3A Fixed Output Voltage LDO Regulator

General Description

The RT9172 series of low-dropout linear regulators operate from a +2.25V to +6.0V input supply. A wide range of preset output voltage options is available. These low dropout linear regulators respond very fast to step changes in load, which are suitable for low voltage microprocessor applications. The RT9172 uses an internal PMOS as the pass device, which does not cause extra GND current in heavy load and dropout condition. The shutdown mode of low operation current makes the IC suitable for power-saving systems. The other features include current limiting and over temperature protection.

Ordering Information

RT9172□-□□ □ □

- Package type
  - T5 : TO-220-5
  - M5 : TO-263-5
  - T : TO-220
  - M : TO-263
  - G : SOT-223
- Operating temperature range
  - C: Commercial standard
- Output voltage
  - 15 : 1.5V
  - 16 : 1.6V
  - :
  - 32 : 3.2V
  - 33 : 3.3V
- S: Pin out exchange
  - N : Pin 5 bond sense
  - F : Pin 5 bond flg

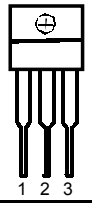
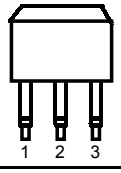
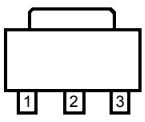
Features

- **Low Dropout Voltage**
- **Low Ground Pin Current**
- **Load Regulation of 0.4% at 3A**
- **0.5μA Quiescent Current in Shutdown Mode**
- **Guaranteed Output Current of 3A DC**
- **Available in TO-263 and TO-220 Packages**
- **Output Voltage Accuracy ±1.5%**
- **Error Flag Indicates Output Status**
- **Sense Option Improves Better Load Regulation**
- **Extremely Low Output Capacitor Requirements**
- **Over-temperature/Over-current Protection**

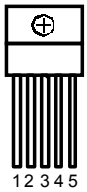
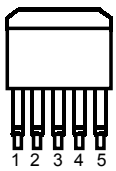
Applications

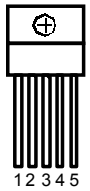
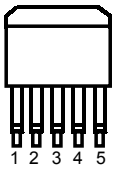
- Microprocessor Power Supplies
- GTL, GTL+, BTL, and SSTL Bus Terminators
- Power Supplies for DSPs
- SCSI Terminator
- Post Regulators
- High Efficiency Linear Regulators
- Battery Chargers
- Other Battery Powered Applications

Pin Configurations

Part Number	Pin Configurations
RT9172-□□CT (Plastic TO-220)	 TOP VIEW 1. VIN 2. GND (TAB) 3. VOUT
RT9172-□□CM (Plastic TO-263)	 TOP VIEW 1. VIN 2. GND (TAB) 3. VOUT
RT9172-□□CG (Plastic SOT-223)	 TOP VIEW 1. VIN 2. GND (TAB) 3. VOUT

To be continued

Part Number	Pin Configurations
RT9172N-□□CT5 RT9172F-□□CT5 (Plastic TO-220-5)	 TOP VIEW 1. EN 2. VIN 3. GND (TAB) 4. VOUT 5. SENSE/FLG
RT9172N-□□CM5 RT9172F-□□CM5 (Plastic TO-263-5)	 TOP VIEW 1. EN 2. VIN 3. GND (TAB) 4. VOUT 5. SENSE/FLG

Part Number	Pin Configurations
RT9172S-□□CT5 (Plastic TO-220-5)	 TOP VIEW 1. VIN 2. EN 3. GND (TAB) 4. SENSE 5. VOUT
RT9172S-□□CM5 (Plastic TO-263-5)	 TOP VIEW 1. VIN 2. EN 3. GND (TAB) 4. SENSE 5. VOUT

