

DESCRIPTION

The MP2004 is a dual-channel, low noise, low dropout and high PSRR linear regulator. The output voltage of MP2004 ranges from 1.2V to 5V and 1% accuracy by operating from a +2.5V to +6.0V input. The MP2004 can supply up to 200mA of load current at each channel.

The MP2004 uses an internal PMOS as the pass element, which consumes 114 μ A supply current (both LDOs on) at no load condition. The EN1 and EN2 pins control each output respectively. When both channels shutdown simultaneously, the chip will be turned off and consume nearly zero operation current which is suitable for battery-power devices. The MP2004 features current limiting and over temperature protection.

It is available in a small 6-pin TSOT23 package.

FEATURES

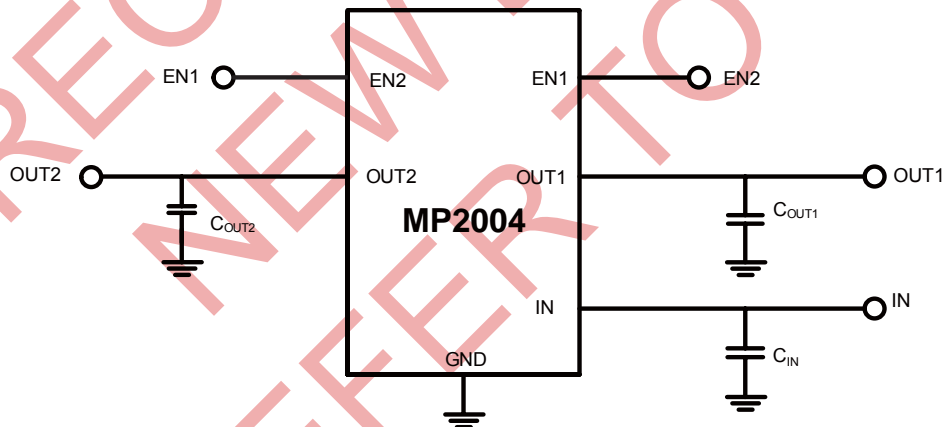
- Two LDOs in a TSOT23-6 Package
- Up to 200mA Output Current (Per Channel)
- Two Enable Pins Control Each Output
- 69dB PSRR (100Hz)
- 95 μ V_{RMS} Low Noise Output
- 110mV Dropout at 100mA Load
- Very Fast Transient Responses with Small Output Capacitor
- Current Limiting and Thermal Protection

APPLICATIONS

- Cellular Phones
- Laptop PCs
- Hand-held Equipment
- Netbook Computing

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TYPICAL APPLICATION



ORDERING INFORMATION*

Part Number	V _{OUT1}	V _{OUT2}	Package	Temperature	Top Marking
MP2004DJ-JG-LF-Z	2.5V	1.8V	TSOT23-6	-40°C to +85°C	2B
MP2004DJ-ZS-LF-Z	5.0V	3.3V			2L
MP2004DJ-PN-LF-Z	3.0V	2.85V			3L
MP2004DJ-DD-LF-Z	1.85V	1.85V			4L
MP2004DJ-SJ-LF-Z	3.3V	2.5V			5L
MP2004DJ-MG-LF-Z	2.8V	1.8V			6L

* Other output voltage versions between 1.2V and 5.0V are available in 100mV increments. Contact factory for availability.

ORDERING GUIDE**

MP2004DJ-□□-LF-Z

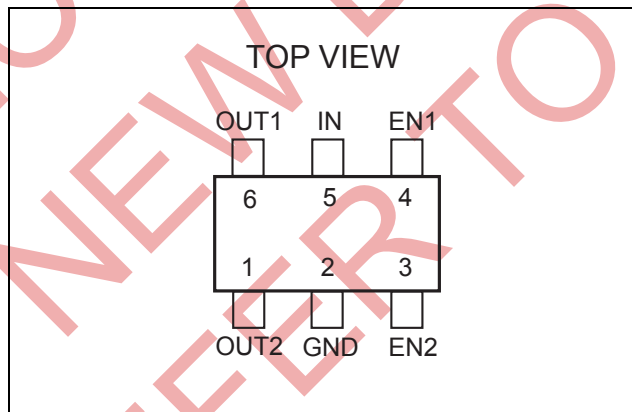


** For RoHS Compliant Packaging, add suffix - LF (e.g. MP2004DJ-□□-LF); For Tape and Reel, add suffix -Z (e.g. MP2004DJ-□□-LF-Z).

