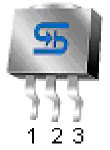
TAIWAN SEMICONDUCTOR

TS317

3-Terminal Adjustable Positive Voltage Regulator

TO-220

TO-263
(D^2PAK)



TO-252
(DPAK)

SOT-223

Pin Definition:
1. Adjustable
2. Output
3. Input
Heatsink is connected to Pin 2

General Description

The TS317 is adjustable 3-terminal positive voltage regulator capable of supplying in excess of 1.5A over an output voltage range of 1.25 V to 37 V. This voltage regulator is exceptionally easy to use and require 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.

Features

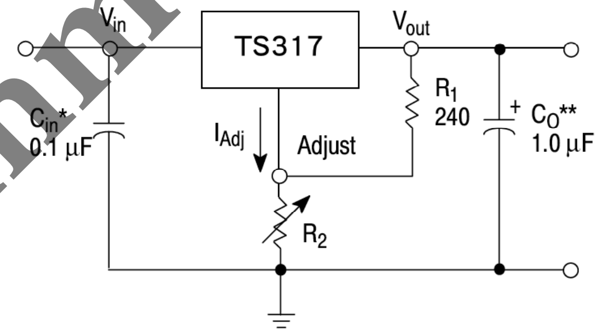
- Output Voltage Range 1.25 to 37V
- Output current
  - TO-220/TO-263 up to 1.5A
  - TO-252/SOT-223 up to 500mA
- Eliminates Stocking Many Fixed Voltages
- Internal Thermal Overload Protection
- Current Limit Constant with Temperature
- Output transistor safe-area compensation
- Output voltage offered in 4% tolerance
- Floating Operation for High Voltage Applications

Ordering Information

Part No.	Package	Packing
TS317CZ C0G	TO-220	50pcs / Tube
TS317CM RNG	TO-263	800pcs / 13” Reel
TS317CP ROG	TO-252	2.5Kpcs / 13” Reel
TS317CW RPG	SOT-223	2.5Kpcs / 13” Reel

Note: “G” denotes for Halogen Free

Standard Application Circuit



Cin is required if regulator is located an appreciable distance from power supply filter.
Co is not needed for stability, however, it does improve transient response.

$$V_{out} = 1.25\ V(1 + R2 / R1) + I_{Adj}R2$$

Since I_{Adj} is controlled to less than 100 µA, the error associated with this term is negligible in most applications

Absolute Maximum Rating (Ta = 25°C unless otherwise noted)

Parameter	Symbol	Limit	Unit
Input Voltage	V_{IN}	40	V
Power Dissipation	P_D	Internal Limited	W
Operating Junction Temperature	T_J	0~+125	°C
Storage Temperature Range	T_{STG}	-65~+150	°C

Thermal Performance

Condition	Package type	Symbol	Typ	Unit
Thermal Resistance Junction to Air	TO-220	$R\Theta_{JA}$	50	°C/W
	TO-263		55	
	TO-252		100	
	SOT-223		130	
Thermal Resistance Junction to Case	TO-220	$R\Theta_{JC}$	5	°C/W
	TO-263		5	
	TO-252		10	
	SOT-223		15	

Electrical Characteristics

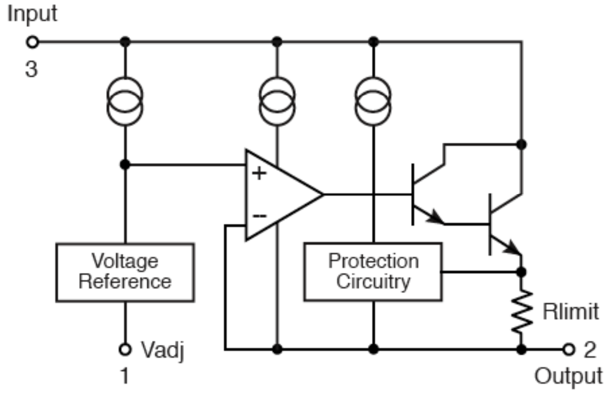
(V_I -V_O = 5.0 V, Io=500mA for TO-220/TO-263 packages, Io=200mA for TO-252/SOT-223 package)

Parameter	Figure	Symbol	Min.	Typ.	Max.	Unit
Reference voltage, 3V ≤ Vi-Vo ≤ 40V 10mA ≤ Io ≤ Imax, Pd ≤ Pmax,	3	Vref	1.20	1.25	1.30	V
Line regulation (Note 3) Ta = 25 °C, 3V≤Vi-Vo≤40V	1	REGline	--	0.01	0.07	%/V
Load regulation Ta = 25 °C, 10mA ≤ I_O ≤ Imax (Note 2) V_O ≤ 5.0 V_O ≥ 5.0	2	REGload	-- --	5.0 0.1	25 0.5	mV %V
Thermal regulation, Ta = 25°C (Note 5), 20mS Pulse		REGtherm	--	0.03	0.07	%Vo/W
Adjustment pin current	3	Iadj	--	50	100	uA
Adjustment pin current change, 3V ≤ V_I - V_O ≤ 40V 10mA ≤ Io ≤ Imax, Pd ≤ Pmax,	1.2	ΔIadj	--	0.2	5.0	uA
Maximum output current, V_I - V_O ≤ 15V, Pd ≤ Pmax TO-220 / TO-263 Package TO-252 / SOT-223 Package	3	Imax	1.5 0.5	-- --	-- --	A
Temperature stability (T_{LOW} ≤ Tj ≤ T_{HIGH})	3	T_S	--	1	--	% Vo
Minimum load current to maintain regulation (V_I - V_O = 40 V)	3	ILmin	--	3.5	10	mA
RMS Noise, % of V_O, Ta =25 °C, 10Hz ≤ f ≤ 10KHz		N	--	0.003	--	% Vo
Ripple Rejection, Vo =10V, f =120Hz (Note 3) Without Cadj Cadj = 10uF	4	PSRR	-- 66	65 80	-- --	dB
Long-term stability (Note 4), Tj = 125°C, 1000hrs	3	S	--	0.3	1.0	%