Typical Application Circuit

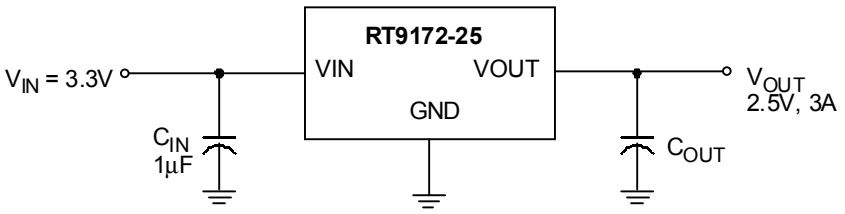


Fig. 1

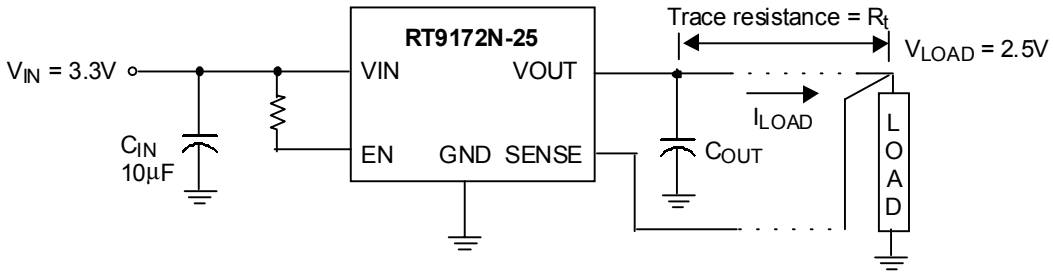


Fig. 2

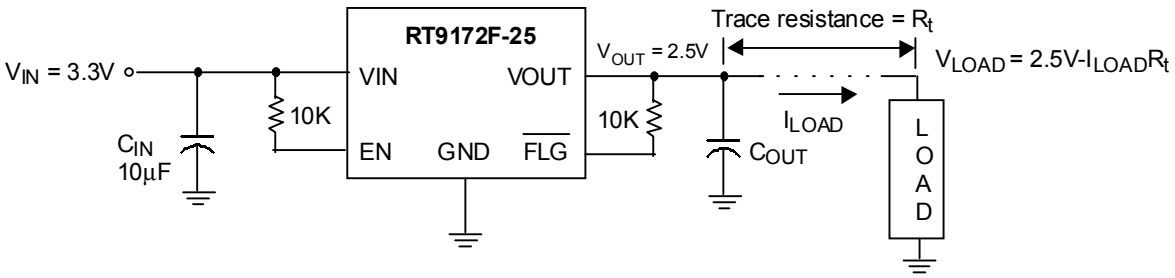
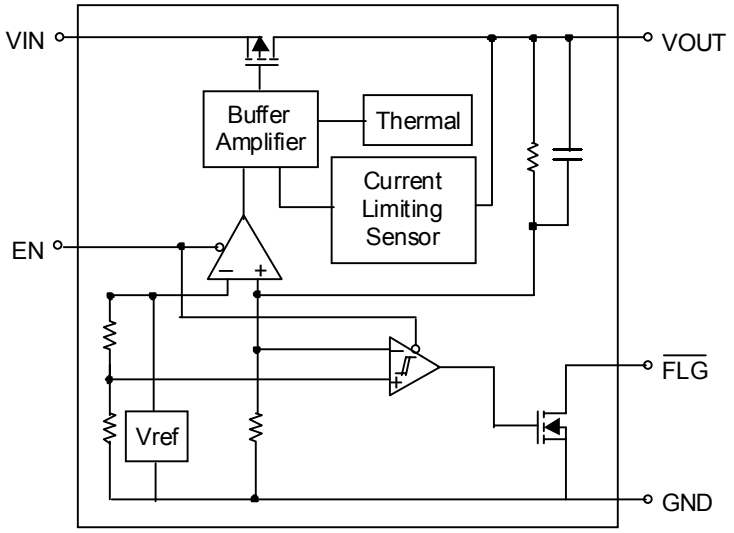


Fig. 3

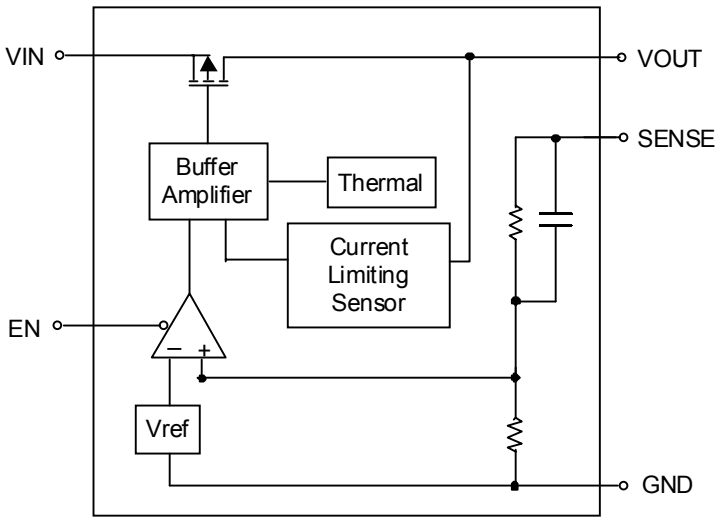
Recommend C_{OUT}: (1) 10μF (or larger) electrolytic or tantalum capacitance
(2) 1μF or 10μF ceromic capacitor parrell with 100μF electrolytic or tantalum capacitance

Function Block Diagram

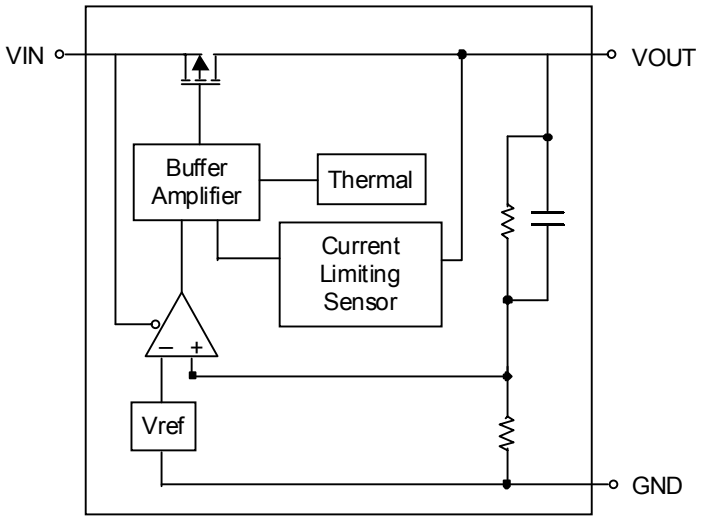
RT9172F



RT9172N/RT9172S



RT9172



Absolute Maximum Ratings

- Input Voltage ---------- 6V
- Power Dissipation ---------- Internally Limited
- ESD Rating ---------- 3 kV
- Storage Temperature Range ---------- –65°C to 150°C
- Lead Temperature (Soldering, 5 sec.) ---------- 260°C
- Package Thermal Resistance
  - TO-263, θ_{JC} ---------- 8°C/W
  - TO-263, θ_{JA} ---------- 19.4°C/W
  - TO-220, θ_{JC} ---------- 8°C/W
  - TO-220, θ_{JA} ---------- 62°C/W
  - SOT-223, θ_{JC} ---------- 15°C/W
  - SOT-223, θ_{JA} ---------- 60°C/W
- Junction Temperature Range ---------- -40°C to +125°C

