500mA Dual LDO Regulator

General Description

The RT9184 is a dual-channel, low noise, and low dropout regulator supplying up to 500mA current at each channel. The output voltage ranges from 1.5V to 3.3V in 100mV increment and 2% accuracy by operating from a +2.7V to +6.5V input.

The RT9184 uses two internal PMOS as the pass device, which consumes 185μA supply current (both LDOs on) independent of load current and dropout conditions. Other features include a current limiting and over temperature protection.

Applications

- Desktop Computers
- CD-RW
- LCD Monitor
- Information Appliance

Ordering Information

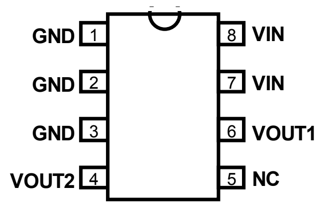
RT9184□ □ □

- Package type
  - H : PSOP-8
- Operating temperature range
  - C : Commercial standard
- Output voltage
  - A : 3.3V (Output1), 1.8V (Output2)
  - B : 3.3V (Output1), 2.5V (Output2)
  - Other voltage versions please contact RichTek for detail.

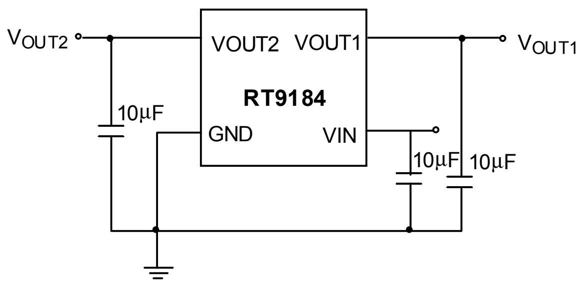
Features

- **Up to 500mA Output Current (Each LDO)**
- **Current Limiting and Thermal Protection**
- **Short Circuit Protection**
- **650mV Dropout at 500mA Load**
- **Two LDOs in Power SOP-8 Package**

Pin Configurations

Part Number	Pin Configurations
RT9184□CH (Plastic PSOP-8)	TOP VIEW 

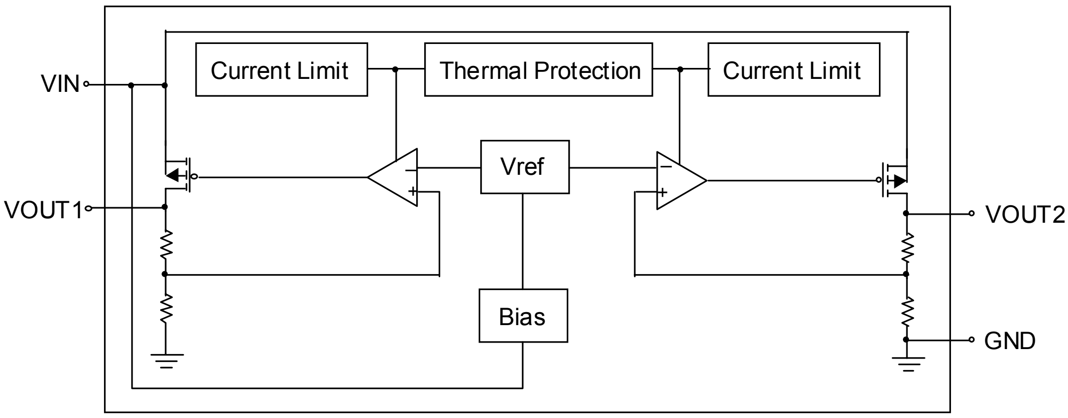
Typical Application Circuit



Pin Description

Pin Name	Pin Function
VIN	Power Input
GND	Ground
VOUT1	Output1 Voltage
VOUT2	Output2 Voltage
NC	No Connected

Function Block Diagram



Absolute Maximum Ratings

- Input Voltage ---------- 7V
- Package Thermal Resistance
  PSOP-8, θ_{JC} ---------- 28°C/W
- Junction Temperature Range ---------- -40°C ~ 125°C
- Storage Temperature Range ---------- -65°C ~ 150°C
- Operating Temperature Range ---------- -40°C ~ 85°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C

Electrical Characteristics

(V_{IN} = 5V, C_{IN} = C_{OUT} = 10μF, typical values at T_A = 25°C, for each LDO unless otherwise specified.)