OUTPUT VOLTAGE SELECTOR GUIDE***

Code	V _{OUT}	Code	V _{OUT}
C	1.2	T	2.65
B	1.3	L	2.7
F	1.5	M	2.8
W	1.6	N	2.85
G	1.8	V	2.9
D	1.85	P	3.0
Y	1.9	Q	3.1
H	2.0	X	3.15
E	2.1	R	3.2
J	2.5	S	3.3
K	2.6	Z	5.0

*** Code in **Bold** are standard versions. For other output voltages between 1.2V and 5.0V contact factory for availability. Minimum order quantity on non-standard versions is 25,000 units.

PACKAGE REFERENCE


ABSOLUTE MAXIMUM RATINGS ⁽¹⁾

Supply Input Voltage	6.5V
Continuous Power Dissipation (T _A = +25°C) ⁽²⁾	0.45W
Operation Temperature Range ...	-40°C to 85°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10sec)	260°C

Recommended Operating Conditions ⁽³⁾

Supply Input Voltage.....	2.5V to 6.0V
Enable Input Voltage	0V to 6.0V
Junction Temperature Range .	-40°C to +125°C

Thermal Resistance ⁽⁴⁾	θ_{JA}	θ_{JC}
TSOT23-6	220	110. °C/W

Notes:

- 1) Exceeding these ratings may cause permanent damage to the device.
- 2) The maximum allowable power dissipation is a function of the maximum junction temperature T_J(MAX), the junction-to-ambient thermal resistance θ_{JA}, and the ambient temperature T_A. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P_D(MAX)=(T_J(MAX)-T_A)/ θ_{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.
- 3) The device is not guaranteed to function outside its operating conditions.
- 4) Measured on JESD51-7 4-layer board.

NOT RECOMMENDED FOR NEW DESIGNS REFER TO MP20041

ELECTRICAL CHARACTERISTICS

$V_{IN}=3.6V$, $V_{OUT1}=2.5V$, $V_{OUT2}=1.8V$, $C_{IN}=C_{OUT1}=C_{OUT2}=2.2\mu F$, $EN1=EN2=V_{IN}$, Typical Value at $T_A=25^\circ C$ for each LDO unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Units
Output Voltage Accuracy (Load regulation) ⁽⁵⁾	ΔV_{OUT}	$I_{LOAD} = 1mA$ to $200mA$	-1		+1	%
Maximum Output Current	I_{MAX}	Continuous	200			mA
Current Limit	I_{LIM}	$R_{Load}=1\ \Omega$		450		mA
Quiescent Current	I_Q	No Load		114		μA
Dropout Voltage ⁽⁶⁾	V_{DROP}	$I_{OUT1} = 100mA$		110		mV
		$I_{OUT1} = 200mA$		250		mV
Line Regulation ⁽⁷⁾	ΔV_{LINE}	$V_{IN}=(V_{OUT}+0.4V$ or $2.5V)$ to $6V$, $I_{OUT}=1mA$	-0.05		+0.05	%/V
EN Input High Threshold	V_{IH}	$V_{IN} = 2.5V$ to $6.0V$	1.6			V
EN Input Low Threshold	V_{IL}	$V_{IN} = 2.5V$ to $6.0V$			0.45	V
EN Input Bias Current	I_{SD}	$EN=V_{IN}=6.5V$			300	nA
Shutdown Supply Current	I_{GSD}	$EN1 = EN2 = GND$		0.03	1	μA
Thermal Shutdown Temperature	T_{SD}			140		$^\circ C$
Thermal Shutdown Hysteresis	ΔT_{SD}			10		$^\circ C$
Output Voltage Noise		10Hz to 100kHz, $C_{OUT}=2.2\mu F$, $I_{LOAD}=1mA$		95		μV_{RMS}
Output PSRR		100Hz, $C_{OUT} = 2.2\mu F$, $I_{LOAD} = 100mA$		69		dB

Notes:

$$5) \text{ Load Regulation} = \frac{V_{OUT[I_{OUT(MAX)}]} - V_{OUT[I_{OUT(MIN)}]}}{V_{OUT(NOM)}} \times 100(\%)$$

6) Dropout Voltage is defined as the input to output differential when the output voltage drops 100mV below its nominal value.

$$7) \text{ Line Regulation} = \frac{V_{OUT[V_{IN(MAX)}]} - V_{OUT[V_{IN(MIN)}]}}{[V_{IN(MAX)} - V_{IN(MIN)}] \times V_{OUT(NOM)}} \times 100(\%/V)$$

