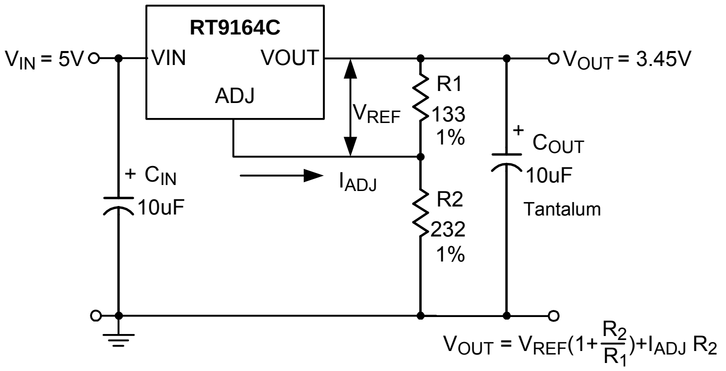
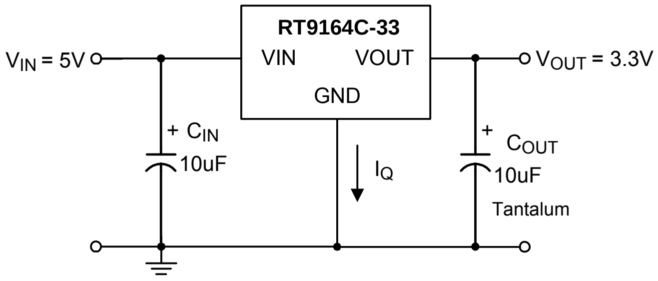
Typical Application Circuit



(1) C_{IN} needed if device is far from filter capacitors.
(2) C_{OUT} required for stability.

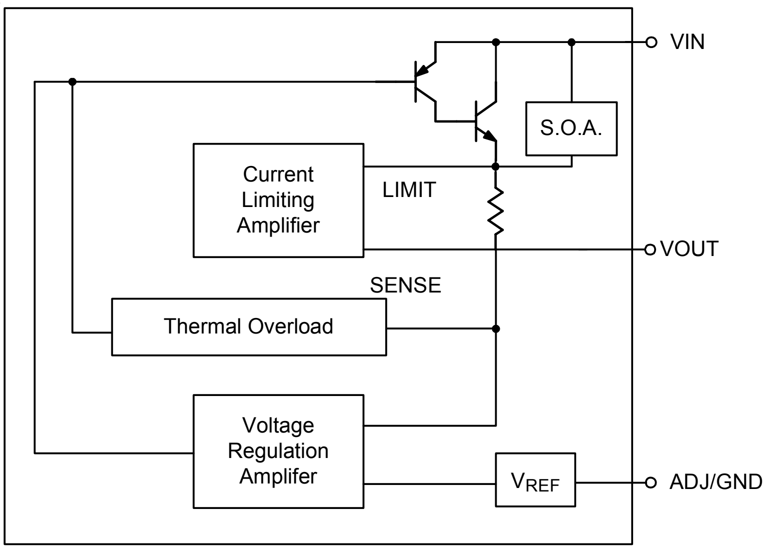
Figure 1. Adjustable Voltage Regulator



(1) C_{IN} needed if device is far from filter capacitors.
(2) C_{OUT} required for stability.

Figure 2. Fixed Voltage Regulator

Function Block Diagram



Functional Pin Description

Pin Name	Pin Function
ADJ/GND	Adjust Output or Ground.
VOUT	Output Voltage.
VIN	Power Input.

Absolute Maximum Ratings (Note 1)

- Supply Input Voltage ---------- 15V
- Power Dissipation, P_D @ T_A = 25°C
  - SOT-223 ---------- 0.740W
  - TO-252 ---------- 1.471W
  - TO-263 ---------- 2.222W
- Package Thermal Resistance (Note 2)
  - SOT-223, θ_{JA} ---------- 135°C/W
  - SOT-223, θ_{JC} ---------- 19°C/W
  - TO-252, θ_{JA} ---------- 68°C/W
  - TO-252, θ_{JC} ---------- 7.5°C/W
  - TO-263, θ_{JA} ---------- 45°C/W
  - TO-263, θ_{JC} ---------- 7.8°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 3)
  - HBM (Human Body Mode) ---------- 8kV
  - MM (Machine Mode) ---------- 750V

