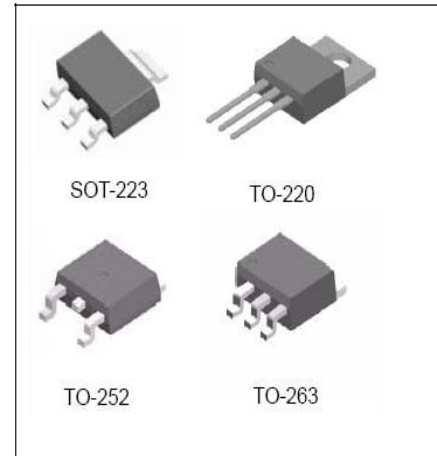


## General Description

The LM317 is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 1.5 A over an output voltage range of 1.2 V to 37 V. This voltage regulator is exceptionally easy to use and requires only two external resistors to set the output voltage. Further, it employs internal current limiting, thermal shutdown and safe area compensation, making it essentially blow-out proof.

The LM317 serves a wide variety of applications including local, on card regulation. This device can also be used to make a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LM317 can be used as a precision current regulator.



## Features

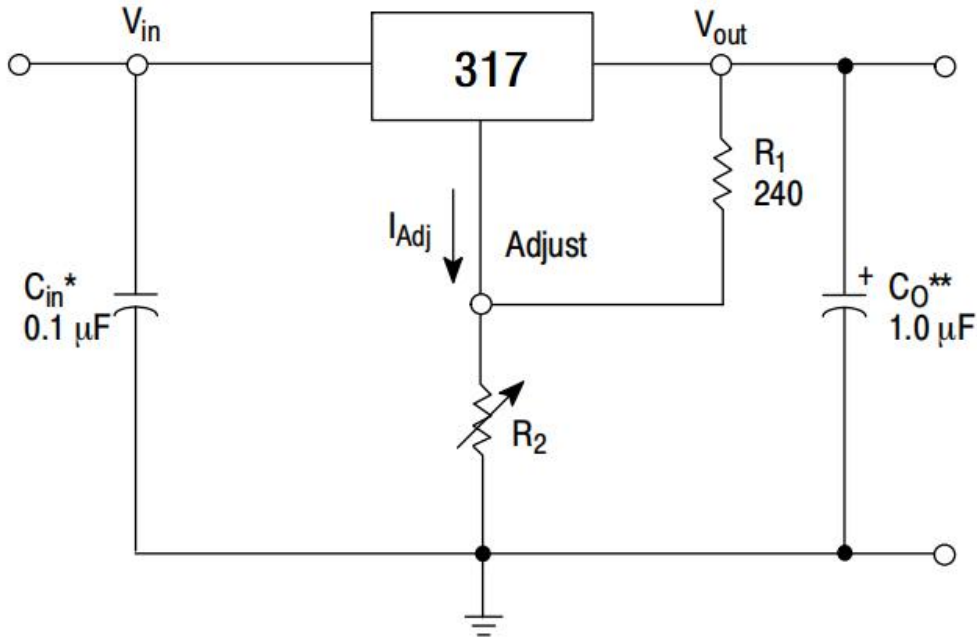
- Output Current in Excess of 1.5 A
- Output Adjustable between 1.2 V and 37 V
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting Constant with Temperature
- Output Transistor Safe-Area Compensation
- Floating Operation for High Voltage Applications
- Eliminates Stocking many Fixed Voltages
- Available in Surface Mount D2PAK-3, and Standard 3-Lead Transistor Package
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

## Ordering Information

DEVICE	Package Type	MARKING	Packing	Packing QTY
LM317S	SOT-223	LM317S	Tape	3000/Reel
LM317T	TO-220	LM317T	Tube	1000/BOX
LM317MDTR	TO-252-2L	LM317M	Tape	2500/Reel
LM317CDTR	TO-263-3L	LM317C	Tape	1000/Reel

## Block Diagram

### 2.1、Block Diagram



\*  $C_{in}$  is required if regulator is located an appreciable distance from power supply filter.

\*\*  $C_O$  is not needed for stability, however, it does improve transient response.

$$V_{out} = 1.25 V \left( 1 + \frac{R_2}{R_1} \right) + I_{Adj} R_2$$

Since  $I_{Adj}$  is controlled to less than  $100 \mu A$ , the error associated with this term is negligible in most applications.

Figure 1. Standard Application

## Absolute Maximum Ratings

Rating	Symbol	Value	Unit
Input-Output Voltage Differential	$V_I - V_O$	-0.3 to 40	Vdc
Power Dissipation			
Case 221A			
$T_A = +25^\circ C$	$P_D$	Internally Limited	W
Thermal Resistance, Junction-to-Ambient	$\theta_{JA}$	65	$^\circ C/W$
Thermal Resistance, Junction-to-Case	$\theta_{JC}$	5.0	$^\circ C/W$
Case 936 (D <sup>2</sup> PAK-3)			
$T_A = +25^\circ C$	$P_D$	Internally Limited	W
Thermal Resistance, Junction-to-Ambient	$\theta_{JA}$	70	$^\circ C/W$
Thermal Resistance, Junction-to-Case	$\theta_{JC}$	5.0	$^\circ C/W$
Operating Junction Temperature Range	$T_J$	-55 to +150	$^\circ C$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ C$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### Electrical Characteristics

( $V_I - V_O = 5V$ ,  $I_O = 0.5A$  for D2T and T packages;  $T_J = T_{low}$  to  $T_{high}$ (Note1);  $I_{max}$  and  $P_{max}$ (Note2); unless otherwise noted.)