Notes: 1. T_{LOW} to T_{HIGH} = 0°C to +125°C, Pmax is internally limited

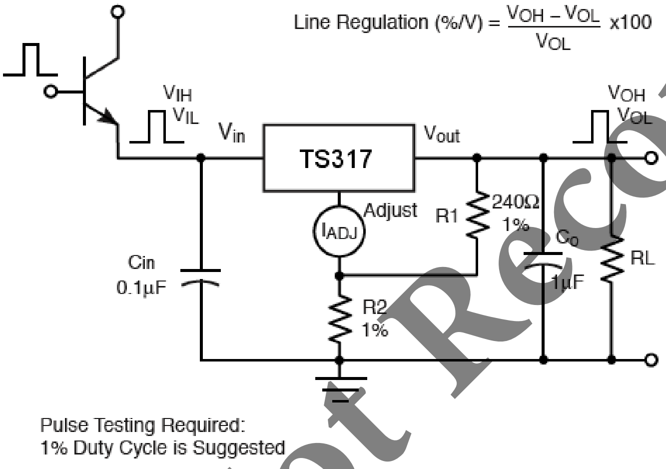
2. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.
3. Cadj, when used, is connected between the adjustment pin and ground. Since Long-Term Stability cannot be measured on each device before shipment, this specification is an engineering estimate of average stability from lot to lot.
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 in the effect of these temperature gradients on the output voltage and is expressed in the percentage of output change per watt of power change in a specified time.

Functional Block Diagram



Test Circuit

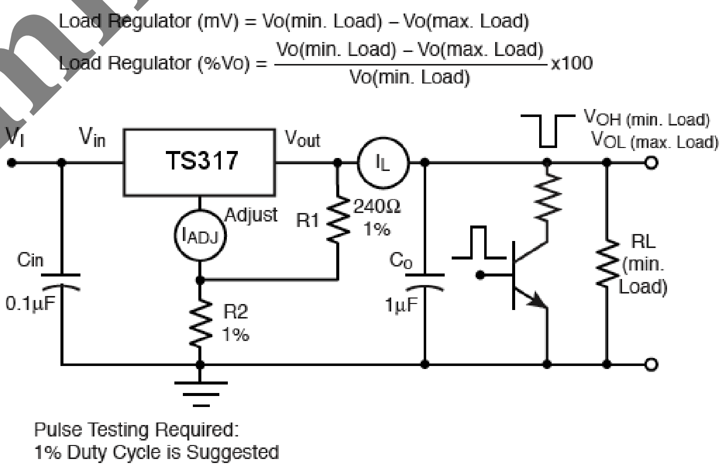
Figure 1. Line Regulation Test Circuit



Line Regulation (%/V) = $\frac{V_{OH} - V_{OL}}{V_{OL}}$ x100

Pulse Testing Required:
1% Duty Cycle is Suggested

Figure 2. Load Regulation and ΔIadj/Load Test Circuit

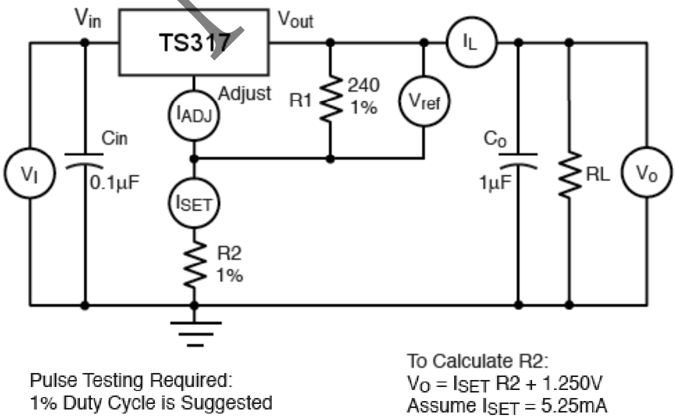


Load Regulator (mV) = Vo(min. Load) – Vo(max. Load)