Electrical Characteristics

(Limits in standard typeface are for T_A = 25°C, unless otherwise specified: $V_{IN} = V_{O(NOM)} + 1.0V$, I_L = 10mA, C_{OUT} = 10μF (Ceramic), $V_{EN} = V_{IN}$)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage Tolerance			-1.5	0	+1.5	%
Input Voltage Range	V_{IN}		2.25	--	6	V
Line Regulation	ΔV_{LINE}	V_{OUT} + 0.4V < V_{IN} < 6.0V	--	0.35	0.8	%
Load Regulation	ΔV_{LOAD}	Note 1	--	0.4	1	%
		Note 2	--	0.1	0.3	
Dropout Voltage	V_{DROP}	I_L = 300mA	--	50	70	mV
		I_L = 3A	--	400	700	
Quiescent Current	I_Q		--	1.2	3	mA
Shutdown Supply Current	I_{GSD}	V_{EN} = 0V	--	0.5	5	μA
Peak Output Current	$I_{O(PEAK)}$		3.5	5	--	A
Short Circuit Protection						
Current Limit	I_{LIMIT}		3.5	5	--	A
Over Temperature Protection						
Shutdown Threshold	T_{SD}	Guaranteed by design	--	170	--	°C
Thermal Shutdown Hysteresis		Guaranteed by design	--	10	--	°C
Shutdown Function						
EN Pin Shutdown Threshold	V_{EN}	Output = High	1.2	V_{IN}	--	V
		Output = Low	--	0	0.4	
EN Input Current		$V_{EN} = V_{IN}$	--	0.1	--	nA
FLG Pin Leakage Current	$I_{LEAKAGE}$		--	1	--	nA
FLG Pin Sink Current		V_{FLG} = 0.5V	2	--	--	mA

Note 1: RT9172-CX, RT9172F-XXCX5, 10mA < I_L < 3A

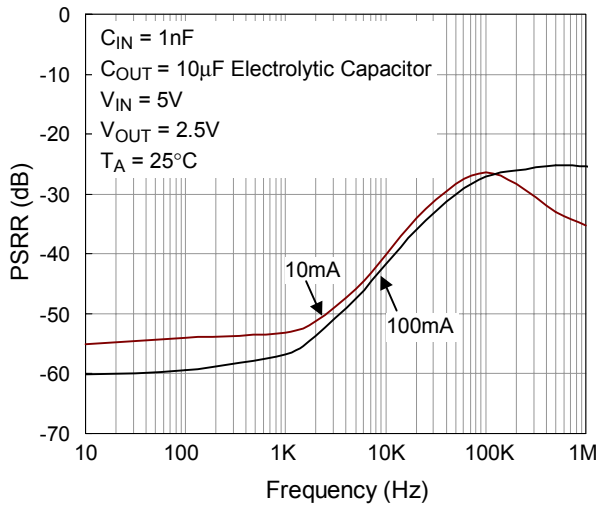
Note 2: RT9172S-XXCX5, RT9172N-XXCX5, 10mA < I_L < 3A

Pin Description

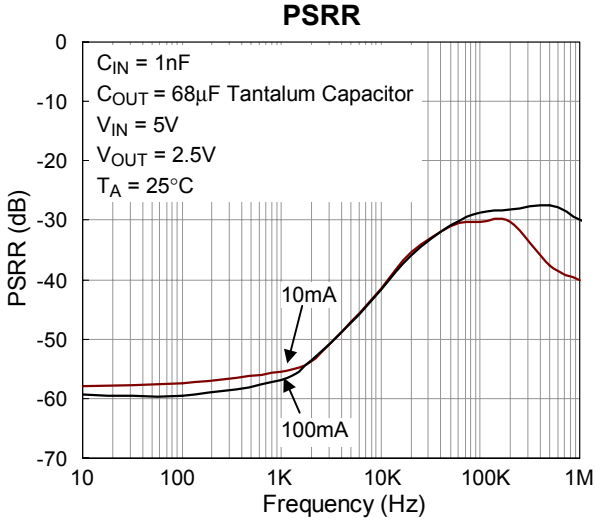
Pin No.				Pin Name	Pin Function
RT9172F	RT9172N	RT9172S	RT9172		
1	1	2	--	EN	Chip Enable
2	2	1	1	VIN	Power Input
3	3	3	2	GND	Ground
4	4	5	3	VOUT	Output Voltage
5	--	--	--	$\overline{\text{FLG}}$	ERROR Flag
--	5	4	--	SENSE	Remote Sense