Characteristics	Figure	Symbol	Min	Typ	Max	Unit
Line Regulation (Note3), $T_A = +25^\circ C$ , $3.0V \leq V_I - V_O \leq 40V$	1	$Reg_{line}$	-	0.01	0.04	%/V
Load Regulation (Note3), $T_A = +25^\circ C$ , $10mA \leq I_O \leq I_{max}$ $V_O \leq 5.0V$ $V_O \geq 5.0V$	2	$Reg_{load}$	- -	5.0 0.1	25 0.5	mV % $V_O$
Thermal Regulation, $T_A = +25^\circ C$ (Note 4), 20 ms Pulse	-	$Reg_{therm}$	-	0.03	0.07	% $V_O/W$
Adjustment Pin Current	3	$I_{Adj}$	-	50	100	$\mu A$
Adjustment Pin Current Change, $2.5V \leq V_I - V_O \leq 40V$ , $10mA \leq I_I \leq I_{max}$ , $P_D \leq P_{max}$	1,2	$\Delta I_{Adj}$	-	0.2	5.0	$\mu A$
Reference Voltage, $3.0V \leq V_I - V_O \leq 40V$ , $10mA \leq I_O \leq I_{max}$ , $P_D \leq P_{max}$	3	$V_{ref}$	1.2	1.25	1.3	V
Line Regulation (Note3), $3.0V \leq V_I - V_O \leq 40V$	1	$Reg_{line}$	-	0.02	0.07	%/V
Load Regulation (Note3), $10mA \leq I_O \leq I_{max}$ $V_O \leq 5.0V$ $V_O \geq 5.0V$	2	$Reg_{load}$	- -	20 0.3	70 1.5	mV % $V_O$
Temperature Stability ( $T_{low} \leq T_J \leq T_{high}$ )	3	$T_S$	-	0.7	-	% $V_O$
Minimum Load Current to Maintain Regulation ( $V_I - V_O = 40V$ )	3	$I_{Lmin}$	-	3.5	10	mA
Maximum Output Current $V_I - V_O \leq 15V$ , $P_D \leq P_{max}$ , T Package $V_I - V_O = 40V$ , $P_D \leq P_{max}$ , $T_A = +25^\circ C$ , T Package	3	$I_{max}$	1.5 0.15	2.2 0.4	- -	A
RMS Noise, % of $V_O$ , $T_A = +25^\circ C$ , $10Hz \leq f \leq 10kHz$	-	N	-	0.003	-	% $V_O$
Ripple Rejection, $V_O = 10V$ , $f = 120Hz$ (Note5) Without $C_{Adj}$ $C_{Adj} = 10\mu F$	4	RR	- 66	65 80	- -	dB
Thermal Shutdown (Note6)	-	-	-	180	-	$^\circ C$
Long-Term Stability, $T_J = T_{high}$ (Note7), $T_A = +25^\circ C$ for Endpoint Measurements	3	S	-	0.3	1.0	%/1.0 kHrs.
Thermal Resistance Junction-to-Case, T Package	-	$R_{\theta JC}$	-	5.0	-	$^\circ C/W$

1.  $T_{low}$  to  $T_{high} = 0^\circ$  to  $+125^\circ C$ , for LM317, D2T.  $T_{low}$  to  $T_{high} = -40^\circ$  to  $+125^\circ C$ , for LM317BT, BD2T,  $T_{low}$  to  $T_{high} = -55^\circ$  to  $+150^\circ C$ , for LM317BT, BD2T.

2.  $I_{max} = 1.5A$ ,  $P_{max} = 20W$

3. Load and line regulation are specified at constant junction temperature. Changes in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

4. Power dissipation within an IC voltage regulator produces a temperature gradient on the die, affecting individual IC components on the die.

These effects can be minimized by proper integrated circuit design and layout techniques.

Thermal Regulation is the effect of these

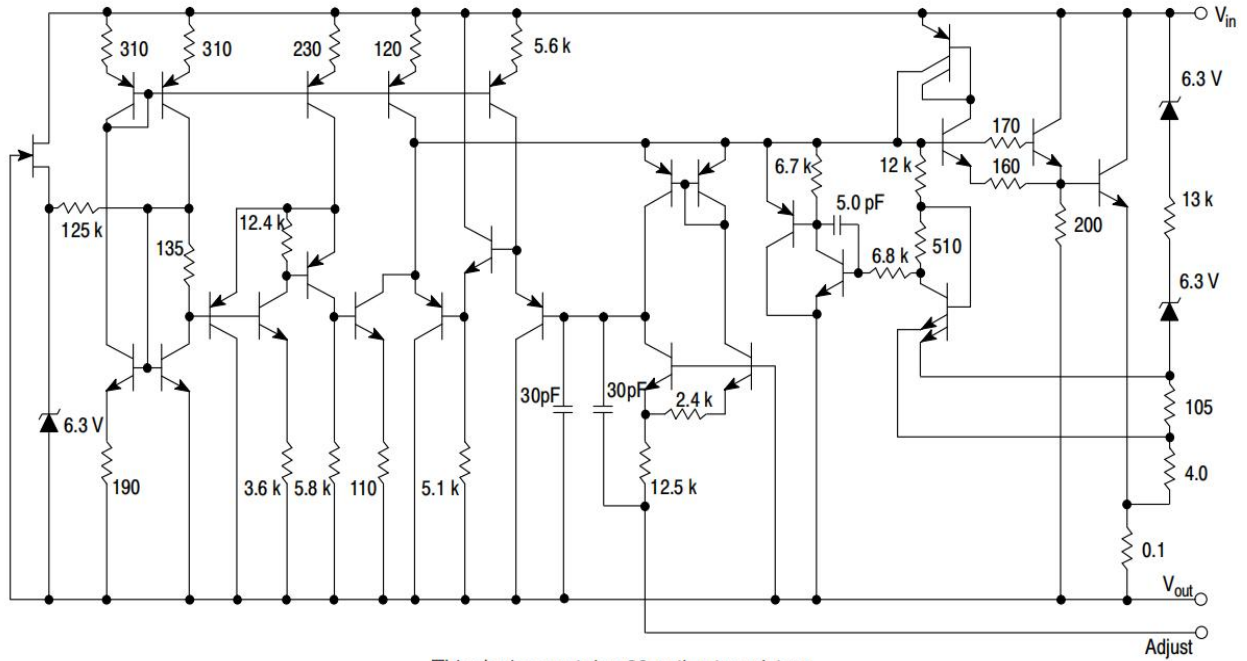
temperature gradients on the output voltage and is expressed in percentage of output change per watt of power change in a specified time.

5.  $C_{Adj}$ , when used, is connected between the adjustment pin and ground.

6. Thermal characteristics are not subject to production test.

7. Since Long-Term Stability cannot be measured on each device before shipment, this specification is an engineering estimate of average stability from lot to lot.

Application Circuit



This device contains 29 active transistors.