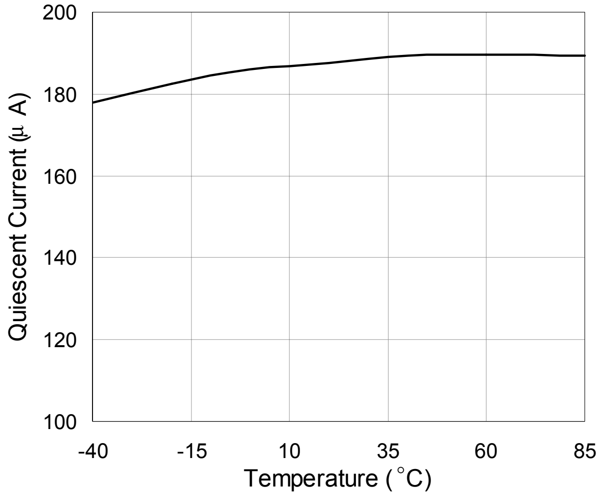
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Input Voltage Range	V_{IN}		2.7	--	6.5	V
Output Voltage Accuracy	ΔV_{OUT}	I_{OUT} = 1mA	-2	--	+2	%
Maximum Output Current	I_{MAX}	Continuous	500	--	--	mA
Current Limit	I_{LIMIT}	R_{LOAD} = 1Ω	510	--	1000	mA
GND Pin Current (Whole Chip)	I_G	No Load	--	185	260	μA
Dropout Voltage [Note]	V_{DROP}	I_{OUT} = 500mA	--	650	--	mV
Line Regulation	ΔV_{LINE}	V_{IN} = (V_{OUT} +0.4V or 2.7V) to 6.5V I_{OUT} = 1mA	-0.2	--	+0.2	%/V
Load Regulation	ΔV_{LOAD}	I_{OUT} = 1mA to 500mA	-35	-20	+5	mV
Thermal Shutdown Temperature			125	180	--	°C
Thermal Shutdown Hysteresis	T_{SD}		--	20	--	°C
Output Voltage AC PSRR		100Hz, C_{OUT} = 10μF I_{LOAD} = 100mA	--	62	--	dB

Note : Dropout voltage definition: V_{IN} – V_{OUT} when V_{OUT} is 50mV below the value of V_{OUT} (normal)

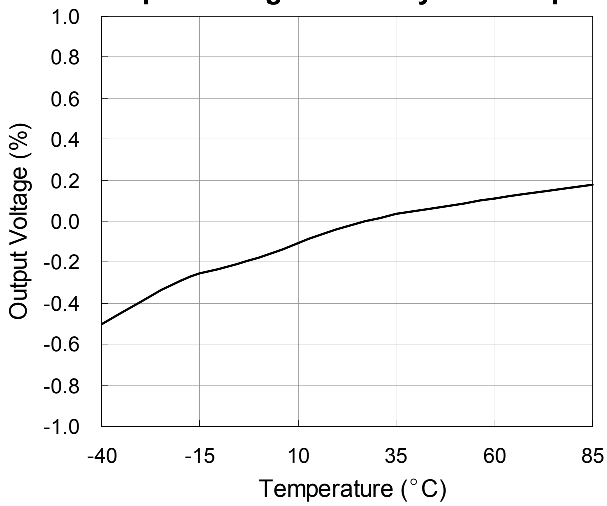
Typical Operating Characteristics

I_{LOAD} = 100mA, V_{IN} = 5V, C_{OUT} = 10μF, and C_{IN} = 10μF, unless otherwise noted.

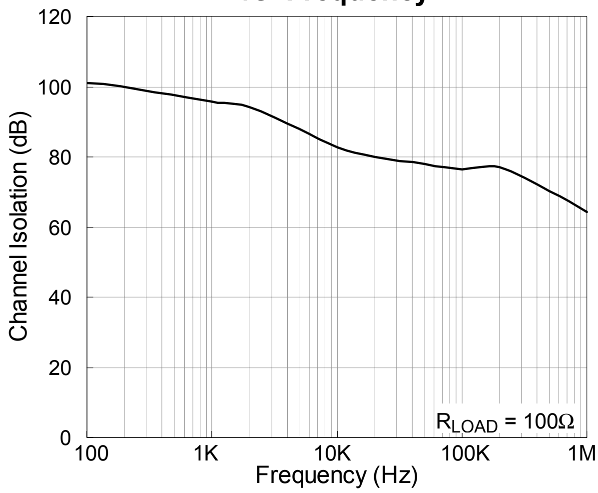
Quiescent Current vs. Temp.



