MP8904

500mA Linear Regulator

The Future of Analog IC Technology®

DESCRIPTION

The MP8904 is a low-current, low-dropout, linear regulator that operates on a single 2.5V-to-6.5V input supply. An external resistor controls the output voltage. The MP8904 can supply up to 500mA of load current. The enable pin (EN) allows the part to enter a low-current shutdown mode (EN=0). The MP8904 features thermal overload and current limit protection. It is available in an 8-pin QFN (2×3mm) package.

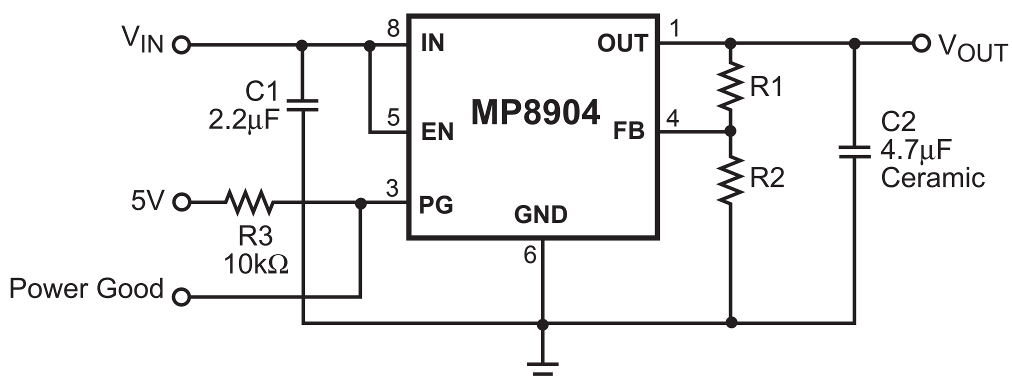
FEATURES

- Power-Good Open Collector Output
- Operates from a 2.5V-to-6.5V Input
- Low 300mV Dropout at 500mA Output
- Stable with Very Small Ceramic Capacitors
- 2% Feedback Reference
- Adjustable Output Voltage from 0.5V to 5V
- Better than 0.001%/mA Load Regulation
- Stable with Low-ESR Output Capacitor
- Low 100µA Ground Current
- Internal Thermal Protection
- Current Limit Protection
- 6µA Typical Quiescent Current at Shutdown

APPLICATIONS

- Low-Current Regulators
- Battery-Powered Systems
- Mobile Devices, such as Cell Phones and GPS Navigators

TYPICAL APPLICATION

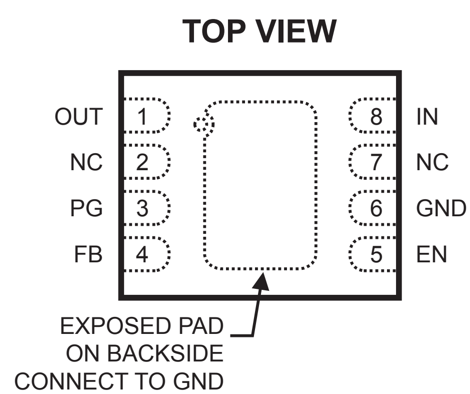


ORDERING INFORMATION

Part Number*	Package	Top Marking
MP8904DD	QFN8(2 x 3mm)	T3

* For Tape & Reel, add suffix –Z (eg. MP8904DD–Z)
For RoHS Compliant Packaging, add suffix –LF (eg. MP8904DD–LF–Z)

PACKAGE REFERENCE



ABSOLUTE MAXIMUM RATINGS (1)

IN, FB to GND .... -0.3V to +7V
EN to GND .... -0.3V to V_{IN} +0.3V
OUT .... -0.3V to V_{IN} + 0.3V
Continuous Power Dissipation (T_A = +25°C)(2)
.... 2.5W

Junction Temperature .... 150°C
Lead Temperature .... 260°C
Storage Temperature .... -65°C to +150°C

Recommended Operating Conditions (3)

Input Voltage V_{IN} .... 2.5V to 6.5V
Output Voltage .... 0.5V to 5V
Load Current .... 500mA Maximum
Operating Junction Temp. (T_J). -40°C to +125°C

Thermal Resistance (4) θ_{JA} θ_{JC}

QFN8 (2 x 3mm) .... 55 ...... 12 ... °C/W

Notes:

1) Exceeding these ratings may damage 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 $P_D(MAX)=(T_J(MAX)-T_A)/\theta_{JA}$. 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.
3) The device is not guaranteed to function outside of its operating conditions.
4) Measured on approximately 1” square of 1 oz copper.