Figure 2. Representative Schematic Diagram

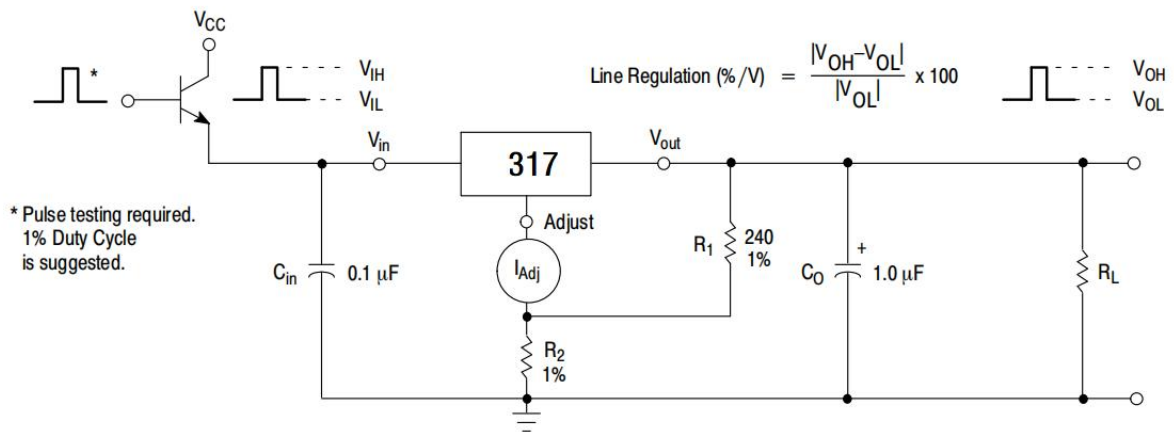


Figure 3. Line Regulation and  $\Delta I_{Adj}$ /Line Test Circuit

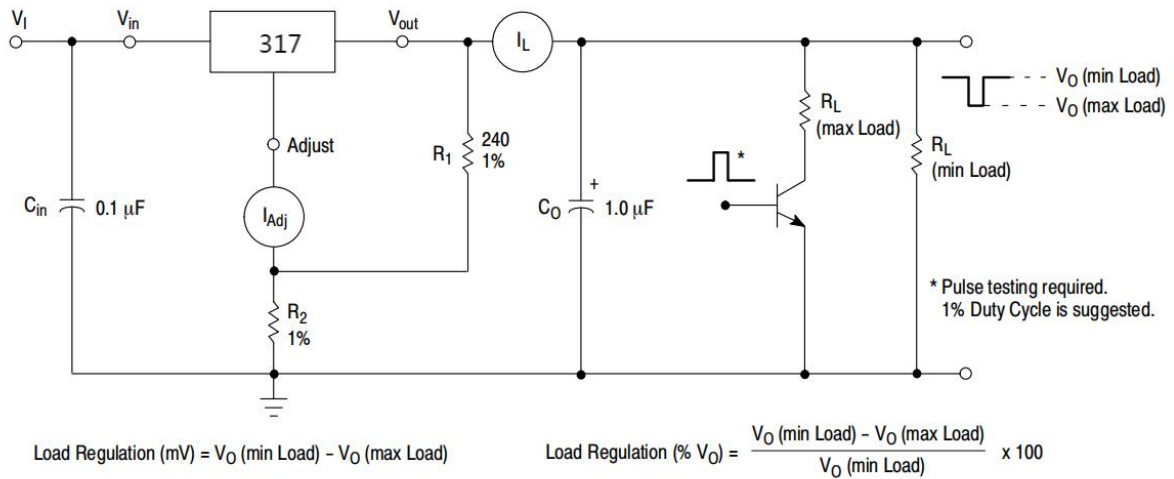


Figure 4. Load Regulation and  $\Delta I_{Adj}$ /Load Test Circuit

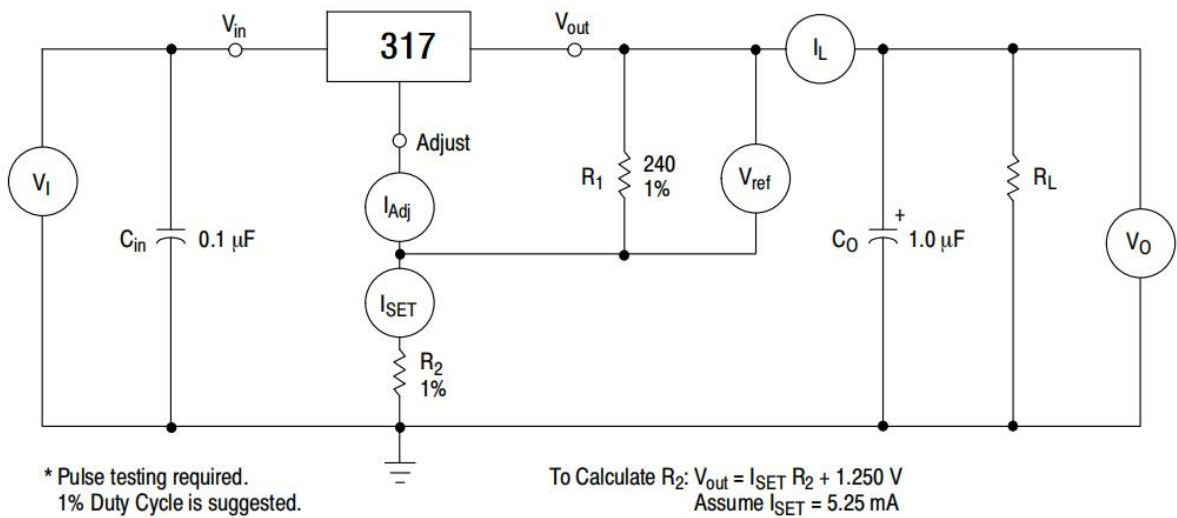


Figure 5. Standard Test Circuit

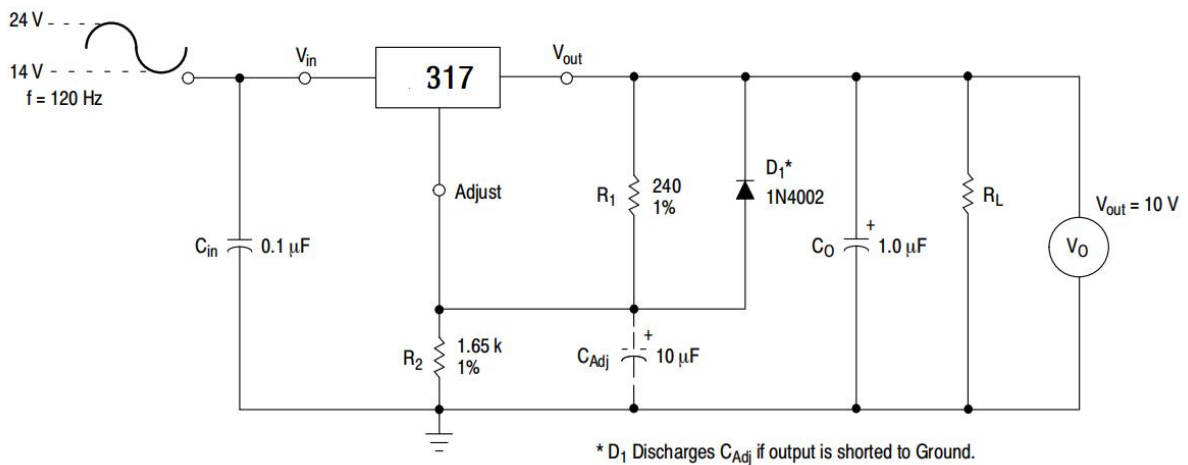


Figure 6. Ripple Rejection Test Circuit