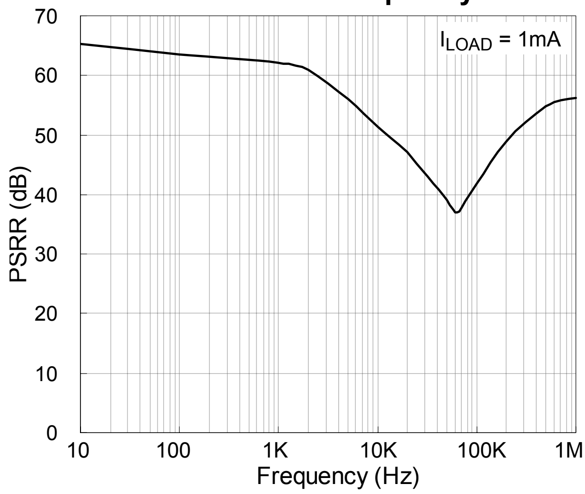
Output Voltage Accuracy vs. Temp.



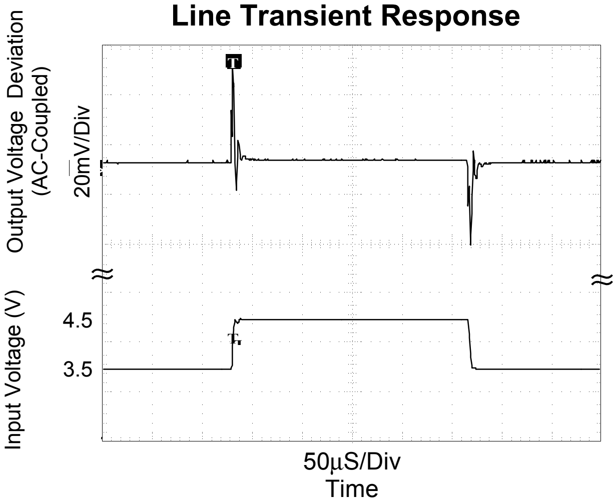
Channel-to-Channel Isolation vs. Frequency



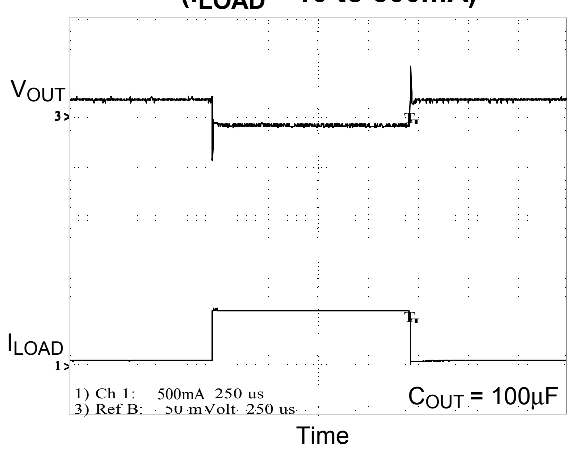
PSRR vs. Frequency



Line Transient Response



Load Transient Response (I_{LOAD} = 10 to 500mA)



Functional Description

The RT9184 integrate two low noise, low dropout, and low quiescent current linear regulators. Output voltages are optional ranging from 1.5V to 3.3V, and each channel can supply current up to 500mA.

Internal P-Channel Pass Transistor

The RT9184 features double typical 1.3Ω P-channel MOSFET pass transistors. It provides several advantages over similar designs using PNP pass transistors. The P-channel MOSFET requires no base drive, which reduces quiescent current significantly than PNP-based regulator, which wastes considerable current in dropout when the pass transistor saturates. They also use high base-drive currents under large loads. The RT9184 does not suffer from these problems and consume only 185μA of quiescent current whether in dropout, light-load, or heavy-load applications.

Current Limit and Thermal Protection

The RT9184 includes two independent current limit structure which monitor and control each pass transistor's gate voltage limiting the guaranteed maximum output current to 510mA minimum.

