

## DESCRIPTION

The MP2000 is a low-voltage, low-dropout bipolar linear regulator. It operates from 1.35V to 6.0V input voltage, and regulates the output voltage from as low as 0.5V.

The MP2000 can supply up to 150mA of load current. The MP2000 features thermal overload and current limit protection. It is available in a 5-pin TSOT23-5 package.

Part Number	Output Voltage
MP2000DJ-ADJ	Adjustable

## EVALUATION BOARD REFERENCE

Board Number	Output*	Dimensions
EV2000DJ-00A	1.2V	2.0"X x 2.0"Y x 0.4"Z

\* Default output voltage adjustable from 0.5V to 5.0V using an external resistor divider.

## FEATURES

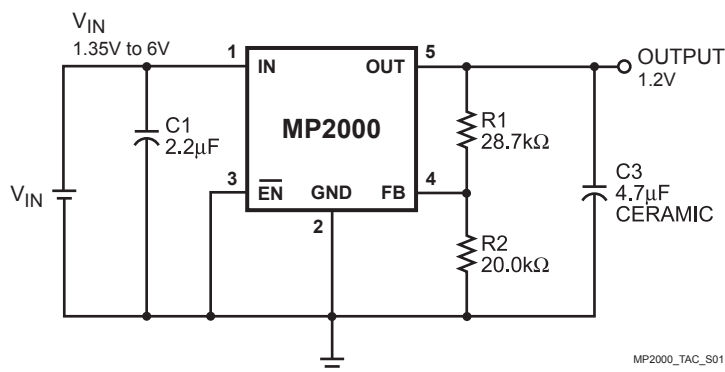
- Operates with  $V_{IN} = 1.35V$
- Low 300mV Dropout at 150mA Output
- $\pm 3\%$  Accurate Output Voltage
- Fixed and Adjustable Output Voltage Option
- Better Than 0.001%/mA Load Regulation
- Stable With Low-ESR Output Capacitor
- Low 65 $\mu A$  Ground Current
- Internal Thermal Protection
- Current Limit Protection
- 7 $\mu A$  Typical Quiescent Current at Shutdown

## APPLICATIONS

- Low Current Regulators
- Battery Powered Systems
- Cellular Phones

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## TYPICAL APPLICATION



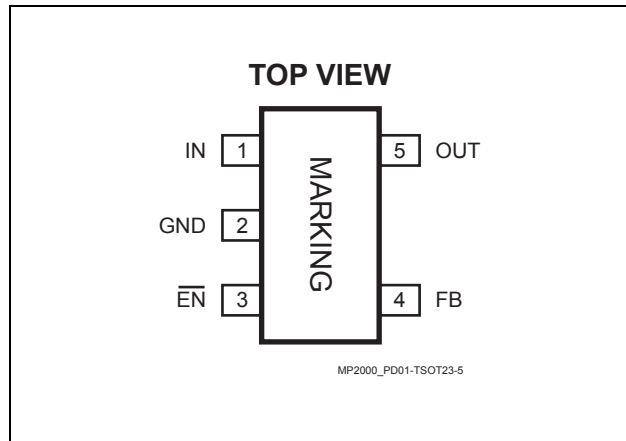
MP2000\_TAC\_S01

### ORDERING INFORMATION

Part Number*	Package	Top Marking	Free Air Temperature (T <sub>A</sub> )
MP2000DJ-ADJ	TSOT23-5	G1	-40°C to +85°C

\* For Tape & Reel, add suffix -Z (eg. MP2000DJ-ADJ-Z);  
 For RoHS compliant packaging, add suffix -LF (eg. MP2000DJ-ADJ-LF-Z)

### PACKAGE REFERENCE



#### ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>

IN Supply Voltage .....	-0.3V to +7.0V
FB Voltage .....	-0.3V to V <sub>OUT</sub> + 0.3V
$\overline{\text{EN}}$ Voltage .....	-0.7V to IN
Continuous Power Dissipation (T <sub>A</sub> = +25°C) <sup>(2)</sup> .....	0.57W
Junction Temperature .....	150°C
Lead Temperature .....	260°C
Storage Temperature .....	-65°C to +150°C