Load Regulator (%Vo) = $\frac{Vo(min. Load) - Vo(max. Load)}{Vo(min. Load)}$x100

Pulse Testing Required:
1% Duty Cycle is Suggested

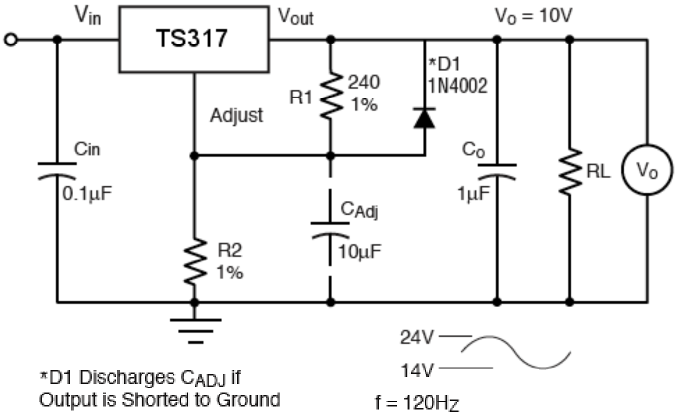
Figure 3. Standard Test Circuit



Pulse Testing Required:
1% Duty Cycle is Suggested

To Calculate R2:
$V_O = I_{SET}$ R2 + 1.250V
Assume I_{SET} = 5.25mA

Figure 4. Ripple Rejection Test Circuit



*D1 Discharges C_{ADJ} if
Output is Shorted to Ground

Electrical Characteristics Curve

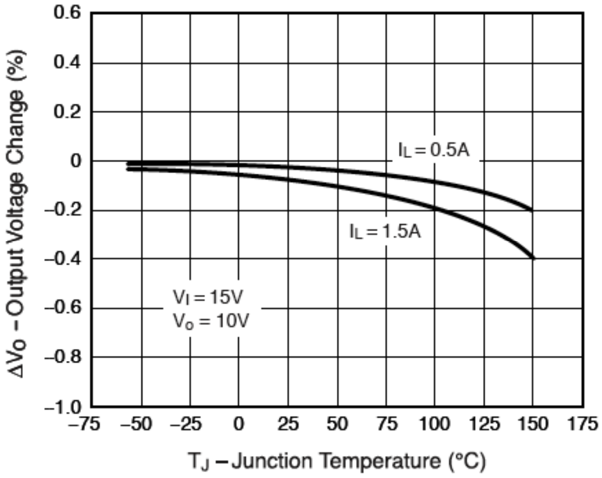


Figure 5. Load Regulation

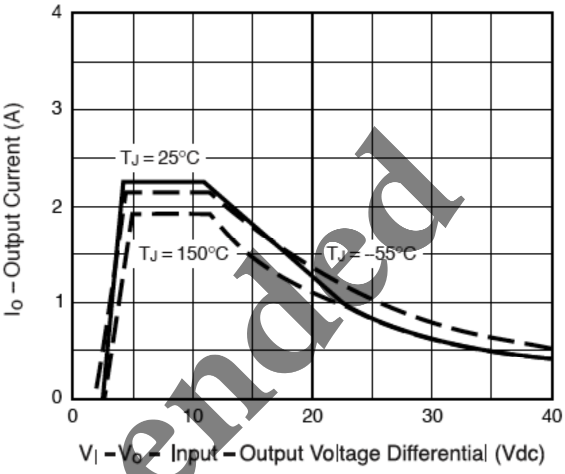


Figure 6. Current Limit

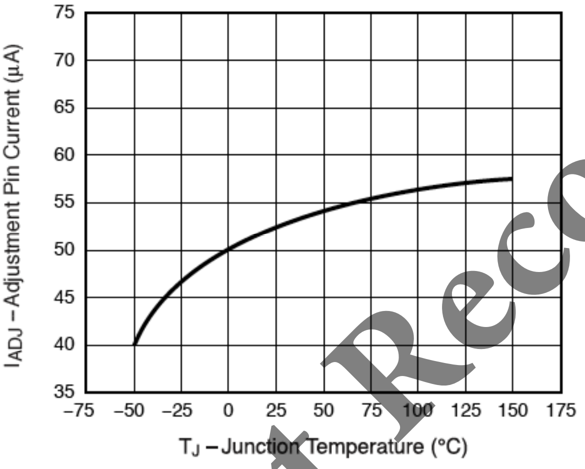


Figure 7. Adjustment Pin Current

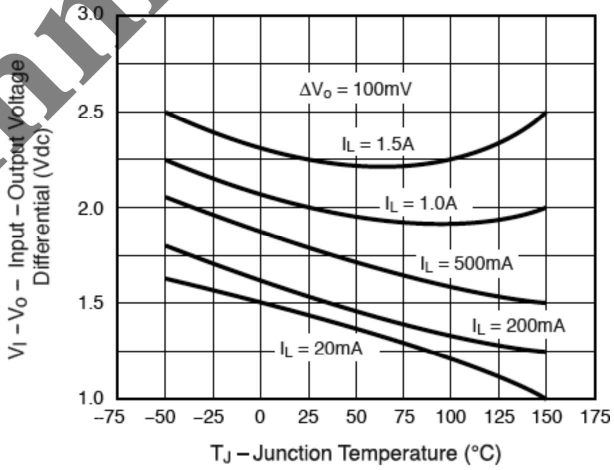


Figure 8. Dropout Voltage

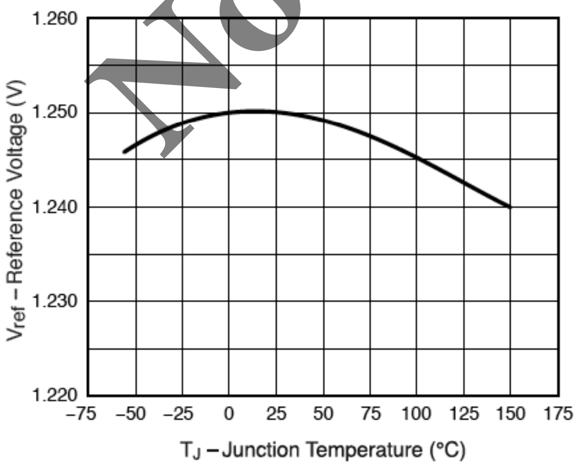


Figure 9. Temperature Stability

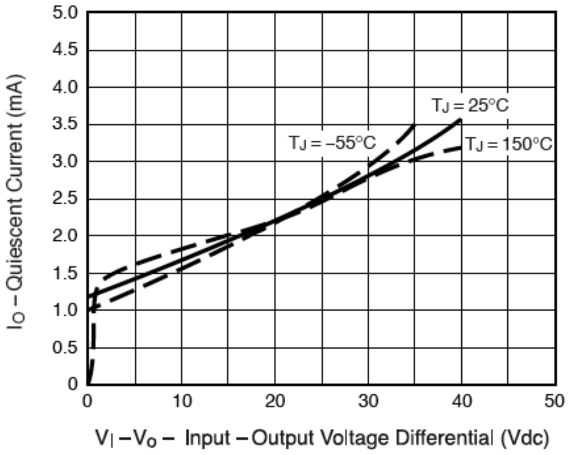


Figure 10. Minimum Operating Current

Electrical Characteristics Curve

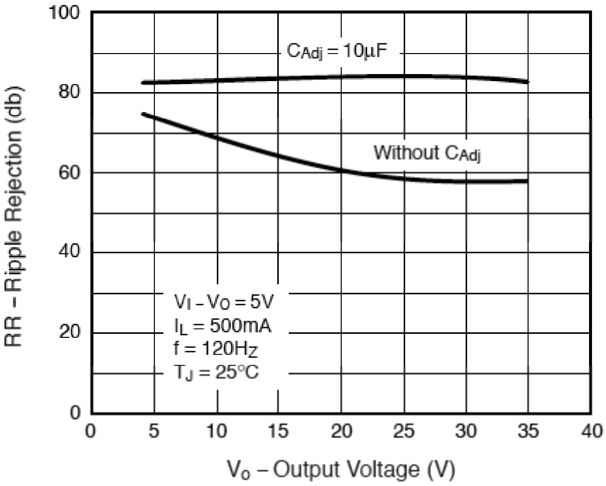


Figure 11. Ripple Rejection vs. Output Voltage

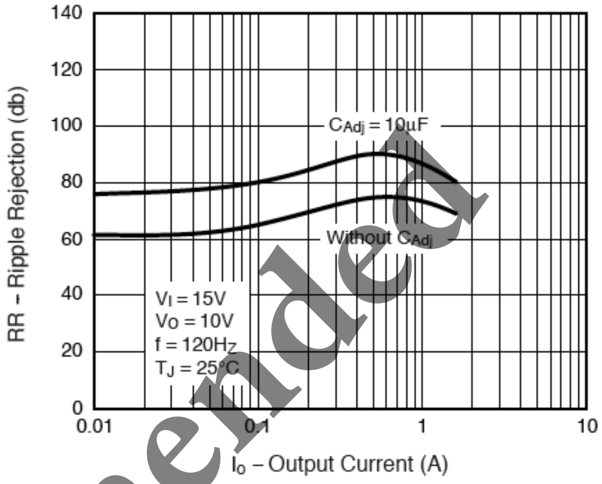