ELECTRICAL CHARACTERISTICS

V_{IN} = 3.3V, V_{OUT} = 1.2V, C_{OUT} = 4.7µF, C_{IN} = 2.2µF, T_A = +25°C, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ [(4)]	Max	Units
Operating Voltage		I_{OUT} = 1mA	2.5		6.5	V
Ground Pin Current		I_{OUT} = 1mA [(6)]		100		µA
		I_{OUT} = 500mA		5		mA
Shutdown Current		V_{EN} = 1.45V, V_{IN} = 5V		7		µA
FB Regulation Voltage			0.484	0.496	0.508	V
		-40°C ≤ T_A ≤ +85°C	0.481	0.496	0.510	
Dropout Voltage [(7)]		I_{OUT} = 500mA		300		mV
Line Regulation		I_{OUT} = 1mA, V_{IN} = (V_{OUT} + 0.5V) to 6.5V [(7)]		0.005		%/V
Load Regulation		I_{OUT} = 1mA to 500mA, V_{IN} = V_{OUT} + 0.5V		0.001		%/mA
Power-Good Output Voltage, Low[(8)]	V_{OL}	I_{sink} = 0.5mA		0.5		V
EN Input, High			1.2			V
EN Input, Low					0.4	V
EN Input Bias Current		V_{EN} = 1.5V, 5V		0.01	1	µA
Thermal Protection				155		°C
Current Limit			550	730		mA

Notes:

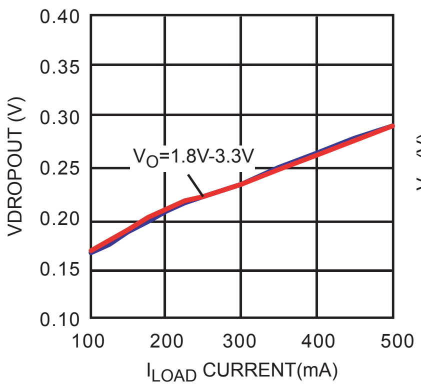
5) Parameter is guaranteed by design, not production tested.
6) Resistors for V_{OUT} measurement are 10kΩ, 14kΩ, 1%
7) The ground current does not include current through feedback current
8) Dropout Voltage is defined as the input to output differential when the output voltage drops 1% below its nominal value
9) $V_{FEEDBACK}$ is 90% of the regulated value with 10kΩ pull-up to 5V

TYPICAL PERFORMANCE CHARACTERISTICS

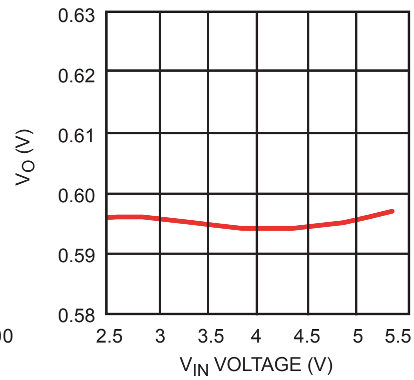
Based on the Figure 2 Typical Application Circuit

C1=2.2μF, C2 =4.7μF, C3=1nF, T_A = +25°C, unless otherwise noted.