#### Recommended Operating Conditions <sup>(3)</sup>

Input Voltage.....	1.35V to 6.0V
Output Voltage.....	0.5V to 5V
Load Current.....	150mA Maximum
Operating Junct. Temp (T <sub>J</sub> ).....	-40°C to +125°C

Thermal Resistance <sup>(4)</sup>	$\theta_{JA}$	$\theta_{JC}$
TSOT23-5 .....	220 .....	110.. °C/W

#### Notes:

- Exceeding these ratings may damage the device.
- The maximum allowable power dissipation is a function of the maximum junction temperature T<sub>J</sub>(MAX), the junction-to-ambient thermal resistance  $\theta_{JA}$ , and the ambient temperature T<sub>A</sub>. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P<sub>D</sub>(MAX)=(T<sub>J</sub>(MAX)-T<sub>A</sub>)/  $\theta_{JA}$ . Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
- The device is not guaranteed to function outside of its operating conditions.
- Measured on JESD51-7 4-layer PCB.

## ELECTRICAL CHARACTERISTICS

$V_{IN} = 1.8V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Units
Ground Pin Current		$I_{OUT} = 1mA$		65		$\mu A$
		$I_{OUT} = 150mA$		2.7		mA
Shutdown Current		$\overline{EN} = 1.0V$ , $V_{IN} = 5V$		7	10	$\mu A$
FB Regulation Voltage			0.485	0.500	0.515	V
Dropout Voltage <sup>(5)</sup>		$I_{OUT} = 100mA$		250		mV
		$I_{OUT} = 150mA$		300		
Line Regulation		$I_{OUT} = 1mA$ , $V_{IN} = (V_{OUT} + 0.5V)$ to $6.0V$ <sup>(7)</sup>		0.01	0.08	%/V
Load Regulation		$I_{OUT} = 1mA$ to $150mA$ , $V_{IN} = V_{OUT} + 0.5V$ <sup>(7)</sup>		0.001	0.02	%/mA
PSRR		$V_{IN} > V_{OUT} + 0.5V$ , $C_3 = 2.2\mu F$ , $V_{IN(AC)} = 100mV$ , $f = 1kHz$		50		dB
Output Voltage Noise		$f = 1kHz$ , $C_{FB} > 0.1\mu F$ , $I_{OUT} = 1mA$		300		nV/ $\sqrt{Hz}$
$\overline{EN}$ Input Low Voltage				0.7		V
$\overline{EN}$ Input Bias Current		$\overline{EN} = 0V$		0.01	1	$\mu A$
Current Limit Protection		$V_{OUT} = 1.2V$		200		mA
Thermal Protection				145		$^{\circ}C$
Thermal Protection Hysteresis				30		$^{\circ}C$

**Notes:**

5) Dropout Voltage is defined as the input to output differential when the output voltage drops 1% below its normal value.

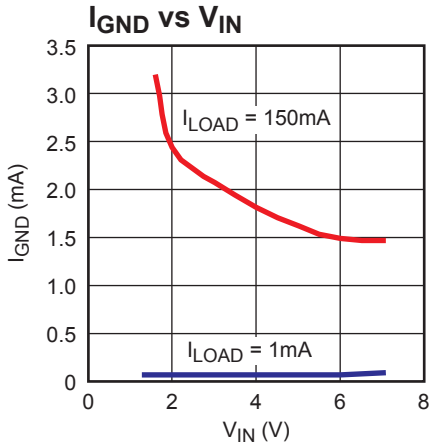
6)  $V_{IN} = 1.35V$  for  $V_{OUT} = 0.5V$  to  $0.85V$