Figure 12. Ripple Rejection vs. Output Current

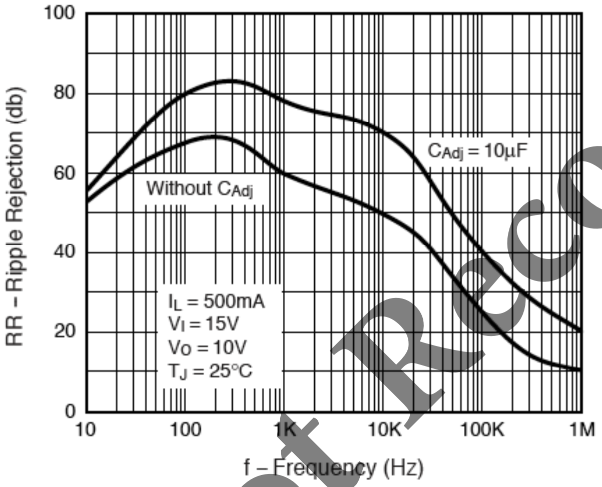


Figure 13. Ripple Rejection vs. Frequency

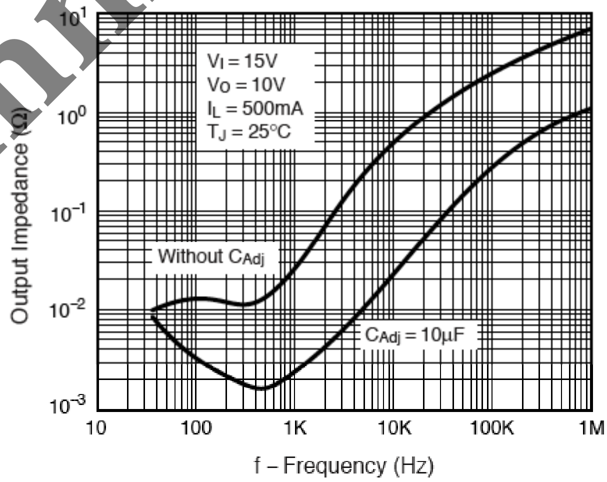


Figure 14. Output Impedance

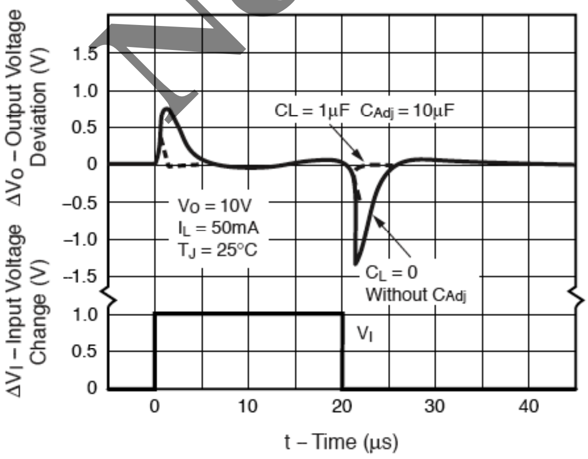


Figure 15. Line Transient Response

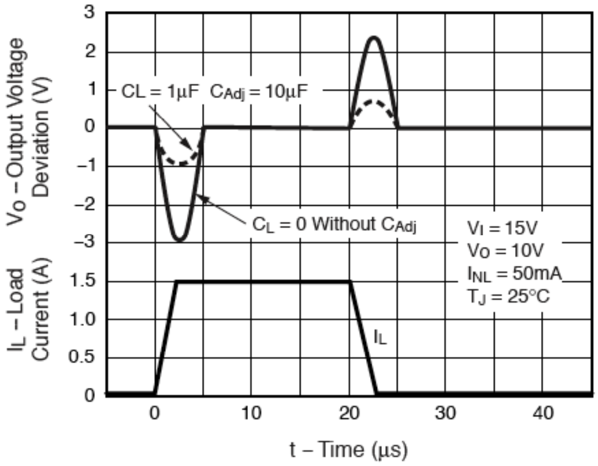


Figure 16. Load Transient Response

Application information

Basic Circuit Operation

The TS317 is a 3-terminal floating regulator. In operation, the TS317 develops and maintains a nominal 1.25V reference (Vref) between its output and adjustment terminals. This reference voltage is converted to a programming current (Iprog.) by R_1 (see Figure 17), and this constant current flows through R_2 to ground. The regulated output voltage is given by:

Vout = Vref (1 + R2 / R1) + Iadj * R2

Since the current from the adjustment terminal (Iadj) represents an error term in the equation, the TS317 was designed to control Iadj to less than 100uA 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 TS317 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.