Recommended Operating Conditions (Note 4)

- Supply Input Voltage ---------- 3V to 12V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(T_A = 25°C, unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Reference Voltage (Note 5)	RT9164C	V_{REF}	I_{OUT} = 10mA, (V_{IN} – V_{OUT}) = 2V, T_A = 25°C	1.243	1.256	1.269	V
Output Voltage (Note 5)	RT9164C -25	V_{OUT}	I_{OUT} = 10mA, V_{IN} = 4.0V, T_J = 25°C	2.475	2.500	2.525	V
	RT9164C -33		I_{OUT} = 10mA, V_{IN} = 4.75V, T_J = 25°C	3.267	3.300	3.333	
Line Regulation (Note 5)	RT9164C	ΔV_{LINE}	I_{OUT} = 10mA, 1.5V ≤ V_{IN} – V_{OUT} ≤ 10V	--	0.1	0.3	%
	RT9164C -25		I_{OUT} = 10mA, 4.0V ≤ V_{IN} ≤ 15V	--	1	6	mV
	RT9164C -33		I_{OUT} = 10mA, 4.75V ≤ V_{IN} ≤ 15V	--	1	6	
Load Regulation (Note 5)	RT9164C	ΔV_{LOAD}	(V_{IN} – V_{OUT}) = 3V, 10mA ≤ I_{OUT} ≤ 1.0A	--	0.2	0.4	%
	RT9164C -25		V_{IN} = 4.0V, 10mA ≤ I_{OUT} ≤ 1.0A	--	1	10	mV
	RT9164C -33		V_{IN} = 4.75V, 10mA ≤ I_{OUT} ≤ 1.0A	--	1	12	
Dropout Voltage (Note 6)		V_{DROP}	I_{OUT} = 500mA	--	1.1	1.2	V
			I_{OUT} = 1.0A	--	1.3	1.4	
Current Limit		I_{LIM}	V_{IN} = 5V	1.0	1.8	--	A

To be continued

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Minimum Load Current	RT9164C		$(V_{IN} - V_{OUT}) = 2V$	--	5	10	mA
Quiescent Current	RT9164C -XX	I_Q	$V_{IN} = 5V$	--	5	10	mA
Ripple Rejection		PSRR	$f_{RIPPLE} = 120Hz$, $(V_{IN} - V_{OUT}) = 2V$, $V_{RIPPLE} = 1V_{P-P}$	--	72	--	dB
Adjust Pin Current		I_{ADJ}		--	65	120	uA
Adjust Pin Current Change		ΔI_{ADJ}	$10mA \leq I_{OUT} \leq 1.0A$, $V_{IN} = 5V$	--	0.2	5	uA

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. θ_{JA} is measured in the natural convection at $T_A = 25°C$ on a low effective thermal conductivity test board of JEDEC 51-3 thermal measurement standard. The case point of θ_{JC} is on the center of the exposed pad. The pad size is $6mm^2$ on SOT-223 packages, $100mm^2$ on TO-252 packages, $125mm^2$ on TO-263 packages.

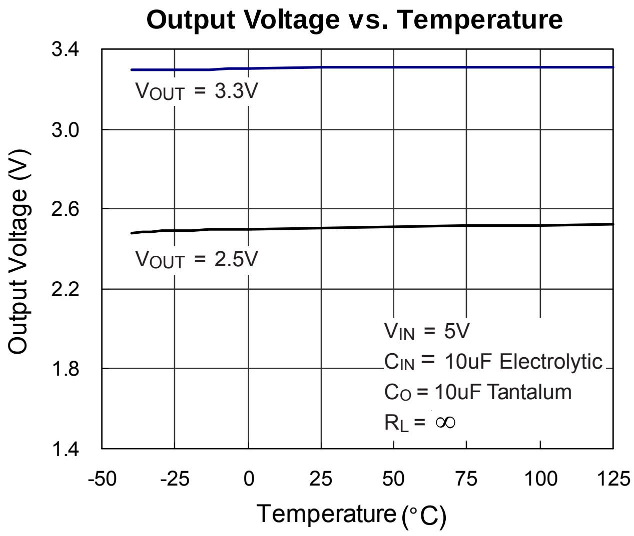
Note 3. Devices are ESD sensitive. Handling precaution is recommended.