**PIN FUNCTIONS**

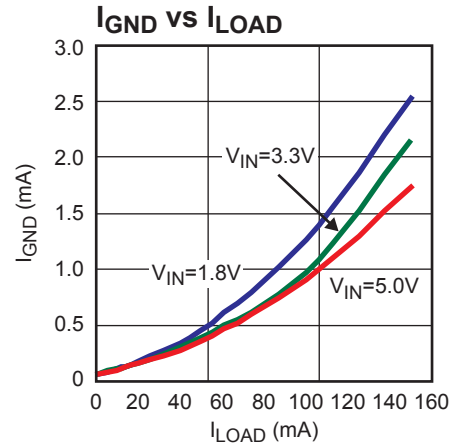
Pin #	Name	Description
1	IN	Power Source Input. IN supplies the internal power to the MP2000 and is the source of the pass transistor. Bypass IN to GND with a 2.2 $\mu$ F or greater capacitor.
2	GND	Ground.
3	$\overline{\text{EN}}$	Enable Input. Drive $\overline{\text{EN}}$ high to turn off the MP2000; low to turn it on. For automatic startup, connect $\overline{\text{EN}}$ to GND.
4	FB	Feedback Input. Connect a resistive voltage divider from OUT to FB to set the output voltage. OUT feedback threshold is 0.5V.
5	OUT	Regulator Output. OUT is the output of the linear regulator. Bypass OUT to GND with a 2.2 $\mu$ F or greater capacitor.

## TYPICAL PERFORMANCE CHARACTERISTICS

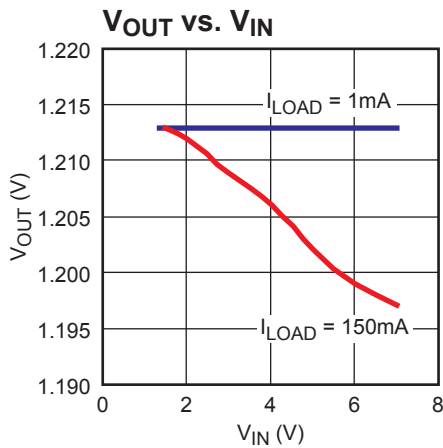
$V_{IN} = 1.8V$ ,  $V_{OUT} = 1.2V$ ,  $C1 = 2.2\mu F$ ,  $C2 = 0.1\mu F$ ,  $C3 = 4.7\mu F$ ,  $T_A = +25^\circ C$  unless otherwise noted.