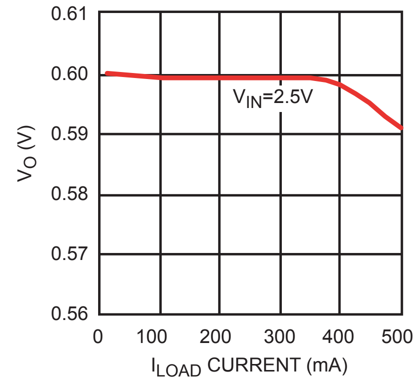
Voltage Dropout vs Current



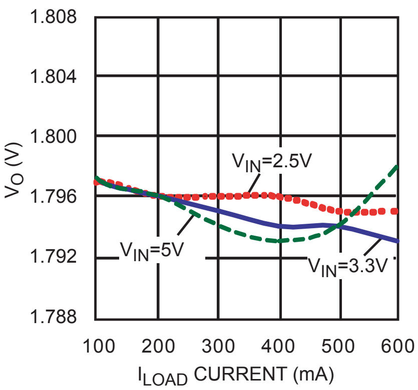
Line Regulation



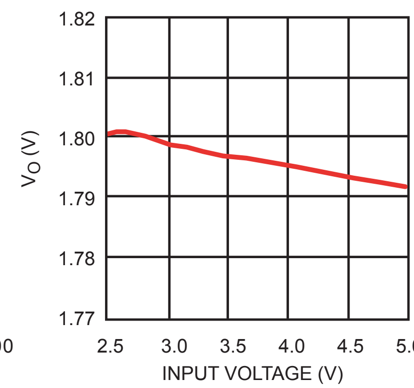
Load Regulation



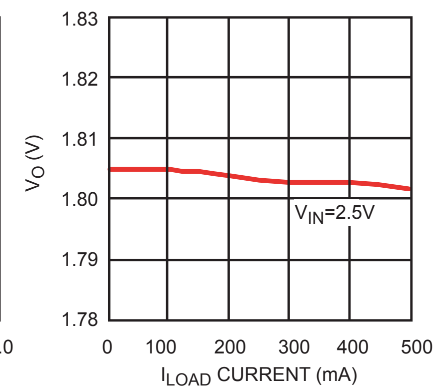
85 °C Load Regulation



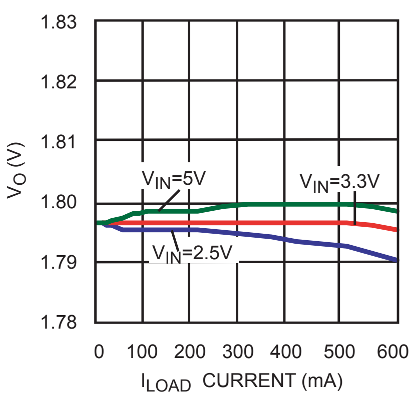
Line Regulation



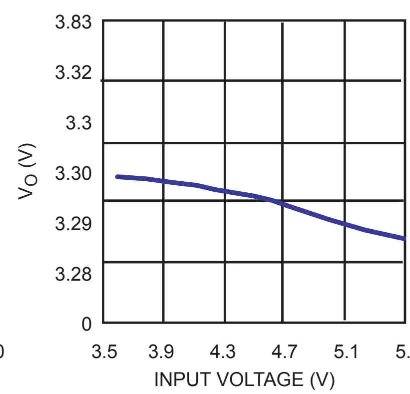
Load Regulation



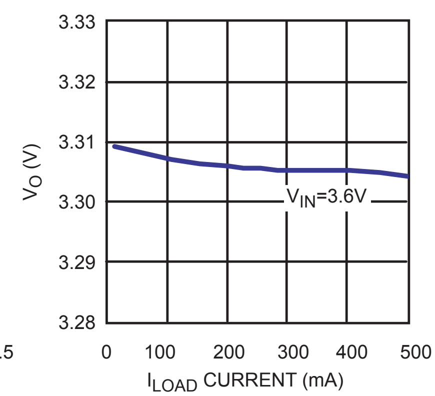
-40 °C Load Regulation



Line Regulation