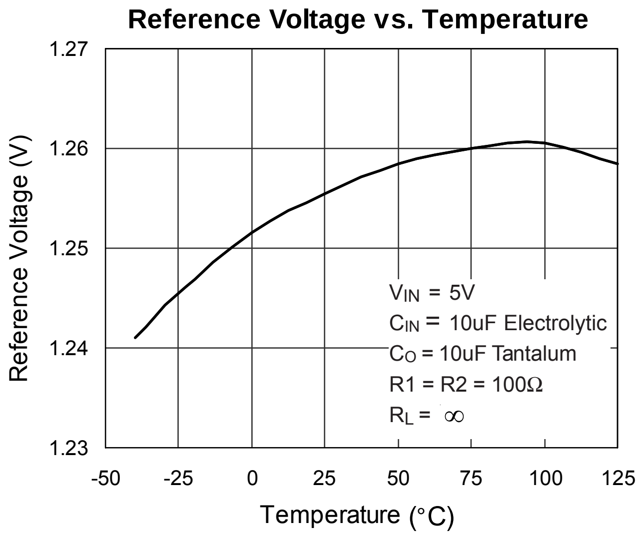
Note 4. The device is not guaranteed to function outside its operating conditions.

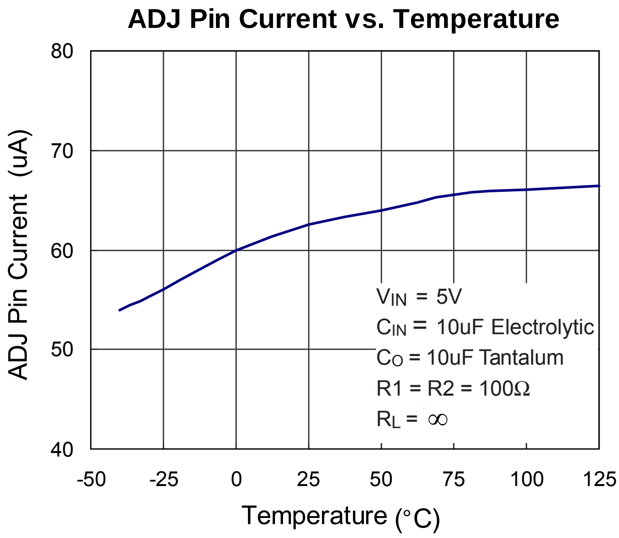
Note 5. Low duty cycle pulse testing with Kelvin connections.

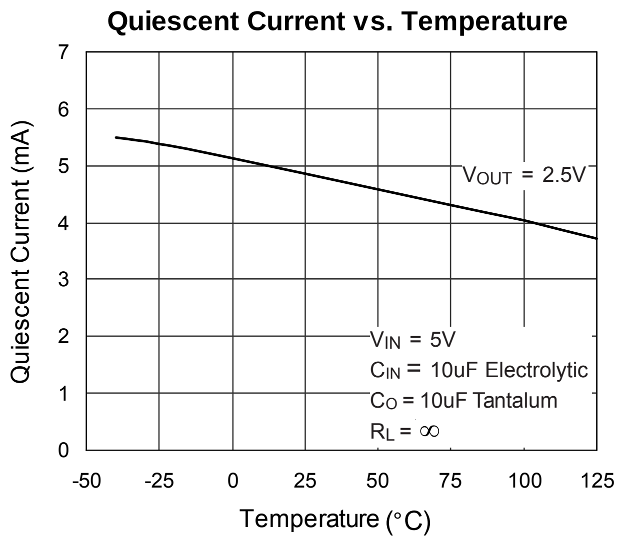
Note 6. The dropout voltage is defined as $V_{IN} - V_{OUT}$, which is measured when V_{OUT} is $V_{OUT(NORMAL)} - 100mV$.