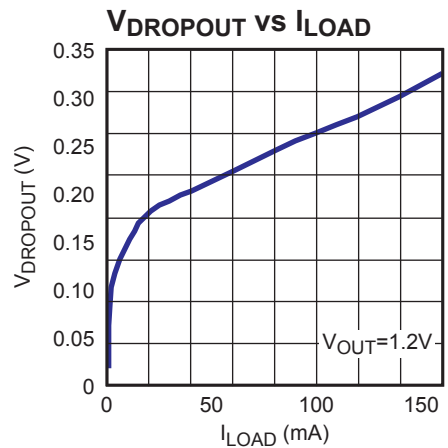
MP2000-TPC01



MP2000-TPC02



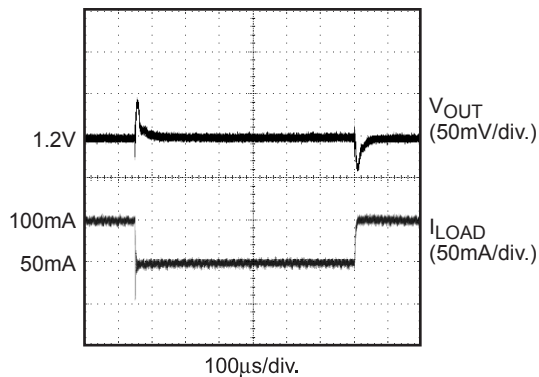
MP2000-TPC03



MP2000-TPC04

### Load-Transient Response

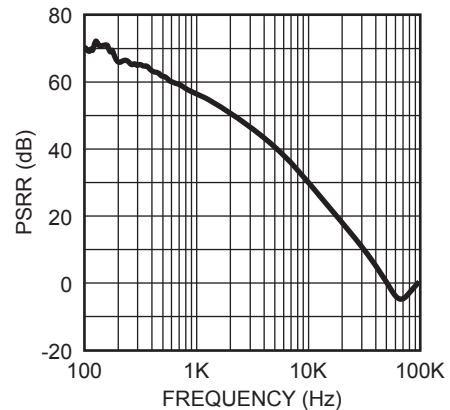
Circuit of Figure 2



MP2000-TPC05

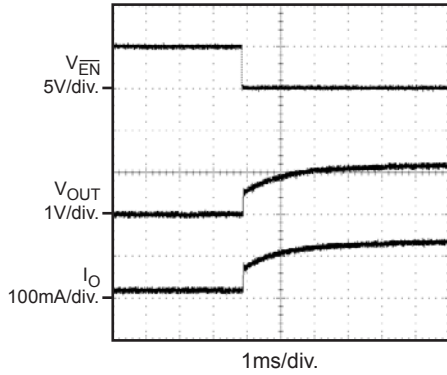
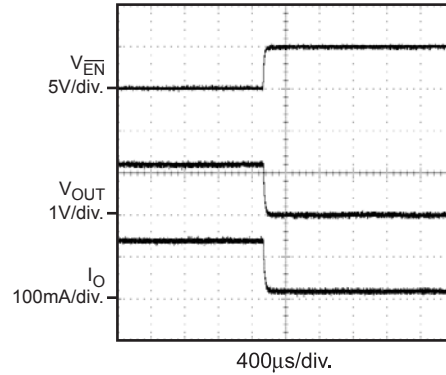
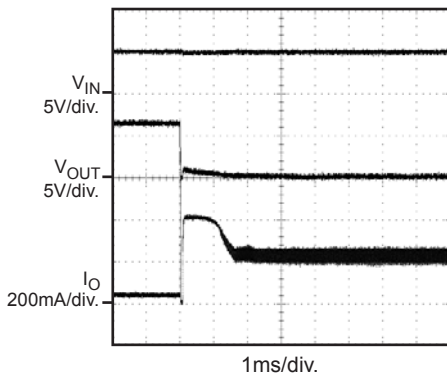
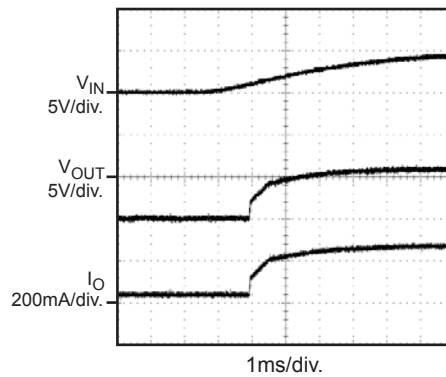
### PSRR vs Frequency

$V_{IN} = 2.5V$ ,  $V_{OUT} = 1.0V$ ,  $I_{LOAD} = 10mA$



MP2000-TPC06

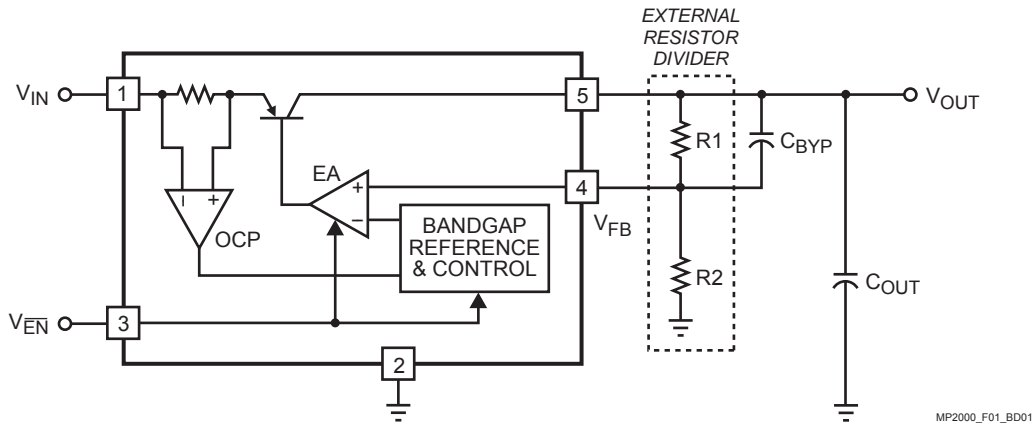
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**
 $V_{IN} = 1.8V$ ,  $V_{OUT} = 1.2V$ ,  $C1 = 2.2\mu F$ ,  $C2 = 0.1\mu F$ ,  $C3 = 4.7\mu F$ ,  $T_A = +25^\circ C$  unless otherwise noted.