Characteristics Curves

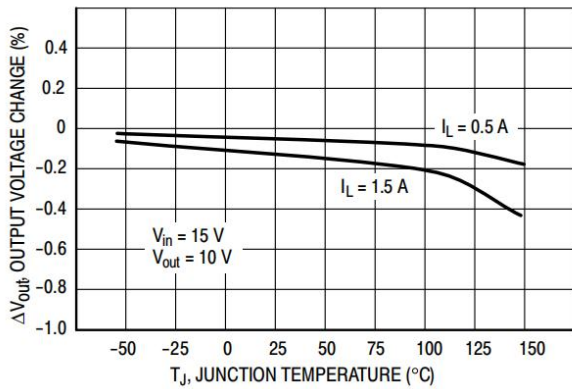
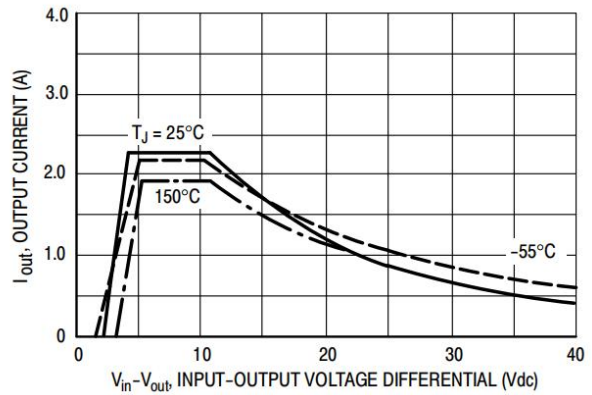


Figure 7. Load Regulation Figure



8. Current Limit

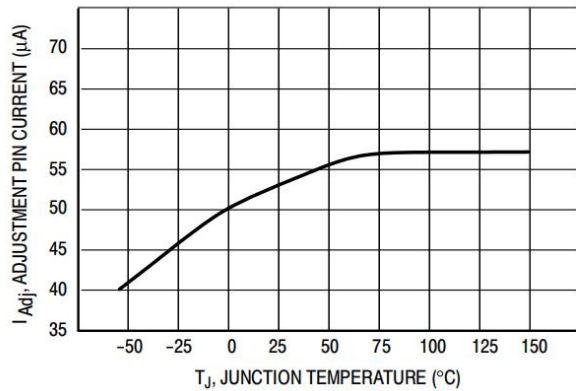
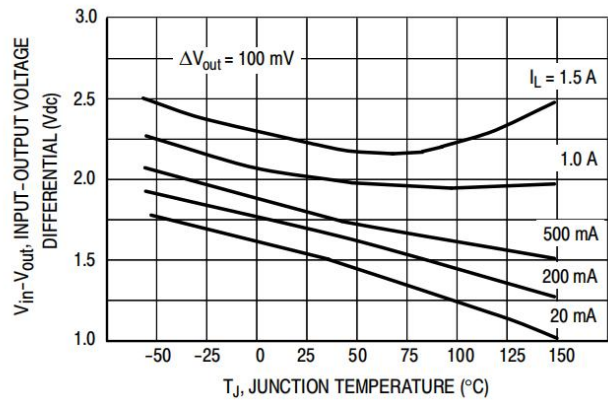


Figure 9. Adjustment Pin Current Figure



10. Dropout Voltage

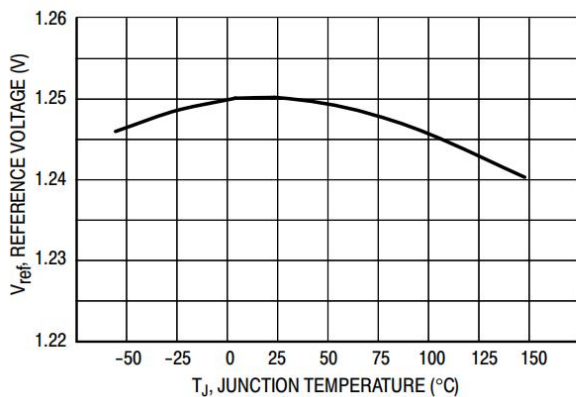
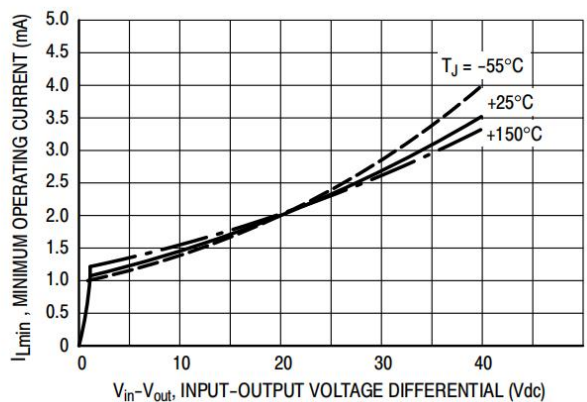


