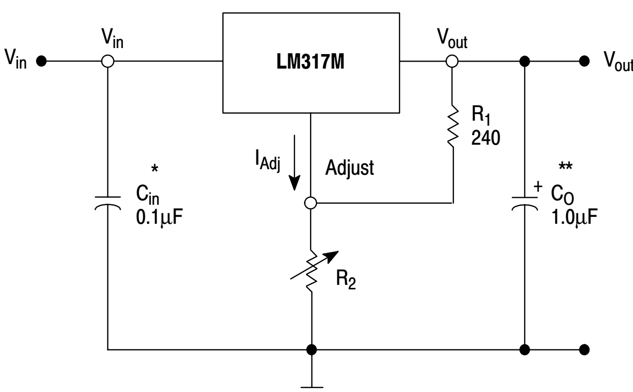
LM317M

500 mA Adjustable Output, Positive Voltage Regulator

The LM317M is an adjustable three–terminal positive voltage regulator capable of supplying in excess of 500 mA 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 LM317M serves a wide variety of applications including local, on–card regulation. This device also makes an especially simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LM317M can be used as a precision current regulator.

- Output Current in Excess of 500 mA
- Output Adjustable between 1.2 V and 37 V
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting
- Output Transistor Safe–Area Compensation
- Floating Operation for High Voltage Applications
- Eliminates Stocking Many Fixed Voltages



* = 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.

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

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

Figure 1. Simplified Application

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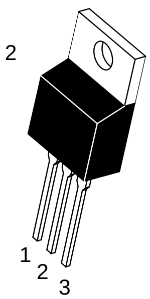
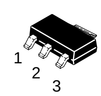
Heatsink surface connected to Pin 2

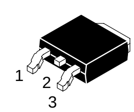


TO–220AB
T SUFFIX
CASE 221A



SOT–223
ST SUFFIX
CASE 318E

DPAK
DT SUFFIX
CASE 369A



Heatsink Surface (shown as terminal 4 in case outline drawing) is connected to Pin 2.

PIN ASSIGNMENT	
1	Adjust
2	V_{out}
3	V_{in}

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

MAXIMUM RATINGS (T_A = 25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Input–Output Voltage Differential	$V_I–V_O$	40	Vdc
Power Dissipation (Package Limitation) (Note 1)			
Plastic Package, T Suffix, Case 221A			
T_A = 25°C	P_D	Internally Limited	
Thermal Resistance, Junction–to–Air	θ_{JA}	70	°C/W
Thermal Resistance, Junction–to–Case	θ_{JC}	5.0	°C/W
Plastic Package, DT Suffix, Case 369A			
T_A = 25°C	P_D	Internally Limited	
Thermal Resistance, Junction–to–Air	θ_{JA}	92	°C/W
Thermal Resistance, Junction–to–Case	θ_{JC}	5.0	°C/W
Plastic Package, ST Suffix, Case 318E			
T_A = 25°C	P_D	Internally Limited	
Thermal Resistance, Junction–to–Air	θ_{JA}	245	°C/W
Thermal Resistance, Junction–to–Case	θ_{JC}	15	°C/W
Operating Junction Temperature Range	T_J	–40 to +125	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS ($V_I–V_O$ = 5.0 V; I_O = 0.1 A, T_J = T_{low} to T_{high} [Note 2], unless otherwise noted.)

Characteristics	Figure	Symbol	Min	Typ	Max	Unit
Line Regulation (Note 3) T_A = 25°C, 3.0 V ≤ $V_I–V_O$ ≤ 40 V	3	Reg_{line}	–	0.01	0.04	%/V
Load Regulation (Note 3) T_A = 25°C, 10 mA ≤ I_O ≤ 0.5 A	4	Reg_{load}				
V_O ≤ 5.0 V			–	5.0	25	mV
V_O ≥ 5.0 V			–	0.1	0.5	% V_O
Adjustment Pin Current	5	I_{Adj}	–	50	100	µA
Adjustment Pin Current Change 2.5 V ≤ $V_I–V_O$ ≤ 40 V, 10 mA ≤ I_L ≤ 0.5 A, P_D ≤ P_{max}	3,4	ΔI_{Adj}	–	0.2	5.0	µA
Reference Voltage 3.0 V ≤ $V_I–V_O$ ≤ 40 V, 10 mA ≤ I_O ≤ 0.5 A, P_D ≤ P_{max}:	5	V_{ref}	1.200	1.250	1.300	V
Line Regulation (Note 3) 3.0 V ≤ $V_I–V_O$ ≤ 40 V	3	Reg_{line}	–	0.02	0.07	%/V
Load Regulation (Note 3) 10 mA ≤ I_O ≤ 0.5 A	4	Reg_{load}				
V_O ≤ 5.0 V			–	20	70	mV
V_O ≥ 5.0 V			–	0.3	1.5	% V_O
Temperature Stability (T_{low} ≤ T_J ≤ T_{high})	5	T_S	–	0.7	–	% V_O
Minimum Load Current to Maintain Regulation ($V_I–V_O$ = 40 V)	5	I_{Lmin}	–	3.5	10	mA
Maximum Output Current	5	I_{max}				A
$V_I–V_O$ ≤ 15 V, P_D ≤ P_{max}			0.5	0.9	–	
$V_I–V_O$ = 40 V, P_D ≤ P_{max}, T_A = 25°C			0.15	0.25	–	
RMS Noise, % of V_O T_A= 25°C, 10 Hz ≤ f ≤ 10 kHz	–	N	–	0.003	–	% V_O
Ripple Rejection, V_O = 10 V, f = 120 Hz (Note 4)	6	RR				dB
Without C_{Adj}			–	65	–	
C_{Adj} = 10 µF			66	80	–	
Long–Term Stability, T_J = T_{high} (Note 5) T_A= 25°C for Endpoint Measurements	5	S	–	0.3	1.0	%/1.0 k Hrs.