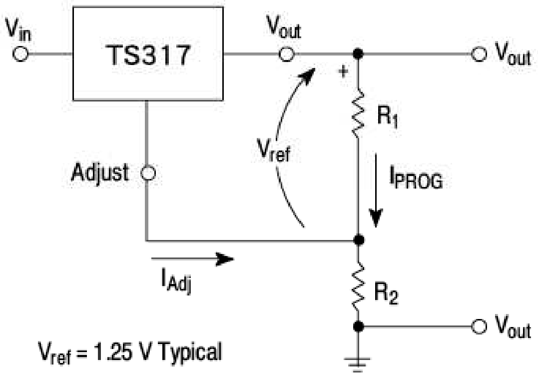


Figure 17. Basic Circuit Configuration

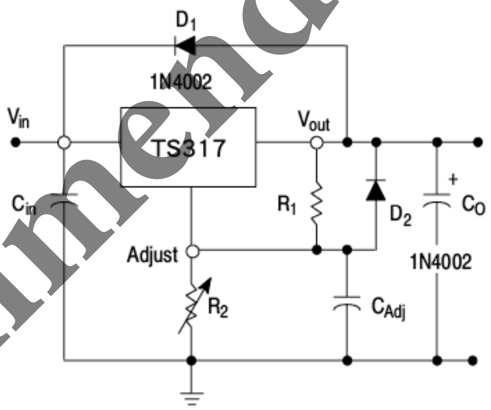


Figure 18. Voltage Regulator with Protection Diode

Protection Diode

When external capacitors are used with any I.C. 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 TS317 with the recommended protection diodes for output voltages in excess of 25 V or high capacitance values (Co > 25uF, Cadj > 10uF). Diode D1 prevents Co from discharging thru the I.C. during an input short circuit. Diode D2 protects against capacitor C_{ADJ} discharging through the I.C. during an output short circuit. The combination of diodes D1 and D2 prevents C_{ADJ} from discharging through the I.C. during an input short circuit.

Load Regulation

The TS317 is capable of providing extremely good load regulation, but a few precautions are needed to obtain maximum performance. For best performance, the programming resistor (R1) 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 R2 can be returned near the load ground to provide remote ground sensing and improve load regulation.

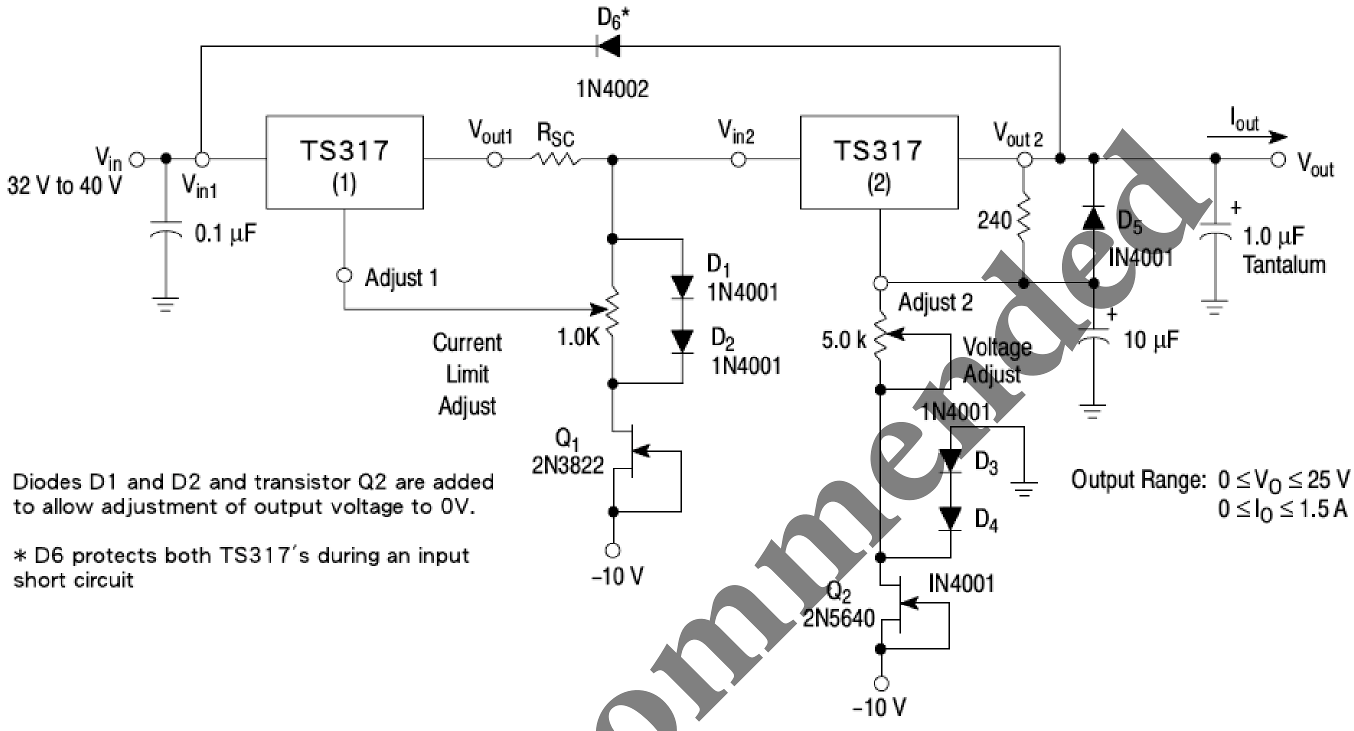
External Capacitor

A 0.1µF disc or 1µF tantalum input bypass capacitor (Cin) is recommended to reduce the sensitivity to input line impedance.

The adjustment terminal may be bypassed to ground to improve ripple rejection. This capacitor (Cadj) prevents ripple from being amplified as the output voltage is rejection about 15dB at 120 H_Z in a 10V application.

Although the TS317 is stable with no output capacitance, like any feedback circuit, certain values of external capacitance can cause excessive ringing. An output increased. A 10uµF capacitor should improve ripple capacitance (Co) in the form of a 1uF tantalum or 25uF aluminum electrolytic capacitor on the output swamps this effect and insures stability.