Figure 11. Temperature Stability Figure



12. Minimum Operating Current



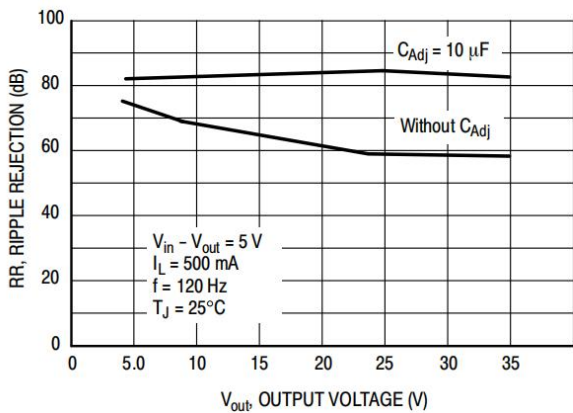


Figure 13. Ripple Rejection versus Output Voltage

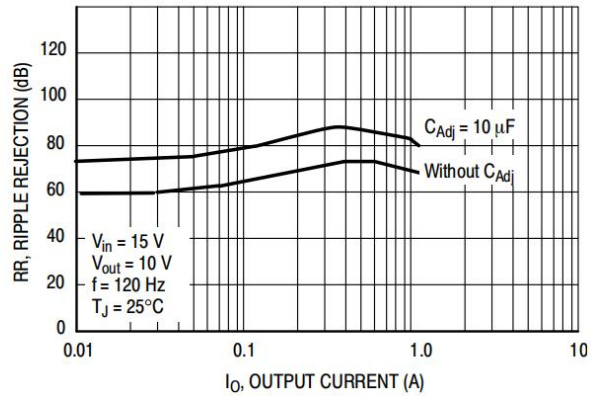


Figure 14. Ripple Rejection versus Output Current

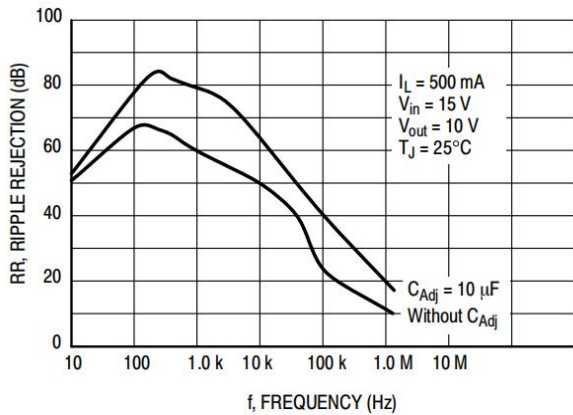


Figure 15. Ripple Rejection versus Frequency

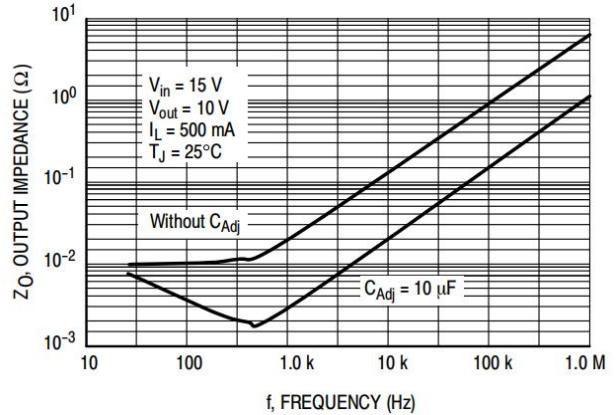


Figure 16. Output Impedance

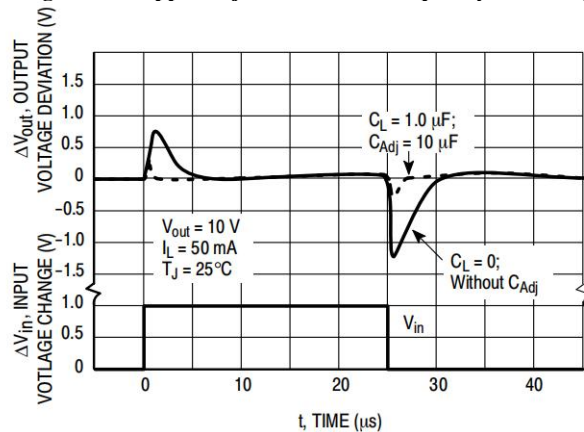


Figure 17. Line Transient Response

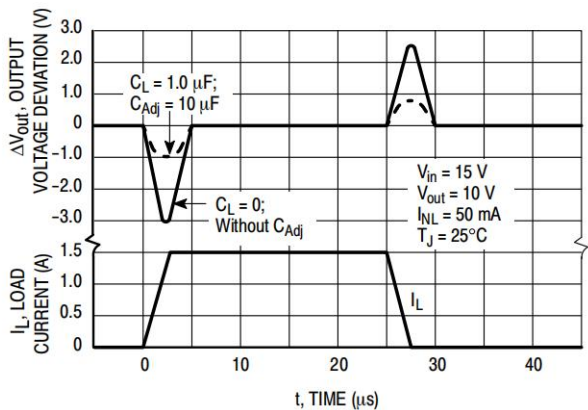


Figure 18. Load Transient Response

## Basic Circuit Operation

The LM317 is a 3-terminal floating regulator. In operation, the LM317 develops and maintains a nominal 1.25 V reference ( $V_{ref}$ ) between its output and adjustment terminals. This reference voltage is converted to a programming current ( $I_{PROG}$ ) by  $R_1$  (see Figure 17), and this constant current flows through  $R_2$  to ground.

The regulated output voltage is given by:

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

Since the current from the adjustment terminal ( $I_{Adj}$ ) represents an error term in the equation, the LM317 was designed to control  $I_{Adj}$  to less than  $100\mu A$  and keep it constant. To do this, all quiescent operating current is returned to the output terminal. This imposes the requirement for a minimum load current. If the load current is less than this minimum, the output voltage will rise. Since the LM317 is a floating regulator, it is only the voltage differential across the circuit which is important to performance, and operation at high voltages with respect to ground is possible.

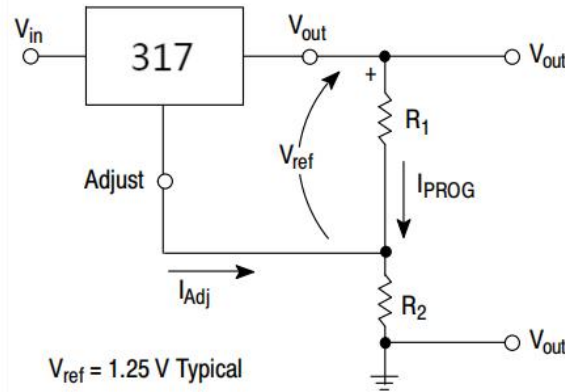


Figure 19. Basic Circuit Configuration

## Load Regulation

The LM317 is capable of providing extremely good load regulation, but a few precautions are needed to obtain maximum performance. For best performance, the programming resistor ( $R_1$ ) should be connected as close to the regulator as possible to minimize line drops which effectively appear in series with the reference, thereby degrading regulation. The ground end of  $R_2$  can be returned near the load ground to provide remote ground sensing and improve load regulation.

## External Capacitors

A  $0.1\mu F$  disc or  $1.0\mu F$  tantalum input bypass capacitor ( $C_{in}$ ) is recommended to reduce the sensitivity to input line impedance. The adjustment terminal may be bypassed to ground to improve ripple rejection. This capacitor ( $C_{Adj}$ ) prevents ripple from being amplified as the output voltage is increased. A  $10\mu F$  capacitor should improve ripple rejection about 15dB at 120Hz in a 10V application. Although the LM317 is stable with no output capacitance, like any feedback circuit, certain values of external capacitance can cause excessive ringing. An output capacitance ( $C_O$ ) in the form of a  $1.0\mu F$  tantalum or  $25\mu F$  aluminum electrolytic capacitor on the output swamps this effect and insures stability.

## Protection Diodes

When external capacitors are used with any IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator.