1. Figure 25 provides thermal resistance versus pc board pad size.
2. T_{low} to T_{high} = 0° to +125°C for LM317M T_{low} to T_{high} = –40° to +125°C for LM317MB
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. C_{Adj}, when used, is connected between the adjustment pin and ground.
5. 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.

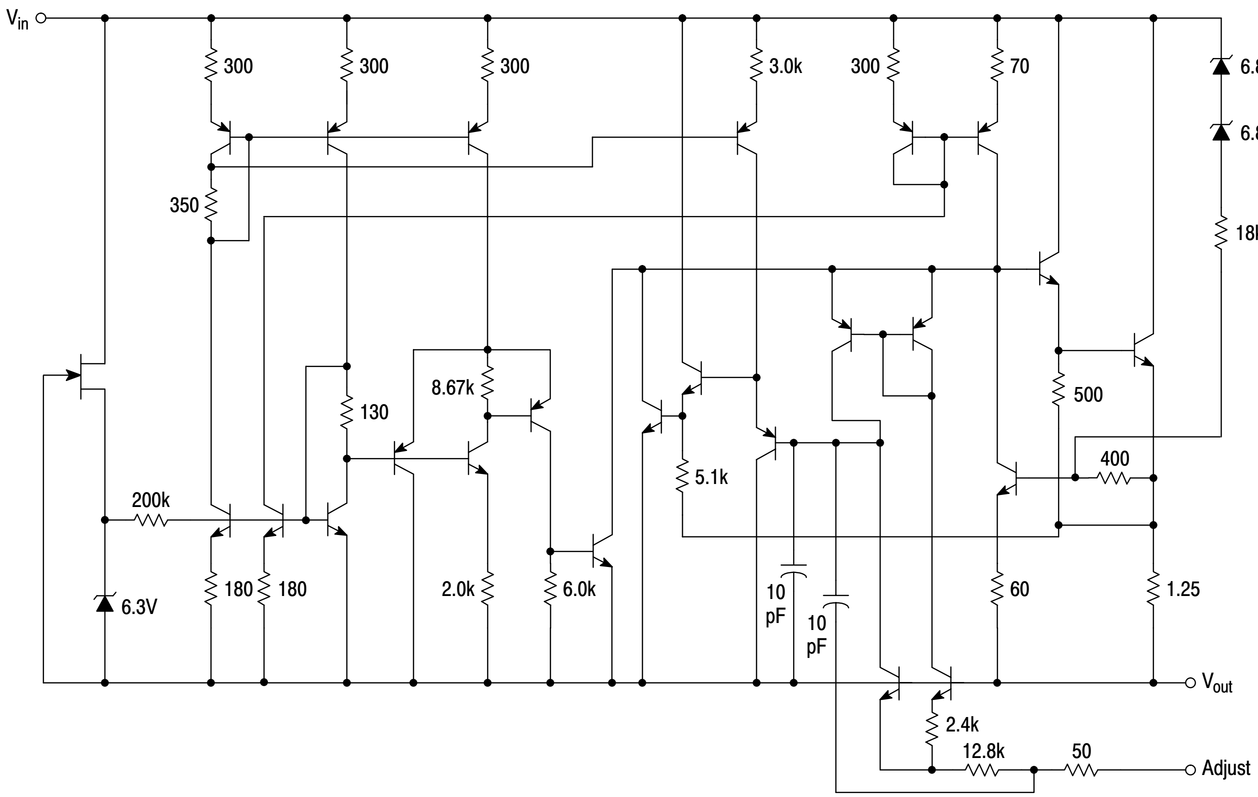


Figure 2. Representative Schematic Diagram

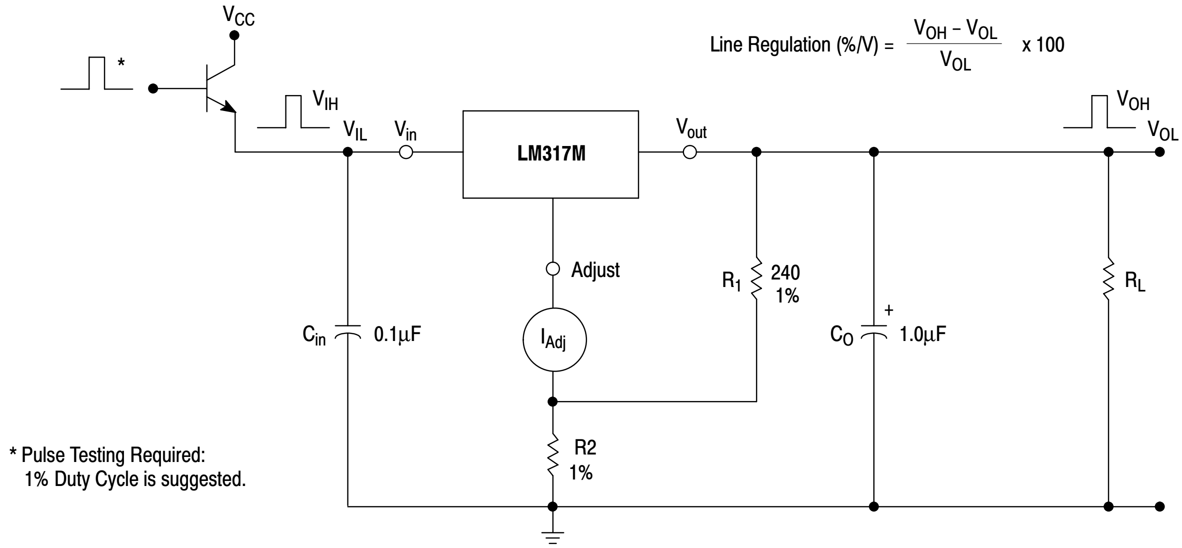


Figure 3. Line Regulation and ΔI_{Adj}/Line Test Circuit

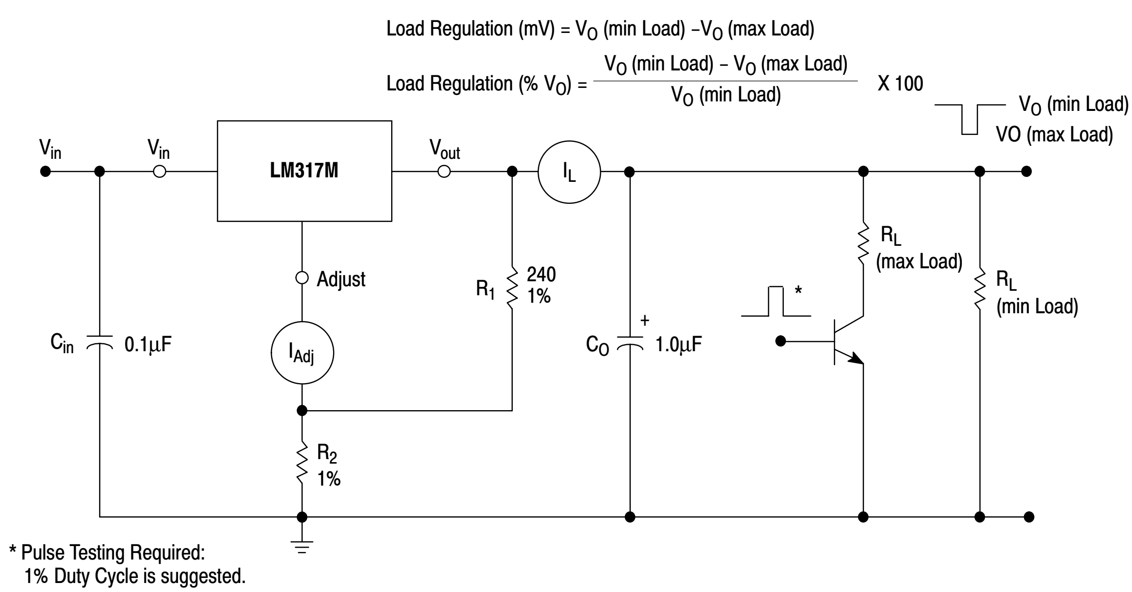