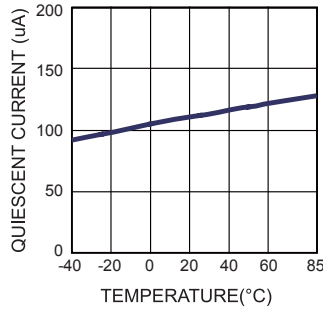
PIN FUNCTIONS

Pin #	Name	Description
1	VOUT2	Channel 2 Output Voltage
2	GND	Common Ground
3	EN2	Channel 2 Enable (Active High). Do Not Float This Pin.
4	EN1	Channel 1 Enable (Active High). Do Not Float This Pin.
5	VIN	Supply Input Pin
6	VOUT1	Channel 1 Output Voltage

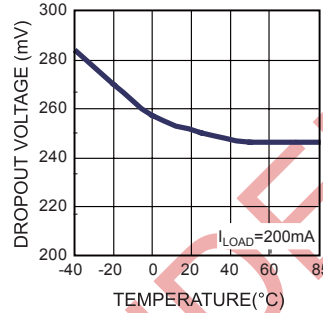
TYPICAL PERFORMANCE CHARACTERISTICS

$V_{IN}=3.6V$, $V_{OUT1}=2.5V$, $V_{OUT2}=1.8V$, $C_{IN}=C_{OUT1}=C_{OUT2}=2.2\mu F$, $EN1=EN2=V_{IN}$, Typical Value at $T_A=25^\circ C$ for Both Channel Enabled.

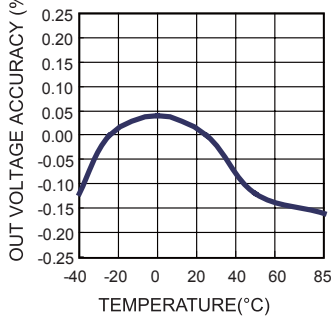
Quiescent Current vs. Temperature



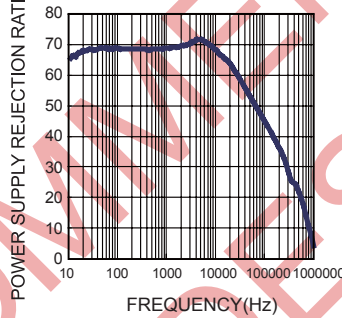
Dropout Voltage vs. Temperature



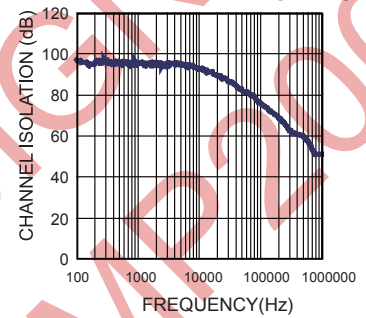
Out Voltage Accuracy vs. Temperature



Power Supply Rejection Ratio vs. Frequency

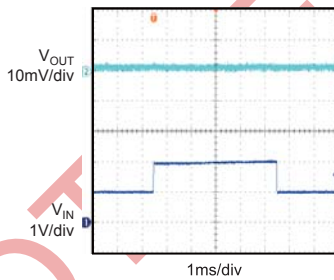


Channel-to-Channel Isolation vs. Frequency



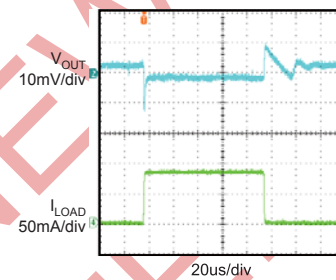
Line Transient Response

$V_{OUT}=3.5V$ to $4.5V$, $C_{IN}=0\mu F$, $C_{OUT}=2.2\mu F$
No Load



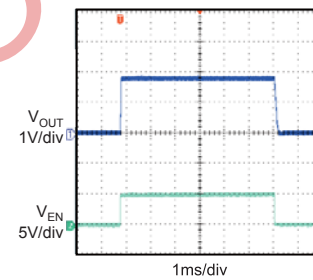
Load Transient Response

$V_{IN}=3.6V$, $V_{OUT}=1.8V$
 $I_{LOAD}=1mA$ to $80mA$, with Resistor Load



EN Pin Shut Down Response

$V_{IN}=3.6V$, $V_{OUT}=1.8V$, $V_{EN}=0$ to $5V$
 $I_{LOAD}=50mA$, with Resistor Load



APPLICATION INFORMATION

Power Dissipation

The power dissipation for any package depends on the thermal resistance of the case and circuit board, the temperature difference between the junction and ambient air, and the rate of airflow. The power dissipation across the device can be represented by the equation:

$$P = (V_{IN} - V_{OUT}) \times I_{OUT}$$

The allowable power dissipation can be calculated using the following equation:

$$P_{(MAX)} = (T_{Junction} - T_{Ambient}) / \theta_{JA}$$

Where $(T_{Junction} - T_{Ambient})$ is the temperature difference between the junction and the surrounding environment, θ_{JA} is the thermal resistance from the junction to the ambient environment. Connect the GND pin of MP2004 to ground using a large pad or ground plane helps to channel heat away.