Application information (Continue)

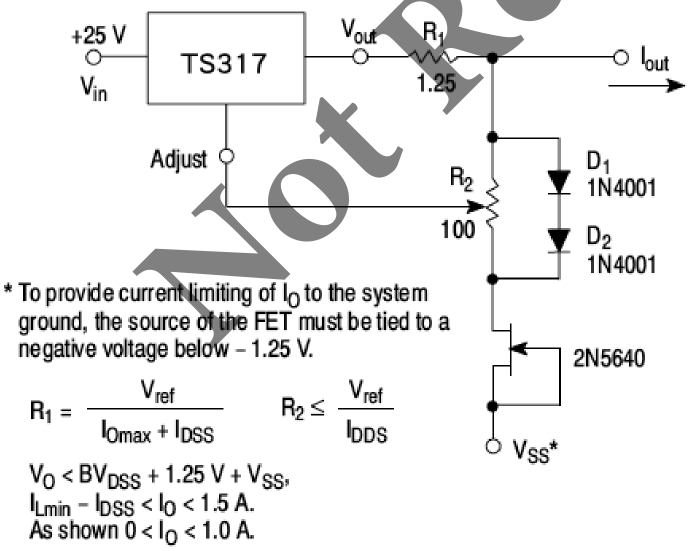


Diodes D1 and D2 and transistor Q2 are added to allow adjustment of output voltage to 0V.

∗ D6 protects both TS317's during an input short circuit

Output Range: $0 \le V_O \le 25$ V
$0 \le I_O \le 1.5$ A

Figure 19. "LABORATORY" power supply with adjustable current limit and output voltage

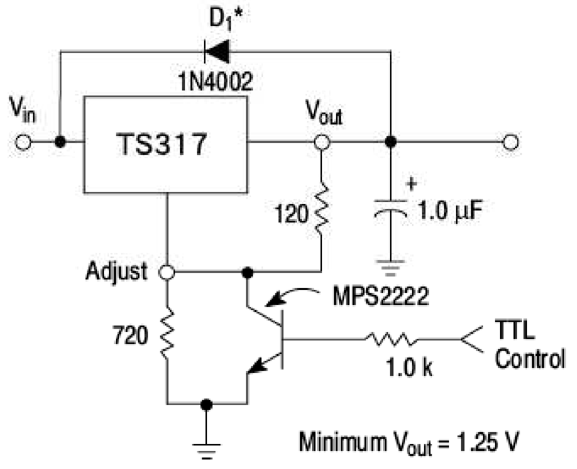


* To provide current limiting of I_O to the system ground, the source of the FET must be tied to a negative voltage below – 1.25 V.

$R_1 = \frac{V_{ref}}{I_{Omax} + I_{DSS}}$ $R_2 \le \frac{V_{ref}}{I_{DDS}}$

$V_O < BV_{DSS} + 1.25\ V + V_{SS}$,
$I_{Lmin} - I_{DSS} < I_O < 1.5$ A.
As shown $0 < I_O < 1.0$ A.

Figure 20. Adjustable Current Limiter



Minimum V_{out} = 1.25 V

* D_1 protects the device during an input short circuit.

Figure 21. 5V Electronic Shutdown Regulator

Application information (Continue)

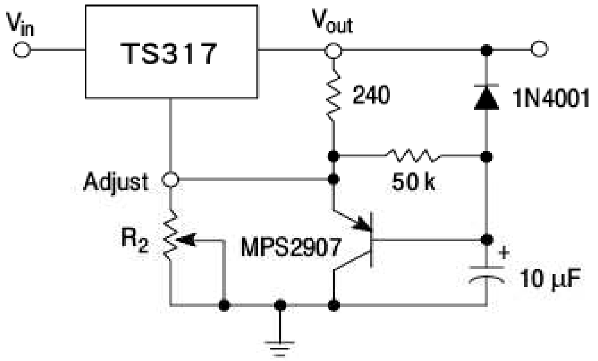


Figure 22. Slow Turn-on Regulator

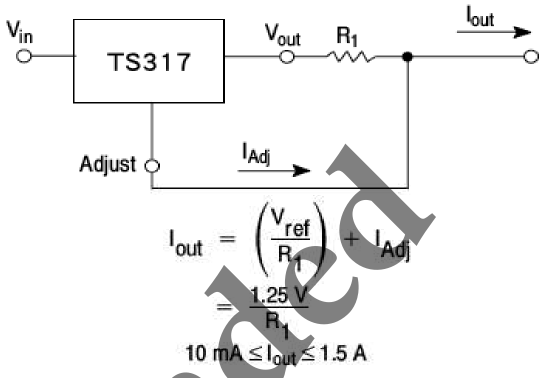


Figure 23. Current Regulator

Application Information

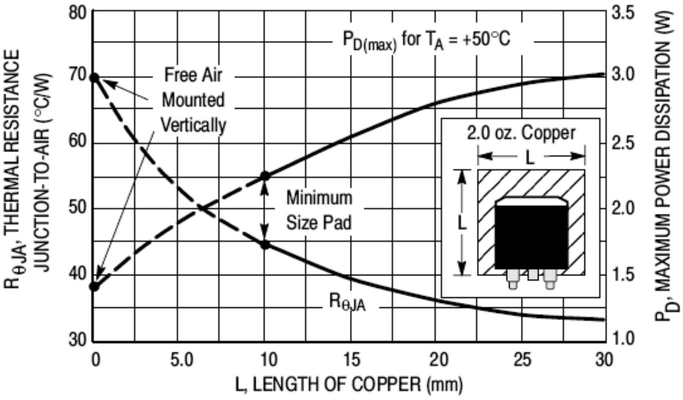


Figure 24. D^2PAK Thermal Resistance and Maximum Power Dissipation vs. P.C.B Copper Length

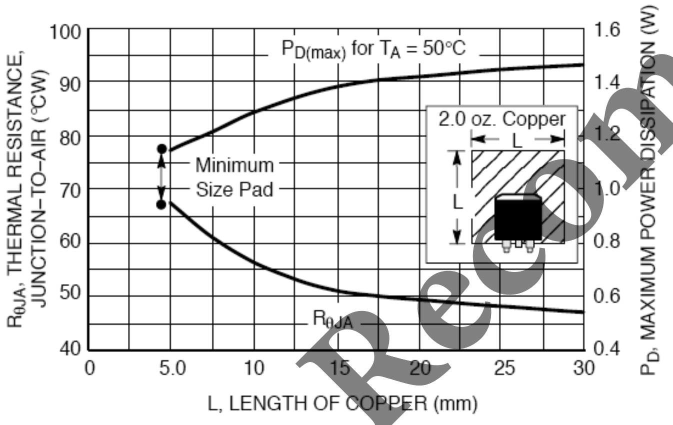


Figure 25. DPAK Thermal Resistance and Maximum Power Dissipation vs. P.C.B Copper Length