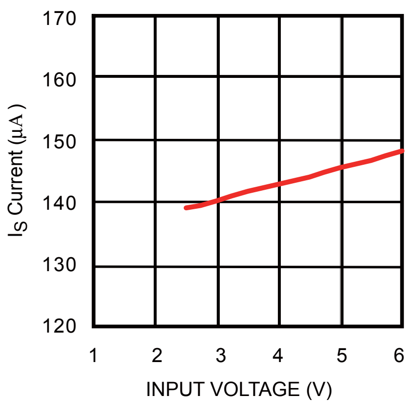
Load Regulation



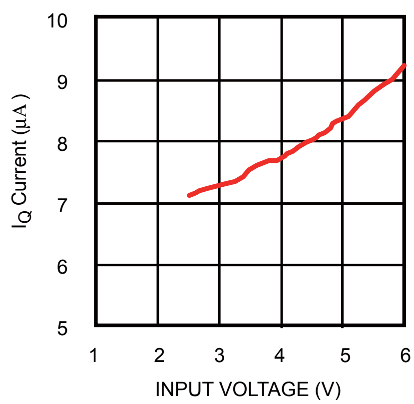
TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

C1=2.2µF, C2 =4.7µF, C3=1nF, T_A = +25°C, unless otherwise noted.

Supply Current vs. Input Voltage

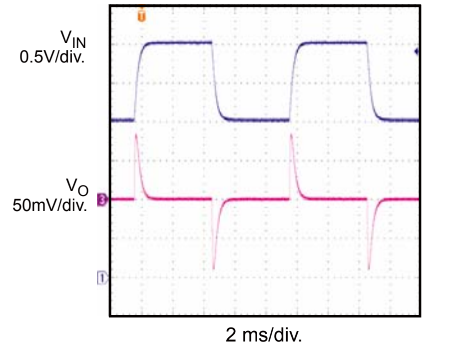


Shut Down Current vs. Input Voltage

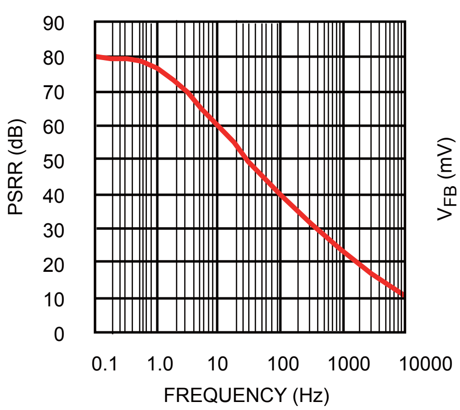


Line Transient

V_{IN} = 2.5V to 3.5V, V_O = 1.8V, V_{EN}= V_{IN}, I_{LOAD} = 50mA, with Resisitor Load