**Startup**
 $V_{IN} = 5V$ ,  $I_{OUT} = 130mA$ 

**Shutdown**
 $V_{IN} = 5V$ ,  $I_{OUT} = 130mA$ 

**Current Limit Protection**
 $V_{IN} = 5V$ ,  $\overline{EN} = 0V$ ,  $I_{OUT} = 90mA$ 

**Power Ramp Up**
 $V_{IN} = 5V$ ,  $\overline{EN} = 0V$ ,  $I_{OUT} = 130mA$ 


**OPERATION**

The MP2000 is a low-current, low-voltage, low-dropout linear regulator. It is intended for use in devices that require very low voltage and low quiescent current power such as wireless modems, pagers and cellular phones.

The MP2000 uses a PNP pass element and features internal thermal shutdown and an internal current limit circuit.



**Figure 1—Adjustable Regulator**

## APPLICATION INFORMATION

### Setting the Output Voltage

The output voltage can be adjusted by changing the values of the external resistor divider.

Use the following equation to determine these values:

$$V_{OUT} = 0.5V \times \left(1 + \frac{R1}{R2}\right)$$

Typically R1 + R2 are recommended to be less than 100kΩ.

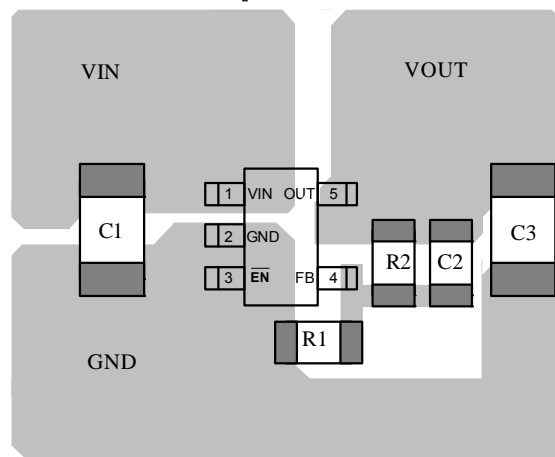
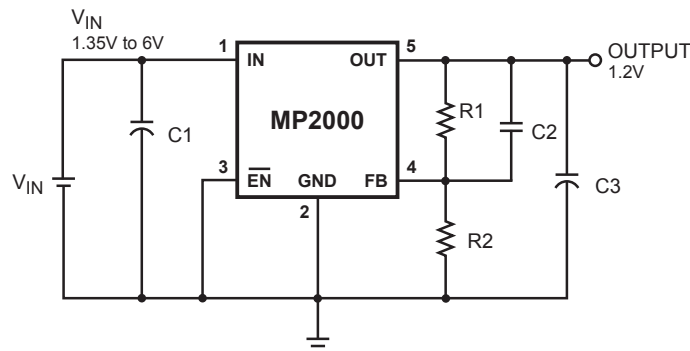
In Figure 2, C2 is added for improved transient response.

### PCB Layout Guide

PCB layout is very important to achieve good regulation, ripple rejection, transient response and thermal performance. It is highly recommended to duplicate EVB layout for optimum performance.

If change is necessary, please follow these guidelines and take Figure 2 for reference.

- 1) Input and output bypass ceramic capacitors are suggested to be put close to the IN Pin and OUT Pin respectively.
- 2) Ensure all feedback connections are short and direct. Place the feedback resistors and compensation components as close to the chip as possible.
- 3) Connect IN, OUT and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.