Typical Operating Charateristics

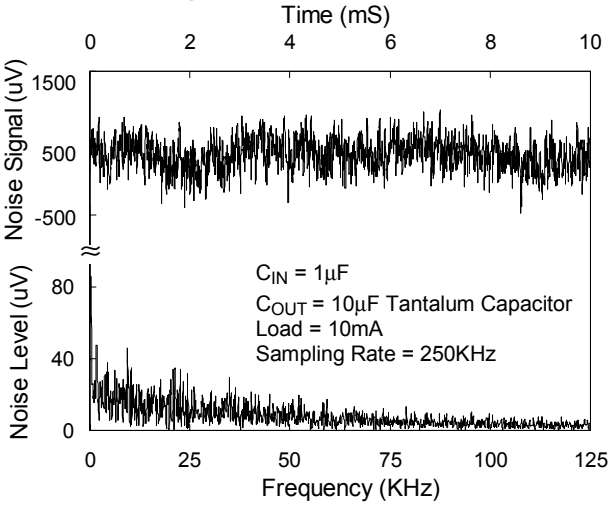
PSRR



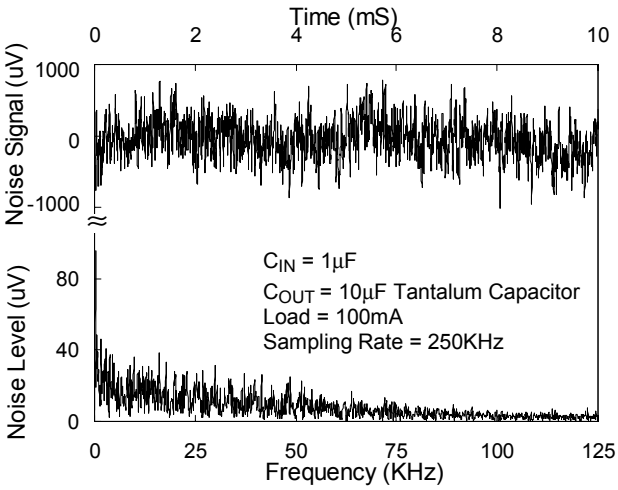
PSRR



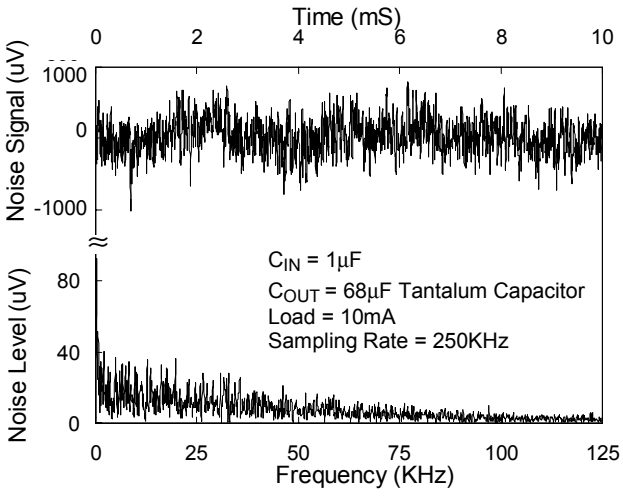
Noise Signal & Spectrum Distribution



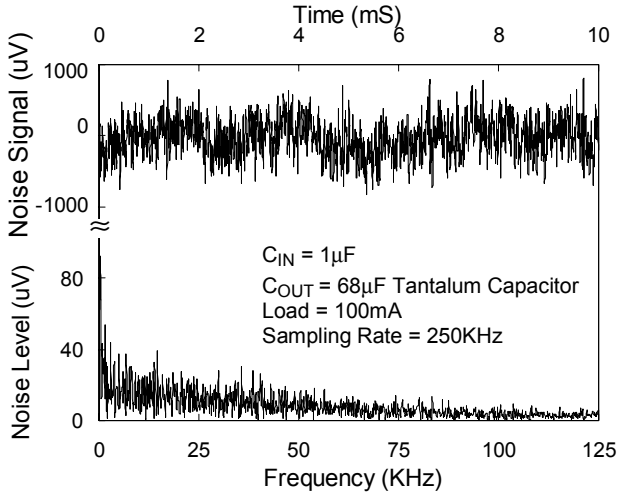
Noise Signal & Spectrum Distribution



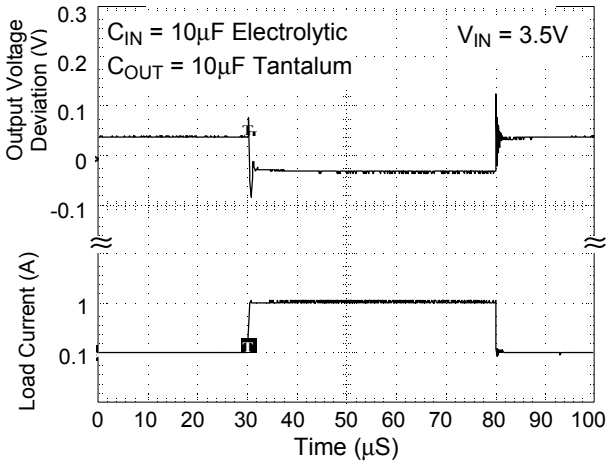
Noise Signal & Spectrum Distribution



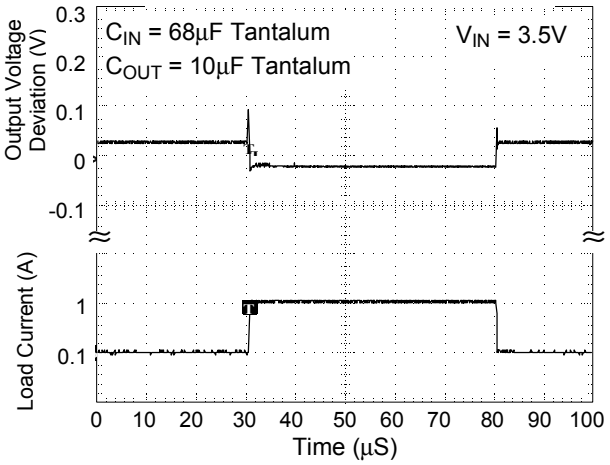
Noise Signal & Spectrum Distribution



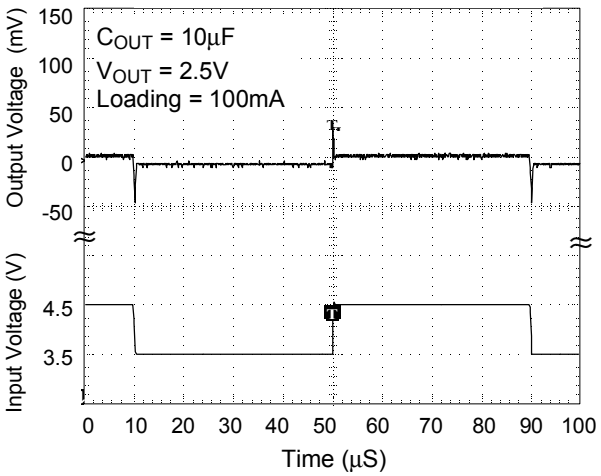
Load Transient Response



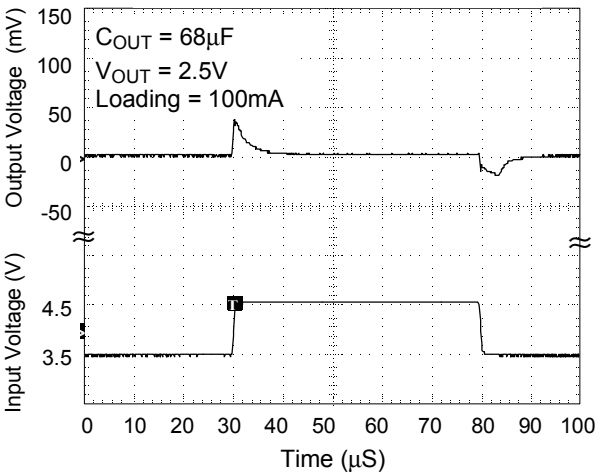
Load Transient Response



Line Transient Response



Line Transient Response



Functional Description

Capacitor Selection

The RT9172 requires a minimum input capacitance of 1μF between the input and ground pins to prevent any impedance interactions with the supply. The RT9172 requires a minimum of 10μF (tantalum, or electrolytic) capacitance between the output and ground pins for proper operation, if used 10μF ceromic please parrell with 100μF tantalum or electrolytic. Larger capacitance provides better load dynamics and noise performance.

Error Operation ($\overline{FLG}$)

The RT9172 produces a logic low signal at the $\overline{FLG}$ pin when the output drops out of regulation due to low input voltage, current limiting, or thermal limiting.

The internal error $\overline{FLG}$ comparator has an open drain output stage. Hence, the $\overline{FLG}$ pin should be pulled high through a pull up resistor.

Sense Pin

In applications where the regulator output is not very close to the load, RT9172 can provide better remote load regulation using the SENSE pin. Fig.2 and Fig.3 depict the advantage of the SENSE option. RT9172 regulates the voltage at the output pin. Hence, the voltage at the remote load will be the regulator output voltage minus the drop across the trace resistance. For example, in the case of a 3.3V output, if the trace resistance is 100mΩ, the voltage at the remote load will be 3V with 3A of load current, I_{LOAD}. The RT9172 regulates the voltage at the sense pin. Connecting the sense pin to the remote load will provide regulation at the remote load, as shown in Fig.2 and Fig.3.