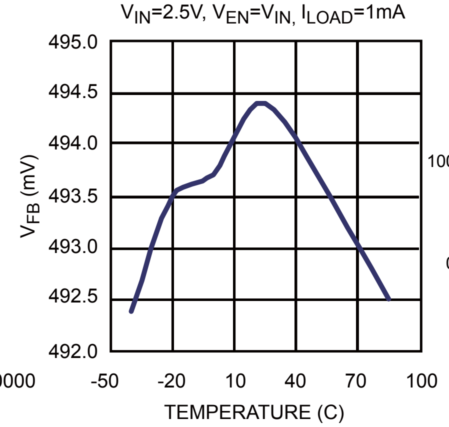


PSRR vs Frequency



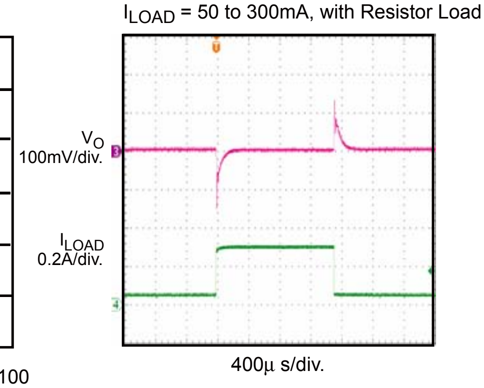
V_{FB} vs Temperature

V_{IN}=2.5V, V_{EN}=V_{IN}, I_{LOAD}=1mA



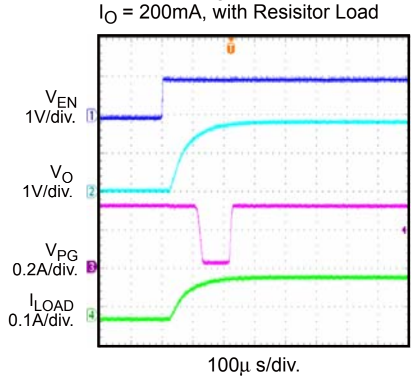
Load Transient

V_{IN} = 2.5V, V_O = 1.8V, V_{EN}= V_{IN}, I_{LOAD} = 50 to 300mA, with Resistor Load



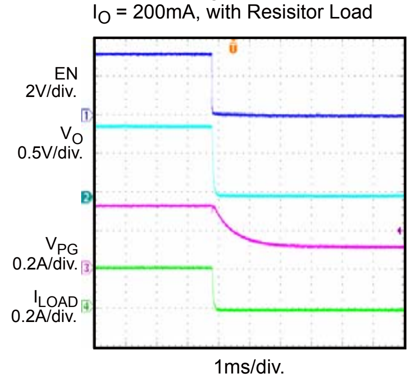
Enable Turn On

V_{IN} = 3.3V, V_O = 1.8V,V_{EN} = 0V - 2V, I_O = 200mA, with Resisitor Load



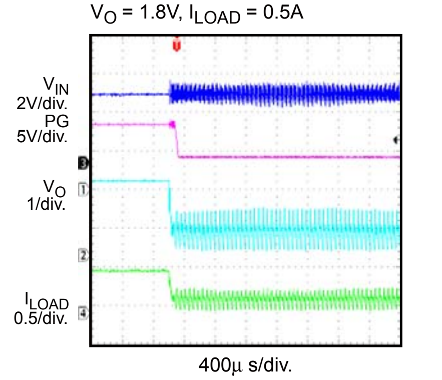
Enable Turn Off

V_{IN} = 3.3V, V_O = 1.8V,V_{EN} = 2V - 0V, I_O = 200mA, with Resisitor Load



Thermal Protection

V_{IN} = V_{EN} = 5V, V_O = 1.8V, I_{LOAD} = 0.5A

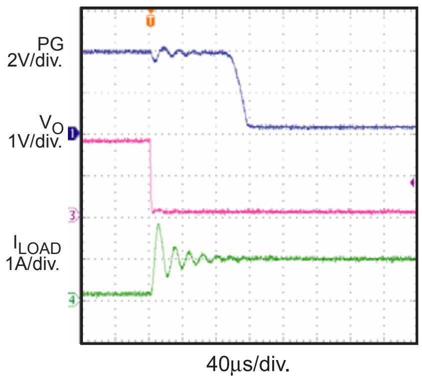


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

C1=2.2µF, C2 =4.7µF, C3=1nF, T_A = +25°C, unless otherwise noted.

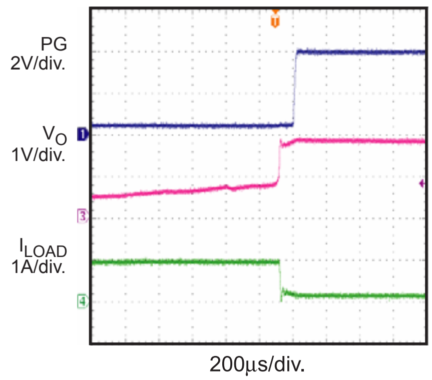
Short Circuit Protection

V_{IN} = 4V, V_O = 1.8V, V_{EN} = V_{IN}



Short Circuit Recovery

V_{IN} = 4V, V_O = 1.8V, V_{IN} = V_{EN}



PIN FUNCTIONS

Pin #	Name	Description
1	OUT	Regulator Output. Bypass OUT to GND with a ≥4.7µF capacitor.
2	NC	No connect.
3	PG	Power-Good Open Collector Output. Monitors the regulator output. If the regulator output falls below 10% of its regulation point, the power-good pin goes low.
4	FB	Feedback. Connect a resistive voltage divider from OUT to FB to set the output voltage. OUT feedback threshold is 0.5V.
5	EN	Enable Input. Drive EN above 1.2V to turn on the MP8904. Drive EN below 0.4V to turn it off.
6	GND	Ground.
7	NC	No connect.
8	IN	Power Source Input. IN supplies the internal power to the MP8904 and is the source for the pass transistor. Bypass IN to GND with a ≥2.2µF capacitor.
Exposed Pad		Connect to GND.