**Top Layer**

**Figure 2—PCB Layout**



TYPICAL APPLICATION CIRCUIT - ADJUSTABLE

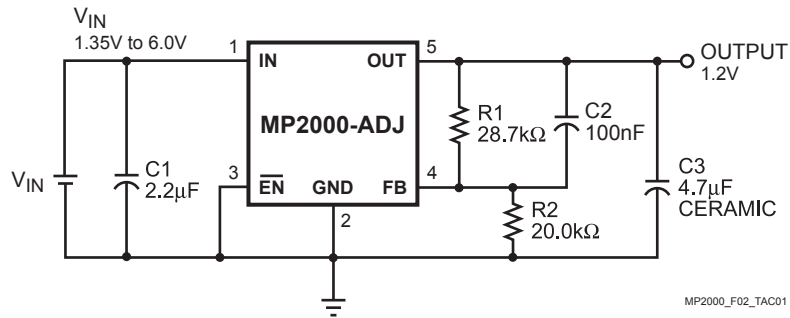
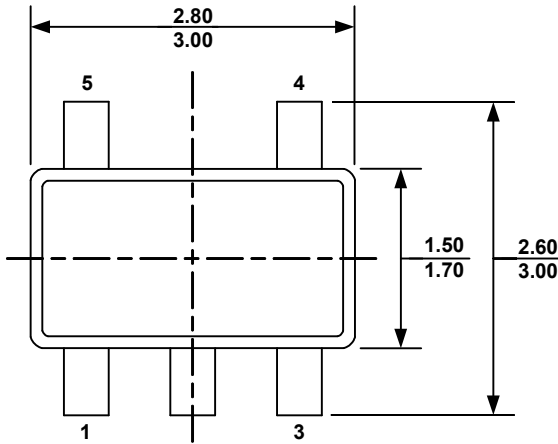


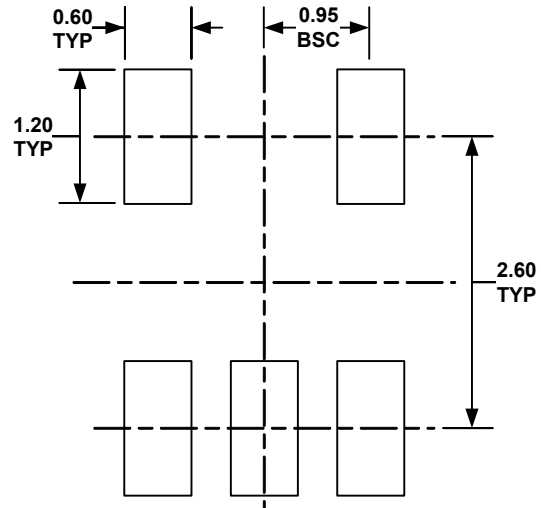
Figure 3—Typical Application Circuit with  $V_{OUT} = 1.2V$

## PACKAGE INFORMATION

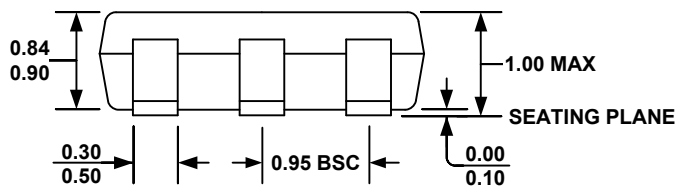
### TSOT23-5



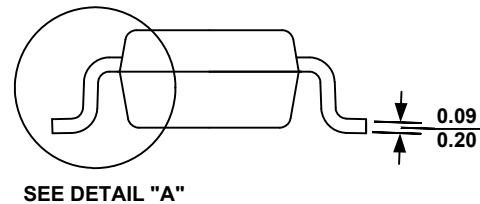
**TOP VIEW**



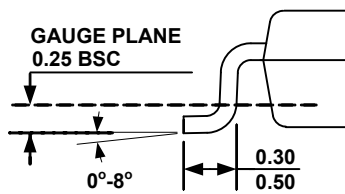
**RECOMMENDED LAND PATTERN**



**FRONT VIEW**



**SIDE VIEW**



**DETAIL "A"**

#### **NOTE:**

- 1) ALL DIMENSIONS ARE IN MILLIMETERS.
- 2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURR.
- 3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION.
- 4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.10 MILLIMETERS MAX.
- 5) DRAWING CONFORMS TO JEDEC MO-193, VARIATION AA.
- 6) DRAWING IS NOT TO SCALE.

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