Figure 4. Load Regulation and ΔI_{Adj}/Load Test Circuit

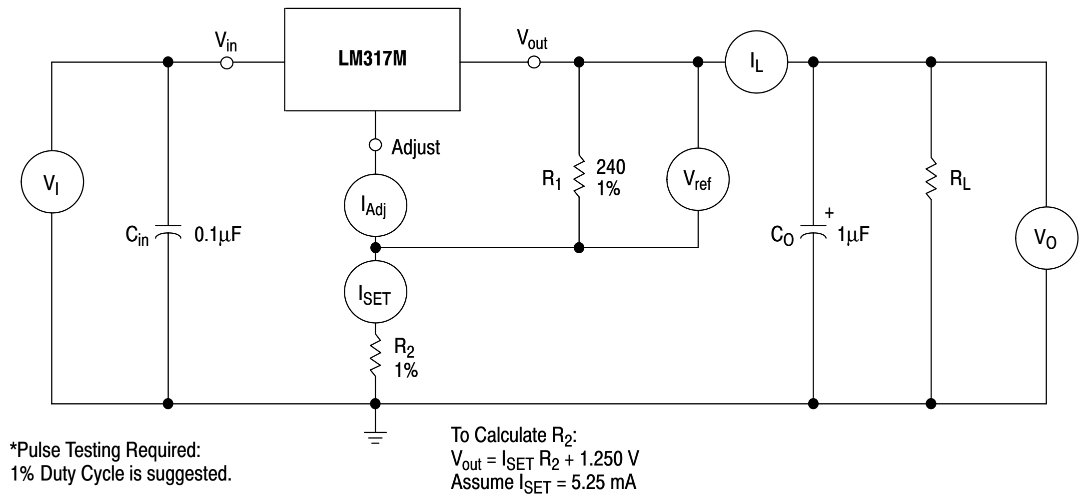


Figure 5. Standard Test Circuit

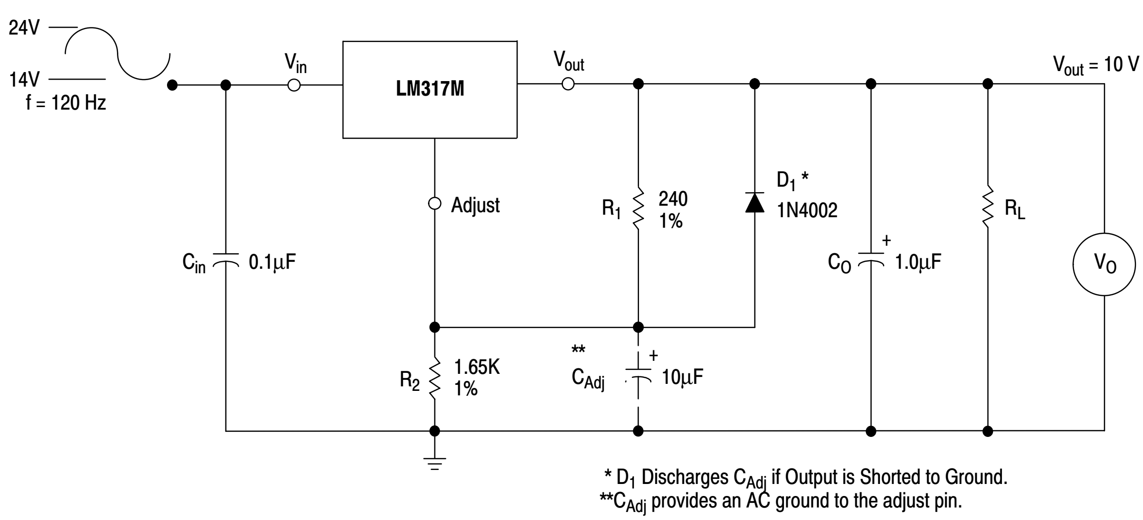


Figure 6. Ripple Rejection Test Circuit

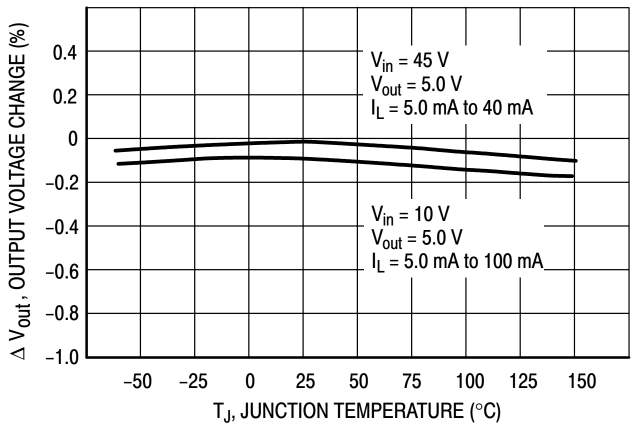


Figure 7. Load Regulation

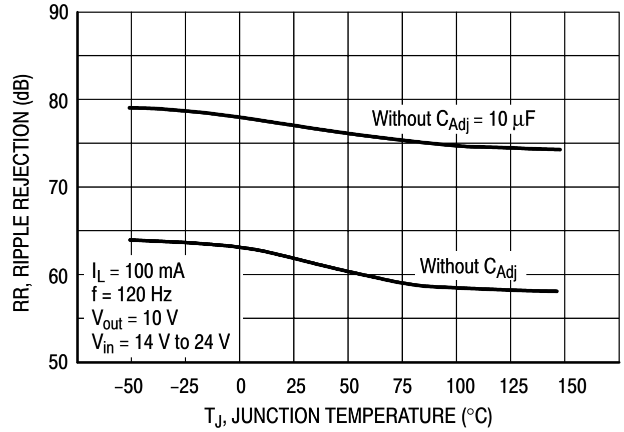


Figure 8. Ripple Rejection

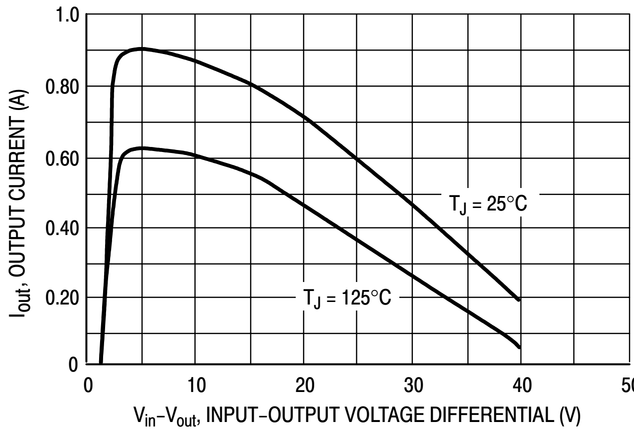


Figure 9. Current Limit

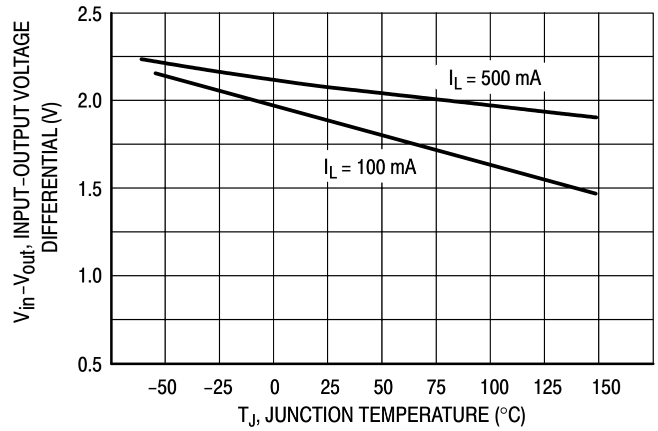


Figure 10. Dropout Voltage

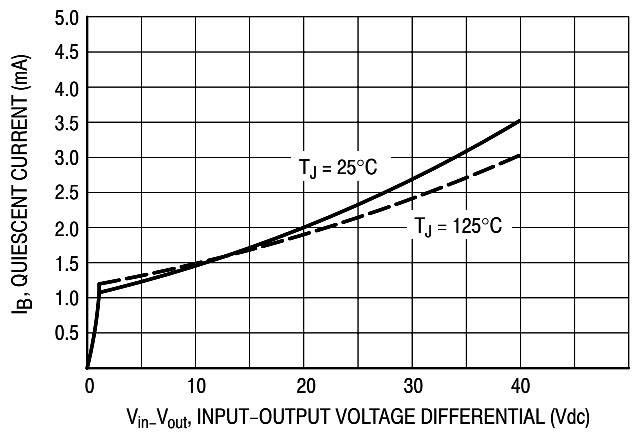


Figure 11. Minimum Operating Current