Figure 18 shows the LM317 with the recommended protection diodes for output voltages in excess of  $25\mu V$  or high capacitance values ( $C_O > 25\mu F$ ,  $C_{Adj} > 10\mu F$ ). Diode  $D_1$  prevents  $C_O$  from discharging thru the IC during an input short circuit. Diode  $D_2$  protects against capacitor  $C_{Adj}$  discharging through the IC during an output short circuit. The combination of diodes  $D_1$  and  $D_2$  prevents  $C_{Adj}$  from discharging through the IC during an input short circuit.



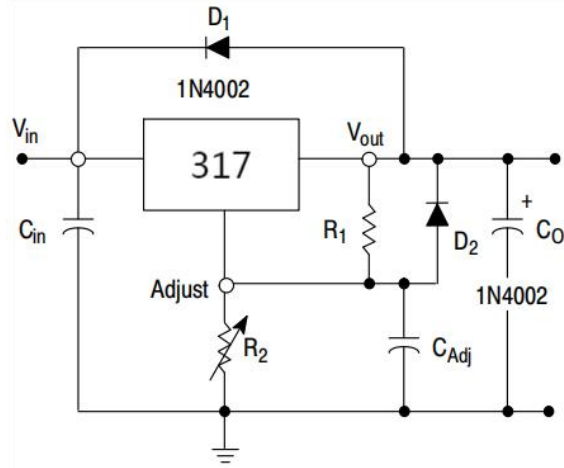


Figure 20. Voltage Regulator with Protection Diodes

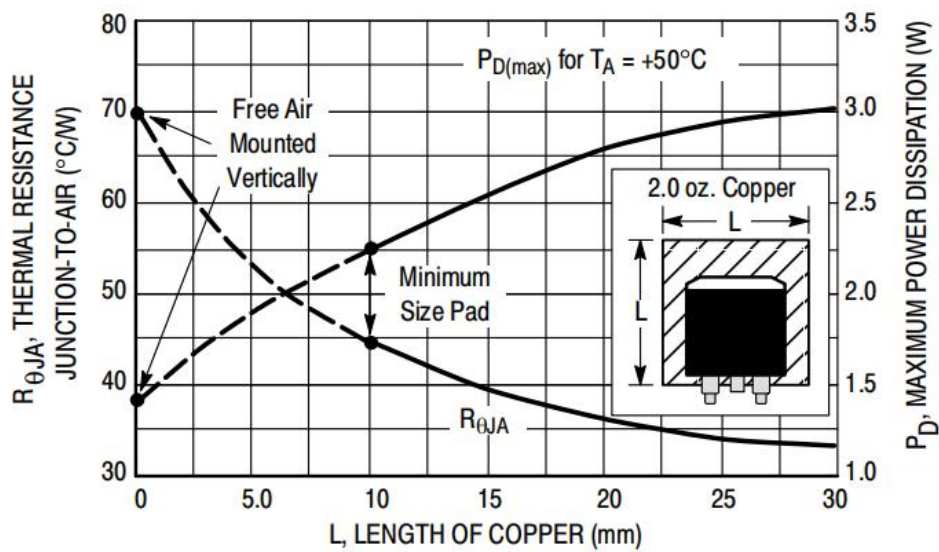


Figure 21. D2PAK Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

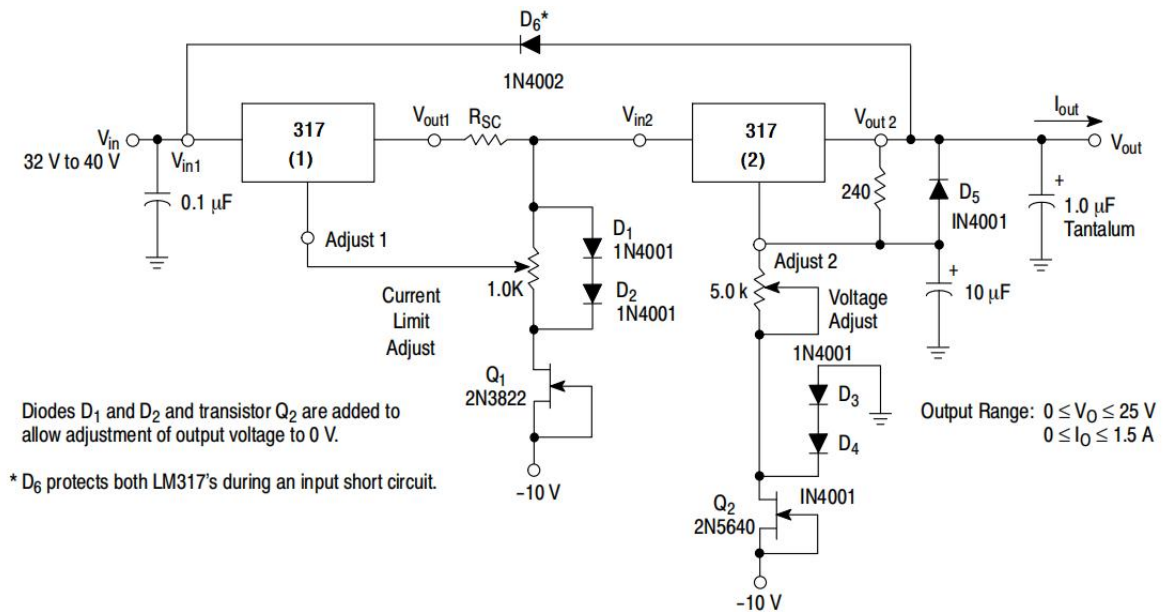


Figure 22. "Laboratory" Power Supply with Adjustable

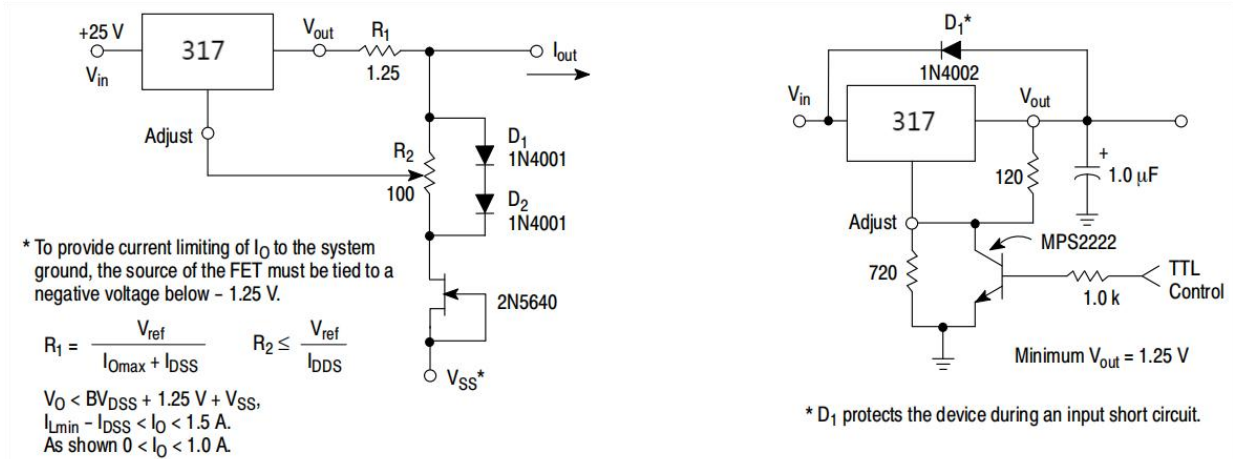


Figure 23. Adjustable Current Limiter Figure 24. 5.0 V Electronic Shutdown Regulator