Thermal-overload protection limits total power dissipation in the RT9184. When the junction temperature exceeds T_J = +180°C, the thermal sensor signals the shutdown logic turning off the pass transistor and allowing the IC to cool down. The thermal sensor will turn the pass transistor on again after the IC's junction temperature cools by 20°C, resulting in a pulsed output during continuous thermal-overload conditions. Thermal-overloaded protection is designed to protect the RT9184 in the event of fault conditions. Do not exceed the absolute maximum junction-temperature rating of T_J = +125°C for continuous operation. The output can be shorted to ground for an indefinite amount of time without damaging the part by cooperation of current limit and thermal protection.

Applications Information

Capacitor Selection and Regulator Stability

Like any low-dropout regulator, the external capacitors used with the RT9184 must be carefully selected for regulator stability and performance.

Using a capacitor whose value is greater than 1μF on the RT9184 input and the amount of capacitance can be increased without limit. The input capacitor must be located a distance of not more than 0.5" from the input pin of the IC and returned with a clean analog ground. Any good quality ceramic or tantalum can be used for this capacitor. The capacitor with larger value and lower ESR (equivalent series resistance) provides better PSRR and line-transient response.

The RT9184 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor whose value is at least 1μF on the RT9184 output ensures the stability. The RT9184 still works well with output capacitor of other types due to the wide stable ESR range. Output capacitor of larger capacitance can reduce noise and improve load-transient response, stability, and PSRR. The output capacitor should be located not more than 0.5" from the V_{OUT} pin of the RT9184 and returned with a clean analog ground.

Note that some ceramic dielectrics exhibit large capacitance and ESR variation with temperature. It may be necessary to use 2.2μF or more to ensure stability at temperatures below -10°C in this case. Also, tantalum capacitors, 2.2μF or more may be needed to maintain capacitance and ESR in the stable region for strict application environment.

Tantalum capacitors maybe suffer failure due to surge current when it is connected to a low-impedance source of power (like a battery or very large capacitor). If a tantalum capacitor is used at the input, it must be guaranteed to have a surge current rating sufficient for the application by the manufacture.

Load-Transient Considerations

The RT9184 load-transient response graphs show two components of the output response: a DC shift from the output impedance due to the load current change, and the transient response. The DC shift is quite small due to the excellent load regulation of the IC. Typical output voltage transient spike for a step change in the load current from 0mA to 50mA is tens mV, depending on the ESR of the output capacitor. Increasing the output capacitor's value and decreasing the ESR attenuates the overshoot.

Input-Output (Dropout) Voltage

A regulator's minimum input-output voltage differential (or dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. Because the RT9184 uses a P-channel MOSFET pass transistor, the dropout voltage is a function of drain-to-source on-resistance [$R_{DS(ON)}$] multiplied by the load current.

Reverse Current Path

The power transistor used in the RT9184 has an inherent diode connected between each regulator input and output (see Fig.1). If the output is forced above the input by more than a diode-drop, this diode will become forward biased and current will flow from the V_{OUT} terminal to V_{IN}. This diode will also be turned on by abruptly stepping the input voltage to a value below the output voltage. To prevent regulator mis-operation, a Schottky diode could be used in the applications where input/output voltage conditions can cause the internal diode to be turned on (see Fig.2). As shown, the Schottky diode is connected in parallel with the internal parasitic diode and prevents it from being turned on by limiting the voltage drop across it to about 0.3V < 100mA to prevent damaging the part.