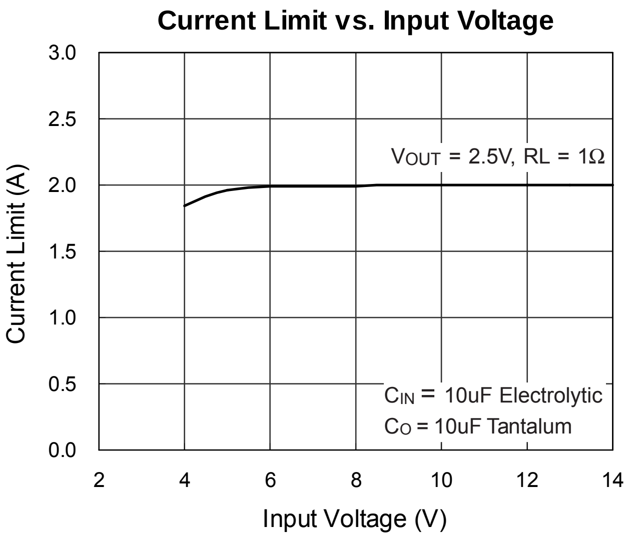
Typical Operating Characteristics

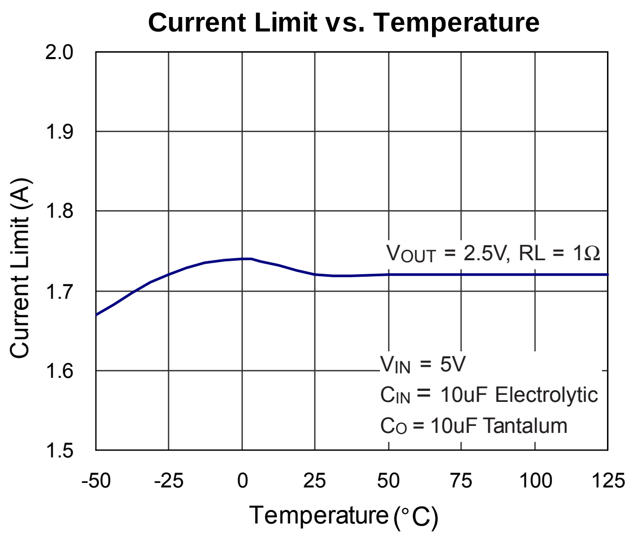




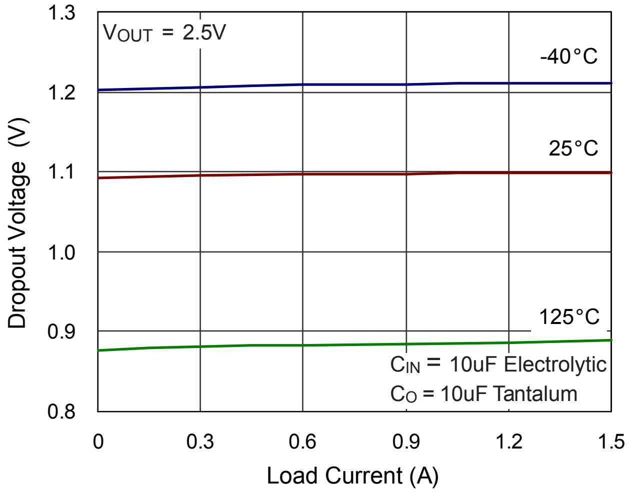




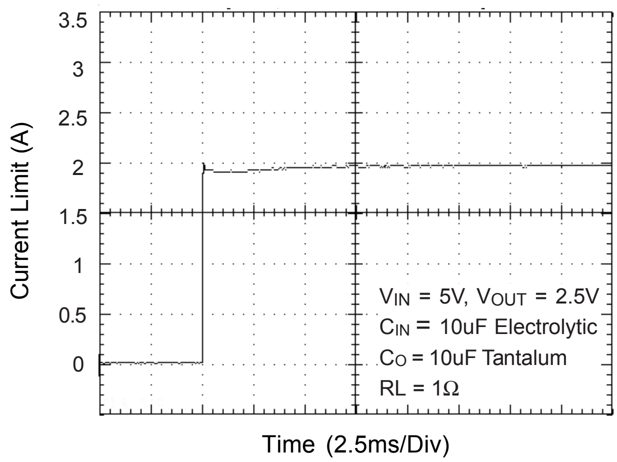




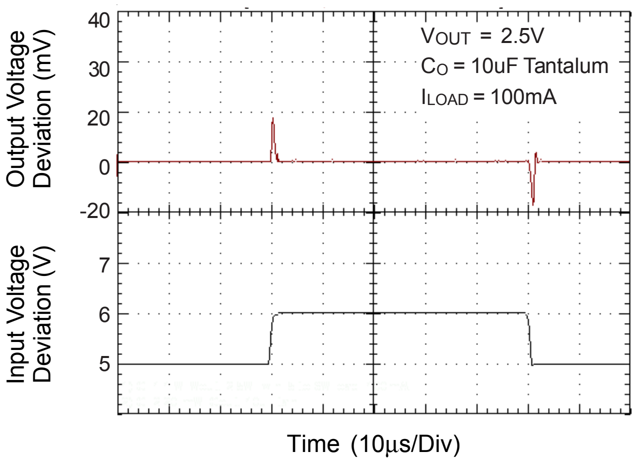
Dropout Voltage vs. Load Current



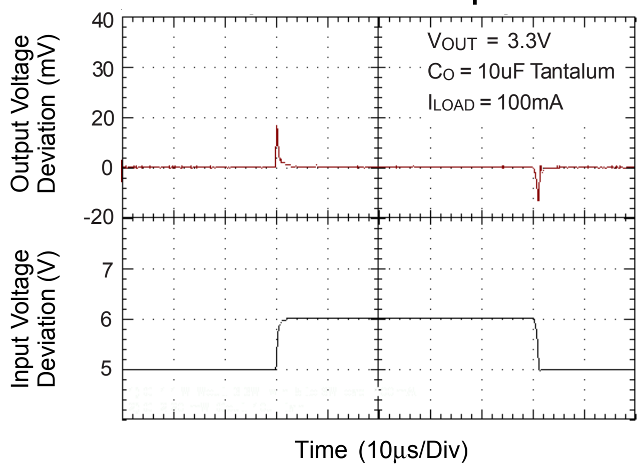
Current Limit



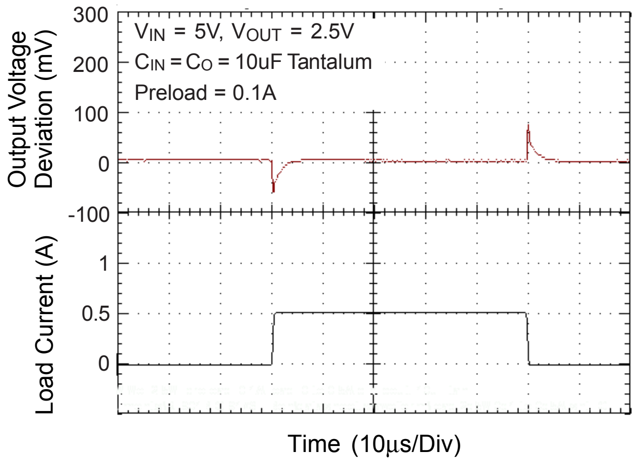
Line Transient Response



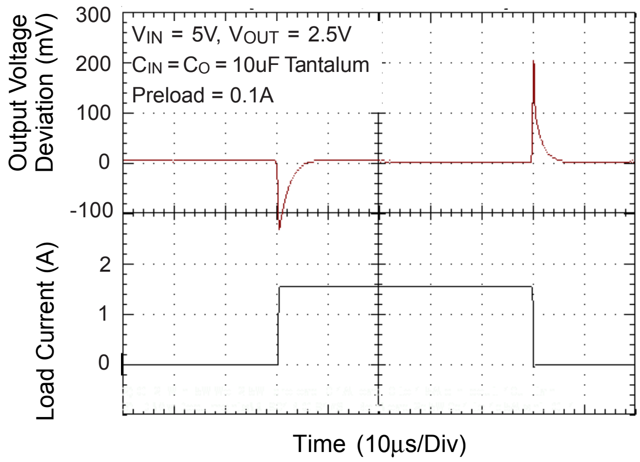
Line Transient Response

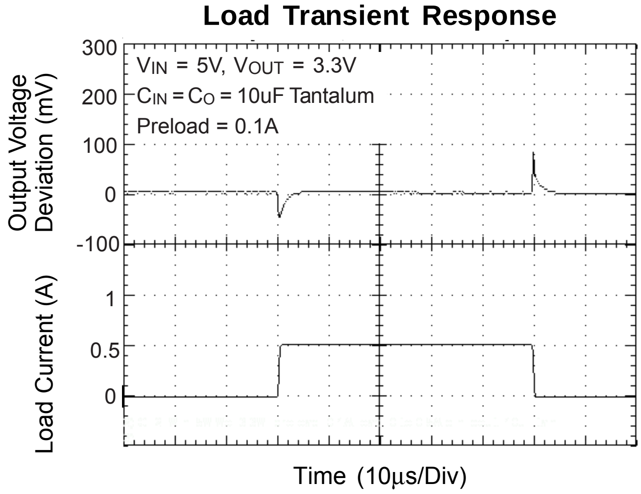


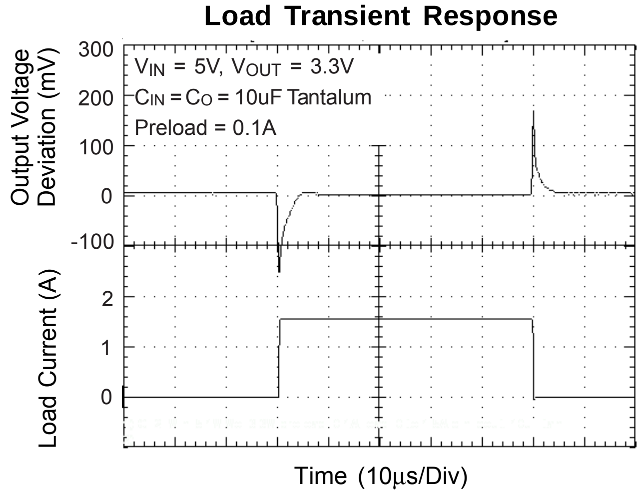
Load Transient Response



Load Transient Response




Load Transient Response
Output Voltage Deviation (mV)
Load Current (A)
VIN = 5V, VOUT = 3.3V
CIN = CO = 10uF Tantalum
Preload = 0.1A
300
200
100
0
-100
1
0.5
0
Time (10µs/Div)


Load Transient Response
Output Voltage Deviation (mV)
Load Current (A)
VIN = 5V, VOUT = 3.3V
CIN = CO = 10uF Tantalum
Preload = 0.1A