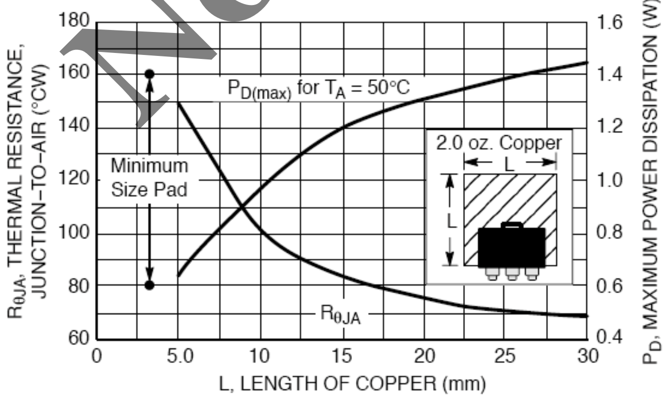
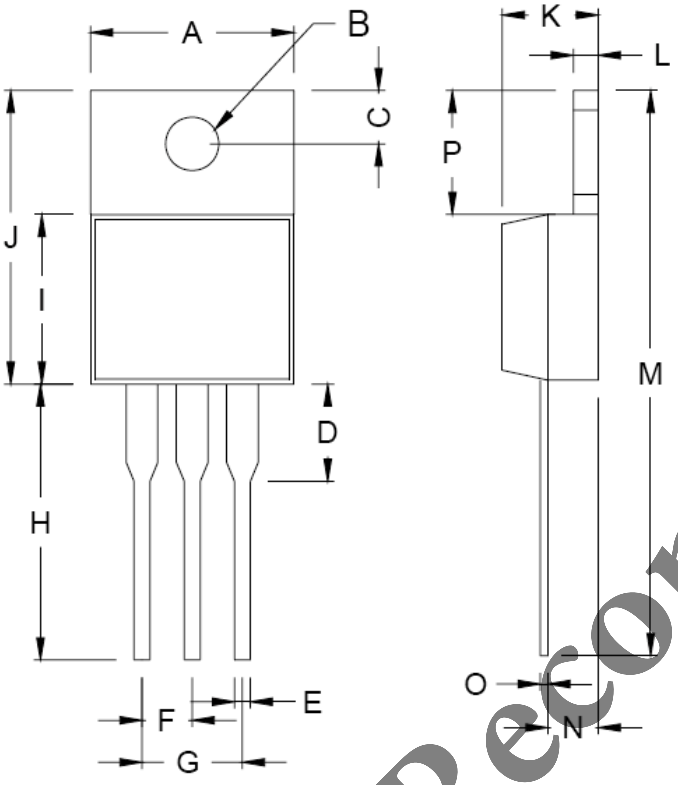


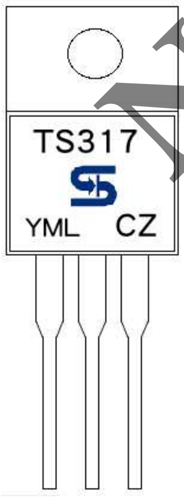
Figure 26. SOT-223 Thermal Resistance and Maximum Power Dissipation vs. P.C.B Copper Length

TO-220 Mechanical Drawing



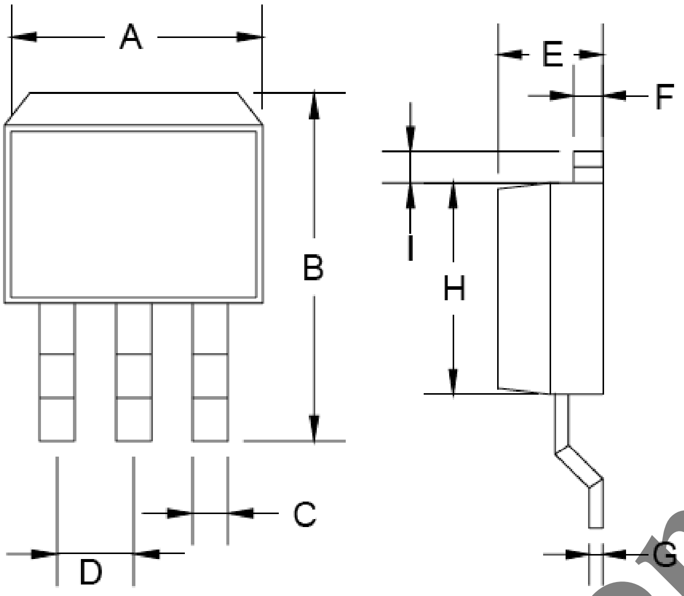
TO-220 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.000	10.500	0.394	0.413
B	3.740	3.910	0.147	0.154
C	2.440	2.940	0.096	0.116
D	-	6.350	-	0.250
E	0.381	1.106	0.015	0.040
F	2.345	2.715	0.092	0.058
G	4.690	5.430	0.092	0.107
H	12.700	14.732	0.500	0.581
I	8.382	9.017	0.330	0.355
J	14.224	16.510	0.560	0.650
K	3.556	4.826	0.140	0.190
L	0.508	1.397	0.020	0.055
M	27.700	29.620	1.060	1.230
N	2.032	2.921	0.080	0.115
O	0.255	0.610	0.010	0.024
P	5.842	6.858	0.230	0.270

Marking Diagram



Y = Year Code
M = Month Code for Halogen Free Product
O =Jan **P** =Feb **Q** =Mar **R** =Apr
S =May **T** =Jun **U** =Jul **V** =Aug
W =Sep **X** =Oct **Y** =Nov **Z** =Dec
L = Lot Code
CZ = Package Code for TO-220

TO-263 Mechanical Drawing



TO-263 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.000	10.500	0.394	0.413
B	14.605	15.875	0.575	0.625
C	0.508	0.991	0.020	0.039
D	2.420	2.660	0.095	0.105
E	4.064	4.830	0.160	0.190
F	1.118	1.400	0.045	0.055
G	0.450	0.730	0.018	0.029
H	8.280	8.800	0.325	0.346
I	1.140	1.400	0.044	0.055
J	1.480	1.520	0.058	0.060