Chip Enable Operation

A CMOS logic level signal at the chip enable (EN) pin will turn-off the regulator. Pin EN must be actively terminated through a 10kΩ pull-up resistor for a proper operation. If this pin is driven from a source that actively pulls high and low (such as a CMOS rail to rail comparator), the pull-up resistor is not required. This pin must be tied to V_{IN} if not used.

Dropout Voltage

The dropout voltage of a regulator is defined as the minimum input-to-output differential required to stay within 2% of the output voltage. The RT9172 uses an internal MOS-FET with an $R_{DS(ON)}$ 160mΩ. For CMOS LDOs, the dropout voltage is the product of the load current and the $R_{DS(ON)}$ of the internal MOSFET.

Maximum Output Current Capability

RT9172 can deliver a continuous current of 1.5 A over the full operating temperature range. A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The total power dissipation of the device is given by:

$PD = (V_{IN} - V_{OUT}) I_{OUT} + (V_{IN}) I_{GND}$

where I_{GND} is the operating ground current of the device (specified under Electrical Characteristics).

The maximum allowable temperature rise (T_{RMAX}) depends on the maximum ambient temperature (T_{AMAX}) of the application, and the maximum allowable junction temperature (T_{JMAX}):

$T_{RMAX} = T_{JMAX} – T_{AMAX}$

The maximum allowable value for junction to ambient Thermal Resistance, $\theta_{JA} = T_{RMAX} - T_{AMAX}$

The maximum allowable value for junction to ambient Thermal Resistance, θ_{JA}, can be calculated using the formula:

$\theta_{JA} = T_{RMAX} / P_D$

RT9172 are available in TO-220, TO-263, and SOT-223 packages. The thermal resistance depends in amount of copper area or heat sink, and on air flow. If the maximum allowable value of θ_{JA} calculated above is ≧ 60 °C/W for TO-220 package, ≧ 60 °C/W for TO-263 package, and ≧140 °C/W for SOT-223 package, no heatsink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable θ_{JA} falls below these limits, a heat sink is required.

