;

2. PLATE OF DOWN-LEAD SHALL NOT HAVE CHANGING COLOR, SPLOTCHY, FLAKE, ETC.;

3. CLEAR MARK IS NEEDED;

4. ALL UNITS ARE IN MILLIMETER;

5. THE DERECTION OF VIEW: .