Marking Diagram

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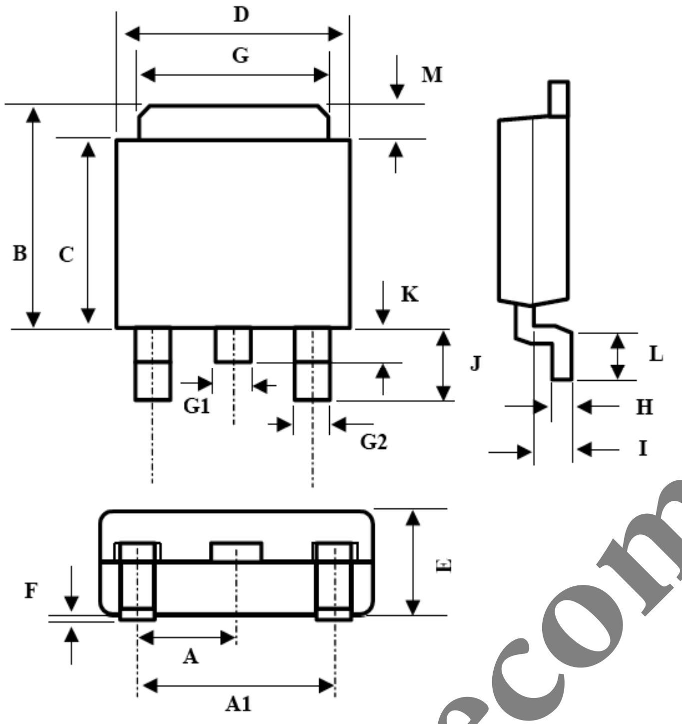
S	=May	**T**	=Jun	**U**	=Jul	**V**	=Aug
W	=Sep	**X**	=Oct	**Y**	=Nov	**Z**	=Dec

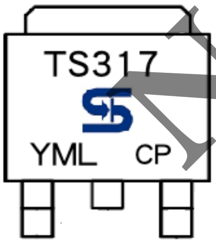
L = Lot Code
CM = Package Code for TO-263

TO-252 Mechanical Drawing



TO-252 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.3BSC		0.09BSC	
A1	4.6BSC		0.18BSC	
B	6.80	7.20	0.268	0.283
C	5.40	5.60	0.213	0.220
D	6.40	6.65	0.252	0.262
E	2.20	2.40	0.087	0.094
F	0.00	0.20	0.000	0.008
G	5.20	5.40	0.205	0.213
G1	0.75	0.85	0.030	0.033
G2	0.55	0.65	0.022	0.026
H	0.35	0.65	0.014	0.026
I	0.90	1.50	0.035	0.059
J	2.20	2.80	0.087	0.110
K	0.50	1.10	0.020	0.043
L	0.90	1.50	0.035	0.059
M	1.30	1.70	0.051	0.67

Marking Diagram



Y = Year Code

M = Month Code for Halogen Free Product

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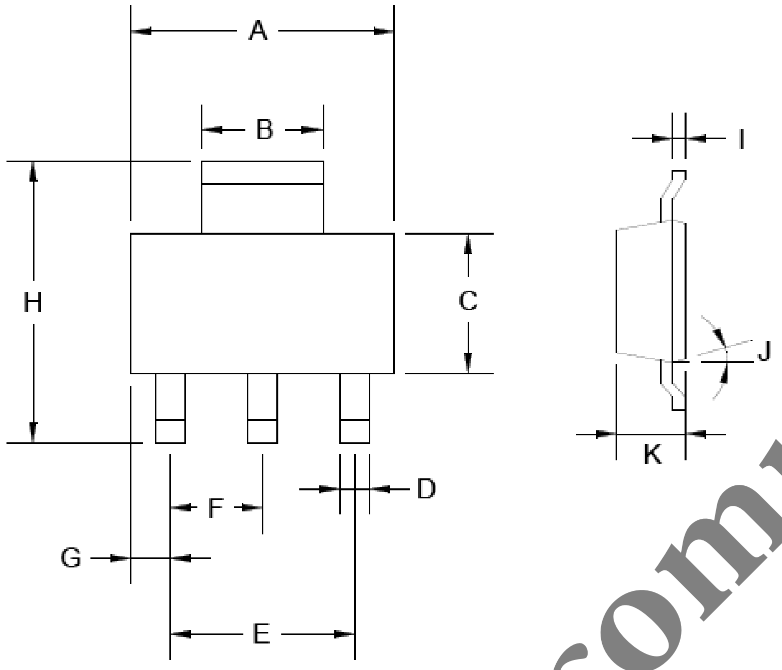
S	=May	**T**	=Jun	**U**	=Jul	**V**	=Aug
W	=Sep	**X**	=Oct	**Y**	=Nov	**Z**	=Dec

L = Lot Code

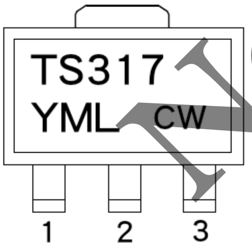
CP = Package Code for TO-252

SOT-223 Mechanical Drawing



SOT-223 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.350	6.850	0.250	0.270
B	2.900	3.100	0.114	0.122
C	3.300	3.750	0.129	0.148
D	0.660	0.840	0.025	0.033
E	4.550	4.650	0.179	0.183
F	2.250	2.350	0.088	0.093
G	0.850	1.050	0.033	0.041
H	6.700	7.300	0.263	0.287
I	0.230	0.355	0.009	0.014
J	10°	16°	10°	16°
K	1.550	1.800	0.061	0.071

Marking Diagram



Y = Year Code
M = Month Code for Halogen Free Product
O =Jan **P** =Feb **Q** =Mar **R** =Apr
S =May **T** =Jun **U** =Jul **V** =Aug
W =Sep **X** =Oct **Y** =Nov **Z** =Dec
L = Lot Code
CW = Package Code for TO-223

TS317

3-Terminal Adjustable Positive Voltage Regulator

Notice