300
200
100
0
-100
2
1
0
Time (10µs/Div)

Application Information

Output voltage adjustment

Like most regulators, the RT9164C regulates the output by comparing the output voltage to an internally generated reference voltage. On the adjustable version as shown in Figure 4, the V_{REF} is available externally as 1.25V between V_{OUT} and ADJ. The voltage ratio formed by R1 and R2 should be set to conduct 10mA (minimum output load). The output voltage is given by the following equation:

$$V_{OUT} = V_{REF}\left(1+\frac{R_2}{R_1}\right) + I_{ADJ}\ R_2$$

On fixed versions of RT9164C, the voltage divider is provided internally.

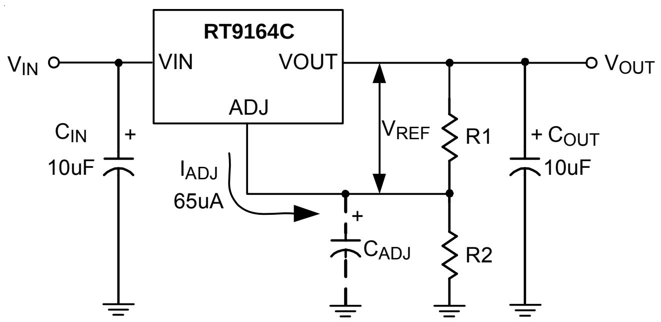


Figure 4. Basic Adjustable Regulator

Input Bypass Capacitor

An input capacitor is recommended. A 10µF tantalum on the input is a suitable input bypassing for almost all applications.

Adjust Terminal Bypass Capacitor

The adjust terminal can be bypassed to ground with a bypass capacitor (C_{ADJ}) to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. At any ripple frequency, the impedance of the C_{ADJ} should be less than R1 to prevent the ripple from being amplified:

$(2\pi \times f_{RIPPLE} \times C_{ADJ}) < R1$

The R1 is the resistor between the output and the adjust pin. Its value is normally in the range of 100-200Ω. For example, with R1 = 124Ω and f_{RIPPLE} = 120Hz, the C_{ADJ} should be > 11µF.

Output Capacitor

RT9164C requires a capacitor from V_{OUT} to GND to provide compensation feedback to the internal gain stage. This is to ensure stability at the output terminal. Typically, 10µF tantalum or 50µF aluminum electrolytic with 30mΩ to 2Ω range capacitor is sufficient.

The output capacitor does not have a theoretical upper limit and increasing its value will increase stability. C_{OUT} = 100µF or more is typical for high current regulator design.