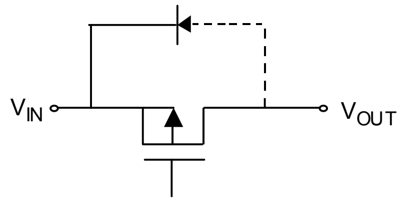


Fig. 1 V_{OUT} Structure of RT9184

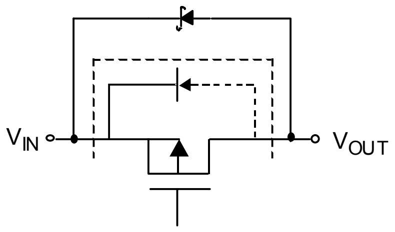


Fig. 2 External Schottky Diode to Prevent Internal Diode Turning on

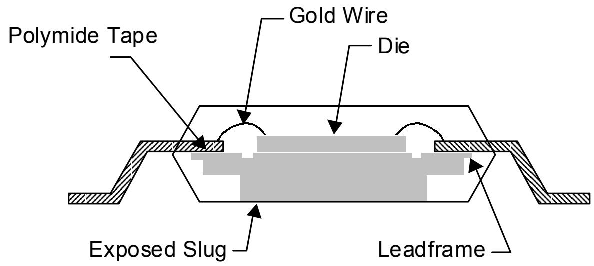


Fig. 3 Power SOP-8 Structure

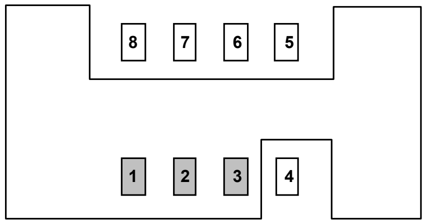


Fig. 4 Typical Footprint of RT9184

Power Dissipation and PCB Layout Note

The maximum power dissipation of RT9184 depends on the thermal resistance from the case to circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The power dissipation across the device is

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

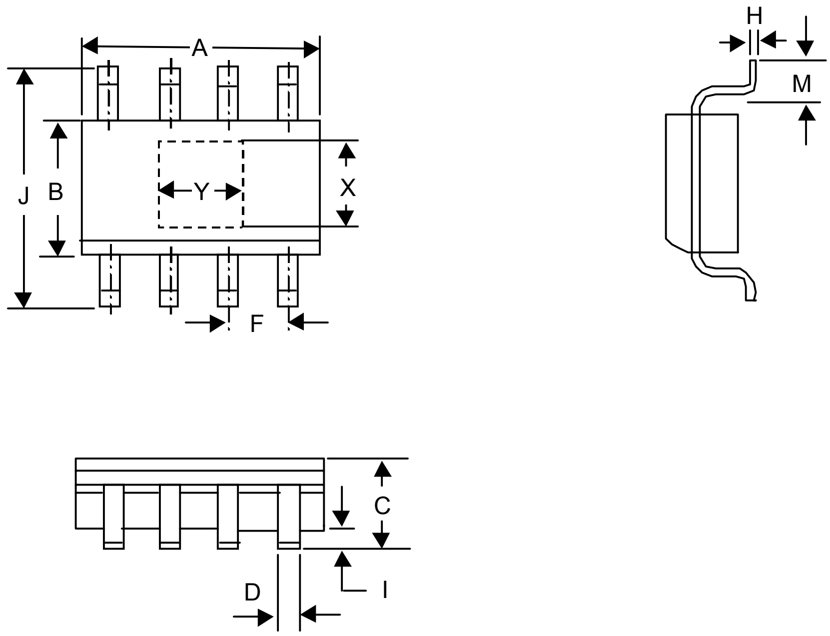
The maximum power dissipation is:

$PMAX = (T_J - T_A) / \theta_{JA}$

where $T_J - T_A$ is the temperature difference between the RT9184 die junction and the ambient environment, θ_{JA} is the thermal resistance from the junction to the ambient environment. The GND pin of the RT9184 performs the dual function of providing an electrical connection to ground and channeling heat away. Connect the GND pin to ground using a large pad or ground plane.

The RT9184 is assembled by power SOP-8 package with direct slug solder to PCB (Fig.3). This structure offers a low thermal resistance of junction to case (θ_{JC}) and can dissipate the heat away by proper PCB layout (a proper $\theta_{CA,}$ thermal resistance of case to ambient). Because the bottom slug of RT9184 plays the role as ground, the footprint in Fig.4 is a typical configuration for heat dissipating copper clad. Medium power dissipations of up to 2W are easily obtainable in practice with this configuration. The heat dissipating copper area on the PCB can be configured in various shapes and sized depending upon the particular application.

Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.801	4.950	0.189	0.195
B	3.810	3.988	0.150	0.157
C	1.470	1.730	0.058	0.068
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.190	0.250	0.007	0.009
I	0.050	0.150	0.002	0.006
J	5.791	6.198	0.228	0.244
M	0.380	1.270	0.015	0.050
X	1.830	2.290	0.072	0.090
Y	1.830	2.290	0.072	0.090

Power 8–Lead SOP Plastic Package

RICHTEK TECHNOLOGY CORP.
Headquarter
6F, No. 35, Hsintai Road, Chupei City
Hsinchu, Taiwan, R.O.C.
Tel: (8863)5510047 Fax: (8863)5537749

RICHTEK TECHNOLOGY CORP.
Taipei Office (Marketing)
8F-1, No. 137, Lane 235, Paochiao Road, Hsintien City
Taipei County, Taiwan, R.O.C.
Tel: (8862)89191466 Fax: (8862)89191465
Email: marketing@richtek-ic.com.tw