OPERATION

The MP8904 is a low-current, low-voltage, low-dropout, linear regulator. It is intended for devices that require very low voltage and low quiescent current power, such as wireless modems and cellular phones.

The MP8904 uses a PNP pass element and features internal thermal shutdown and internal current limit circuit.

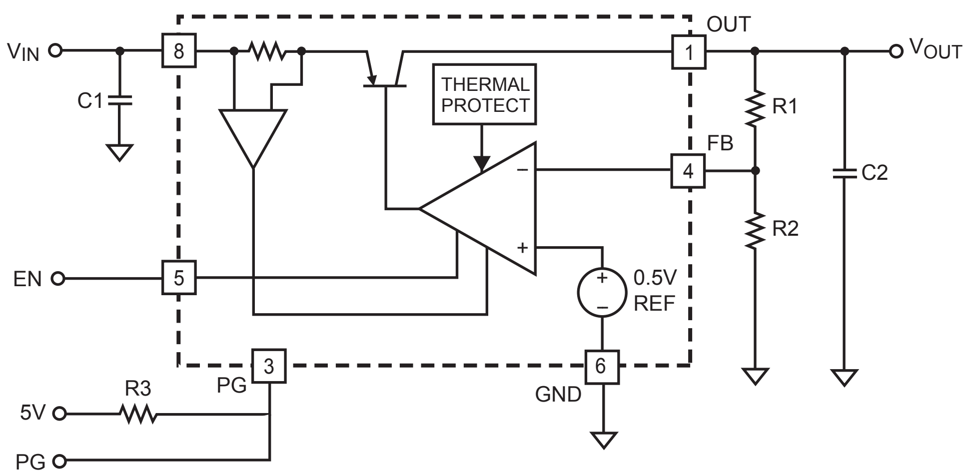


Figure 1: Functional Block Diagram

APPLICATION INFORMATION

Setting the Output Voltage

The MP8904 has an adjustable output voltage set via an external resistor divider (R1 and R2 in Figure 2).

$$R1 = R2 \times \left(\frac{V_{OUT} - V_{FB}}{V_{FB}} \right)$$

where V_{FB} = 0.5V is the OUT feedback threshold voltage.

Example: For a 2.5V output and R2=10kΩ

$$R1 = 10k \times \left(\frac{2.5 - 0.5}{0.5} \right) = 40k$$

Use a standard 40kΩ (±1%) resistor for R1.

Table 1 lists selected R1 values for typical output voltages (R2 = 10kΩ).

Power-Good

The power-good (PG) pin monitors the output voltage; if the output voltage goes below 10% of its regulation point, the PG pin goes low. The PG pin is an open collector output that connects to a pull-up resistor (typically 10kΩ). Tie the pull-up resistor to 0V-to-5.5V supply, such as regulated input voltage.

Table 1: Adjustable Output Voltage Values vs. R1 (R2 =10kΩ)

V_{OUT} (V)	R1 (Ω)
1.25	15k
1.5	20k
1.8	26k
2	30k
2.5	40k
2.8	46k
3	50k
3.3	56k
4	70k
5	90k

Bypass Capacitors

Bypass the reference voltage can be bypassed with an external capacitor to reduce noise. Use a low-ESR ceramic capacitor for the best performance.