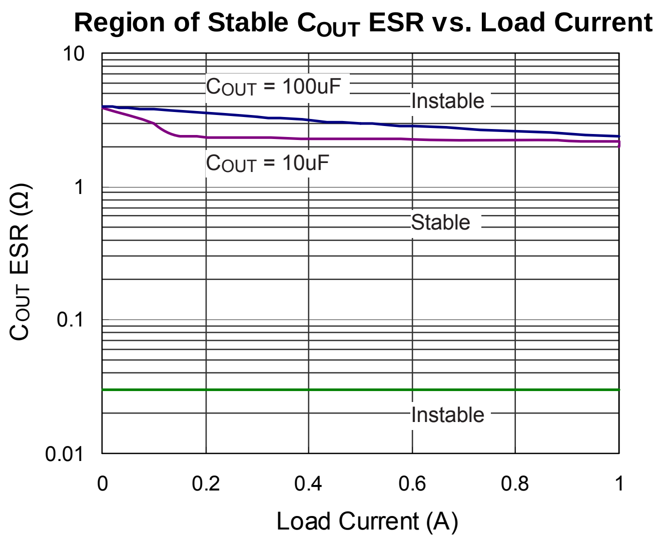


Figure 5

Load Regulation

When the adjustable regulator is used (Figure 6), the best load regulation is accomplished when the top of the resistor divider (R1) is connected directly to the output pin of the RT9164C. When so connected, R_P is not multiplied by the divider ratio. For Fixed output version, the top of R1 is internally connected to the output and ground pins can be connected to low side of the load.

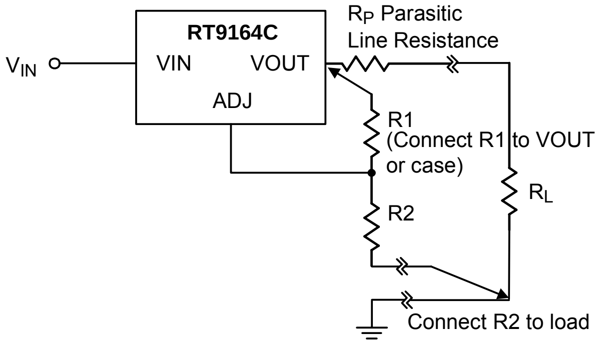


Figure 6. Best Load Regulation Using Adjustable Output Regulator

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

$T_{JUNCTION} = T_{AMBIENT} + (P_D \times \theta_{JA})$

Note : $T_{JUNCTION}$ must not exceed 125°C

Current Limit Protection

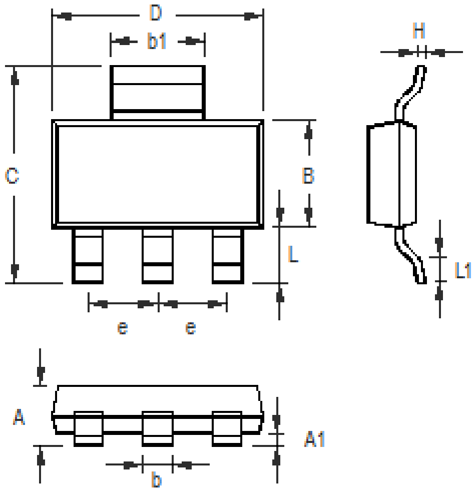
RT9164C is protected against overload conditions. Current protection is triggered at typically 1.8A.

Thermal Consideration

The RT9164C series contain thermal limiting circuitry designed to protect itself from over-temperature conditions. Even for normal load conditions, maximum junction temperature ratings must not be exceeded. As mention in thermal protection section, we need to consider all sources of thermal resistance between junction and ambient. It includes junction-to-case, case-to-heat-sink interface, and heat sink thermal resistance itself.