Heatsinking TO-220Packages

The thermal resistance of a TO-220 package can be reduced by attaching it to a heat sink or a copper plane on a PC board. If a copper plane is to be used, the values of θ_{JA} will be same as shown in next section for TO-263 package.

Heatsinking TO-263 and SOT-223 Packages

The TO-263 and SOT-223 packages use the copper plane on the PCB as a heatsink. The tab of these packages are soldered to the copper plane for heat sinking. Fig.4 shows a curve for θ_{JA} of TO-263 package for different copper area sizes, using a typical PCB with 1 ounce copper and no solder mask over the copper area for heat sinking.

θ_{JA} vs. Copper (1 Ounce) Area for TO-263

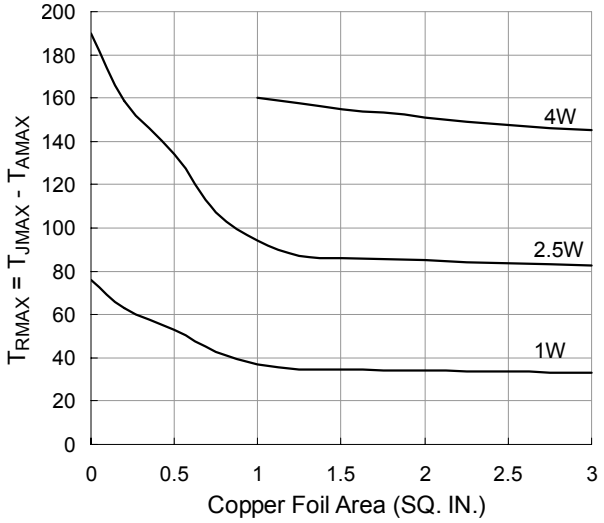
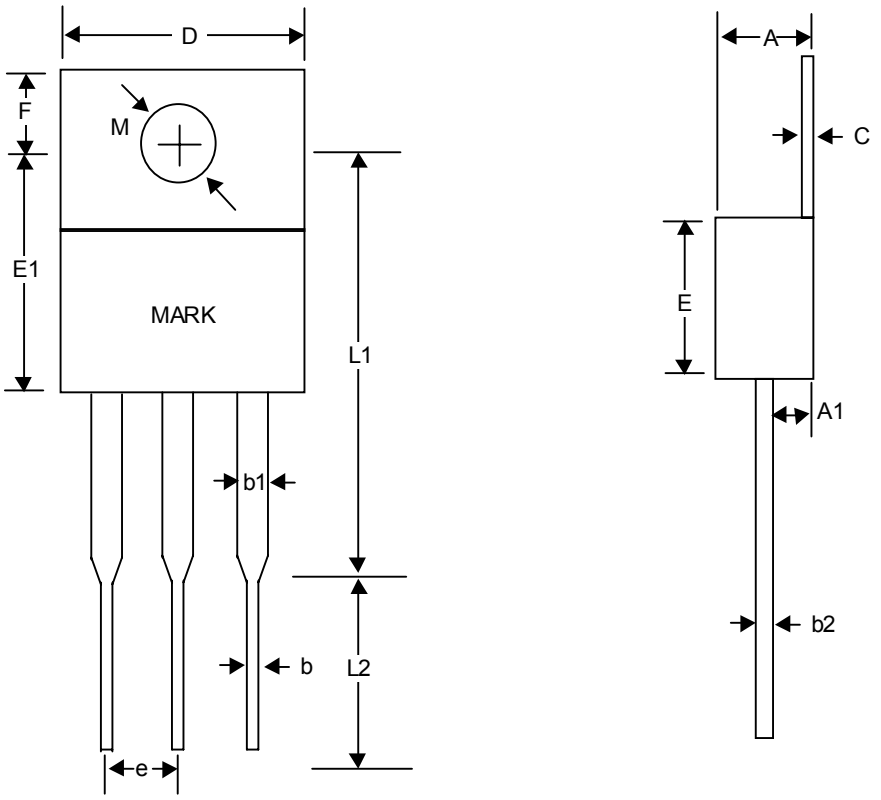