TYPICAL APPLICATION CIRCUIT

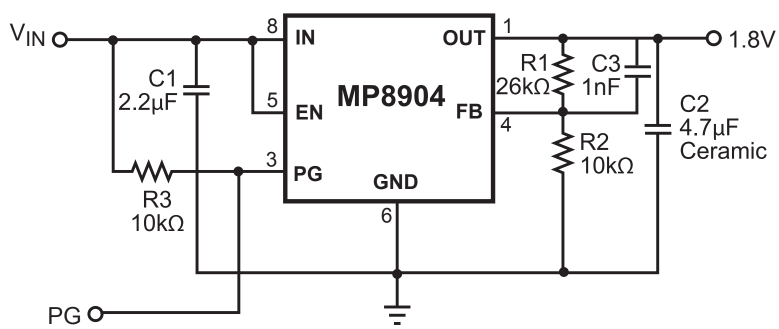


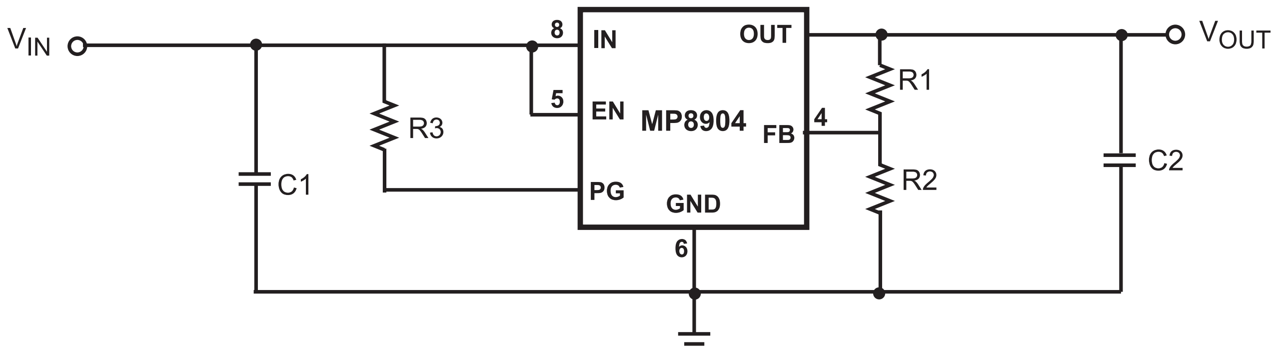
Figure 2: Typical Application Circuit

PCB layout guide

PCB layout is very important to achieve good regulation, ripple rejection, transient response and thermal performance. For optimal performance, duplicate the EVB layout from Figure 3.

For any changes, follow the guidelines below:

1) Place the input and output ceramic bypass capacitors close to their respective IN and OUT pins.
2) Use short and direct feedback connections. Place the feedback resistors and compensation components as close to the chip as possible.
3) Connect IN, OUT and GND to large copper surfaces to help cool the chip to improve thermal performance and long-term reliability.



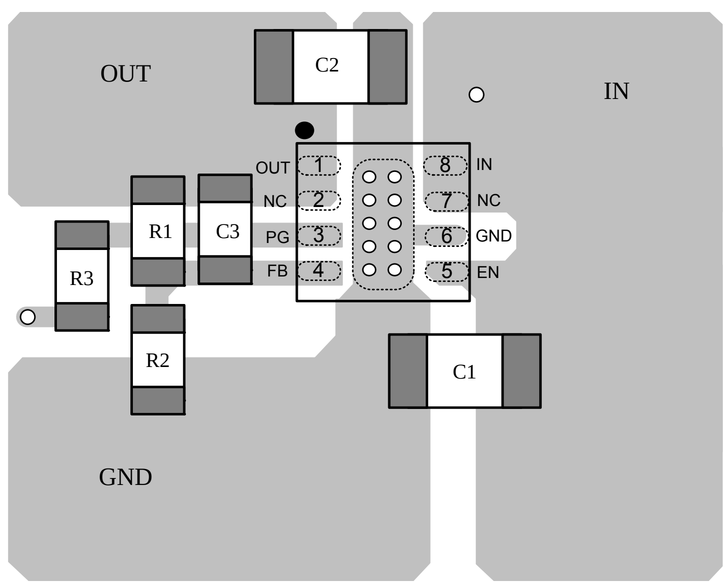


Figure 3: PCB Layout, Top Layer