Input Capacitor Selection

Using a capacitor whose value is $>0.47\mu F$ on the MP2004 input and the amount of capacitance can be increased without limit. Larger values will help to improve line transient response with the drawback of increased size. Ceramic capacitors are preferred, but tantalum capacitors may also suffice.

Output Capacitor Selection

The MP2004 is designed specifically to work with very low ESR ceramic output capacitor in space-saving and performance consideration. A ceramic capacitor in the range of $0.47\mu F$ and $10\mu F$, and with ESR lower than 1.2Ω is suitable for the MP2004 application circuit. Output capacitor of larger values will help to improve load transient response and reduce noise with the drawback of increased size.

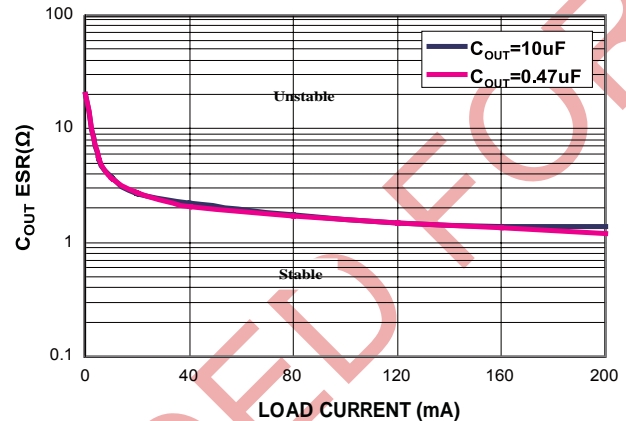


Figure 2—Relationship between ESR and LDO Stability

Reverse Current Path

The PMOS used in the MP2004 has an inherent diode connected between input and output (see Figure 3). If $V_{OUT} - V_{IN}$ is more than a diode-drop, this diode gets forward biased and starts to conduct. To avoid misoperation, an external Schottky connected in parallel with the internal parasitic diode prevents it from being turned on by limiting the voltage drop across it to about 0.3V (see Figure 4).

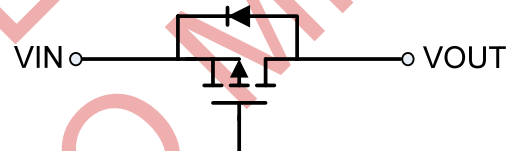


Figure 3—Inherent Diode Connected between Each Regulator Input and Output

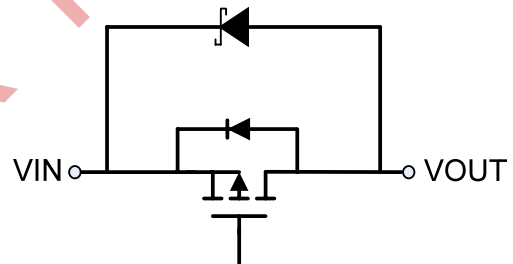


Figure 4—External Schottky Diode Connected in Parallel with the Internal Parasitic Diode

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 5 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.