Fig. 4

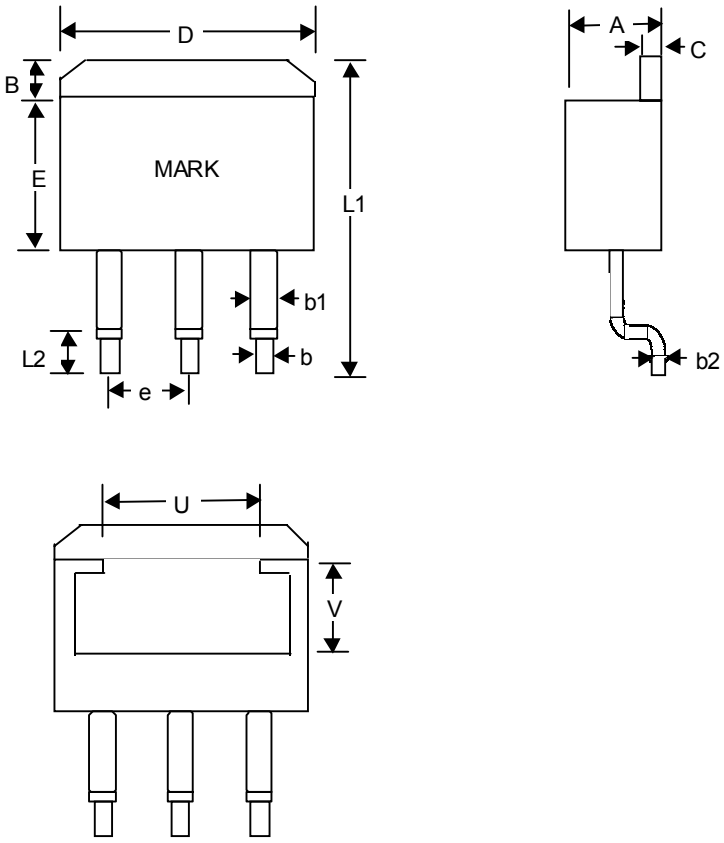
As shown in the figure, increasing the copper area beyond 1 square inch produces very little improvement. The minimum value for θ_{JA} for the TO-263 package mounted to a PCB is 32°C/W.

Package Information



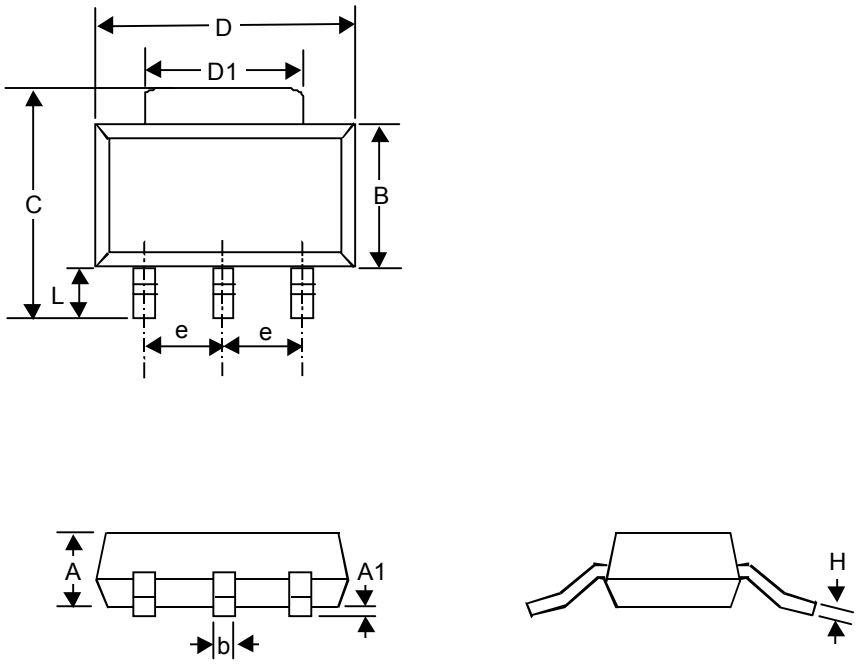
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.064	4.826	0.160	0.190
A1	2.032	2.921	0.080	0.115
b	0.635	1.016	0.025	0.040
b1	1.143	1.524	0.045	0.060
b2	0.305	0.559	0.012	0.022
C	1.143	1.397	0.045	0.055
D	9.779	10.668	0.385	0.420
E	7.620	9.398	0.300	0.370
e	2.286	2.794	0.090	0.110
E1	11.176	12.954	0.440	0.510
F	2.616	2.870	0.103	0.113
L1	17.526	18.542	0.690	0.730
L2	7.544	8.636	0.297	0.340
M	3.708	3.962	0.146	0.156

3-Lead TO-220 Plastic Package



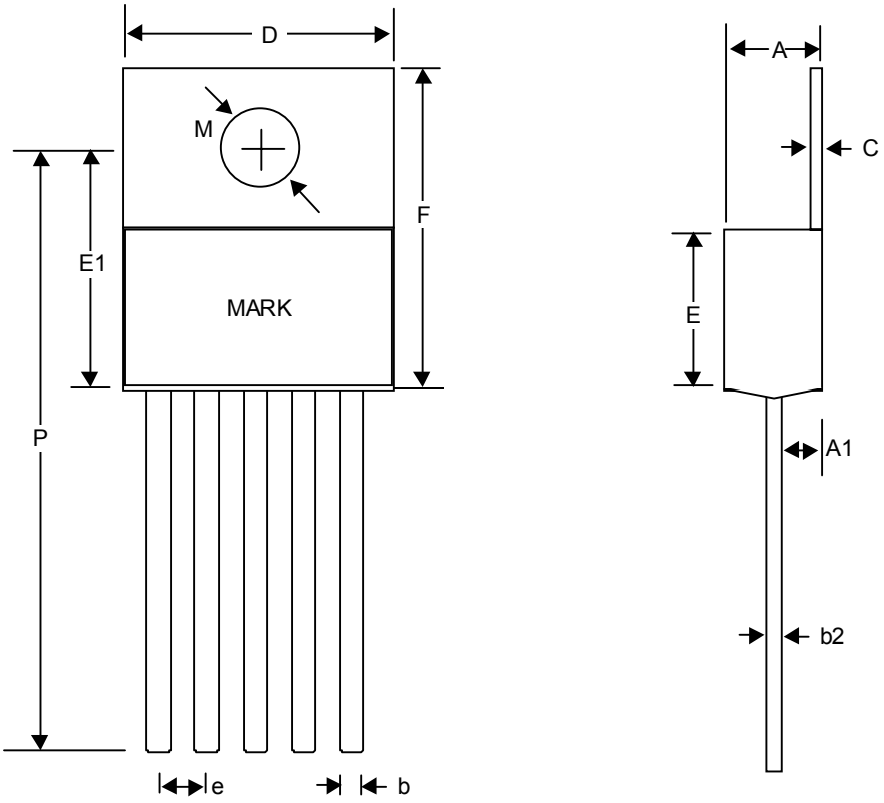
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.064	4.826	0.160	0.190
B	1.143	1.676	0.045	0.066
b	0.660	0.914	0.026	0.036
b1	1.143	1.397	0.045	0.055
b2	0.305	0.584	0.012	0.023
C	1.143	1.397	0.045	0.055
D	9.652	10.668	0.380	0.420
E	8.128	9.652	0.320	0.380
e	2.286	2.794	0.090	0.110
L1	14.605	15.875	0.575	0.625
L2	2.286	2.794	0.090	0.110
U	6.223 Ref.		0.245 Ref.	
V	7.620 Ref.		0.300 Ref.	