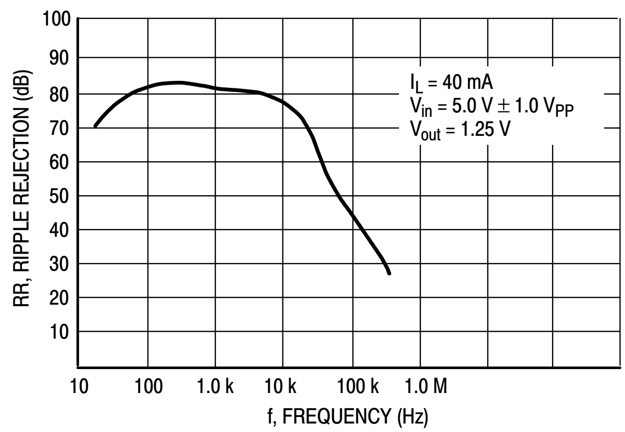


Figure 12. Ripple Rejection versus Frequency

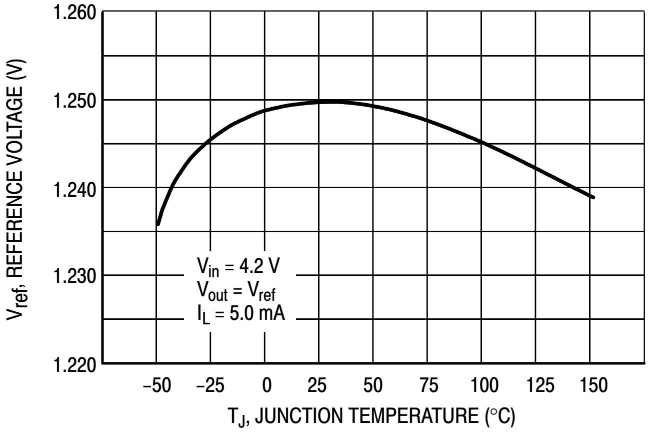


Figure 13. Temperature Stability

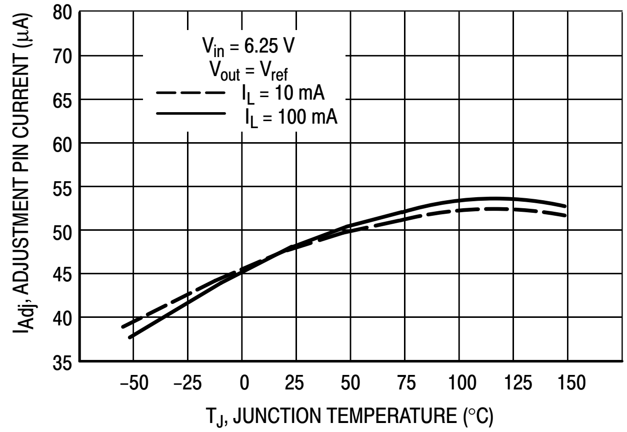


Figure 14. Adjustment Pin Current

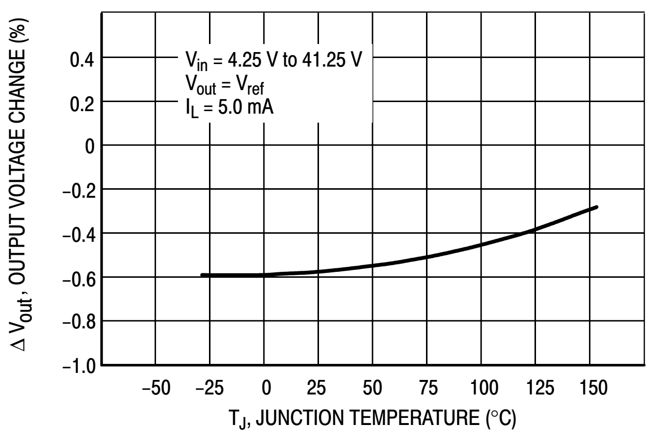


Figure 15. Line Regulation

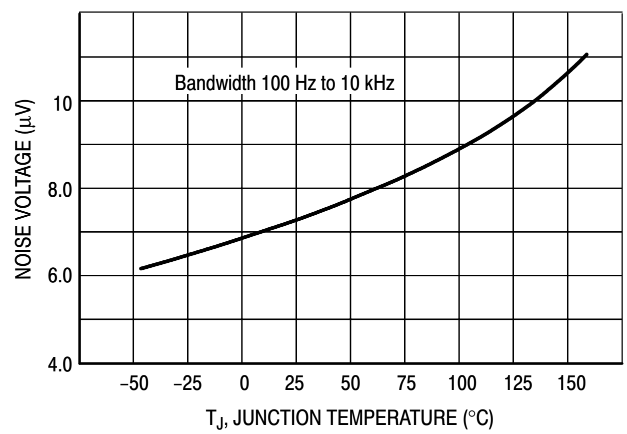


Figure 16. Output Noise

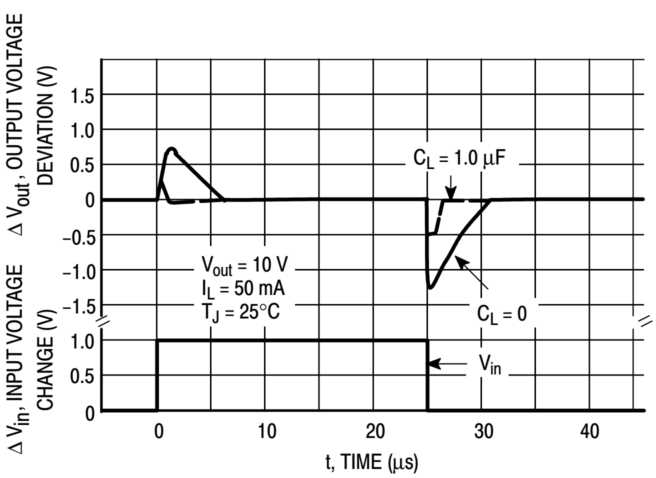


Figure 17. Line Transient Response

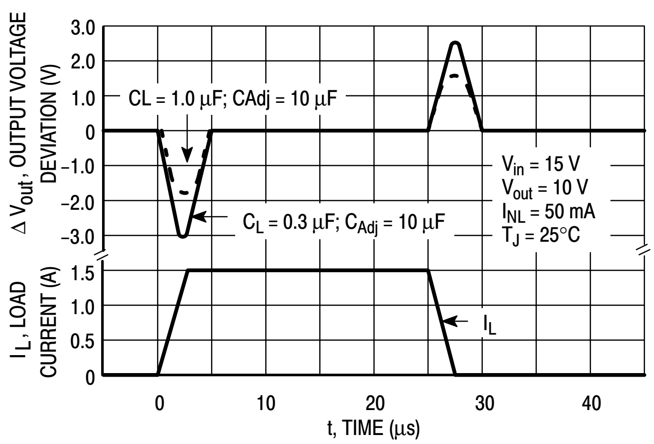


Figure 18. Load Transient Response

APPLICATIONS INFORMATION

Basic Circuit Operation

The LM317M is a three–terminal floating regulator. In operation, the LM317M 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 19), 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 terminal (I_{Adj}) represents an error term in the equation, the LM317M was designed to control I_{Adj} to less than 100 μA 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 LM317M 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.

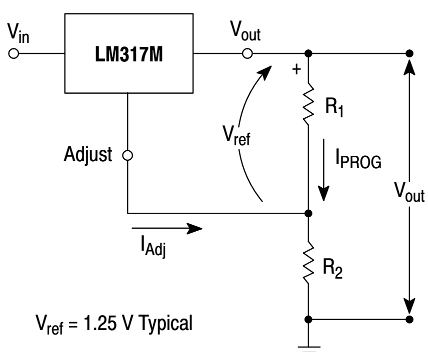


Figure 19. Basic Circuit Configuration

Load Regulation

The LM317M 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 μF disc or 1.0 μF 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 μF capacitor should improve ripple rejection about 15 dB at 120 Hz in a 10 V application.

Although the LM317M 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 μF tantalum or 25 μF 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 20 shows the LM317M with the recommended protection diodes for output voltages in excess of 25 V or high capacitance values (C_O > 25 μF, C_{Adj} > 5.0 μF). 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.