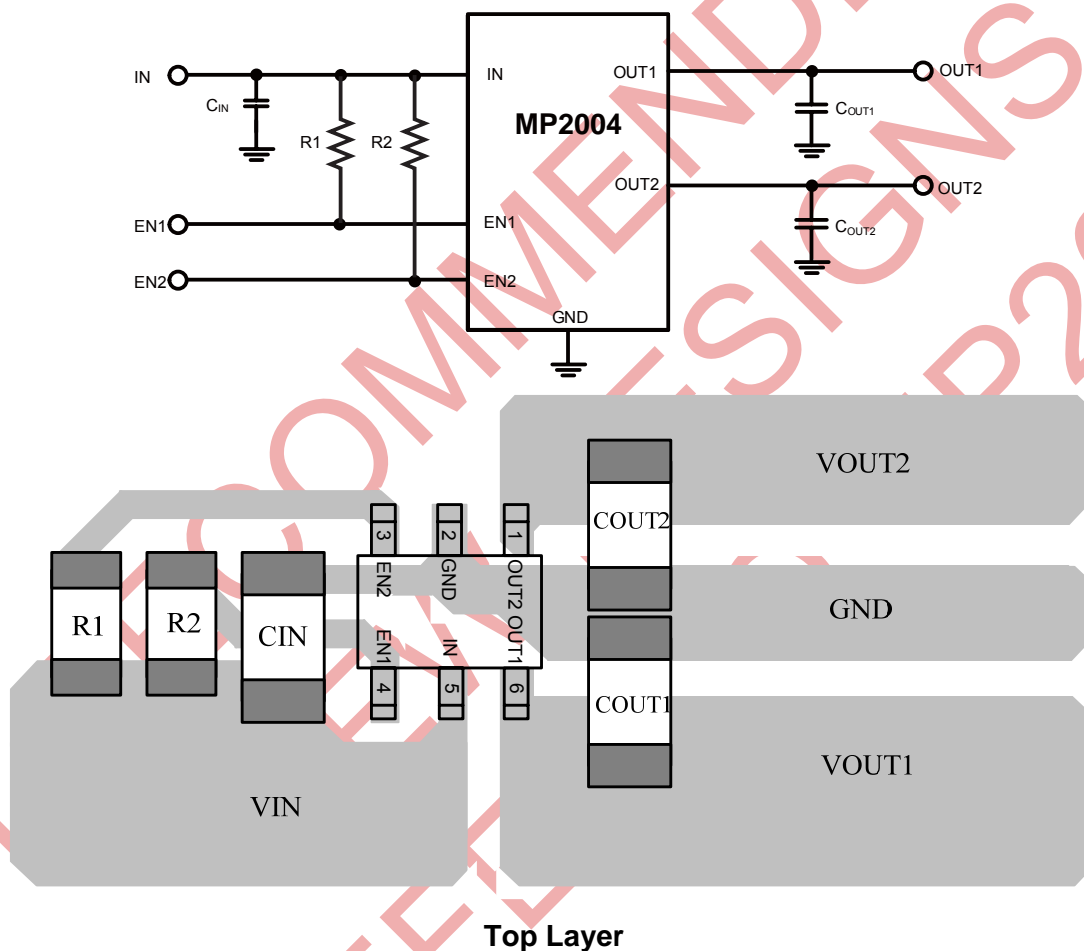
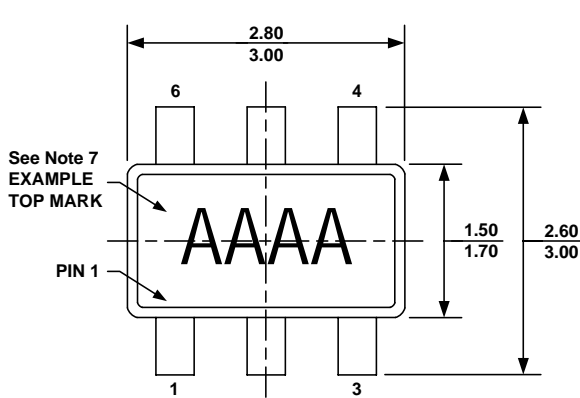


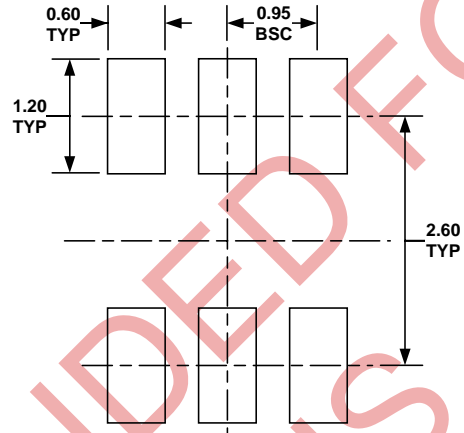
Figure 5—PCB Layout

PACKAGE INFORMATION

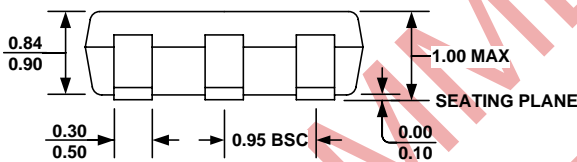
TSOT23-6



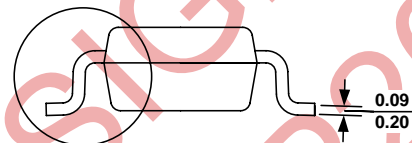
TOP VIEW



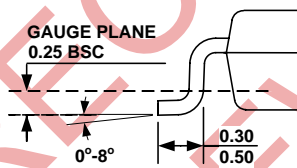
RECOMMENDED LAND PATTERN



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 AB.
- 6) DRAWING IS NOT TO SCALE.
- 7) PIN 1 IS LOWER LEFT PIN WHEN READING TOP MARK FROM LEFT TO RIGHT, (SEE EXAMPLE TOP MARK)

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