3-Lead TO- 263 Surface Mount



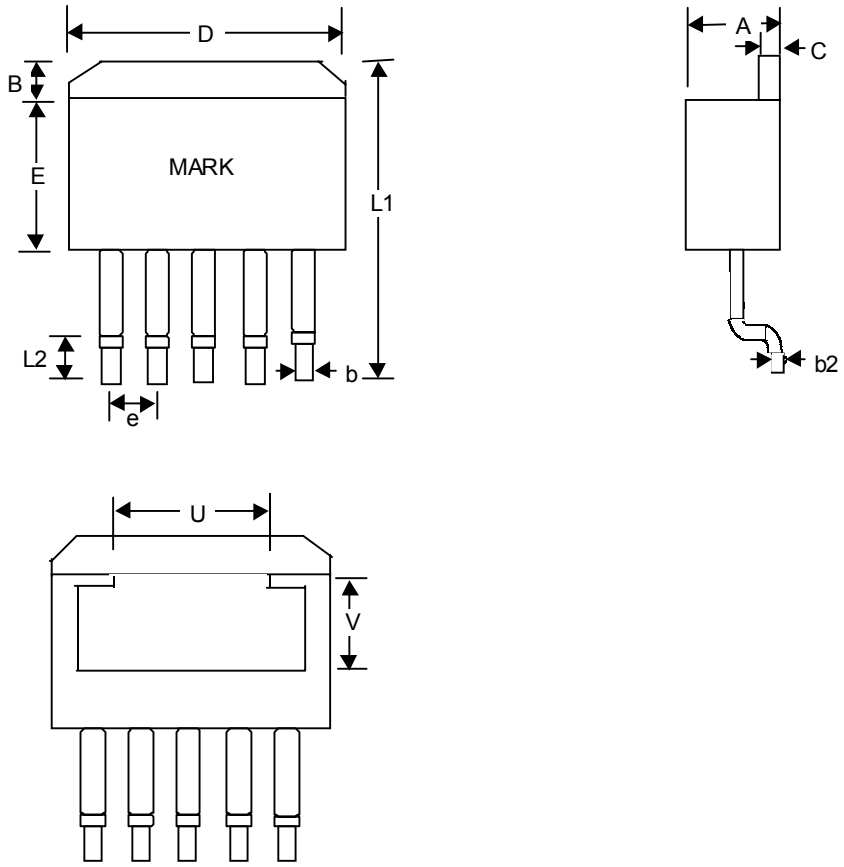
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	--	1.803	--	0.071
A1	0.020	0.100	0.0008	0.0047
b	0.610	0.787	0.024	0.031
B	3.302	3.708	0.130	0.146
C	6.706	7.290	0.264	0.287
D	6.299	6.706	0.248	0.264
D1	2.896	3.150	0.114	0.124
e	2.261	2.362	0.089	0.093
H	0.229	0.330	0.009	0.013
L	0.914	--	0.036	--

3-Lead SOT-223 Plastic Surface Mount



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.064	4.826	0.160	0.190
A1	2.032	2.921	0.080	0.115
b	0.635	1.016	0.025	0.040
b2	0.305	0.559	0.012	0.022
C	1.143	1.397	0.045	0.055
c	1.524	1.829	0.060	0.072
D	9.779	10.668	0.385	0.420
E	7.620	9.398	0.300	0.370
E1	11.176	12.954	0.440	0.510
F	14.224	15.113	0.560	0.595
M	3.708	3.962	0.146	0.156
P	24.689	26.416	0.972	1.040

5-Lead TO-220 Plastic Package



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.064	4.826	0.160	0.190
B	1.143	1.676	0.045	0.066
b	0.660	0.914	0.026	0.036
b2	0.305	0.584	0.012	0.023
C	1.143	1.397	0.045	0.055
D	9.652	10.668	0.380	0.420
E	8.128	9.652	0.320	0.380
e	1.524	1.829	0.060	0.072
L1	14.605	15.875	0.575	0.625
L2	2.286	2.794	0.090	0.110
U	6.223 Ref.		0.245 Ref.	
V	7.620 Ref.		0.300 Ref.	

5-Lead TO-263 Plastic Surface Mount 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