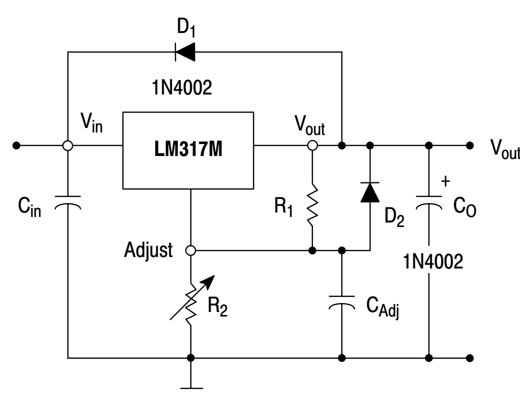


Figure 20. Voltage Regulator with Protection Diodes

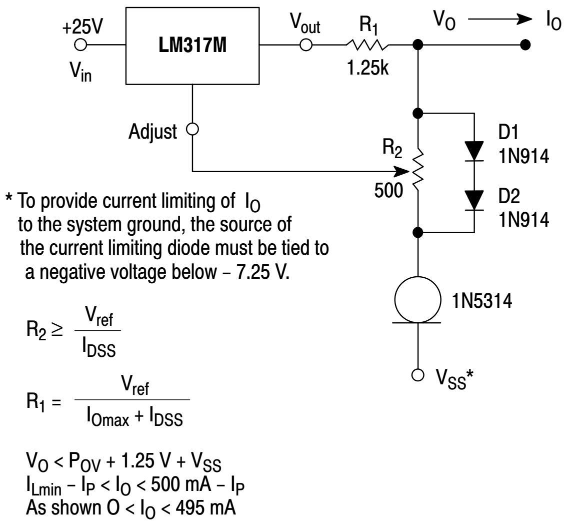


Figure 21. Adjustable Current Limiter

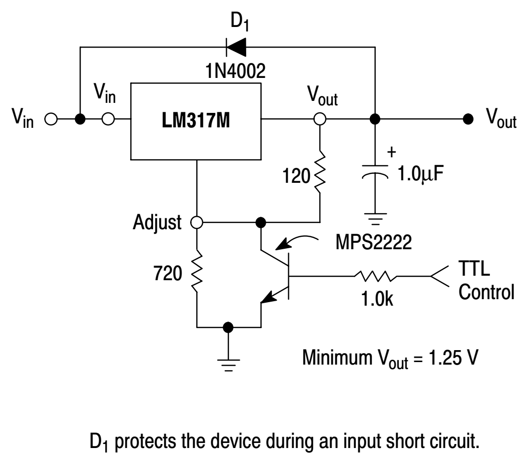


Figure 22. 5 V Electronic Shutdown Regulator

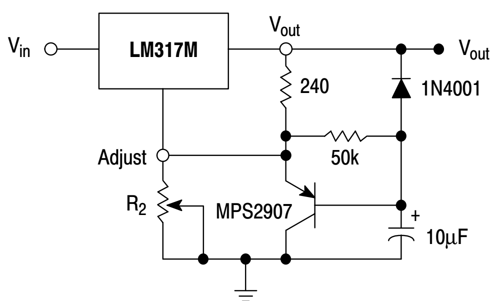


Figure 23. Slow Turn−On Regulator

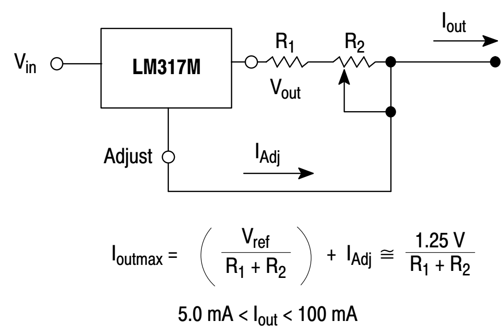


Figure 24. Current Regulator

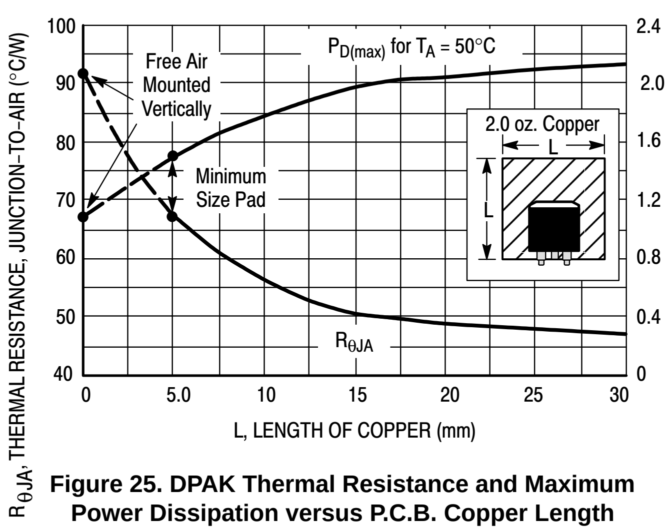


Figure 25. DPAK Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

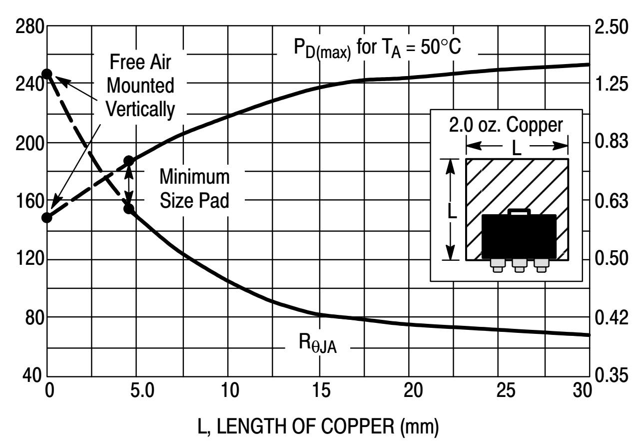


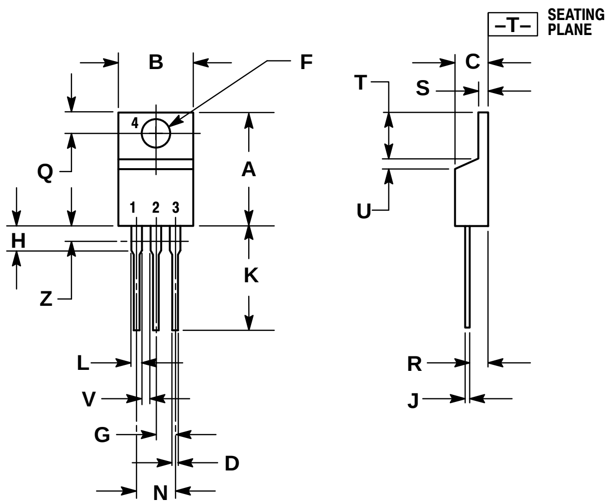
Figure 26. SOT−223 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