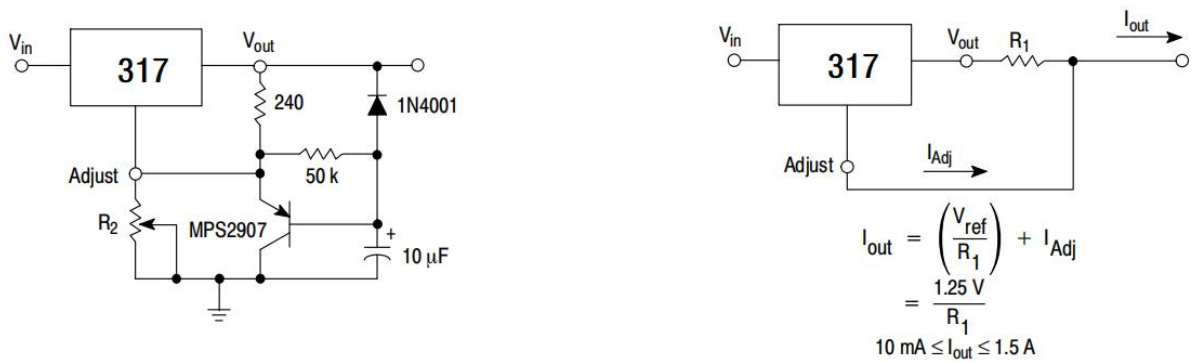
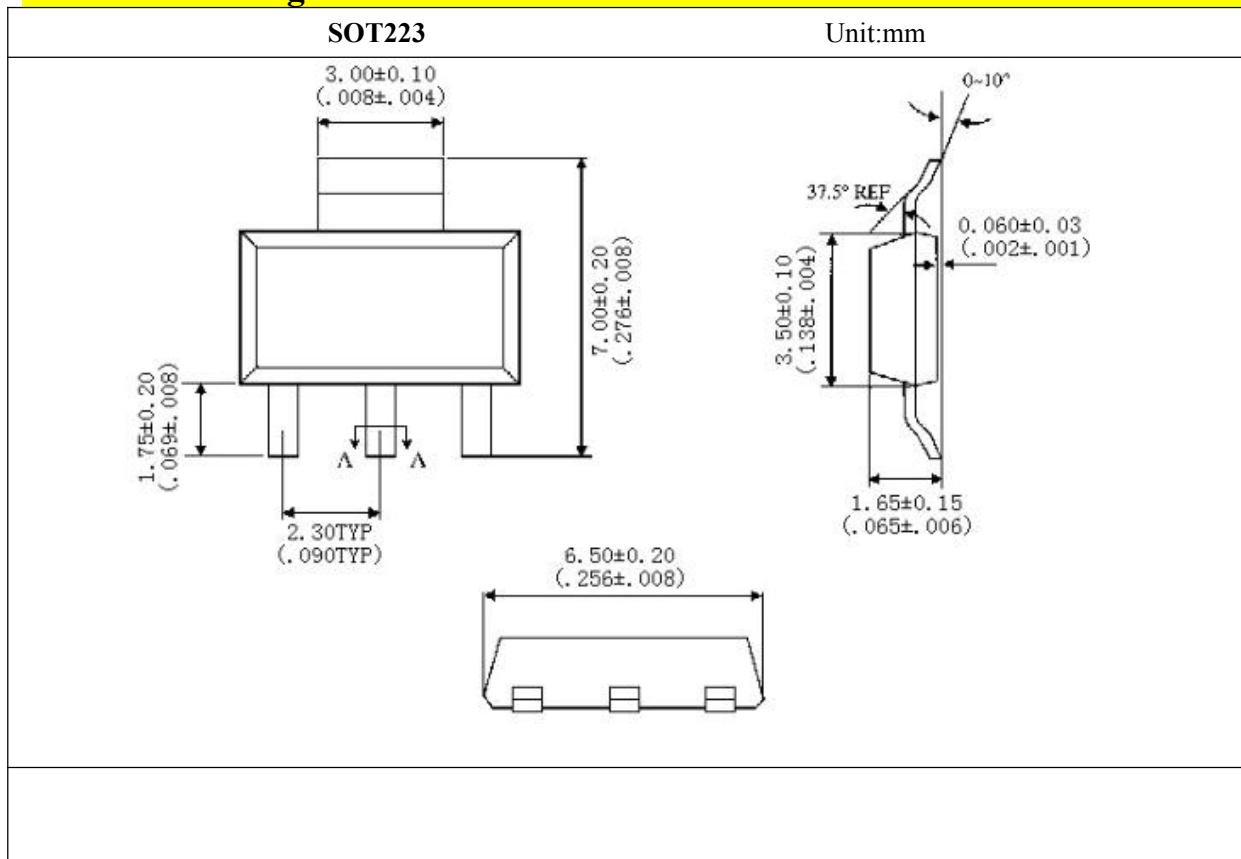