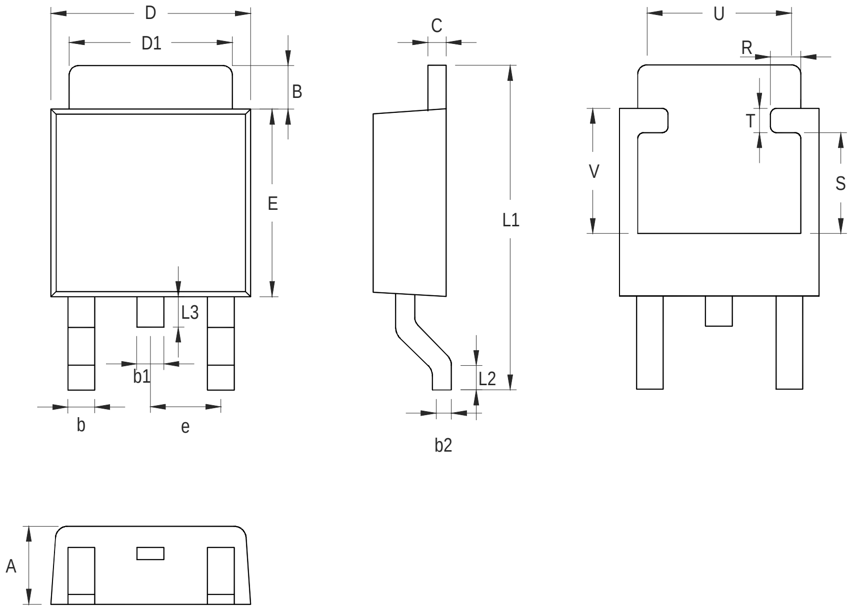
Junction-to-case thermal resistance is specified from the IC junction to the bottom of the case directly below the die. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. The case of all devices in this series is electrically connected to the output. Therefore, if the case of the device must be electrically isolated, a thermally conductive spacer is recommended.

Outline Dimension



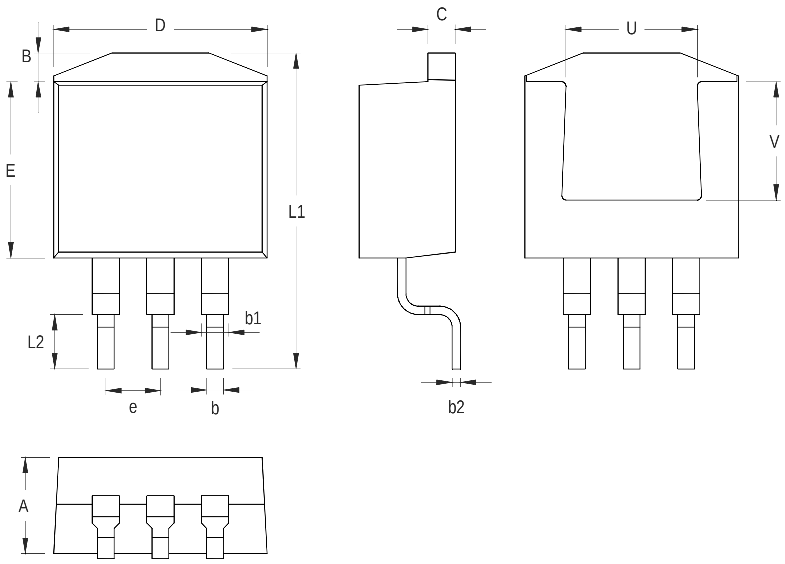
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.800	0.055	0.071
A1	0.020	0.100	0.001	0.004
b	0.600	0.840	0.024	0.033
B	3.300	3.700	0.130	0.146
C	6.700	7.300	0.264	0.287
D	6.300	6.700	0.248	0.264
b1	2.900	3.100	0.114	0.122
e	2.300		0.091	
H	0.230	0.350	0.009	0.014
L	1.500	2.000	0.059	0.079
L1	0.800	1.100	0.031	0.043

3-Lead SOT-223 Surface Mount Package



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	2.184	2.388	0.086	0.094
B	0.889	2.032	0.035	0.080
b	0.508	0.889	0.020	0.035
b1	1.016 Ref.		0.040 Ref.	
b2	0.457	0.584	0.018	0.023
C	0.457	0.584	0.018	0.023
D	6.350	6.731	0.250	0.265
D1	5.207	5.461	0.205	0.215
E	5.334	6.223	0.210	0.245
e	2.108	2.438	0.083	0.096
L1	9.398	10.414	0.370	0.410
L2	0.508 Ref.		0.020 Ref.	
L3	0.635	1.016	0.025	0.040
U	3.810 Ref.		0.150 Ref.	
V	3.048 Ref.		0.120 Ref.	
R	0.200	0.850	0.008	0.033
S	2.500	3.400	0.098	0.134
T	0.500	0.850	0.020	0.033

3-Lead TO-252 Surface Mount 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 Package

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