ORDERING INFORMATION

Device	Operating Temperature Range	Package	Shipping
LM317MT	T_J = 0°C to 125°C	TO–220	50 units/rail
LM317MDT	T_J = 0°C to 125°C	DPAK	75 units/rail
LM317MDTRK	T_J = 0°C to 125°C	DPAK	2500 units/Tape & Reel
LM317MSTT3	T_J = 0°C to 125°C	SOT–223	4000 units/Tape & Reel
LM317MBT	T_J = –40°C to 125°C	TO–220	50 units/rail
LM317MBDT	T_J = –40°C to 125°C	DPAK	75 units/rail
LM317MBDTRK	T_J = –40°C to 125°C	DPAK	2500 units/Tape & Reel
LM317MBSTT3	T_J = –40°C to 125°C	SOT–223	4000 units/Tape & Reel

PACKAGE DIMENSIONS

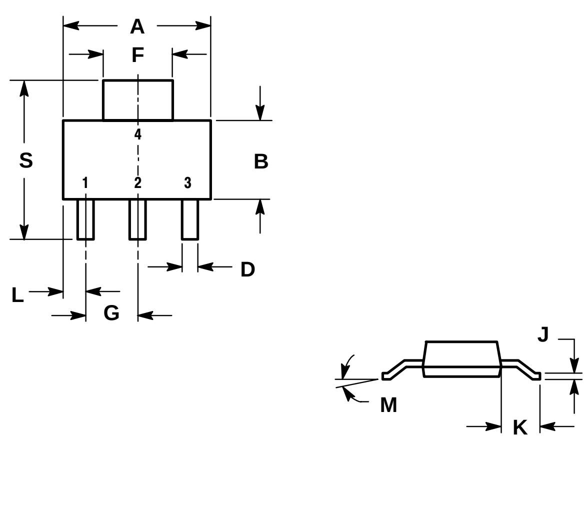
T SUFFIX
PLASTIC PACKAGE
CASE 221A–09
ISSUE AA



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.147	3.61	3.73
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.018	0.025	0.46	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	---	1.15	---
Z	---	0.080	---	2.04

(SOT–223)
ST SUFFIX
PLASTIC PACKAGE
CASE 318E–04
ISSUE K

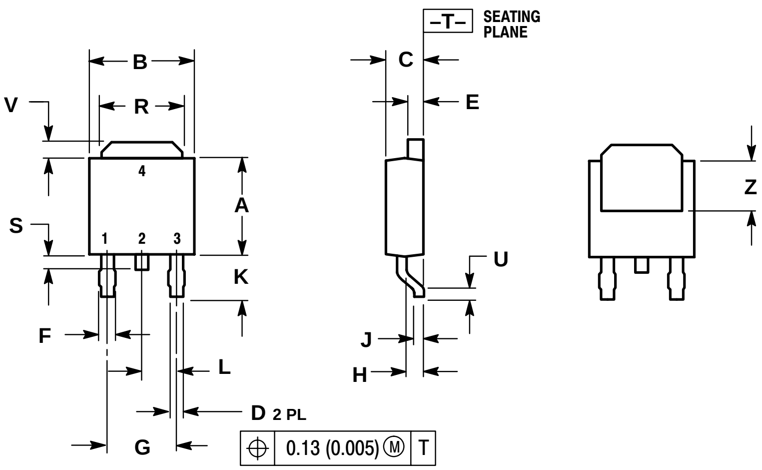


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.249	0.263	6.30	6.70
B	0.130	0.145	3.30	3.70
C	0.060	0.068	1.50	1.75
D	0.024	0.035	0.60	0.89
F	0.115	0.126	2.90	3.20
G	0.087	0.094	2.20	2.40
H	0.0008	0.0040	0.020	0.100
J	0.009	0.014	0.24	0.35
K	0.060	0.078	1.50	2.00
L	0.033	0.041	0.85	1.05
M	0 °	10 °	0 °	10 °
S	0.264	0.287	6.70	7.30

PACKAGE DIMENSIONS

(DPAK)
DT SUFFIX
PLASTIC PACKAGE
CASE 369A–13
ISSUE AB



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.235	0.250	5.97	6.35
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.027	0.035	0.69	0.88
E	0.033	0.040	0.84	1.01
F	0.037	0.047	0.94	1.19
G	0.180 BSC		4.58 BSC	
H	0.034	0.040	0.87	1.01
J	0.018	0.023	0.46	0.58
K	0.102	0.114	2.60	2.89
L	0.090 BSC		2.29 BSC	
R	0.175	0.215	4.45	5.46
S	0.020	0.050	0.51	1.27
U	0.020	---	0.51	---
V	0.030	0.050	0.77	1.27
Z	0.138	---	3.51	---

PUBLICATION ORDERING INFORMATION

Literature Fulfillment:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303–675–2175 or 800–344–3860 Toll Free USA/Canada
Fax: 303–675–2176 or 800–344–3867 Toll Free USA/Canada
Email: ONlit@hibbertco.com

N. American Technical Support: 800–282–9855 Toll Free USA/Canada

JAPAN: ON Semiconductor, Japan Customer Focus Center
4–32–1 Nishi–Gotanda, Shinagawa–ku, Tokyo, Japan 141–0031
Phone: 81–3–5740–2700
Email: r14525@onsemi.com

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