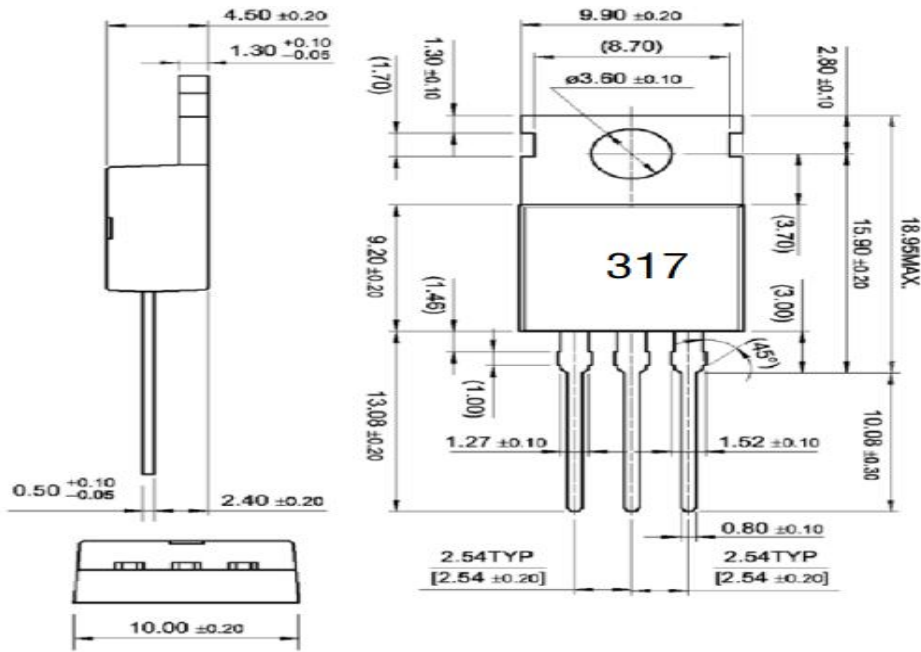
Figure 25. Slow Turn-On Regulator Figure 26. Current Regulator

## Outline Drawing



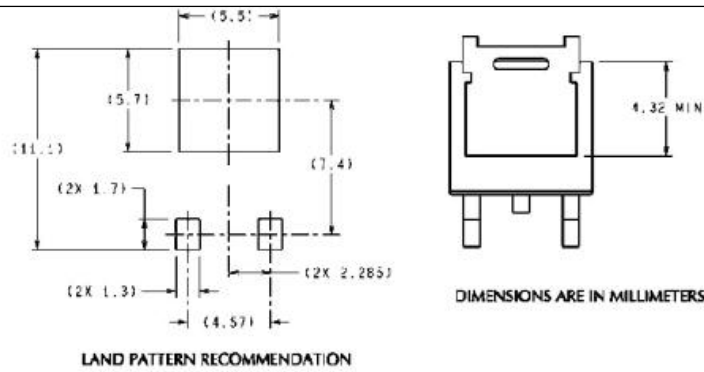
TO220

Unit:mm

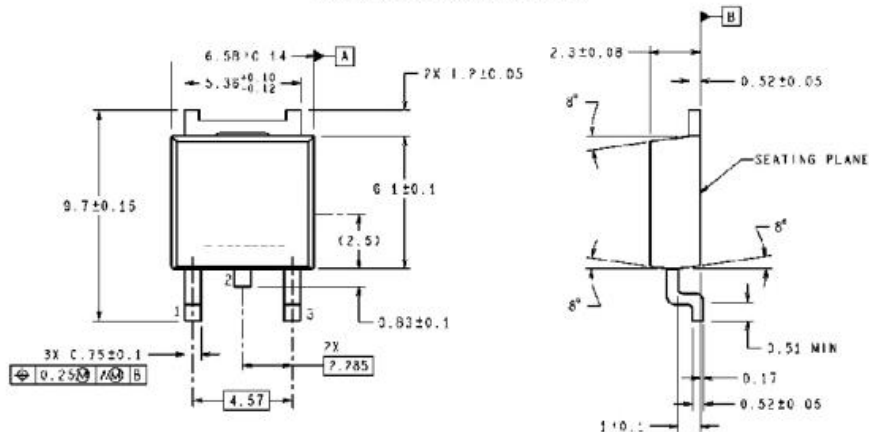


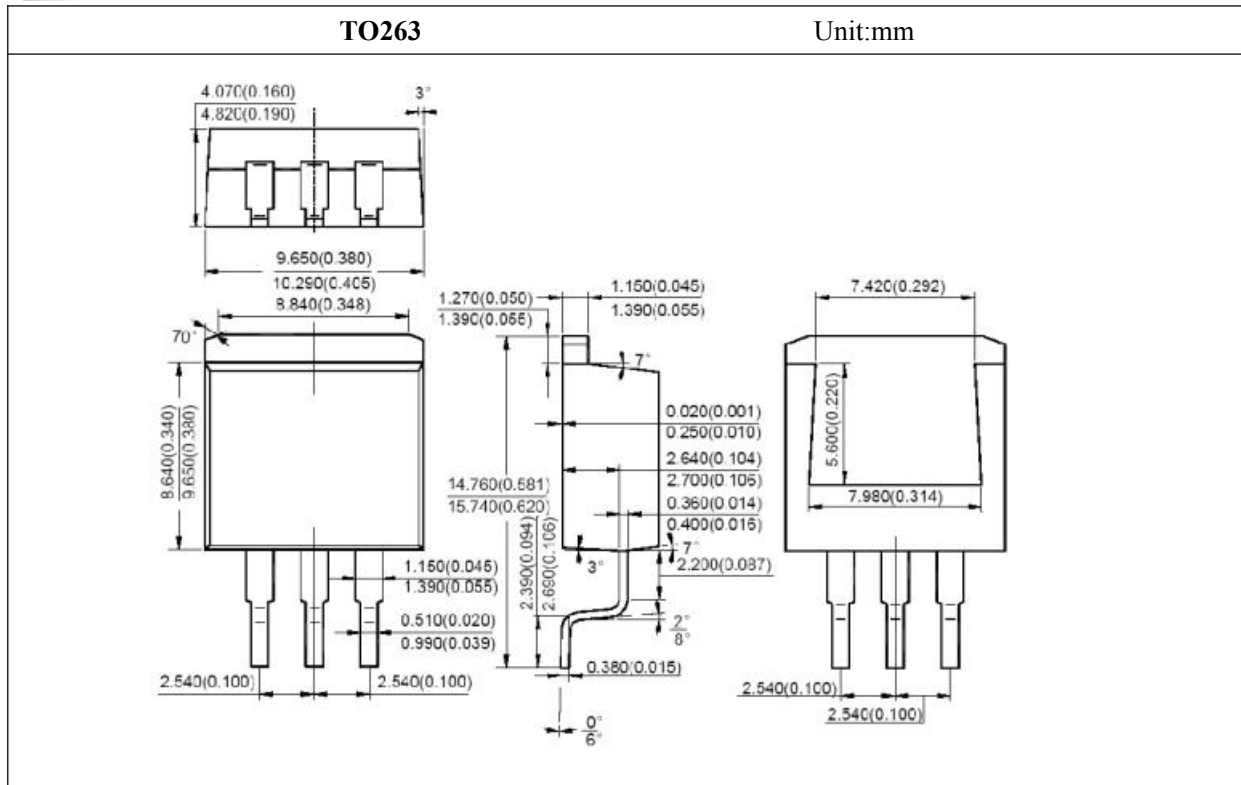
TO252

Unit:mm



LAND PATTERN RECOMMENDATION





Current Limit and Output Voltage



Statement:

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